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Increase of Paper Strength and Bulk by Co-Flocculation of Fines and Fly Ash-based Calcium Silicate

Meiyun Zhan (1), Qiumei Li (1), Shunxi Song (1,2), Ning Hao (1), and Guodong Liu (1)

Fly ash finds a number of uses, almost always outside of the Paper Industry. Here the authors take fly ash from a coal-fired power station and co-flocculate it with cellulose fines to produce larger aggregates that are better retained during paper formation. In addition, within defined limits, they have no negative impact on paper strength. This is an excellent example of pushing the envelope of what is possible as regards recycling of what has previously been defined as a 'waste' material.

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Increase of Paper Strength and Bulk by Co-Flocculation of Fines and Fly Ash-based Calcium Silicate

Meiyun Zhang,[a,*] Qiumei Li,[a] Shunxi Song,[a,b,*] Ning Hao,[a] and Guodong Liu [a]

Fly ash-based calcium silicate (FACS), which has a large surface area (121 m^2/g) and porous structure, has the potential to be used as a filler for the production of high-bulk paper. In theory, paper with a higher bulk has a lower strength. This work explores the possibility of improving paper strength without compromising its bulk through co-flocculation of cellulosic fines and FACS. To investigate the effect of co-flocculation on paper properties, composites made with various ratios of fines to FACS were studied. Results showed that paper bulk and tensile strength increased with increasing ratio of fines to FACS, up to 0.3 at 17% filler content. To further confirm these findings, the structures of composites were studied with a light microscope and scanning electronic microscope (SEM). Images showed that the composite formed at the ratio of 0.3 exhibited a larger size and looser structure than other composites, which can be attributed to the improvement of the paper's strength and bulk. Schemes for the composite formation process and its interactions with fibers were also proposed.

Keywords: Bulk, strength; Composite; Fines; Fly ash based calcium silicate; Co-flocculation

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INTRODUCTION

Fine paper, especially printing paper, with low cost, high strength, and high bulk, is ceaselessly pursued by papermakers. For many paper grades, filler is used to decrease production costs and improve paper properties (*e.g.*, brightness, printability). However, paper strength can be negatively affected because the filler impedes the inter-fiber hydrogen bonding. To improve the strength of filled paper, many methods have been tried, such as strength additives (Hamzeha *et al.* 2013), lumen loading (Miller and Paliwal 1985), filler pre-flocculation (Sang *et al.* 2012; Chauhan and Bhardwaj 2014), and filler modification (Yan *et al.* 2005; Zhao *et al.* 2005; Yoon and Deng 2007; Shen *et al.* 2009, 2010). Among those methods, filler pre-flocculation and modification are of great interest. In the pre-flocculation process, filler aggregates are formed by polymers. Chauhan and Bhardwaj (2014) pre-flocculated talc with cationic starch, resulting in a 7% to 15% increase in tensile index with 24% filler content. Yan *et al.* (2005) showed a significant improvement in the strength of paper filled with starch-coated clay compared with that filled with unmodified clay.

Bulk is another important paper parameter, particularly for printing, because it affects printability and runnability. For printing-grade paper, high bulk is preferred, which correlates with high stiffness. Paper with a higher stiffness can make the printers work more smoothly (Gao *et al.* 2009; Chen *et al.* 2013). Moreover, improving paper bulk is a

good way to reduce fiber amounts at a given thickness. The addition of high-yield pulp (HYP) is one of the most frequently used methods to produce high-bulk paper (Resalati 2007; Xu and Zhou 2007; Zhang *et al.* 2011). Although the bulk of paper can be improved, the thick-walled HYP fibers may affect paper surface smoothness and can cause the surface to roughen upon rewetting when printing (Danby 2002; Nesbakk and Helle 2002).

It is typically believed that paper bulk and strength are contradictory parameters. The inter-fiber hydrogen bonds, which are related to the number of free hydroxyl groups and the total area in molecular contact, provide the mechanical strength of paper (Retulainen *et al.* 1998; Mark 2002; Dongbo 2013). When the bulk of paper increases, the distance between fibers increases, which decreases paper strength. The aforementioned methods can enhance paper strength, but compromise paper bulk, or *vice versa*. Hence, it is necessary to investigate a method that improves both paper bulk and strength.

Previous research has found that fly ash-based calcium silicate (FACS), an environmentally friendly by-product prepared from the silicate-rich fly ash of coal-fired power plants, has the potential to produce high-bulk paper (Song *et al.* 2012; Zhang *et al.* 2013). However, the strength of FACS-filled paper was sacrificed with improvements to the bulk. In this study, the co-flocculation of FACS particles and cellulosic fines with a high-molecular weight cationic polyacrylamide (CPAM) was employed to explore the possibility of improvement to both the strength and the bulk of FACS-filled paper.

EXPERIMENTAL

Materials

Bleached softwood kraft pulp was supplied by a pulp mill in Fujian province, China. The pulp was refined to a freeness of 425 mL (Canadian Standard Freeness) with a PFI refiner following TAPPI T248 sp-00 (2000). The pulp was diluted to a consistency of 0.3% before use. FACS was obtained from a coal-fired power plant in China. CPAM with a molecular weight of approximately $(6.5\pm0.5)\times10^6$ g/mol was supplied by Nalco Chemical Company, Nanjing, China. CPAM solution (0.01% (w/v)) was prepared daily with deionized water and stirred by a magnetic stirrer at room temperature for 30 min.

Fines were produced by extensively refining the bleached softwood kraft pulp to a freeness of 50 mL and separating the fraction that passed through the 200-mesh screen of a SWECO fiber classifier (Sweco division of M-l L.L.C.).

Methods

Filler and fines characterization

The morphology and particle size of the FACS were tested with a scanning electron microscope (S-4800, Hitachi Ltd., Japan) and a BT-9300H particle size analyzer (Bettersize Instruments Ltd., China). The surface area of the FACS was measured by the multi-point Brunauer Emmett Teller (BET) nitrogen adsorption method (Gemini VII2390, Micromeritics Instrument Corporation, USA). The morphology of the fines was observed by a light microscope (DMB5-223IPL-5, Motic Electric Group Co., Ltd., China).

Preparation and observation of composites

Five grams of FACS (oven-dried weight) was diluted with deionized water to 5 wt%, followed by stirring at 300 rpm for dispersion. Then, various amounts of fines (Table 1) were added to the FACS slurry, and the solution was mixed for 1 min. After that, 0.05

wt% (based on the dry weight of FACS) CPAM solution was added. The resulting mixture was stirred for another 5 min at 300 rpm to form a stable composites slurry. The structure of the composites was observed with the light microscope.

Table 1. Amounts of FACS and Fines

ID	FACS (g)	Fines (g)	Ratio of fines to FACS
1	5	0.00	0
2	5	0.75	0.15
3	5	1.50	0.3
4	5	2.25	0.45
5	5	3.00	0.5
6	5	3.75	0.75

Handsheet preparation and testing

The pulp slurry was disintegrated to a 1.2% consistency and then diluted to a concentration of 0.3%. The prepared filler-fines composite slurry was subsequently added to the pulp to make the filler content to be 17 wt%. Sheets with a target basis weight of 70 g/m^2 were made with a laboratory sheet former.

The wet sheets were pressed in accordance with TAPPI T205 sp-95 (1995) and then air-dried for 24 h at 25 °C at 50% relative humidity before testing. Paper bulk, tensile, and tear index were measured according to TAPPI T220 sp-01(2001). The filler content was measured following TAPPI T211 om-93(1993).

RESULTS AND DISCUSSION

Characterization of FACS and Fines

The morphology and properties of the FACS are shown in Fig. 1 and Table 2, respectively.

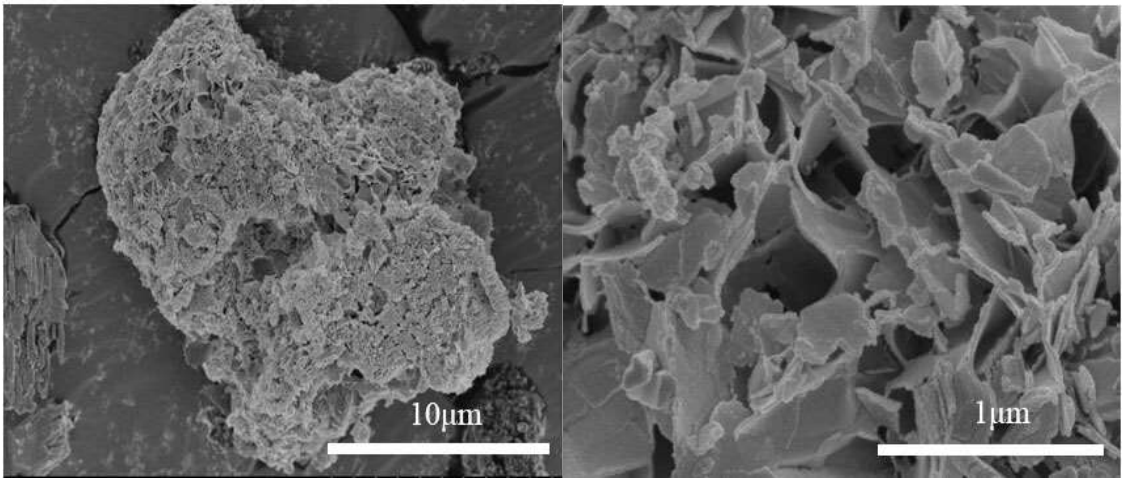

Fig. 1. Scanning electron micrographs of FACS

Table 2. Characteristics of FACS

Average particle size (μm)	22.52
Specific surface area (m^2/g)	121
Pore volume (cm^3/g)	1.63
Pore size (μm)	0.3 to 1
Ignition loss (525 °C; %)	10.5
Brightness (%ISO)	90.5

As shown in Fig. 1, FACS is formed by the accretion of lamellar structures and exhibits a wrinkled, porous surface, which gives it large specific surface area. Additionally, the air voids on the surface of FACS contribute to a lower bulk density. These properties help to produce high-bulk paper but may negatively affect paper strength.

In general, pulp fines are defined as the fraction passing through a 200-mesh screen. They are categorized into primary and secondary fines according to their shape (Lee *et al.* 2011; Hyll 2015). Primary fines (flakes) are present in pulp before refining (*e.g.*, vessel elements and ray cells). Secondary fines (fibrils) are produced in the refining process. In this study, most of the fines are secondary as a result of the extensive refining. The fines morphology is shown in Fig. 2.

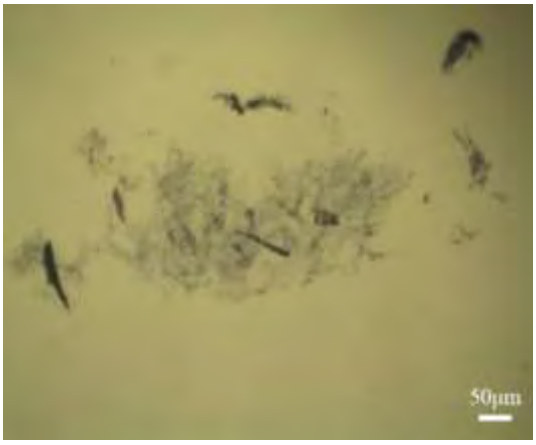

Fig. 2. Light microscope image of fines

Morphology of Composites

The molecular weight and charge density of CPAM are $6.5\pm0.5\times10^6$ g/mol and 1015 μequiv/g, respectively. It is generally believed that CPAM, with a high molecular weight and a low charge density, flocculates fillers through a bridging mechanism (Biggs *et al.* 2000; Blanco *et al.* 2002; Rasteiro *et al.* 2008). The CPAM adsorbs on the surface of FACS particles or fines randomly, and its loops and tails extended far beyond the particle surface to interact with other particles, forming FACS-fines composites.

As shown in Fig. 3, the FACS particles were entwined with fines fibers, but the composite size and package density were different. All of the composites had larger particle sizes than the FACS flocs. At ratios of 0.15 and 0.3, all the filler and fines formed composites, and no fines or FACS particles existed alone. However, the composites formed at the ratio of 0.3 were larger in size and had a looser structure than those formed at 0.15. At a ratio of 0.75, excess amounts of fines existed alone or self-flocculated to form fines aggregates, which can improve the paper strength but decrease the paper bulk.

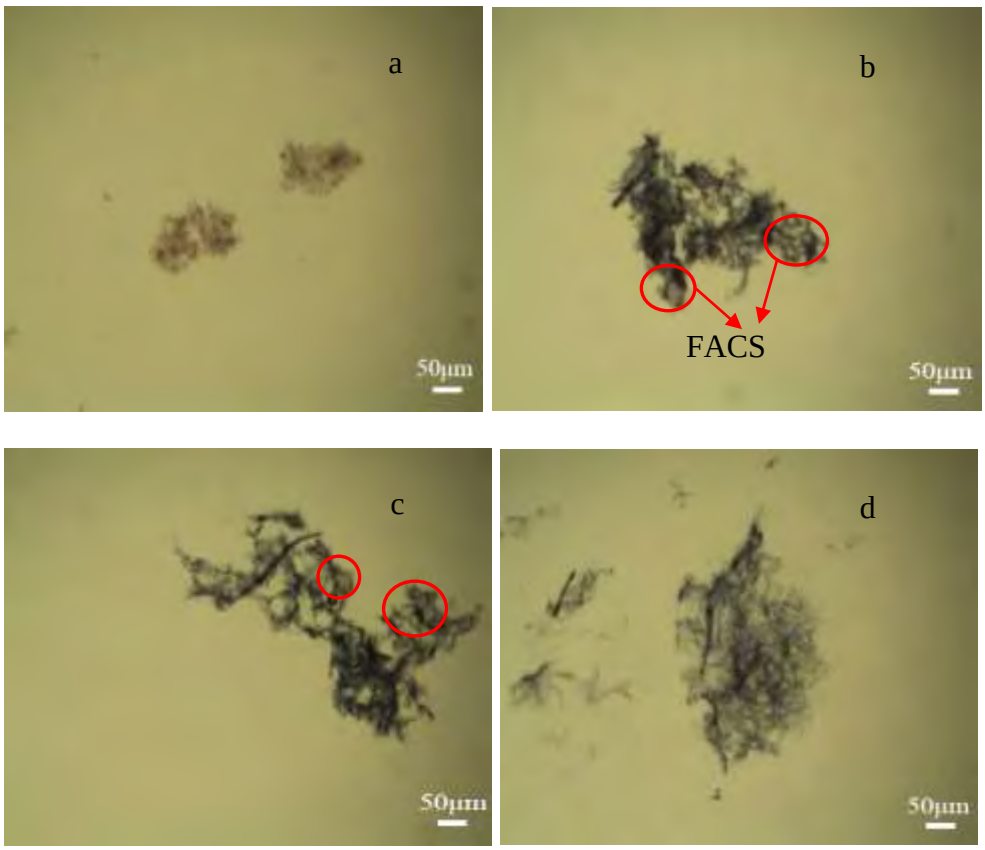

Fig. 3. Light microscope images of composites formed at various ratios: (a) 0, (b) 0.15, (c) 0.3, and (d) 0.75

Paper Properties

Paper bulk is an important property that influences printing performance. The paper basis weight will decrease if the bulk increases at a constant thickness, which reduces the amount of fibers and production cost. Figure 4 shows that when increasing the ratio of fines to FACS to 0.3, the value of paper bulk increased by 6% in comparison with the control sample (no fines). This is contrary to the popular theory that paper bulk decreases when fines content increases (Sirviö and Nurminen 2004). When the ratio was larger than 0.3, paper bulk decreased (the filler content of all paper samples was 17±0.5%).

The particle size and structure of the filler are responsible for paper bulk (Brown 1998). Large particles can create greater inter-fiber spaces in the fiber-fiber bonding domain, which helps to improve bulk (Hubbe and Gill 2004). Additionally, composites with a loose structure can result in more air voids, which also creates more bulk.

As shown in Fig. 3, compared with FACS flocs, composites formed at a ratio of 0.15 exhibited larger particle sizes, which improved the bulk. However, the composite formed at a ratio of 0.3 was bigger and had a looser structure than that formed at 0.15, which resulted in continued improvements to paper bulk. When the ratio was greater than 0.3, although the particle size of composite is larger than FACS, the excess amount of fines filled the voids in the bonds and placed the fibers closer to each other. This resulted in a decreased paper bulk.

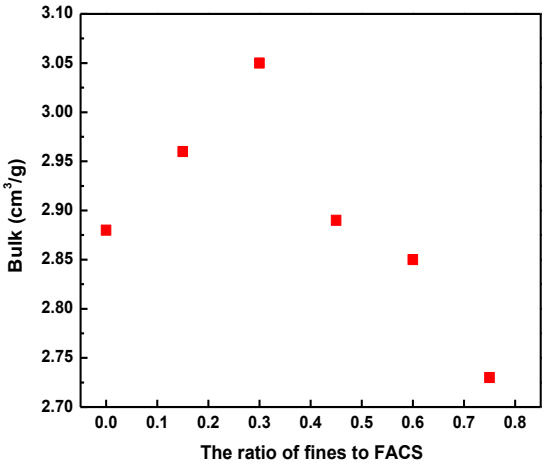

Fig. 4. Effect of the ratio of fines to FACS on paper bulk

The tensile strength of paper is influenced by hydrogen bonding. Compared with fibers, fines have a larger surface area and more surface hydroxyl groups per unit mass, which favors the formation of hydrogen bonds. Thus, fines can be regarded as strengthening agents (Xu and Pelton 2005). On the other hand, the composites have larger sized particles than FACS aggregates, as shown in Fig. 3, which helps to decrease the number of particles at the same filler content. Hence, the inter-fiber bonding is affected to a lesser extent. This explains why the paper tensile index increased when fines increased. Fiber average length and hydrogen bonding are critical for tear strength (Liu *et al.* 2012). Hydrogen bonding and fiber average length are two contradictory parameters with the ratio increase. When the amount of fines increased, the hydroxyl bonding increased and the average length of fibers decreased. Hence, there should be an equilibrium ratio at which the tear strength reaches its maximum. In this work, that ratio is 0.3.

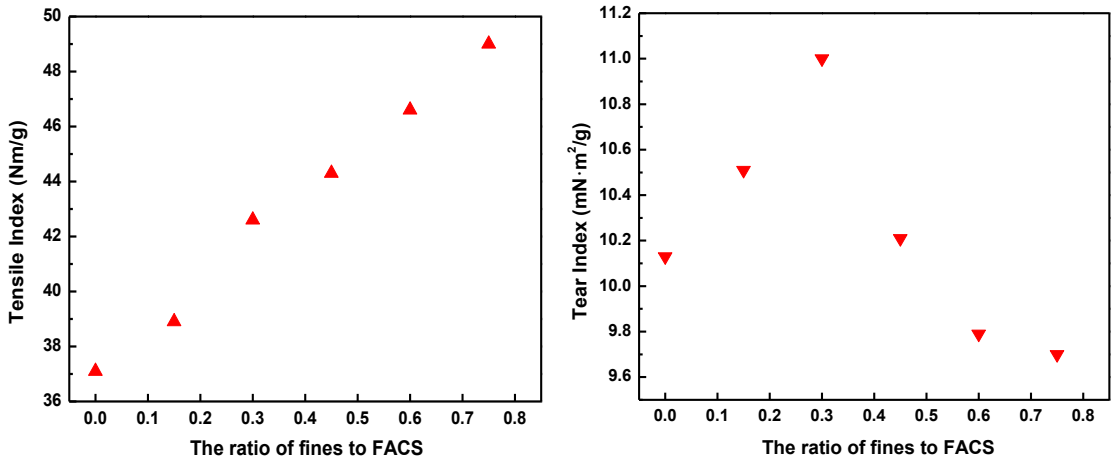

Fig. 5. Effect of the ratio of fines to FACS on paper tensile and tear strengths

To confirm the formation of filler-fines composites in paper, the paper morphology was observed by SEM. As shown in Fig. 6, the fines were coated on the surface of the FACS, playing the role of a bridge linking the FACS and fibers, which mitigated the destruction of hydrogen bonds between fibers.

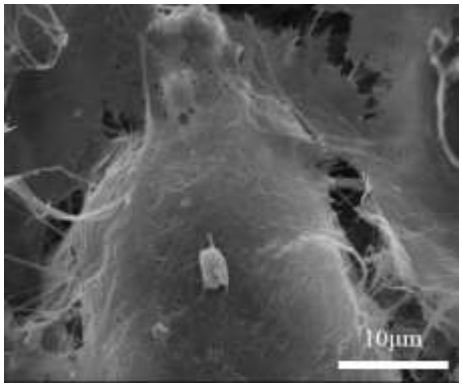

Fig. 6. Scanning electron micrograph of composites in paper sheet

Proposed Mechanism Models

Some possible mechanisms of the composite formation process are shown in Fig. 7. The FACS and fines slurry is homogenously dispersed until the addition of CPAM. The chains of CPAM extend its loops and tails, which attach to the filler particles or fines randomly and interact with other particles to form open-structure composites. Without fines, FACS particles flocculate together to form filler flocs. At ratios of 0.15 and 0.3, all the filler and fines form composites, and no fines or FACS particles exist alone. Moreover, the composite formed at a ratio of 0.3 has larger size and looser structure than that formed at 0.15. However, with an increased ratio, excess fines exist or flocculate to flocs, which fill the voids in fiber networks and cause fibers to be closer to each other, resulting in a decreased paper bulk.

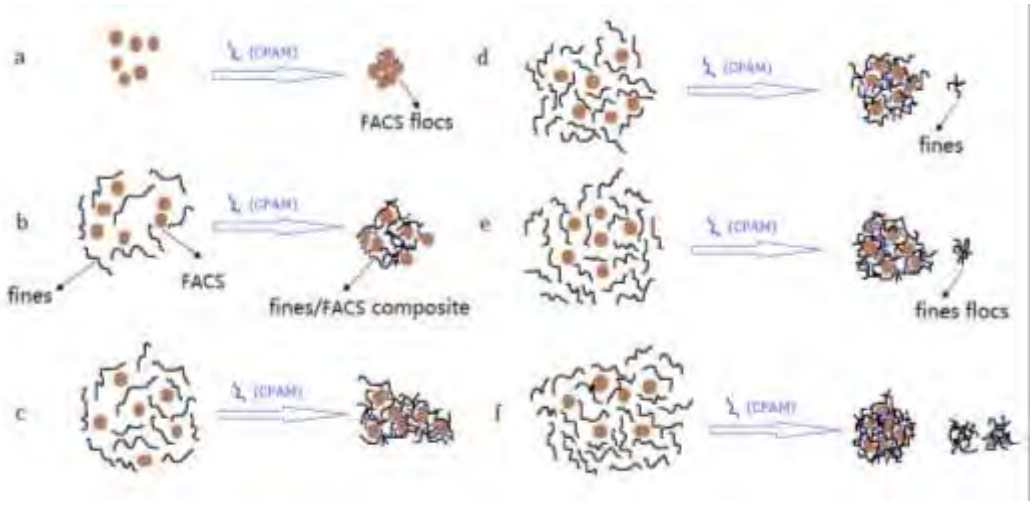

Fig. 7. Scheme of fines and FACS co-flocculation by CPAM at various fines to FACS ratios: (a) 0, (b) 0.15, (c) 0.3, (d) 0.45, (e) 0.6, and (f) 0.75

The mechanism model demonstrates the interaction between fibers and composites (Fig. 8). In the traditional filling method, some fillers exist on the surface of fibers and disturb the fiber-fiber hydrogen bonding. In contrast, in the co-flocculation filling method, FACS are enfolded and entwined by fines, which decrease the direct contact between fillers and fibers. Fines bridge the interaction between fibers and fillers and bring fibers closer together, which increases paper strength and decreases bulk. However, the formed composites have a larger particle size than FACS flocs, which compensates for the decrease

in bulk to some extent. This may be the reason that paper strength and bulk both increased within a certain ratio range.

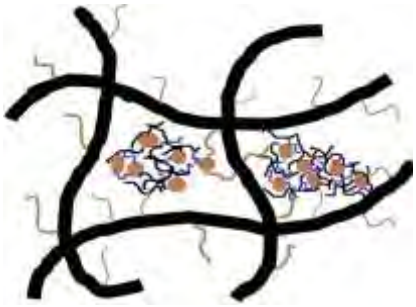

Fig. 8. Scheme of the interaction mechanism between composites and fibers

CONCLUSIONS

1. Composites were formed by the co-flocculation method. The ratio of fines to FACS has an influence on the composite structure. The composites formed at the ratio of 0.3 exhibited larger particle size and looser structure compared with other composites.
2. The co-flocculation of fines and FACS prior to pulping can improve paper strength without a loss in bulk within a certain ratio range. When the ratio is below 0.3, paper bulk and strength can be improved. This demonstrates the potential for the production of high-bulk and high-strength paper.
3. Possible mechanisms of interaction between filler and fines were proposed to explain the improvements in paper bulk and strength. Fines improved the inter-fiber bonding ability, and composites with large size and loose structure were responsible for improvements in paper bulk.

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Design and Materials Selection: analysis of similar sanitary pads for daily use

M Pohlmann

An interesting analysis of material selection for the top sheet (usually a synthetic nonwoven) of a sanitary pad, by a Brazilian academic. Since this is the layer contacting the body directly, it is the part of the pad that can have most effect on local ventilation, local temperature, and transfer of substances to the body, all of which can lead to infection.

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ABSTRACT
Hygiene practices have effects on vulvovaginal microbiota. Specific products for intimate female hygiene are available in the market, such as the sanitary pads. Since these pads were introduced in the market , they became the focus of research that seek to improve their shape, manufacturing processes and the properties of materials used in order to provide more benefits to users. Thus, the present study aimed to characterize the fabrics used in daily sanitary pads, focusing on the development of future products. The spectra generated by FTIR/ATR suggest that the samples were composed of polypropylene. The photomicrographs showed that the polymeric outer layer was made of nonwoven fabric manufactured by spunbond and point bonding processes.
Keywords: product design, material selection, analysis of similar sanitary pads.

I. INTRODUCTION

The vulva is a complex structure that provides the interface between external environment and the internal portion of the female genitals. Due to exposure, the vulva is susceptible to diseases that may even compromise the female reproductive development and functions. One of the defense mechanisms in the prevention of infections in this area is the composition of the vaginal microbiota. Several factors, including hygiene practices, may contribute to the increased instability of the vaginal ecosystem.

For women, these practices include bathing and drying of the whole body and hygiene of the genital area after urination/defection and during menstruation. In a study with American women, Czerwinski [1] pointed out that most of them make use of sanitary pads for daily genital hygiene.

Many doctors claim that the daily use of sanitary pads may prevent proper ventilation, increase the local temperature, and change vaginal pH, potentially leading to the development of vulvovaginal infections. However, new researches have indicated that a continuous daily use of sanitary pads does not increase recurrences of vulvovaginitis, bacterial vaginosis, vulvovaginal irritation or inflammation [2-5].

Research conducted on the textile sector may improve the properties of materials and processes used in sanitary pads for everyday use. In recent years, researchers have investigated the use of functional textiles in the areas of health, hygiene and beauty. Textile materials that have in their composition elements of body care, fitness and health are known as "cosmetic textiles". On contact with human body and skin, these textiles transfer an active substance for cosmetic purposes [6-13].

Therefore, the present study aimed to characterize the materials used in the top sheet of sanitary pads available in the market. The results obtained from the analysis can be used as a future reference for processing and for materials selection used in products with similar characteristics. Nevertheless, the knowledge of some physic-chemical and morphological properties of sanitary pads for daily use can be helpful in determining procedures for the improvement of these products design.

II. THE EVOLUTION OF SANITARY PADS

Sanitary pads have been used for thousands of years. These pads were made of soft material to absorb menstrual discharge. The ancient Greek physician Hippocrates mentioned in his manuscripts the use of tampons. For centuries, the methods of menstrual protection have not evolved: women often used strips of cloth or rags to provide menstrual protection which they would wash and reuse [14].

The first disposable sanitary pad was created (without success) by Johnson & Johnson in 1896. The Kimberly-Clark Company put Kotex on the market in 1921. Meanwhile, Johnson & Johnson introduced Modess®. These disposable absorbents were extended front and back so as to fit through loops in a special girdle or belt worn beneath undergarments. The first major improvement in disposable sanitary pads came around 50 years later when an adhesive was included underside the product to ensure it would remain in the same position [3, 14-22].

With the technological advances, the industry started to manufacture thinner pads made of cotton wool mixed with special polymer crystals

(polyacrylamide and sodium polyacrylate) designed to absorb liquid. Once liquid enters the pads, the polymer crystals absorb it turning it into a gel-like substance and trapping it inside. The next step was the development of more comfortable and safer products. In the 1990s, the industry introduced innovations such as wings on maxi pads, with wraparound edges that fold under to fit multiple panty style [3, 21].

Recently, several studies have been carried out in order to improve the characteristics of sanitary pads. One of the main concerns is to lock away odor [23-31]. Improvements are also being made with regard to the absorption of fluid [32, 33].

III. MATERIALS AND METHODS

Fig. 1 shows the basic structure of sanitary pads. It consists of a top sheet layer that allows the passage of organic fluids, an absorbent layer and an underlying adhesive layer used as structural support.

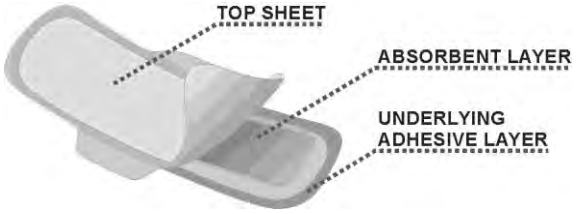

Fig. 1 Basic structure of sanitary pads.

The present study was carried out using six top sheet of sanitary pads available in the market. The materials characterization was performed by the analysis of the chemical composition, morphology and the rate of capillary absorption.

The chemical composition analysis was performed using the technique of Attenuated Total Reflection in conjunction with Fourier Transform Infrared Spectroscopy (ATR-FTIR). Sixteen cumulative readings were made from each sample, over the wavelength range of 4000-650 cm^{-1}, in transmission mode (Perkin-Elmer® Spectrum 100).

The top sheets morphological analysis was performed using a Hitachi® TM 3000 Scanning Electron Microscope (SEM). The magnified images (X50) allowed the analysis of the structure and manufacture aspects of the material under study.

The rate of capillary absorption of water is among the tests prepared by the Brazilian Standards NBR-13735:2006 [34] that proved to be adequate to evaluate this parameter in nonwoven. This material is often used in products that are directly in contact with the skin, therefore, it is of fundamental importance that the liquid moisture (mucous, urine, blood or sweat) flows quickly through the nonwoven, reducing the moisture built up in the microclimate. So the top sheet samples were partially immersed in distilled water at selected times (10, 30 and 60 seconds) to measure the height attained by the water.

IV. RESULTS AND DISCUSSION

For the trials, it was necessary to separate the top sheet layer from the other parts of the sanitary pads samples. Most of the six pads analyzed (samples 2, 3, 5 and 6) had only a few adherence points between the top sheet and the absorbent layer, which was thicker and slightly compressed. In contrast, samples 1 and 4 had a more compressed and homogeneous absorbent layers. It should be observed that the total thickness of the sanitary pads was determined mostly by the thickness of the absorbent layer. The process of separation was made difficult by these characteristics, and the top sheet samples were contaminated with the absorbent material (cellulose). Moreover, it was observed that, in the nonwoven, the web was stretched transversely in samples 1 and 2, and in the remaining ones, longitudinally.

After the samples of top sheet were separated from the sanitary pads, the analysis of the chemical composition was performed. The spectra generated by ATR-FTIR from the scan area (Fig. 2) showed that samples 1, 3, 4, 5 and 6 were composed of polypropylene $(C_3H_6)n$. Samples 2 and 6 showed the presence of cellulose $(C_6H_{10}O_5)n$. It was probably some residue from the absorbent layer.

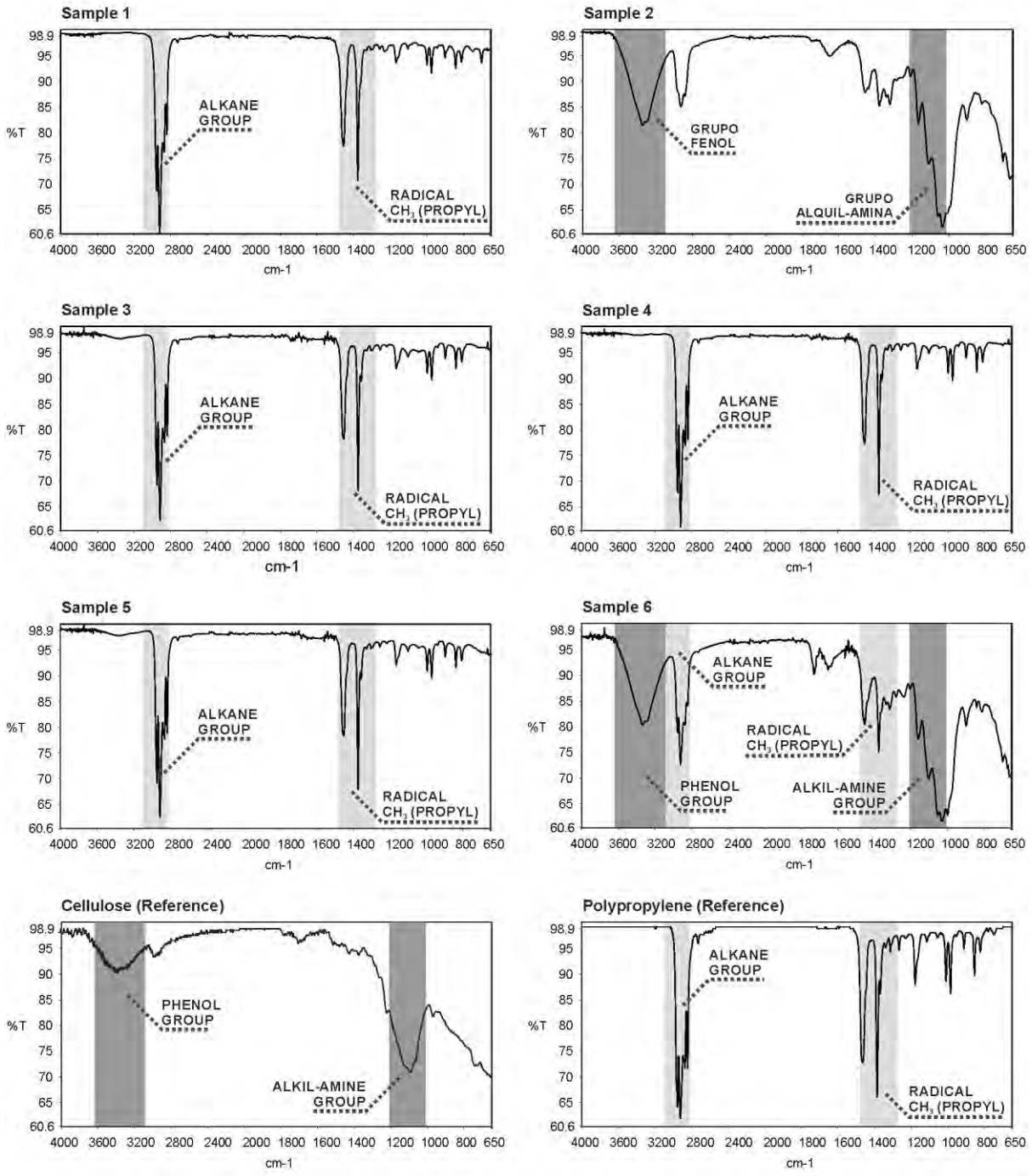

Fig. 2 Spectra of chemical composition of the sanitary pads top sheet generated by FTIR/ATR spectroscopy. The interpretation was based on the scheme prepared by Lopes; Fascio [35], which corroborate those used as reference (cellulose and polypropylene).

The SEM analyses made it possible to identify the morphological aspects and the manufacturing process of sanitary pads top sheet. The material photomicrographs (Fig. 3) magnified 50X revealed plates of aggregate material, apparently bonded. This is one of the morphological characteristics of materials known as nonwoven fabrics (NWF).

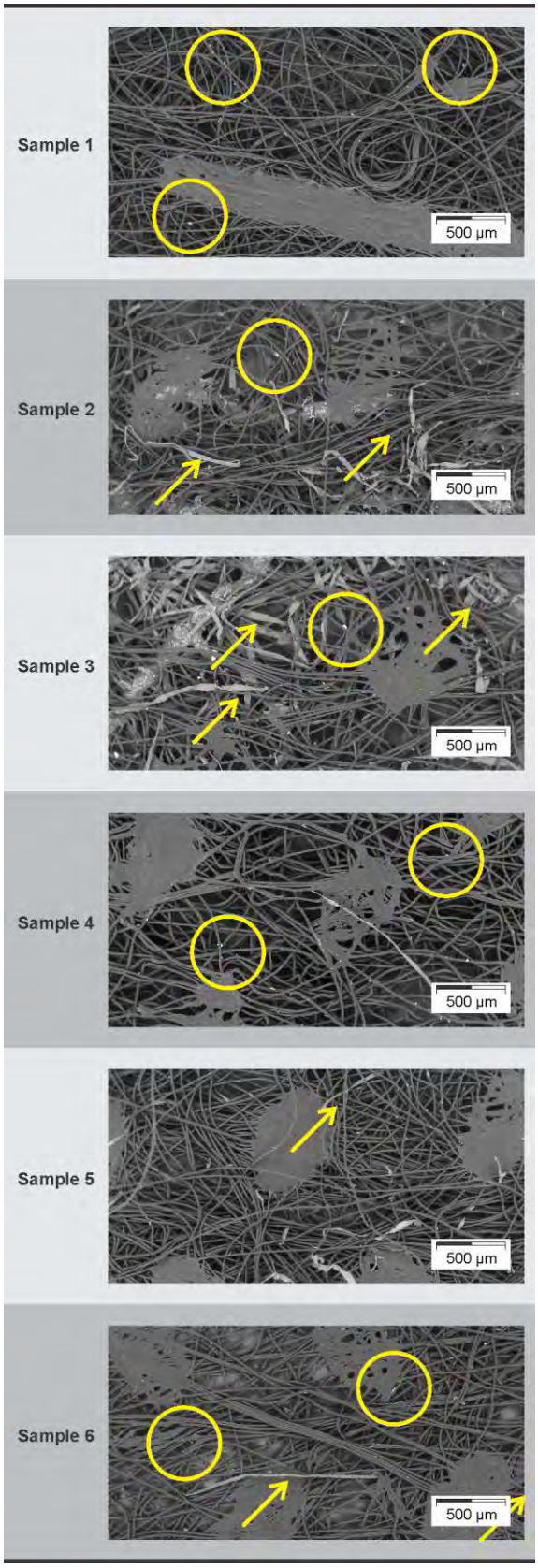

Fig. 3 Photomicrographs of sanitary pads top sheet. Arrows indicate cotton fibers intertwined to polypropylene; circles show contaminant particles.

The NWFs are widely applied in personal care and hygiene products due to their ability to absorb moisture. NWFs are disposable, comfortable and can be fabricated faster. Although the NWFs are made up of fibers and filaments, these materials differ from textile fabrics, because their fibers are not knitted, woven or plaited [36-39]. In accordance to Brazilian Standards [40], "the nonwoven is a flat, flexible and porous structure consisting of a mat or veil of fibers or filaments directionally or randomly oriented, consolidated by mechanical means (friction) and / or chemical (adhesion) and / or thermal (cohesion) and combinations thereof".

SEM photomicrographs of the analyzed material showed that it was manufactured by spunbond and point bonding processes, as described by Gupta; Smith [20]. It was also observed that the samples were contaminated by small particles. However, the analysis of the substrate morphology was not able to determine whether it was dust or cellulose from the absorbent outer layer. Additionally, with the exception of sample 1, the other samples had interwoven cotton fibers in their structure. The cotton fibers have a flat irregular shape and can be easily visualized in the midst of the regular polypropylene fibers.

According to Alcântara; Daltin [38], cotton consists of mainly cellulose, with a large number of hydroxyl groups, and is highly absorbable due to its hydrophilic nature. Therefore, it is believed that the incorporation of this material is intended to improve both the tactile and the absorption aspects.

To obtain the rate of capillary absorption, the NWF samples were partially immersed in distilled water at selected times (10, 30 and 60 seconds) to measure the height attained by the water. Three specimens were tested for each sample. Fig. 4 shows the mean values obtained.

In general, samples 1 and 2 presented higher capillary rates, absorbing up to 1.66 mm in 60s.The maximum height of capillary rise in the other samples was 0.66 mm. It is believed that this result is due to the fact that sample 2 had ingredients that could interfere with water absorption. However, no relationship was found between the composition of sample 1 and the amount of water absorbed. Moreover, it was observed that there was not a pattern of water absorption by capillarity of the evaluated materials.

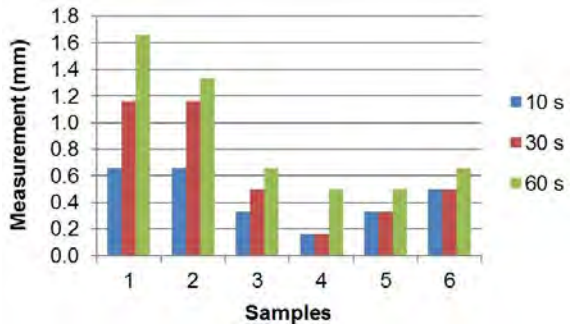

Fig. 4 Capillary rate measurement (mm) of sanitary pads top sheets. It was taken at 10, 30 and 60 seconds. Each bar corresponds to the mean of three samples.

V. CONCLUSIONS

The spectra generated by ATR-FTIR showed that samples 1, 3, 4, 5 and 6 were composed of polypropylene. Samples 2 and 6 showed the presence of cellulose $(C_6H_{10}O_5)n$, which was probably some residue from the inner lining. The SEM photomicrographs of the analyzed material showed that the top sheets were composed by nonwoven fabric and they were manufactured by spunbond (a direct conversion of a polymer into continuous filaments) and point bonding (a process of binding thermoplastic fibers into a nonwoven fabric by applying heat and pressure). Contaminants and particles of cotton fibers were found in most samples. There was not a pattern of water absorption by capillarity of evaluated materials.

The present study described some of the physicochemical and morphological characteristics of the materials used in sanitary pads top sheet for daily use. The data obtained from the analyses can assist in the design, manufacturing processes and material selection of future projects for intimate hygiene products.

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Theoretical Aspects of Environmental Lifecycle Analysis

Mirsad TARIĆ (1), Vladimir RADOJIČIĆ (2), Žana DŽUBUR (3), Ramo BAKIĆ (4)

The rather idiosyncratic translation makes for heavy reading in places, but essentially this is a quick summary of the LCA concept, concentrating particularly on the need to apply realistic limits to such analyses.

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THEORETICAL ASPECTS OF ENVIRONMENTAL LIFECYCLE ANALYSIS

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***Abstract*—**Environmental Lifecycle Analysis (LCA) is a method that can be utilized to assess the potential ecological effects of an item, material, process, or action. An LCA is a far-reaching technique for evaluating a scope of natural effects over the full lifecycle of an item framework, from materials obtaining to assembling, utilize, and last demeanor. LCA contemplate comes about assistance to advance the capable plan and upgrade of items and procedures, prompting to diminished general ecological effects and the lessened utilize and the arrival of more lethal materials. LCA contemplates recognizing key materials and procedures inside the items' life cycles that are probably going to represent the best effects, including word related and open poisonous quality effects. These appraisals permit organizations to make item enhancements through the ecologically stable process, material and plan decisions.

***Keywords*—**environment, life-cycle, analysis

I. INTRODUCTION

THE Lifecycle Analysis (LCA) has a need to satisfy a reason for existing, be it simply passing on data to understudies in the classroom or speaking with an administrator in the Ministry of Environment in our nation's legislature. The closures, as it's been said, decide the methods furthermore legitimize them. The meaning of the degree itself is reliant on what the objective is. We would settle on which natural effect classes we need to study when we characterize the degree.

An effect class is a sort of harm done to the earth (air as well as water or potentially soil as well as land and additionally verdure or potentially fauna), by the procedures and exercises happening inside frameworks – anthropogenic or something else, Azapagic [1], Batterman [2] and Buc, Soyka and Glick [3].

1) Global warming
2) Eutrophication
3) Acidification
4) Freshwater and marine ecotoxicity
5) Human toxicity
6) Photochemical ozone creation
7) Ozone depletion
8) Abiotic depletion

These effect classifications are named as 'ecological systems prompting to the midpoint markers.' (The ReCiPe technique to which we are coordinated by means of this commentary reference, will be valuable later on if any of we choose to think about LCA in more prominent detail).

The cooperation of a framework with the earth – by uprightness of asset utilization and discharges – can be thought to be the immediate reasons for the midpoint pointers or natural effects which are an immediate outcome of the ecological components activated by the said collaborations. Midpoint pointers acting in show prompt to the alleged 'endpoint markers' or 'harm pointers,' Espinosa, Krebs and Lampert [4], Frick, Van Wees, Kaltschmitt and Schröder [5] and Jason Pierce and Seeley [6]. The ReCiPe technique alluded to above distinguishes three as:

1) Human health damage
2) Ecosystem damage
3) Resource depletion

II. PHASES IN ENVIRONMENTAL LIFE-CYCLE ANALYSIS

In the year 2006, ISO 14040:2006 and ISO 14044 appeared to supplant the principles attracted up 1997-2000, viz.: ISO 14040–14043. These guidelines basically shape the system inside which experts and professionals on the planet perform LCA. These of we who are occupied with perusing the total ISO reports are urged to do as such, Jeswiet [7] and Jones, Tucker and Tharumarajah [8].

As the lead picture on the past page appears, LCA involves four noteworthy strides, with definitive objectives being at least one of the accompanying (likewise delineated in Fig. 1):

1) Looking out for possibilities to reduce the environmental impacts of products at different stages in their life-cycles
2) Conveying information to decision-makers in industry, government, and NGOs, which will assist in strategic planning
3) Identifying relevant environmental performance indicators

4) Marketing and promoting products

5) *Education on environmental state and impact*

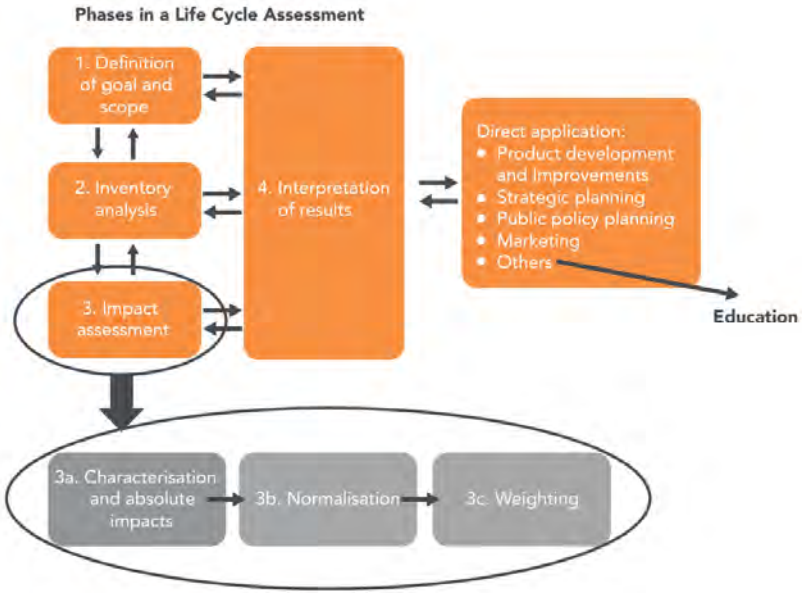

Fig. 1. Phases in Environmental Life-cycle Analysis

We will without a moment's delay take note of that step 3 ahead of the packed picture, has been part up into 3a, 3b and 3c and the last two boxes have dubbed lines as their outskirts. This is to show that these two – 3b and 3c – are generally discretionary sub-steps, which require not (may not) be completed. From 'potential effect' to distinguishable/quantifiable "harm" is obviously a landscape weighed down with vulnerabilities. This is the place one discusses the conceivable destinies of the radiated toxins and the likelihood of presentation of a given natural medium (air, water, soil, arrive or the biosphere which incorporates individuals) to them. It is this vulnerability which here and there makes investigators limit their extension around the natural instruments setting off the midpoint pointers, Jungbluth and Frischknecht [9]. One may wish to either choose at least one of the ecological components recorded above or select at least one of the endpoint pointers. These choices are to a great extent affected by the extension, which thusly, is dictated by what the objective is. The more vulnerability one presents while characterizing the degree, the more prominent would be the need to complete an instability examination. Whatever the objective is, it is the examiner's duty to be completely forthright and straightforward, as there is a stark plausibility that chiefs who don't have much time to look for second feelings, may simply take the suggestions of the investigator. Along these lines, when we complete an LCA and impact the outcomes, we are boring an incredible duty – our activities may impact changes and it is better if the improves would be, Khanna, Zhang, Grubb and Bakshi [10].

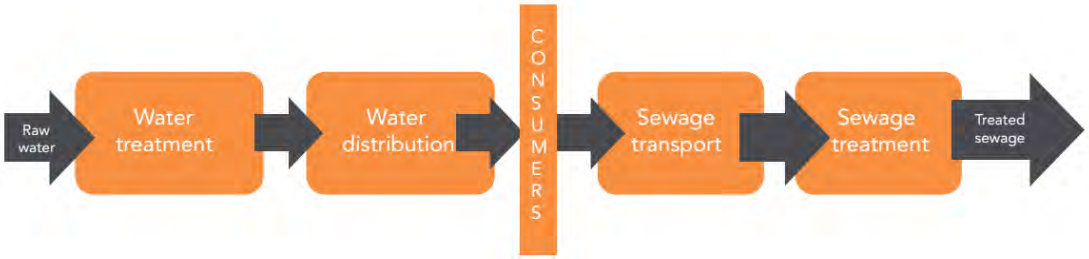

Fig. 2. Scope and system boundaries – multiple options shown for an LCA of a conventional urban water and wastewater system as an example

As we have utilized the urban water and wastewater framework for instance in Fig. 2 to comprehend defining the framework limits, we will pick two of the eight choices alluded to in the past area – water treatment and sewage treatment. The stock – inflows/necessities of materials and vitality, and outpourings of items, by-items, reusables/recyclables and emanations, for both of these two, are appeared in Fig. 3. The life-cycle of this framework is delineated with the spotted blue rectangle.

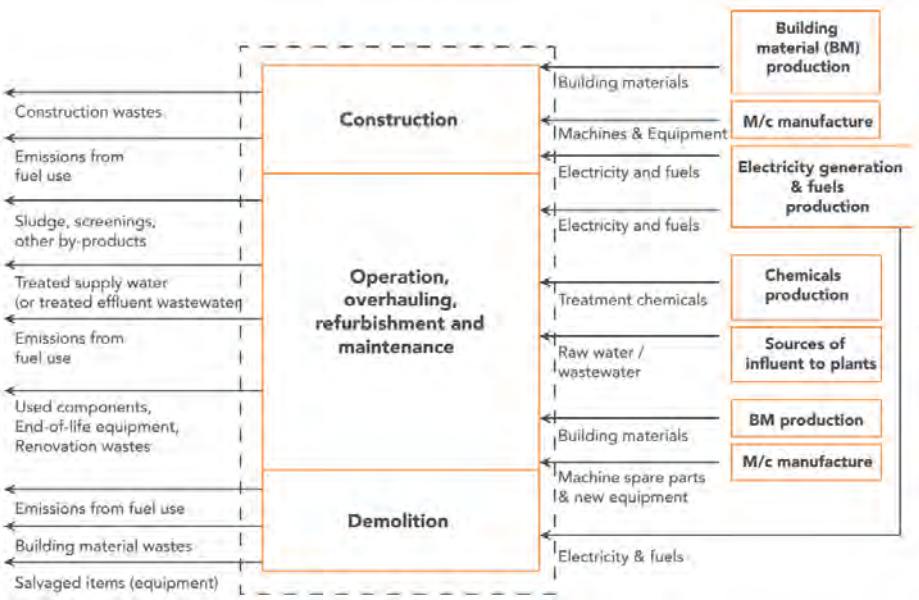

Fig. 3. Inflows to conventional water treatment plants

The streams can be stocked on day by day/week by week/month to month/yearly premise. The frequencies would fluctuate contingent upon the sort of stream (inflow or outpouring). For example, building materials for development go into the framework toward the start of the lifecycle and remain on more often than not, till the pulverization of the structure and the making of building material squanders towards the end of the life-cycle. Crude water into and consumable water out of a water treatment plant; crude sewage into and treated sewage out of a wastewater treatment plant, stream on a persistent premise. So do chemicals and fills and related outflows, Lenel [11]. Communications of the framework we are considering in Fig. 3, with other item frameworks upstream (on the privilege in the outline), are the reasons for roundabout ecological effects.

To place it at the end of the day, in light of the fact that the water treatment plant utilizes aluminum sulfate as a coagulant, a concoction plant upstream delivers it, and amid creation and transport of the same to the point-of-utilization, itself needs to connect with different frameworks (providers, control makers, transport organizations and so forth.) and nature, bringing about ecological effects all the while, Lippke and Bowyer [12]. Along these lines, by incorporating the aluminum sulfate in the stock, one is crediting the natural effects connected with its creation and transport to the water treatment plant. Presently, on the off chance that we extend the framework limit and incorporate every one of the frameworks on the upstream, we would characteristic the ecological effects because of the generation and transport of aluminum sulfate to the extended framework which now would incorporate the maker of the aluminum sulfate and the transporter of the same, Omont, Froelich, Gésan-Guiziou, Rabiller-Baudry, Thueux and Beudon [13].

III. LIFE-CYCLE IMPACT ASSESSMENT ANALYSIS

Everything or organization utilized by the system is essentially a flawlessness of a game plan of methodology, each of which coordinates with and impacts nature – claimed winding environmental impacts of the structure under survey. Progress, there are techniques inside the system which, by the integrity of the radiations to nature, speak to its direct environmental impacts. There are a couple of databases (which are changing in nature and are continually being altered and upgraded), which document the data sources and yields of an extent of systems and the formation of a vast gathering of conclusive outcomes and organizations (like transport in the past portion) of the basic, discretionary and even tertiary fragments of the economy. These are insinuated as the establishment data. These databases are used as a piece of the show with E-LCA programming to finish the impact evaluation, Pătrașcu [14] and Poncet, Lety and Contini [15].

The item does it for us, fundamentally. For the item (the gourmet authority in Fig. 4) to do it, one needs to perceive the system (the recipe in Fig. 4) which the item would use on the 'establishment data' from the database and the 'frontal region data' from our stock examination (both the rough materials required). The last examination is the sustenance. Handling it is compared to decoding the results.

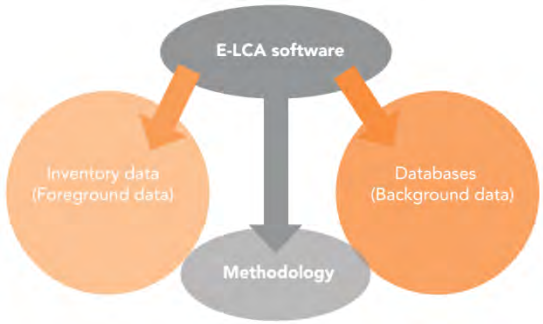

Fig. 4. Impact assessment – raw materials, recipe, and the chef

The most commonly used methods are as under:

1) *The CML methodology (Institute of Environmental Sciences at the University of Leiden in the Netherlands)*
2) *Eco-Indicator (also developed by the Institute of Environmental Sciences at the University of Leiden in the Netherlands)*
3) *TRACI (or the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts, developed by the US Environmental Protection Agency)*
4) *ReCiPe (created by the National Institute for Public Health and Environment, CML-Leiden, PRè Consultants and Radbound Universiteit, Nijmegen, all from the Netherlands).*

The decision of technique for the effect appraisal is unequivocally impacted by the objective determined – what we wish to pass on and how and why. Presently, the steps 3a, 3b, and 3c appeared in Fig. 1 of this paper, are altogether implanted in the LCA technique. We sustain information to the product which has the support of a broad database and indicate the approach we need the product to receive (contingent upon the choices accessible to us, as a rule), and it does the effect evaluation for us.

However, even as only an end-client of the LCA programming, it is of most extreme significance to have some thought regarding what precisely the product does with the information and the strategy we need it to take after.

IV. FORECASTING AND BACKCASTING LIFE-CYCLE ANALYSIS

Estimating and backcasting are what one does by utilizing a blend of attributional and noteworthy LCA, and considering a mess of outside persuasive components. Chiefs in charge of setting targets and tweaking money related instruments like expenses, appropriations and punishments need to make estimates in view of the same old thing situation (no systemic changes things go ahead as they seem to be). Thy then set focuses for themselves – decrease of natural effects for example – and attempt to discover how to achieve those objectives. Simply needing to achieve some place does not take one there! Also, the far off target is regularly separated into a few closer ones on the way to the previous. There could be a few ways prompting to the last target, Schaltegger [16].

Entropy is a disorder. Natural harm or absence of ecological upkeep is likewise a confusion. Any confusion should be controlled, and on the off chance that it is expanding, the rate of increment must be diminished. Give us a chance to utilize entropy as an intermediary for natural harm (see Fig. 5) and attempt to comprehend anticipating and backcasting understanding something with the assistance of something else frequently makes seeing sublimely simpler. Give us a chance to expect a fanciful begin in time, at which entropy in the universe/world was zero, Swarr [17] and Swarr [18].

We expect a straight increment in entropy with time (however this is a gross distortion, and it is likewise sketchy if entropy can really be measured and recorded hence) – the violet line in Fig. 5. The blue hover on the X-pivot speaks to the time when we choose to sit up and take stock – conjecture and back-cast at the end of the day. We can discover a period, later on, spoke to by the red hover on the X-hub.

In the event that we amplify the violet line upwards, we would have a measure of the entropy if current patterns proceed unabated. Presently, we wish to bring the aggregate entropy down in the year portrayed by the red hover, to an esteem relating to the tip of the blue bolt. That is an overwhelming undertaking, as we see immediately, Thorn, Kraus and Parker [19] and Ward [20].

When we made the fig., we expected a direct increment in entropy with time. we know where we will be on the off chance that we don't do anything by any means. We know where we wish to be, and for that, we need to accomplish something, or really, a few things! Presently, it is the ideal opportunity for back-throwing. We see the most distant focus regarding two closer ones, as indicated – the tips of the green and red bolts in Fig. 5. We have now settled three-time interims and three target-focuses to go for.

The ways followed inside these interims may not be straight lines they likewise require not be smooth bends. Having done this, we would choose the usual way of doing things. Regularly, we may find that it is difficult to simply fall back on better hardware configuration to realize the radical change spoke to by the distinction in inclines of the violet line and the red line. we may need to include measurements of 'better process plan' and "adequacy" to the formula. Also, this may apply for the following two interims too. Yet, as we will concur, more grounded the adversary, more shrewd it is battle it as a group. The all the more overwhelming the test, savvier it is to surmount it with a 'group of arrangements' and no one in segregation.

There are several published papers which approach the problem of with life-cycle assessment, Kovalevskyy, Starodubcev, Tarić and Džubur [21] and Dašić, Nedeff

and Petropoulos [22] and Dašić, Nedeff and Ćurčić [23]. Software solutions and tools which serve for evaluation and analysis purposes are discussed in papers: LCSoft Software-tool by Supawanich, Malakul and Gani [24], ILCYM Software by Sporleder, Tonnang, Carhuapoma, Gonzales, Juarez and Kroschel [25], visualization tool for risk assessment by Sanusi and Mustafa [26], software comparison by Ren and Su [27], assessment software tools review, Martínez, Blanco, Jiménez, Saenz-Díez and Sanz [28], ECOCOST software by, Levizzari, Debenedetti and Accusani [29] and software tools overview, Lam, Klemeš, Kravanja, and Varbanov [30].

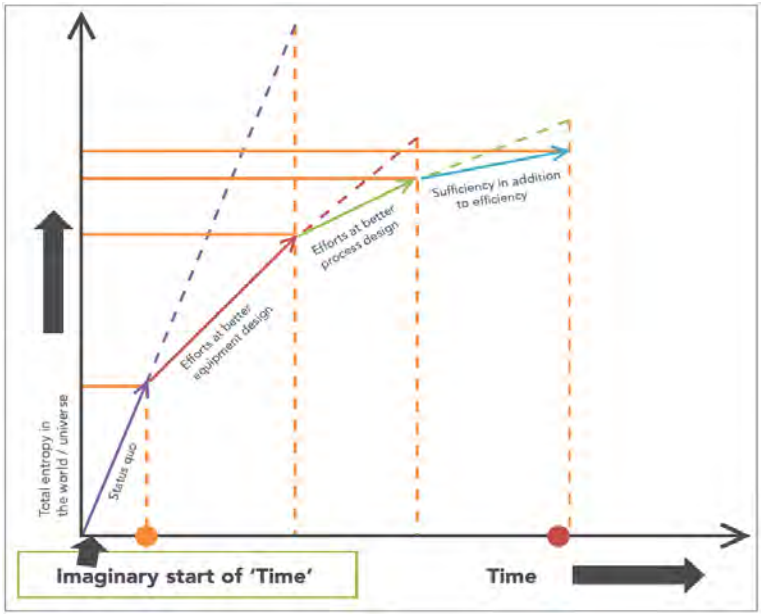

Fig. 5. Diagram of rising entropy

V.CONCLUSION

E-LCA while empowering one to gauge the effects on current patterns will likewise empower one to recognize the diminishment capability of endeavors made to enhance gear and process plan/proficiency and to motivate customers to comprehend the significance and estimation of adequacy. To comprehend, acknowledge and grasp adequacy, one needs to backtrack to the philosophical introduce of natural frameworks examination, which we suggested in this paper. The three means we have recognized to hold down the rate of ascent of entropy, are particularly material to natural harm also. We would fig. and back-cast for various natural effect classifications, setting generally all the more difficult objectives for those classifications which request more prominent consideration.

For example, if the water bodies in the district are nearing their conveying limit and there are clear indications of the tenability of the same being dissolved after some time, eutrophication ought to fig. noticeably on the table. On the off chance that the vitality blend of the locale is, all things considered, made up of renewable assets and the gauge proposes this would not change considerably over the day and age considered, an Earth-wide temperature boost require not be organized as profoundly as eutrophication for this situation in any event.

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The Environmental Challenges of Biomass Utilisation for Combined Heat and Power Generation in a Paper Mill in Tanzania

Sisty Basil Massawe (1), AO Olorunnisola (2) and A. Adenikinju (3)

An assessment of a questionnaire undertaken by villagers surrounding a paper mill in Tanzania on the environmental impact of using wood biomass for power generation. The article discusses: environmental management programmes; forest fires; problems associated with substitution of land away from agricultural use; pollution from lorries carrying wood to the mill; dust (ash) and odour concerns; and water pollution issues. The need for greater communication with the public was identified to mitigate many of these problems.

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The Environmental Challenges of Biomass Utilisation for Combined Heat and Power Generation in a Paper Mill in Tanzania

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Abstract

Biomass-driven, combined heat and power (CHP) also known as co-generation plants are said to provide reliable, efficient, clean power and heat worldwide. However, it is known that the use of biomass for energy applications may lead to land use competition, environmental degradation and food in-security. This study was therefore carried out at a Paper Mill and the seven surrounding villages with the aim of assessing the environmental challenge of wood biomass utilisation for CHP generation.

Data were collected by interviewing technical staff at the paper mill, Sao Hill Plantation, Government officials from Ministry of energy and other energy regulatory bodies. A questionnaire was used to collect data from seven villages surrounding the paper mill while a check list was used to collect information on environmental management aspect within the paper mill departments. Descriptive Statistics was used in assessing environmental challenge of biomass use at the Paper Mill while a chi square was used also to establish the relationship and association between variables.

Findings revealed that there were negative impacts on air quality, land use and water. The chi square test revealed that there was no significant difference (x^2=0.253 and $p > 0.05$) in having environmental problems and distance from Paper Mill. It was also observed that arable land which was needed to grow trees was becoming scarce affecting the sustainable supply of raw materials.

Keywords: Wood biomass resources; Cogeneration of electricity; Pulp and paper mill; Forestry; Environmental management

Introduction

Biomass is a versatile raw material that can be used for production of heat, power, transport fuels, and bio-products. When generated and used on a sustainable basis, it is a carbon-neutral carrier that can make a large contribution to reducing greenhouse gas emissions. Currently, biomass accounts for about 10% of the total primary energy consumption in the world [1]. Despite the fact that traditional biomass in the form of wood fuel still remains a major source of bio energy; liquid biofuel and processed biomass production have shown rapid growth during the last decade [2].

Several studies including Dasappa et al., Smeets et al., Smeets et al. and Marrison et al. [3-6] have highlighted the potential for bio-energy production on the African continent. In Tanzania for example several studies [7-9], have been conducted on the use of sisal, charcoal, animal sludge and bagasse as raw materials for energy use and generation of electricity, But at the country level, the use of wood biomass residue have not received high attention in the context of specific assessments, associated environmental impacts as well as awareness on electricity generated despite the fact that wood biomass is currently contributing more than 11 MW of electricity to the national grid [10].

The Tanzanian energy demand is estimated at 22 million tonnes of oil equivalent (TOE) per annum or 0.7 TOE per capita. According to MEM-2013 [11], the quantitative distributions of the different energy sources to the energy balance were biomass fuels 90%, Petroleum 8%, electricity 1.2% and others less than 1% (including coal and renewable energy sources). These percentages show low per capita consumption of commercial energy (petroleum, coal and electricity) and relatively high dependence on biomass fuels in Tanzania. According to MFA-2011 [12], only 14% of the population had access to electricity (approximately 2% of rural population where 80% of country's population live and 37% of urban population) despite the fact that the country had very huge potential of renewable energy sources especially wood biomass.

Tanzanian industries using wood or agricultural feedstock (e.g., sugar, tannin, and sisal) have been generating their own power from waste biomass materials. It is estimated that about 58 MW of such generation is taking place [11]. According to Gwang'ombe [9], the estimated co-generation potential in Tanzania was more than 315 GWh per year. This was 10.5% of the national electricity generation. Songela [7] asserts that the energy generation potential from excess bagasse in sugar mills was about 99 GWh per year which was 3.5% of the national electricity generation; Private sector has been leading in utilizing biomass to generate heat and power.

The Paper Mill Combined Heat and Power Capacity

The paper mill has two product lines; Line 1 for manufacturing 30,000 tons per annum of industrial packaging grades, Line 2 for manufacturing 30,000 tons per annum of graphic paper grades; newsprint, mechanical printing and wood free printing paper grades.

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The production lines are integrated with a Chemical Pulp Mill (Kraft) with a designed capacity to produce 150 tons per day of unbleached chemical pulp, 80 tons per day of mechanical pulp; Chemical Recovery Plant for handling 320 tons per day dry black liquor solids and supplying 640 m^3/day white Liquor to the Kraft Pulp Mill.

Process heat and part of the electrical energy requirement are met through a captive co-generation plant comprising one (1) 10.5 MWe Extraction-Back Pressure Turbine, one (1) 60 Tonnes Per Hour (TPH), 45 bar of pressure, temperature of 450˚C, coal/Wood biomass fired Steam Boiler and one (1) 40 TPH, 45 bar, 450˚C Chemical Recovery Boiler firing the dissolved organics from the Kraft Mill Spent Chemicals. The total electrical energy demand at optimum operating levels is at 25 MW, out of which, approximately 9.0 MW is met from the co-generation plant and the balance 16 MW drawn from the grid; TANESCO [13].

The objective of this study was to examine the environmental impacts of biomass utilisation for heat and power generation at a Paper Mill and also to identify available environmental management programmes.

Paper Mill Raw Material Requirements

Information collected from Paper Mills on their current wood raw material are as follows:

Sufficiency of Wood Raw Material Requirements for Paper Mill Medium and Long Term Requirements

Data collected from the paper mill indicated that, with first level upgrades on Paper Machine No.1, It had increased the installed rated capacity of Paper Machine No.1 of 30,000 FTPA, to a new level capacity of 54,545.50 FTPA from Year 2010/2011.

Increase in the mill capacity means increase demand in the raw materials for both power plant and paper making. Paper Mill current projections on raw materials stands at.

Materials and Methods

This study was carried out at a paper mill and in the seven surrounding villages in southern highlands of Tanzania. The following sample determination formula based on Kothari [14] was used to generate a sample size to be used in this study.

$$n = \frac{z^2 pq}{d^2} \quad (1)$$

Where:

n =sample size in the study area when population > 10 000.

z = Standard normal deviation, set at 1.96 (2.0 approximate) corresponding to the 95% confidence interval level.

p = Proportion of the target population (50% if population is not known).

q = 1.0 – p (1-50) (1-0.5) = 0.5

d = degree of accuracy desired, (set at the 95% equivalent to 0.05)

Based on the above formula, the sample size for this study was supposed to be 384 respondents, but due to number of households which were at a distance of less than 30km from the paper mill 28% of the cases were selected for this study. Therefore, 106 respondents were selected to participate in the study, based on the fact that a sample of 30 respondents, according to Bailey [15] irrespective of the population size is the bare minimum for a study in which statistical analysis is to be done while, Kumar [16], observes that a sample size of between 80 and 120 respondents is suitable for rigorous statistical analysis.

Purposive sampling of the seven surrounding villages was done based on accessibility and proximity to the Mufindi Paper Mill site [17] as well as the wood plantations within a radius of 30 kilometres. Systematic sampling technique was used to select the required 106 households and from each, a household head or spouse to the household head was enumerated. A survey of the seven villages was conducted to determine the geographical location of the village as well as household distribution; therefore data was collected from every 5th household in each of the seven villages.

Primary data were collected using structured questionnaire containing both open and closed-ended questions on biomass utilization from the selected villages. Key informant interview was used to collect data from government officials and other stakeholders; these included Ministry of Energy and Minerals (MEM), National Environmental Management Council (NEMC), Rufiji Water Basin Authority - Iringa, Rural Energy Agency (REA), Tanzania forest services (TFS), Energy and Water Regulatory Authority (EWURA),Tanzania Traditional Energy Development and Environment Organization *(TaTEDO*) and Tanzania Renewable energy Association (TAREA) and a checklist was used to collect data during Focus group discussion from various departments at the Paper mill.

Quantitative data were analysed using Statistical Package for Social Sciences (SPSS), while chi-square test was used to establish the relationship between socio-demographic characteristics of the respondents and their awareness of the cogeneration activities at the paper mill as well as environmental impacts.

Results and Discussion

Size of land owned by the villagers

The size of land owned by respondents varied from one village to another and from one household to another, the study indicated that 70% of the respondents owned ≤ 10 hectares of land, 19.8% of the respondents owned 11-20 hectares while the remaining 9.4% of the respondents owned ≥ 21 hectares (Table 2). Land ownership was one of the crucial factors as the bigger the land the household possesses the more the income derived from agricultural activities and tree plantations. However, the presence of larger tree plantations and increase in tree product prices had led to not only increased land prices but, also land scarcity and land use related-conflicts [18] had argued that Sub-Saharan Africa, including Tanzania, would witness an a 8% increase in the total land use for wood fuel cultivation, offset by fall, incomes decline, and their ability to access food depreciate roughly 3.4% decrease in forested land and a 4.5% reduction in pastureland. In a rural area, like the study area, having the larger percentage of people owning less than 10 hectares of land is a typical sign that most of land is now under wood cultivation by larger companies.

The findings also showed that due to increasing lack of sufficient land, the available natural forest had been encroached upon in opening new farms. Also, there had been frequently burning of existing larger plantations and this was associated with the increasing scarcity in land ownership by the villagers. The same argument had been canvassed by Narain et al. [19] who found that households with less land tend to perceive conservation programmes as a limitation to their subsistence needs and therefore are likely to have negative attitude toward conservation. Masozera [20], Reardon and Vostii [21] furthermore,

S. N	Area	Unit	Conversion formula	Total wood	Remarks
1	Paper production	54,545.50 FTPA	5.5 m^3 tonne of FTPA	300,000 m^3	
2	Biomass for power generation and power boiler	292,000 tonnes/a (800t/d*365 days)	575 kg/m^3	167,900 m^3	About 44.6 (35.6+9.0) MW will be generated.
Total wood requirement				467,900 m^3	

Table 1: Paper mill wood requirement.

argued that households with less land tend to be poor in off-farm capital and therefore cannot afford to continue sustainable agriculture.

Size of land used for tree plantation

About 84% of the respondents used ≤ 10 ha for tree planting, 11.3% used 11-20 ha, while 2.8% used ≥ 21 hectares for tree planting. There was a noticeable shift from growing of food crops to cash crops, especially tree planting. The shift was motivated by the increasing prices of wood products especially timber and the huge market for electricity poles and wood fuel at the Paper Mill. At the time of this study, there were already cases of food price increases. Despite the fact that many respondents believed that this might have been caused by increased demand from the number of people who were working at the mill, another reason could be due to the decline in the number of farmers who were involved in growing food crops. These results correlate the findings of ABN-2007 [22] who reported that in Zambia, farmers were persuaded by agribusinesses to grow cotton instead of maize only to see market prices.

Wood waste utilization

Fuel wood used at the Paper Mill for electrical power generation was in form of wood waste. The researcher wanted to know what the respondents did with the wood waste after they had harvested their trees. The findings indicated that 71.7% of the respondents had no idea of what they would do with such wood waste after harvesting. This was perhaps because 78.3% of the respondents had not yet harvested their trees. However 13.2% of the respondentsleft their wood waste on the farm after harvesting, 12.3% used as firewood, while 2.8% were burning it on the field as a means of land clearing for the next planting season. The researcher also observed that even Paper Mills left most of the waste at the field after harvesting trees (Figure 1). When asked why they were leaving the tree branches and roots while they could be used as fuel at the cogeneration plant the harvesting manager said:

"The branches and roots are the smallest parts and for now we don't have any mechanism to transfer them to the mill. Also we have a lot of raw materials in forms of wood chips from other supplies and from our sister company".

Environmental problems resulting from wood biomass use at paper mill

Data collected from the field indicated that 78.3% of the respondents believed that there were environmental impacts associated with Mufindi paper mill, while 21.7% believe that there were no environmental impacts. From such finding it is clear that the majority of the respondents believed that the mill operation caused environmental problems.

The mill had different levels of impact environmental impacts across the villages (Figure 2), of all the respondents, 31.1% mentioned air pollution in form of smoke, bad smell and ashes from the Paper Mills, 25.5% mentioned bad smell only, while 20.8% reported that there had not been any significant environmental impact. Less than 10% mentioned smoke from the power Plant, dust pollution especially that which was caused by moving cars carrying tree logs from harvesting sites to the paper mill.

These findings corroborate those by WWF-2006 which argued that plantations and biomass use have negatively impact on biodiversity, water resources, soil quality, and air pollution. An environmental impact assessment done at Mufindi Paper Mill by Nzalalila et al. [23] also indicated that, the likely key environmental issues relating to mill operations included generation of solid, liquid, heat, and gaseous wastes which, if not properly disposed could lead to environmental pollution. The same source also asserted that solid wastes can result in abnormal piling of debris and emission of noxious and malodorous gases and that sometimes fire may result, dust might lead to breathing and lung problems.

Again the type of environmental problems mentioned differed depending on the distance of the village from the Paper Mill. Air pollution by ashes from the power generation plant was recorded only at the distances greater than 17 km. Dust had environmental impact at 6-17 km or more (Figure 3).

This is because most of these villages are close to the main road heading to the paper mill. Hence, there was higher vehicle traffic especially during the transportation of both raw materials from the forest to the paper mill, and the paper products to Dar es Salaam.

When the distance from the paper mill and the associated environmental problem was statistically tested, however there was no significant association between the two variables (Table 3). Therefore the null hypothesis was accepted. This means that despite the change in distance from the paper mill, most villages experienced the same type of environmental problems. This could be due to the height of the smoke chimney of the paper mill.

Effects of environmental pollution on human health, physical facilities and biodiversity

About 34% of the respondents opined that the pollution caused by the paper mill led to frequent coughing, 14.2% reported being diagnosed with chest diseases as the result of inhaling the polluted air from the paper mill while 6.6% reported food contamination by ashes coming from the paper mill. About 4% reported death of fishes as the result of discharge of untreated effluent from the Paper mill to the nearby river. About 32.2% of the respondents were not aware of any environmental impact resulting from operation of the paper mill. These respondents believed that further scientific studies should be carried out to identify the likelihood of any impact as some of the impacts might take years to identify. The remaining 6.6% believe that the environmental pollution problems had led to iron sheet rusting, flue and coughing (Table 4).

Availability of environmental management programmes

From the findings, about 82.2% of the respondents reported that there were environmental management programmes and activities being undertaken. Also this study indicated that there were several types of environmental programmes mostly aimed at mitigating the

Where	Upto 2012		2015-2020		2025 And Beyond	
Paper Machine I/Ii	300'000 m^3	45,000-54,545.50	495000 m^3	90,000 FTPA	900,000 m^3	180,000 FTPA
Biomass Powered Power Plant	167'900 m^3	44.6MW	167900 m^3	44.6 MW	167,000 m^3	44.6 MW
Total	467-500,000 m^3		662,900 m^3		1,157,900 m^3	

Table 2: Short and long term paper mill wood requirements.

Figure 1: Paper Mill harvesting site and typical type of waste left at the site.

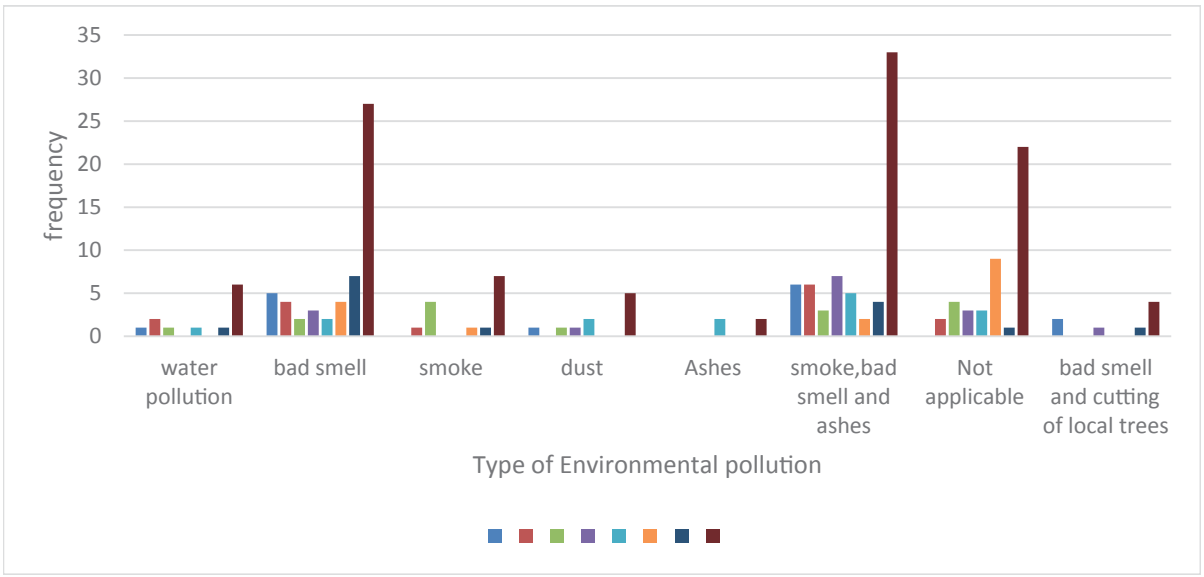

Figure 2: Environmental impacts per each village.

impact of climate change and controlling unsustainable use of natural resources. About 17.9% of these environmental management activities were in the form of fire burning control. 17% on tree planting activities and 20.8% on tree planting, water sources management and bush burning control. About 17.9% of the respondents were not aware of any environmental management programme, activity or campaign at the study area (Figure 4).

Effectiveness of the available environmental programmes

Findings showed that the available environmental management programmes had been effective at different levels. About 28.3% of the respondents believed that the available environmental management programmes had led to an increase in tree planting activities, 22%, believed that awareness towards environment management had led to decrease in forest fires. The decrease in forest burning activities was

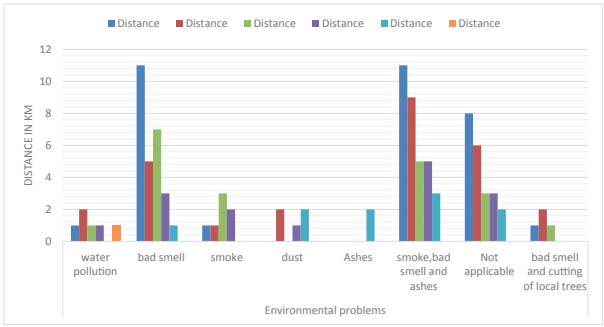

Figure 3: Effect of distance from the paper mill on environmental impact

Size of Land	Frequency (N)	Percent (%)
≤ 10 hectares	75	70.8
11- 20hectres	21	19.8
≥ 21 Hectares	10	9.4
Total	106	100

Table 3: Size of land owned.

Distance from Mufindi paper mill	Environmental problems				Chi-square value (x^2)	P-value
	Yes	%	No	%		
< 6 km	25	75.8%	8	24.2%	0.253	0.881
6-17 km	37	80.4%	9	19.4%		
> 17 km	21	77.8%	6	22.2%		

Table 4: Chi-square test of association between having environmental problems and distance from Mufindi Paper Mill.

associated with the increased environmental management programmes as confirmed by 19% of all respondents (Figure 5). Despite these achievements there is still much to be done on improving the quality of the environment as well as solving the land use conflicts.

Conclusion

The focus of this paper was on the environmental challenge of wood biomass utilisation for energy cogeneration in one of the paper mill in Tanzania. The sustainability of wood biomass cogeneration will mostly depend on the awareness of the people; this is because majority of villagers where this study was conducted were not aware of electricity generation at the mill. this lack of awareness in a way affected the raw material supply to the mill due to the fact that people are mostly planting trees for other uses than wood fuel such as for timber which takes up to 15 years before harvesting while if they were to plant for fuel purposes it would take them up to only 5 years and also increasing their income. The study also found that there are environmental problems being caused by Paper Mill, with direct impacts on the air quality, land use and water .Although some cases might need technical evaluation, numerous complaints from various stakeholders signifies the extent of the problem. Despite the presence of environmental programmes at the study area, their effectiveness is also a matter of concern. In villages like Kitasengwa where fire prevention education has been preached every day and despite the presence of Sao hill plantation division office, fire cases have been occurring repeatedly. Also due to the fact that most programs at village have been championed by the villagers themselves the financial and technical operation has always been a problem.

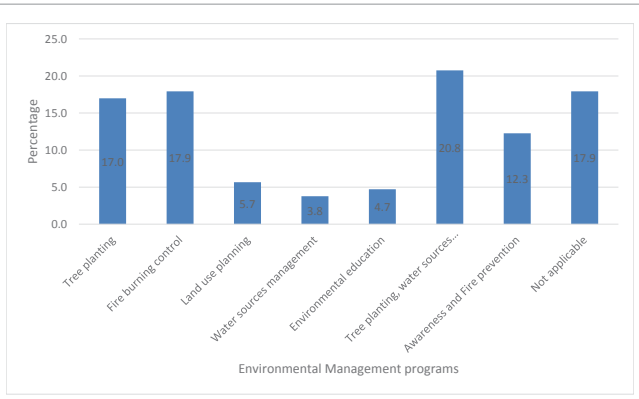

Figure 4: Environmental management programs.

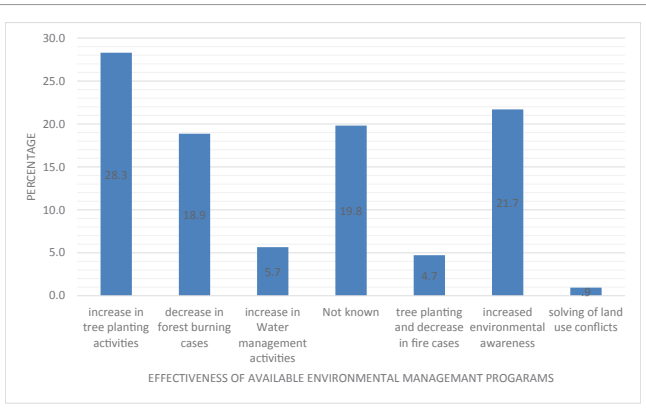

Figure 5: Effectiveness of available environmental management programs.

Coughing of residents near the industry	36	34.0
Chest diseases	15	14.2
Dying of fish	4	3.8
Crop diseases 'burning'	3	2.8
Food contamination	7	6.6
Not known	34	32.1
Iron sheet rust, flue and coughing	4	3.8
burning of crops, dust, coughing	3	2.8
Total	**106**	**100.0**

Table 5: Effects of the environmental problems at the study area.

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Properties of Oriented Strand Boards with External Layers made of Non-Strand Chips

Radosław Mirski, Dorota Dziurka, and Adam Derkowski

OSB is made from chips with a large aspect ratio of quite large defined size. This requires raw materials of considerable size, which are quite costly. This article describes use of small chips (up to four times shorter than standard) in the outside layers, which increases the raw material pool from which chips suitable for OSB production can be drawn. It includes a detailed analysis of mechanical properties of the different trial materials.

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Properties of Oriented Strand Boards with External Layers made of Non-Strand Chips

Radosław Mirski,* Dorota Dziurka, and Adam Derkowski

This study evaluated the possibility of producing oriented strand boards (OSB) from non-strand chips. Properties of the produced boards were compared with commercially available OSB/3. Research has shown that replacing the strand chips of external layers with smaller chips allowed for the manufacturing of OSB/3 using chips up to four times shorter than standard strand chips. Oriented strand board manufacturers should consider preparing a new standard and introducing the market to a new type of OSB with very good mechanical properties and made of selected strand chips comprising one of the fractions obtained during screening.

Keywords: OSB; MFP; Strand; Fine chips; Mechanical properties

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INTRODUCTION

The feature distinguishing oriented strand boards (OSB) from other wood-based boards is mainly the size of chips used for their production. In general, the chips used for this purpose should be 75 mm to 150 mm long, 5 mm to 30 mm wide, and 0.4 mm to 0.8 mm thick (Barnes 2000, 2001; Chen *et al.* 2008). These linear dimensions make it possible to achieve the second essential property of these boards, *i.e.*, chip orientation within the individual layers. Perpendicular orientation of the chips within individual layers provides very good mechanical properties along one axis of the board. Chips of this type are usually obtained from aspen, poplar, or pine. The wood used for the manufacturing of these boards should be characterized by low brittleness. Obtaining chips of these dimensions requires raw materials of considerable size, and preferably in the round form directly from the forest. This, however, significantly affects the price of the final product. Attempts at reducing the price of wood include introducing new species or using wood from fire-impacted trees (Zhang *et al.* 1998; Shupe *et al.* 2001; Hermawan *et al.* 2007; Moya *et al.* 2009; Cheng *et al.* 2012). The final price may be also lowered by reducing the board density or using smaller chips in the core layer (Fakhri *et al.* 2006a, b; Han *et al.* 2006, 2007; Chen *et al.* 2008; Mirski and Dziurka 2011a,b; Mirski and Dziurka 2015). On the other hand, research conducted by Lee and Tahir (2003) and Sackey *et al.* (2011) has shown that using smaller chips on the outer layers of OSB smoothes their surface and reduces the linear expansion compared to particleboard.

An important alternative to OSB on the European market is multifunctional panel (MFP) construction board (Type P5, EN 312 2010), made of fine chips with geometric structures resembling the structure of chips used in the core layer of standard furniture particle boards (P2, EN 312) (Pfleiderer 2016). The modulus of rigidity in these boards is over 20 MPa, and their modulus of elasticity is greater than 3500 MPa, regardless of the direction of the sample collection. Therefore, they meet the requirements for OSB/3 boards

as per the EN 300 standard (2006), even for their longer axis, irrespective of the sampling direction. Moreover, the coefficient of orientation for these boards is only 1.14, which means they can be used without paying attention to the chip orientation. Another advantage of the MFP board is their smooth surface that, after light sanding, may be finished with melamine foil, making the boards highly suitable for formworks.

Mechanical properties of industrial OSB are often much better than what is required by the EN 300 (2006) standard (Derkowski *et al.* 2014). This means there is a room for solutions improving both the economic aspect and the scope of the OSB use. A possible solution for improving functional quality of OSB is to give up on the orientation and manufacture unoriented strand board (USB) (Haute Innovation 2016). Unoriented strand board, manufactured by the Egger Company and Büsgen Institute of the University of Göttingen from soft wood of deciduous trees (birch, poplar, willow, alder), exhibited better mechanical properties and emitted less volatile organic compounds (VOC) than a pine-based OSB (Roffael *et al.* 2006). This paper evaluated the possibility of producing OSB with external layers made of non-strand chips which due to their properties will be able to replace traditional OSB in their construction applications.

EXPERIMENTAL

The study involved laboratory-manufactured three-layer boards with the core layer made of industrial strand chips intended for the internal layer of OSB panels. The external layers were made of microchips, fine chips, average chips, long chips, and strand chips from pine (*Pinus sylvestris* (L.)) (Table 1). The chips were glued with pMDI (Bayer, Fribourg, Switzerland) and therefore the reference boards were industrial OSB/3 (OSB) glued in both layers with the same adhesive.

Table 1. Chips used in OSB panels

Type of Chip	Abbreviation	Description
Microchips	AA	industrial chips intended for external layers of furniture particle boards
Fine Chips	BB	subscreen fraction obtained by screening industrial chips intended for the manufacture of OSB on a screen with 10 × 10 mm mesh and grinding in a laboratory mill
Average Chips	CC	industrial chips intended for the core layer of furniture particle boards
Long Chips	DD	fraction retained on a screen with 10 × 10 mm mesh and passing through 15 × 15 mm mesh during screening of industrial chips intended for the manufacture of OSB
Strand Chips	EE	fraction retained on a screen with 15 × 15 mm mesh during screening of industrial chips intended for the manufacture of OSB

The fractional composition, linear dimensions, slenderness (l/t), width coefficient (l/w), flatness (w/t), and specific weight (Fw) of chips were investigated. Specific weight is defined in Eq. 1,

$$F_w = \frac{2}{\rho_0}\left(\frac{1}{l^*}+\frac{1}{w^*}+\frac{1}{t^*}\right) \quad (1)$$

where F_w is specific surface (m^2/kg), ρ_0 is average density of dry pine wood intended for chip manufacture (0.511 g/cm^3) (Mirski and Dziurka 2015), l is length (mm), w is width (mm), and t is thickness (mm). The symbol * denotes the theoretical (calculated) linear dimension of the chips worked out based on linear dimensions of at least 100 chips and average (of 10 repetitions) weight of 100 to 200 chips taken from each screen. Dimensions of EE chips were determined based on 850 chips taken at random from the batch intended for board pressing.

Table 2. Conditions for OSB Pressing

Resin content (%)		MC Chips (%)		Pressing Time (s/mm)	Pressing Temperature (°C)	Unit Pressure (N/mm^2)
Face	Core	Face	Core			
4	3	9.25	6.10	15	200	2.5

The conditions of board manufacture are presented in Table 2. The materials with the above-described properties were used to prepare three-layer 750×450 mm, 15 mm thick OSB panels with a density of 590 kg/m^3 and weight ratio of face/core layers 1:2. Three pieces were prepared for each experimental variant.

The OSBs were then tested using relevant standards. The modulus of rigidity (MOR) and modulus of elasticity (MOE) were tested by EN 310 (1993). The internal bond (IB) was tested according to EN 319 (1993), and swelling in thickness (TS) after 24 h water soaking was tested according to EN 317 (1993). The properties of manufactured OSB boards were compared to industrial made OSB (Kronopol) and MFP (Pfleiderer).

Determination of the longer and shorter axis was based on the orientation of chips in the core layer. It was assumed that for the longer axis, the chips in the core layer were oriented perpendicularly to the longer axis of a sample. Statistical analyses were performed using the Statistica 12 (StatSoft Inc., Tulsa, USA) and TableCurve 2D v. 5.01 software packages (Systat Software Inc., London, England).

RESULTS AND DISCUSSION

Dimensional characteristics of the experimental chips are presented in Table 3. The investigated types of chips differed mainly in their length and width, and only slightly in their thickness.

Table 3. Dimensional Characteristics of Chips Used for External Layers of OSB

Size	AA		BB		CC		DD		EE	
-	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
l (mm)	**4.15**	4.06	**10.15**	9.83	**15.07**	13.95	**49.69**	46.35	**96.79**	102.2
w (mm)	**0.54**	0.55	**1.10**	1.10	**1.46**	1.42	**3.38**	3.35	**12.76**	11.85
t (mm)	**0.17**	0.17	**0.45**	0.42	**0.61**	0.57	**0.61**	0.61	**0.61**	0.59
λ (l/t)	**24**	24	**23**	23	**25**	24	**81**	76	**159**	173
κ (l/w)	**8**	7	**9**	9	**10**	10	**15**	14	**8**	9
φ (w/t)	**3**	3	**2**	3	**2**	2	**6**	5	**21**	20
F_w (m^2/kg)	**1433.6**	1421.1	**819.2**	868.3	**614.4**	647.8	**512**	502	**435.2**	458

Due to the method of chip acquisition, neither their weight as the weight of wood material intended for board production, nor the chips retained on the screens during screening followed a normal distribution of linear dimensions. The linear dimension that was most often characterized by a normal distribution was chip width. Sample histograms of chip width distribution for selected screens are presented in Fig. 1.

The results indicated that, for the screening method used in this study, the presence of specific chip sizes on the screen was determined by at least two of their largest linear dimensions. Moreover, the finer the fraction, the more often the linear dimensions followed a normal distribution. However, as shown in Table 3, the differences between the mean and median were usually small (≤ 8%) and concerned mainly the length of the chips. Shape factors, except for slenderness determined for DD and EE chips, were practically the same, regardless of whether they were due to mean or median relationships. AA, BB, and CC chips had similar shape factors. The DD chips had the greatest width coefficient that affected the ease of orientation, and EE chips were characterized by the greatest slenderness. Chip slenderness significantly affected the board bending strength. Linear dimensions of the chips, presented in Table 3, significantly depended on the share of specific fractions in the total weight of the chips.

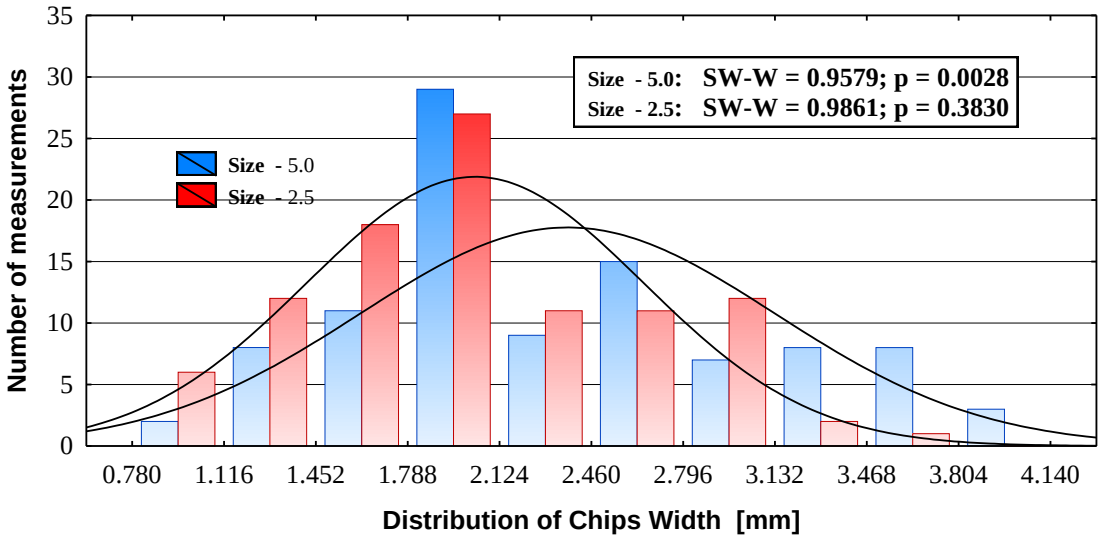

Fig. 1. Histograms of BB chip width distribution on the screens with 5 mm and 2.5 mm

As shown in Table 4, AA, BB, and CC chips were dominated by the fraction retained on the screen with 1 mm mesh. The DD and EE variants contained mainly the chips retained on the screen with 6.3 mm mesh. The share of fine fraction mainly affects the bulk density of the chips, and this parameter determines the shape of the board density profile or internal bond through greater or smaller densities of individual layers.

Table 5 shows the mechanical properties of the investigated particle boards. The experimental data indicated that both industrial boards (OSB and MFP) not only met the requirements of relevant standards, but often exceeded them by as much as 100%. The results for the OSB/3 were more favorable. However, of all the investigated boards, MFP was better than OSB as a multi-functional construction board, as MFP also met the requirements of EN 300 (2006) for OSB/3. Moreover, the MFP mean modulus of rigidity was comparable with that of OSB and was accompanied by a very low coefficient of orientation that was 1.14 compared to 2.18 for OSB. The MFP board also had a higher

mean modulus of elasticity and a higher IB. This was most likely due to its density that was 130 kg/m^3 higher than that of OSB. The production of MFP boards requires more, but cheaper wood and may use lower quality wood material for the small chips necessary for MFP production.

Table 4. Fines Distribution

Fines Screen Size Dimensions	AA		BB		CC		DD		EE	
(mm x mm)	*x* (%)	υ (%)	*x* (%)	υ (%)	*x* (%)	υ (%)	*x* (%)	υ (%)	*x* (%)	υ (%)
> 6.3	0	0	5.23	19.1	5.54	12.1	85.21	1.20	90.52	1.18
> 5	0	0	1.76	27.3	6.09	15.2	0.52	38.6	1.34	37.2
> 4	0	0	1.96	21.29	5.80	14.1	0.75	30.1	0.97	41.7
> 2.5	0.25	40.21	25.16	3.21	40.62	3.21	5.32	16.7	3.61	5.50
> 1	51.24	2.37	55.55	4.29	39.63	2.89	2.46	7.22	3.56	8.54
> 0.5	20.13	3.17	5.42	24.2	1.92	21.1	2.45	17.0	0	0
<0.5	28.38	3.27	4.97	27.1	0.40	21.0	2.09	27.1	0.42	27.1

Considering the parameters for modulus of rigidity, all laboratory boards fell into the category of OSB/3 (Table 5).

Table 5. Mechanical Properties of the Boards and the Results of HSD Test for Homogeneous Groups

Type of Board	MOR II		MOR ⊥		MOE II		MOE ⊥		IB		TS	
	MPa	υ (%)	MPa	υ (%)	MPa	υ (%)	MPa	υ (%)	MPa	υ (%)	%	υ (%)
OSB*	32.5	11.1	14.9	6.6	4940	9.4	2070	6.4	0.64	8.9	5.6	12.7
MFP*	24.6	2.7	21.6	3.8	4430	2.0	3870	1.9	0.80	12.6	8.8	9.2
300**	20	-	10	-	3500	-	1400	-	0.32	-	15	-
312**	16	-	16	-	2400	-	2400	-	0.45	-	10	-
AA	14.1^{a}	6.4	21.0^{a}	9.1	2120$_{a}$	7.0	3030^{a}	6.3	0.60^{a}	8.8	13.8	6.1
BB	15.6^{a}	6.7	22.2^{a,b}	5.9	2770$_{b}$	7.3	3110^{a}	6.2	0.65^{b}	9.7	16.9	7.2
CC	18.4^{b}	10.9	24.2^{b,c}	9.8	3320$_{c}$	4.1	3290^{a,b}	10.6	0.81^{d}	16.5	16.6	11.1
DD	27.0^{c}	9.8	25.2^{c}	8.7	4380$_{d}$	8.3	3390^{b,c}	8.0	0.71^{c}	10.6	14.9	7.4
EE	41.0^{d}	10.8	27.8^{d}	8.2	6420$_{e}$	9.2	3580^{c}	7.1	0.68^{b}	10.9	17.3	9.9
* density of dry boards: OSB - 590 kg/m^3 (υ -3.7%), MFP - 720 kg/m^3 (υ -0.51%); ** EN - 310 for OSB/3, EN - 312 for P5												

The boards made of fine chips (AA and BB) did not achieve a modulus of elasticity above 3500 N/mm^2 in either of their axes or at least 2400 N/mm^2 in both axes, and, therefore, they should be classified as P3 boards, *i.e.*, non-load-bearing boards to be used in humid conditions. The CC boards met the requirements for P5 particle boards, DD

boards met the requirements for OSB/3, and EE boards matched OSB/4 standards. All manufactured boards had a very high internal bond, similar to the industrial boards. They also showed relatively low thickness swelling, considering the fact that no water resistance improving agents were used during manufacturing. Moreover, an analysis of the group homogeneity for the experimental boards demonstrated a much lower variability of their shorter axis properties, particularly regarding the modulus of elasticity. This was probably due to the fact that their core layer was made of the same type of strand chips arranged along the longer axis of a sample, thereby stabilizing their properties for transverse direction.

In manufactured OSB, a linear relationship with chip length was observed only for modulus of rigidity (Fig. 2). The equation for modulus of rigidity (MORII = 0.2884L + 13.005) was characterized by a high coefficient of fit (R^2) amounting to 0.9988. Large length differences in the individual types of chips, particularly between AA and EE chips made the coefficient trend towards a linear relationship (Anscombe's quartet). The other parameters investigated during the bend test fell into two intervals, depending on chip length. The first interval featured a strong increase of a specific value and comprised chips from 4.2 mm to 15.1 mm long, and the second interval included chips from 15.1 mm to 96.8 mm long belonging to CC and EE groups in which the parameter increase was slower.

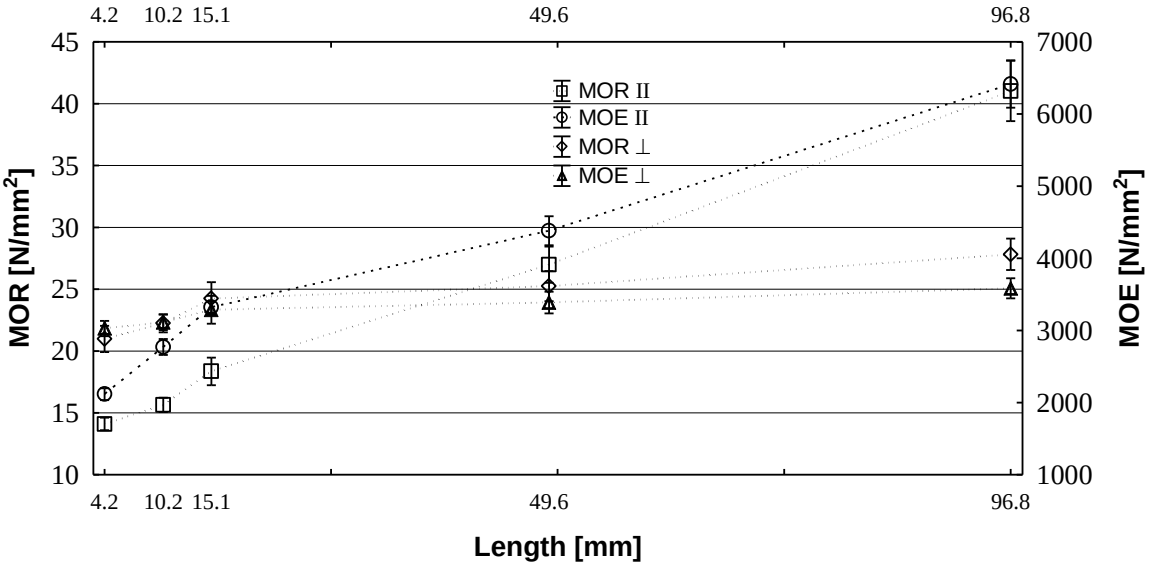

Fig. 2. Effect of the mean (weighted) average length of the chips on the static bending strength and modulus of elasticity

Even though the length of the chips within individual groups showed a high variability of linear dimensions, the obtained values fit the relationships described by Barnes (2000) (Fig. 2). The quality of the chip orientation in the individual layers of OSB was essential for MOR and MOE for specific board axis. The better the orientation was, the higher the orientation index. For OSB the expected orientation index is 2, and for the MFP panels it should be as close as possible to 1. Both industrial boards met the relevant requirements, and the lowest values of the investigated parameters for the laboratory-manufactured boards were observed in those made from CC and DD chips. Therefore, they may serve as an alternative for MFP boards, as their properties were also similar to the requirements of EN 312 (2010).

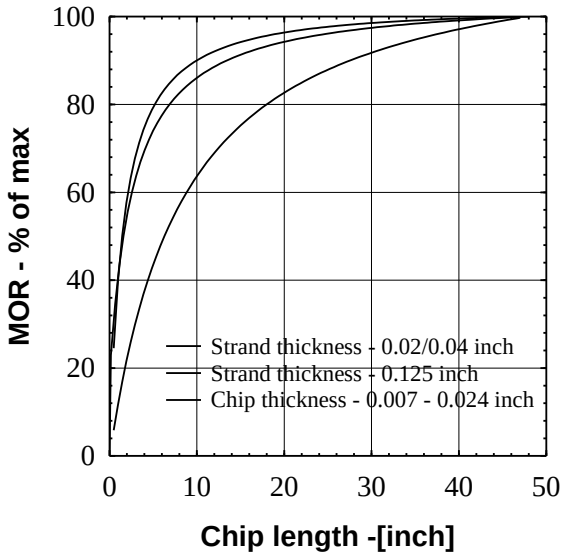

Fig. 3. Correlation of Hankinson equations with the effect on MOR of strand length (red and blue line (from Barnes 2000)

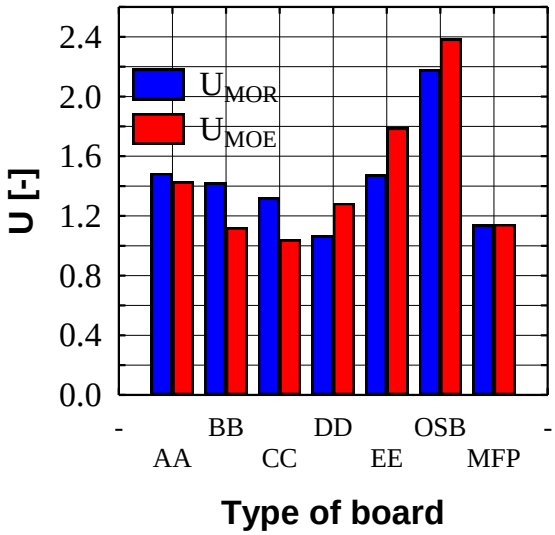

Fig. 4. Orientation coefficient of the investigated boards, where U=MOR(E)$_{max}$/MOR(E)$_{min}$

The parameter joining such properties as chip linear dimensions, their mutual relations (λ, κ, φ), fractional composition, or a resin content (treated as the ratio of the dry weight of adhesive to the dry weight of the wood) is a resination coefficient (RC), *i.e.*, the ratio of the dry weight of the adhesive to the specific surface of the chips. In this study, where the resin content was the same for all types of chips, the changes in the modulus of rigidity and modulus of elasticity should be treated as changes of exponential character (Fig. 5). Coefficient of fit (R^2) for the equation expressed as MOR(E) = a + b exp(-RC/c) was around 0.99, irrespective of the investigated axis. The nature of the MOR and MOE changes for the shorter axis may be also considered linear; however, the coefficient of fit was lower and ranged around 0.93.

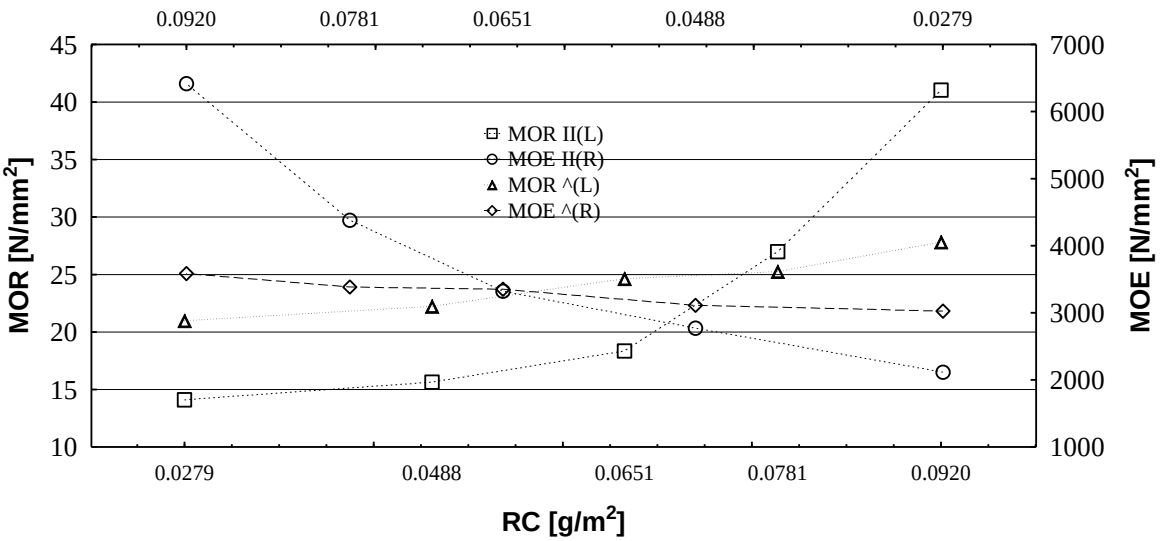

Fig. 5. The effect of resination coefficient on modulus of rigidity and modulus of elasticity

The highest IB was reported for the CC board, which was the board in which the chips in the external layer were those intended for the core layer of furniture particle boards that were also used in the manufacturing of MFP boards (Table 5). The value of this parameter was similar to the investigated MFP panel. Internal bond was strongly related to chip thickness and susceptibility of the mat to pressing. Although the average thickness of CC chips was similar to that of DD and EE chips, they also comprised about 20% of thicker chips, while in the other groups the share of chips with 1 mm or similar thickness was only a few percent. Therefore, assuming the same susceptibility of the core layer chips to pressing, CC chips were probably the most resistant during mat pressing, which translated into high IB of the boards made of this type of chips.

This study demonstrated that chips significantly shorter than strand chips, or even fine chips, may be successfully used in the manufacturing of external layers of OSB. Core layers made of strand chips provided high IB, whereas modulus of rigidity and modulus of elasticity strongly depended on the type of chips used in the external layers. Nevertheless, the boards made of the finest chips met all the relevant requirements for OSB/3 except for the requirements for modulus of elasticity for the longer axis set out in EN 310 (1993). The properties of the experimental boards were highly favorable when the chips in their external layers were the chips intended for MFP boards or for the core layer of furniture particle boards. Boards of this type met the requirements for P5 particle boards and, despite much lower density, they were only slightly less durable than MFP. High internal bond indicated that the resin content of the experimental boards was too high. It can be successfully lowered to 14.40 kg/m^3, and when accompanied by an increase in the gluing of external layers, a modulus of elasticity of 3500 N/mm^2 would probably be achieved. As far as the linear dimensions of the chips were concerned, the chips slightly longer than BB, *i.e.*, those with a computational length of 10.34 mm, should be enough to produce P2 boards in these experimental conditions. The chips suitable for OSB/3 production should be characterized by the computational length of about 25 mm.

The characterization of chips by both their linear dimensions and shape factors was found to be very cumbersome and did not provide an accurate description of the specific chip batch if they were not screened into a homogeneous dimension group. This was due to the fact that the dimensions of the chips retained on screens during screening for

dimensional analysis and the chips in the entire batch rarely follow a normal distribution. Precise characterization of the experimental chip batch would require screening with several types of sorting machines and detailed statistical analysis for each screen and each sorting machine. Research publications usually report only the mean size, minimum, and maximum values for specific linear dimension. Specific surface of the chips seems to be a suitable parameter describing a chip batch, as it accounts for both linear dimensions relationships and the share of individual fractions. Following this assumption, the boards of P5 type with the core layer made of strand chips should have their external layers made of chips with specific surface of about 715 m^2/kg, which is of a mixture of BB and CC chips. The OSB/3 board, a serious alternative for MFP, due to low coefficient of orientation, can be manufactured using chips with specific surface of 590 m^2/kg, which is slightly larger than CC chips.

CONCLUSIONS

1. This study showed that the described modification of OSB structure, *i.e.*, replacing the strand chips of external layers with smaller chips, allowed for the manufacturing of OSB/3 using chips up to four times shorter than the standard strand chips.
2. With slight modifications of the gluing degree (core/face), the use of fine chips from a subscreen fraction of a 10 mm mesh screen, should enable the production of P5 type boards.
3. Reports from studies, including chips of different fractions, should be accompanied not only by a sieve analysis, but also by specific surface of the chips.

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The European pulp and paper industry in transition to a bio-economy: A Delphi study

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This article models evolution of the (Western) European Pulp and Paper Industry to 2030. It suggests the main drivers will be energy and material efficiency, and sees the industry moving towards a diversified product range focussing mainly on high value added grades and on segments with higher environmental awareness. In particular by 2030 it is predicted around 40% of turnover will come from genuinely new products – such as from the biorefinery concept.

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The European pulp and paper industry in transition to a bio-economy: A Delphi study

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ABSTRACT

The current challenge facing the European pulp and paper industry is how to materialize the transformation to a bio-economy, as well as to realize the necessary new green innovations. The risks, costs and constraints of doing business will increase, thereby further intensifying competition, but at the same time new business opportunities will open up. This study adopts a three-round dissensus-based Delphi approach in order to explore our key research question of how the pulp and paper industry may change strategically, and what is the potential for value creation in the year 2030. According to our expert panel, the main drivers of competitiveness in 2030 will include energy and material efficiency, sustainability, as well as new innovations in products to serve customer needs better. According to the projected 2030 scenario, the pulp and paper industry will produce more diversified products, focus on higher value-added, and aim at consumer segments with higher environmental awareness. On average, 40 percent of the turnover will according to the panel come from genuinely new products. Strategic cross-sectorial partnerships will have a key role in making this big leap, while simultaneously acknowledging the changing needs of sustainability-conscious customers and other stakeholders.

1. Introduction

The pulp and paper industry (PPI) has traditionally been one of the most environmentally sensitive sectors due to its heavy dependence on water, its use of energy, and the vitality of forest ecosystems as a source of wood fiber. Taking a historical perspective, Ojala, Lamberg, Ahola, and Melander (2007) concluded that only a moderate degree of competition existed in the global forest industry up until the end of the 1990s on account of constantly growing markets, a low degree of internationalization in the leading firms, and an emphasis on business-to-business products associated with long-term buyer-supplier contracts. However, things have changed dramatically since then. The strategic orientation of the forest industry in general has evolved in the course of time through four distinct stages: forestry orientation, production orientation, market orientation, and sustainability orientation (Toppinen, Wan, & Lähtinen, 2013, Chap 17). In a recent work, Kozak (2013, Chap 18) describes the global landscape of the forest industrial sector as eclipsed by large, multinational

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corporations producing commodity products and struggling in a phase of ongoing transformation towards a conservation-based economy.

The PPI has been seeking renewal under the emerging concept of bio-economy, particularly in Europe (Kivimaa & Kautto, 2010; McCormick & Kautto, 2013). Bio-economy is a concept that has attracted increasing attention in the last decade (Staffas, Gustavsson, & McCormick, 2013), and has developed to include great challenges and opportunities for the forest sector to the extent that might blur its traditional boarders (Kleinschmit et al., 2014; Pätäri, Tuppura, Toppinen, & Korhonen, 2016). The EU and some of its member states focus on an economy that is based on the use of biomass resources (Pätäri et al., 2016), comprising "[. . .]biological resources from the land and sea, as well as waste, as inputs to food and feed, industrial and energy production [. . .]" (European Commission, 2012). According to Sisto, van Vliet, & Prosperi (2016:45) "for its cross-cutting nature, bio-economy represents a great challenge to comprehensively address inter-connected rural development issues such as sustainable economic growth, natural resource scarcity, food security, fossil resource dependence and climate change."

The diffusion of biorefinery technology is the key concept with regard to the bio-economy in the forest sector (Hetemäki & Hänninen, 2013), but the PPI's low willingness to take investment risks has been perceived as a barrier to the diffusion of biorefineries (Näyhä & Pesonen, 2012). Although there has been research on the future outlook of the European forest sector (e.g. Hurmekoski & Hetemäki, 2013; Olsmats & Kaivo-oja, 2014; see also the review in Näyhä, Pelli, & Hetemäki, 2015), no scientific studies have considered the future of the pulp and paper industry from a strategic viewpoint, covering the full spectrum of aspects ranging from industry structure, technology and innovations to competition in product and raw-material markets, and combining industry-specific factors with the emerging societal transition towards sustainability (Loorbach & Wijsman, 2013).

Instead, published reports on factors of strategic change in PPI have predominantly been industry-led, or developed by policy makers. For example, the roadmap for the Finnish forest sector drawn up in 2010 developed four scenarios for an operating environment leading up to 2030: the global bio-economy (with consumers and industry recognizing climate change and working towards a carbon-neutral society), the forest as a source of bioenergy (substituting fossil fuel keeps value capture low), business as usual (in which the dominant logic prevails), and a self-sufficient society (characterized by extensive biomass food production due to repercussions from climate change) (The world's leading forest cluster, 2010). In accordance with these alternative futures for the business environment, the key necessary strategic actions identified in the report were specialization in the most value-adding products and solutions, aiming for global leadership in standardization and norms, and taking a global role as a resource integrator. The European Commission (2013) has also recently drawn up a blueprint for the forest-based industries, identifying altogether 12 challenges, which collectively underline the importance of stimulating sectorial transition with a radical change in the industry's mind-set, and the need to improve innovation, structural adaptation, production efficiency and the quality of products and services in order to grow in markets both within and outside the EU.

In order to fill the research gap, we aim to produce a methodologically sound study on industry transformation and change in business logic in the European PPI, and to map the expectations of high-level industry experts concerning the future business and business environment. Our first research question is *how the pulp and paper industry may change strategically in the development towards bio-economy, and what kind of business opportunities the industry transformation will offer to the existing and new companies in the field*? A more practical secondary question is also addressed, based on the results, concerning *what are the pathways open to the European PPI in order to maintain its competitiveness in the changing business environment?*

We adopt a Delphi approach aimed at PPI experts in several European countries to explore the current situation in terms of industry structure and the potential for transformation and value creation in the year 2030. According to Hurmekoski and Hetemäki (2013:17), "there are potential advantages in complementing the current modeling approach dominant in the forest sector with other methods from the field of foresight", which also warrants the use of the Delphi method. With regard to the future, we aim to assess the expected change and its significance in terms of seven key factors (i.e. technology, raw materials, products, markets, strategic partnerships, specialization and sustainability investments) that are assumed to shape future business in the European pulp and paper sector over a time span extending to 2030. On this basis we further construct an industry scenario and discuss the changes this would require to current business logics.

2. Theoretical foundations

2.1. The dominant logic of an industry

Prahalad and Bettis (1986) introduced the construct of dominant logic, or dominant general management logic, in order to better understand relationship between industry diversification and performance. One of the key motivations behind this stream of strategy literature is the question of why is it so hard for organizations to change. First the approach focused on diversification-driven organizational change and then moved on revolving around environmental-driven organizational change (Bettis & Prahalad, 1995; Prahalad & Bettis, 1986). Prahalad and Bettis (1986:491) defined the concept of dominant logic as "a mind set or a world view or conceptualization of the business and the administrative tools to accomplish goals and make decisions in that business". It relates to how business is conducted to make profits in the markets and how firms interact with customers and competitors, and it also gives some indication of its perceived key success factors (Prahalad &

Bettis, 1986). Dominant logic can be manifested through e.g. organization's business model, processes and approaches to competition (Prahalad, 2004). It is embedded in an organization and according to Prahalad (2004:172), "it becomes the lens through which managers see all emerging opportunities". Thus, it limits the incumbent organization's ability to rethink and question the traditional business logic and way of doing business – one is not agilely able to recognize changes in the competitive environment and drive innovation.

Due to its cognitive nature, "changing the dominant logic is extremely difficult" (Prahalad, 2004:172), although vital for future value creation requiring, for example, internal development of new products or markets, or external development through acquisitions or the building of strategic alliances. Prahalad (2004) had defined approaches how firms can better understand the emerging changes and opportunities in the competitive environment, including focusing on next practices (instead of benchmarking current best practices), learning from low-cost experimentation, and looking beyond the borders of industries and geographic borders. According to Kaplan (2011), in aim to understand strategic changes of organizations, the cognitive-based explanations have found to be very useful.

2.2. Industry dynamics and structural change within the forest industry

The PPI is an interesting example of an industry in which technology has for the most part developed only incrementally, with low-intensity research and development, and relatively high dependency on wood raw material (including pulp and recycled paper, 44% altogether), energy (16%), and chemicals (16%) in its total manufacturing costs (CEPI, 2013). Globally, the export value of forest industry products (pulp, paper and wood products) amounts to 250 billion USD annually.

Table 1 summarizes some of the most recent studies analyzing the future of the forest sector from a strategic perspective (excluding technologically focused studies). Based on it, quite a few of the studies in question focus on the forest-based bioenergy business. Earlier research has also analyzed potential developmental trends or proposed future scenarios for the industry, but the overall state of art seems very limited to address issues that have become eminent in industry renewal and strategic transformation in the future bio-economy. We will next discuss these issues in more depth.

Highly volatile forest product and input prices have traditionally had the most significant impact on the development of company performance, dictated by economies of scale and scope (e.g. Diesen, 2007). Investments in production facilities and plants are capital intensive, especially in the pulp and paper segment, and therefore the return on investments is relatively

Table 1
An overview of recent (2010–2015) strategically focused future-oriented studies in the forest sector.

Study	Main objective	Method	Main findings
Jonsson (2011)	Analyzes trends and possible future developments in global wood-product markets and discusses the implications for the Swedish forest sector	Qualitative scenario analysis	Provides four possible scenarios. The outlook for the Swedish solid wood-product industry is optimistic, but the prospects for the PPI in Sweden are more difficult to predict.
Koskela (2015)	Discusses the measurement of eco-efficiency in the Finnish forest industry	Delphi method and public data	The economic performance of eco-efficiency should be measured using the 'value added' indicator and environmental performance based on output by emission groups or environmental impact.
Lindahl and Westholm (2012)	Analyzes how the future is handled by actors in the present day	Twenty-four semi-structured interviews supplemented with written material	Actors' perceptions of the changes facing the forest sector diverge widely. However, most actors see its future as linked to the broader issues of climate mitigation and energy transition.
Näyhä and Pesonen (2012)	Outlines global and national drivers of forest biorefineries in Scandinavia and North America	An expert opinion survey combined with a Delphi approach	There seems to be potential for success in the biorefinery business, but support from the macro-scale environment is needed and the industries themselves need to be active.
Näyhä and Pesonen (2014)	Explores the current forest industry in terms of its change features, necessary resources, and management for the biorefining business	Data from the final round of a three-phase Delphi study	A conservative organizational culture and a lack of financial resources create barriers to change. New managerial and operational-level skills are needed, and a readiness for change should be embedded in the organizational culture.
Olsmats and Kaivo-oja (2014)	Maps and analyzes general trends and drivers among consumers and businesses within the packaging industry	Participatory foresight and focus-group methodology	Trends and changes in the environment will affect packaging and may bring both threats and opportunities.
Pätäri (2010)	Identifies the main industry- and company-level factors that are most likely to influence the bioenergy sector and its value-creation potential	Delphi study	The complementary resources held by forest and energy companies make collaboration in the bioenergy business favorable.
Pätäri et al. (2016)	Analyzes how the PPI experts and the industry understand and foresee the expected influences arising from sustainability megaforces	Delphi study	Global sustainability megaforces are perceived more as opportunities than as threats. Adaptation to climate change was identified as the greatest threat.

long-term compared to other industries. Furthermore, the industry has become more exposed to changes in its value chains, including media digitalization, growing customer awareness of sustainability issues, more intensive global competition, and the increasing complexity of industry regulation (of which recent examples include the EU chemical directive REACH and the EU Timber Regulation establishing legality verification needs for wood raw material).

The global demand for pulp and paper products has been relatively stable on the product level: although the rapidly growing digital media have reduced the demand for newsprint and other printing and writing paper, the consumption of paper and paperboard is continuously rising, being the material most commonly used in the global packaging sector. On the regional level, industry in Europe has been lacking large-scale investment in the 2000s (CEPI, 2013), and its competitiveness has dramatically changed in recent decades. The lower costs of production in Latin America (pulp) and Southeast Asia (paper, packaging) have intensified competition, the use of digital media has rapidly curtailed the use of printing paper, and European Union policies promoting the production of renewable bioenergy have increased the costs of wood raw material.

Being closer to end-user growth markets has been a key driving force behind the location of global paper investments, whereas pulp investments have been more inherently resource-driven (Zhang, Toppinen, & Uusivuori, 2014). The European paper industry has been suffering from low profitability and significant price erosion since 2009, especially in the market for graphic paper, leading to a wave of consolidation, divestments and capacity reduction. This financial hardship has led to the elimination of non-core activities and a constant need to reduce costs. According to Uronen (2010), most producers of paper and board are positioned in the middle of the value chain, where they can only generate about five percent of the total value creation.

Conversely, markets for pulp and recycled paper have developed more favorably on the raw materials side, with booming demand in China and other emerging countries. Longer rotations in wood fiber markets in the boreal zone (which is the major procurement area for producers in the European PPI), as compared to the fast-growing plantations of the Southern hemisphere, have put the companies under cost pressure. Currently there are plans for new investments in softwood pulp capacity in Finland, for example, but the focal areas for new investments are now Latin America and Asia, and in terms of paper and paperboard manufacturing in particular, China (Zhang et al., 2014).

The conditions of the forest industry, i.e. a mature industry in which the profitability is decreasing, are characteristics that challenge the existing business models and thus the industry dominant logic (Sabatier, Craig-Kennard, & Mangematin, 2012). However, this characteristic of a mature industry brings about also challenges specific to old and large firms (Peltoniemi, 2013). An industry's dominant logic could be described as reflecting its strategy across different businesses, and is also often connected with too strong lock-in and perceived inefficiency to diversify existing business models (Prahalad & Bettis, 1986; see also Abrahamson & Fombrun, 1994). Typically, the forest industry has been suffering from stagnation, not only in financial sense, but also in the way how it renews the business. According to Näyhä, Hetemäki, and Stern (2014), companies in the European forest sector are diversifying their business models and product portfolios by developing new products and services based on forest biomass, and the traditional sector will most likely fragment into several segments specialized in a variety of forest products. Consequently, regions such as Europe and Asia will also have to compete with each over where the companies will situate their activities in global value chains. Hence, the degree of specialization and diversification is expected to increase in the future. It is also evident in the strategies of some large forest industry companies (see, e.g., the recent shift in the business segments of UPM-Kymmene Ltd.) that in future the strategic orientation will increasingly diversify to include the production of renewable fuels, chemicals, bio-based fibrils and wood composite materials, for example. All this underlines the need for building strategic cross-sector partnerships. Such strategy may bring some benefits to the PPI in terms of corporate sustainability in that knowledge about the sourcing and production of raw materials could be used in ensuring forest-industry compliance with sustainability requirements, particularly at the beginning of the value chain (e.g. Pätäri, 2009).

The globalization of markets and a growing awareness of sustainability are making the PPI increasingly vulnerable to corporate sustainability images and more complex demands from a wide range of stakeholders for operational accountability. Issues related to corporate responsibility are no longer of marginal importance. Corporate investments in sustainability have been suggested to focus on improved energy and resource efficiency, more synergic value creation between various stages in forest-wood value chains, and the development of solutions to enhance customers' quality of life in the form of durable and safe products with integrated service components (Toppinen et al., 2013, Chap 17). Within the European PPI, despite an emphasis on sustainability leadership, the increasing environmental regulation is seen as a threat to maintaining current forest-industry production levels (CEPI, 2013). The sustainability-related risks, costs and constraints of doing business have clearly intensified competition between regions, but also provide significant new innovation opportunities.

To sum up, the future business environment of the European PPI is highly uncertain in light of the multitude of change factors outlined above. This uncertainty has an impact on the rivalry between current players and new entrants both in Europe and beyond, and merits empirical foresight studies as proposed in Hurmekoski and Hetemäki (2013) and Hetemäki and Hänninen (2013), for example.

3. Data and methods

The Delphi method is one of the best-known and most used forecasting mechanisms. Although the Delphi approach has faced quite a lot of criticism, it has an established position as an effective tool for gathering expert opinions on a variety of

topics in different domains. A Delphi study typically entails two or more paper- or web-based survey rounds with feedback given to respondents, or panelists, after each round. (Ribeiro & Quintanilla, 2015; Steinert, 2009) The number of panelists ranges from a few to 50, although the key criterion in selecting the panel is the members' expertise and contribution to the topic (Hatcher & Colton, 2007). Iteration, participant and response anonymity, controlled feedback, and statistical group response have been identified as the key characteristics of a Delphi study. (Blind, Cuhls, & Grupp, 2001; Förster, 2015; Kuusi, 1999; Landeta, 2006; Steinert, 2009; Tapio, 2002; Turoff, 1975). Nevertheless, there are many variants, of which the later ones in particular (e.g., Policy Delphi, Argument Delphi, and Disaggregative Policy Delphi) highlight the importance of finding reasons for dissensus rather than striving for consensus among the experts.

The key objective of our Delphi study was to elicit expert opinions on the current business conditions of the PPI and the emergent strategies that are likely to facilitate development towards a bio-economy and sustainable value creation. The overall Delphi process depicted in Fig. 1 was conducted in spring 2014 (from March to June). We used the dissensus-based approach, thus our aim was to bring up for discussion all relevant issues and reasons for differences of opinion among the panelists. The time scale we covered extended to 2030, and the questionnaires included closed questions and statements with response alternatives, as well as open-ended questions. The study comprised three rounds of online inquiry. The rounds were iterative so that the responses of the previous rounds formed the basis of the following rounds. In the second and third rounds, the focus was especially on the themes and issues that either provoked a lot of comments and discussion or differing opinions among the panelists in the previous round or needed further clarification. In addition, members of the panel were given feedback after each round informing them of their anonymous colleagues' opinions. The panelists, who were carefully selected on the basis their solid expertise, knowledge and experience of the subject matter, represented a total of six European countries and the following three expert groups: (1) representatives of industry associations and other experts, (2) representatives of academia, and (3) industry experts. Thus, our aim was to form a panel of top-experts in the field that would consider the PPI from different perspectives in order to give a comprehensive view of the topic under scrutiny. More than 70% of the experts had over 10 years of experience from the forest sector. Nineteen experts responded to the first-round questionnaire, and the panel size decreased by two in the second and third rounds. The titles of the 19 experts are presented in Appendix A. Among the first expert group (representatives of industry associations and other experts), the representatives hold mainly the titles of a consultant or director of forest/bioeconomy/environment. Representatives of academia (group 2) have degrees in forestry, forest management, corporate environmental management, environmental and innovation management, or in chemistry. The titles of the experts range from a professor to a researcher. The industry experts (group 3) are all involved in sustainability affairs, and their titles are similar to a sustainability or environmental manager.

Fig. 2 summarizes the main elements covered in the Delphi study. The issues in Fig. 2 base on the previous literature on industry dynamics and structural change within the forest industry. Thus, our aim was to analyze the transformation of the

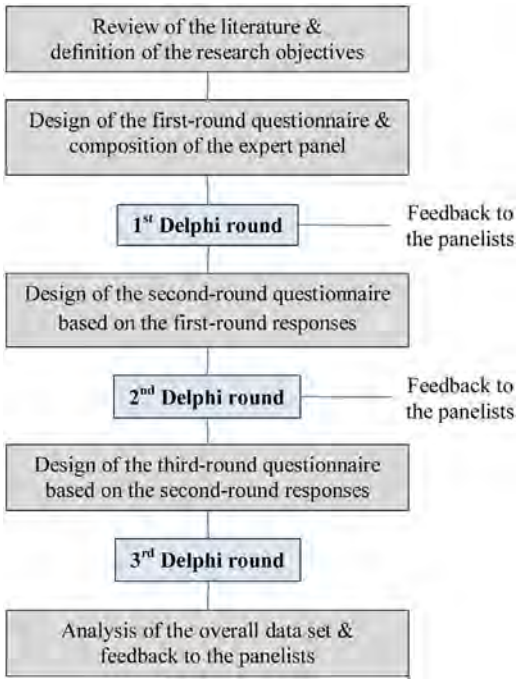

Fig. 1. The Delphi process.

Fig. 2. The main change factors covered in the Delphi study.

industry by focusing on the main change factors that enables us to analyze the industry from many perspectives. The questions in the first round, which were also based on previous literature regarding industry change factors, related mainly to the current and future situation of the PPI in terms of competition, profitability, long-term survival, and industry structure. The panelists were also asked to evaluate future business opportunities and sources of long-term value creation. The second round focused on the issues that provoked the most discussion or dissenting opinions in the first round, with an emphasis on innovativeness and industry renewal. The key issues discussed in the previous rounds were brought together in the third and final round, and the panelists were asked to evaluate the expected change in factors and the significance of this change. They were also asked to describe a future scenario of the European PPI in 2030.

4. Results and discussion

4.1. The current industry structure in terms of profitability and innovativeness

In the first round we asked the panelists to assess the current situation of the European PPI, especially with regard to competition, profitability and long-term survival, and the vitality of the business. Referring to competition and profitability, they clearly communicated that the situation differed in different segments of the industry. The decline in demand for some paper grades was characteristic of European markets in particular, but the situation was better in some other segments such as northern softwood pulp. Packaging paper, hygiene products, specialty papers, and liner board were also mentioned as examples of product groups showing higher current profitability. Even though overall profitability was perceived as generally rather low, it had its strengths. As one respondent put it:

Table 2
Innovativeness and future orientation (mean values by respondent groups).

	Representatives of industry association and other experts [1]	Representatives of academia [2]	Industry experts [3]	Overall mean
Innovativeness in the industry is more widespread now than ten years ago.	3.83	3.71	4.00	3.82
R&D should be more strongly directed to developing new innovations.	3.83	4.57	4.25	4.24
The companies in the industry take climate change well into account in their R&D strategies.	3.50	2.57	3.50	3.12
The companies in the industry take end-customers' needs well into account in their long-term decision-making.	3.50	2.71	4.50	3.41

"*Europe has know-how, education and technological advantage in its side, which can be seen competitive advantage. Also, the sustainability in Europe is taken more seriously into account, which may give access to certain markets where less sustainable peers fail to succeed*."

The panelists expressed divergent opinions about long-term survival and vitality. Again, the perceived prospects of the different segments differed. Some respondents saw further cost-cutting as a necessity, whereas other experts highlighted opportunities related to replacing fossil-based with bio-based and renewable products. The following citation exemplifies the potential seen in the PPI, but also points out the need for change in this traditional mature industry:

"It seems to me like there are good opportunities for the pulp and paper industry. The logistics are there, the renewable material and the environmental benefits are there and a number of global trends and political initiatives are in line with the pulp and paper potential to grow. But to meet that potential I guess the industry has to be very innovative and ready to develop."

In the second round we asked the panelists to further assess the current situation in terms of innovation, R&D and end-customer orientation (Table 2). They graded the following statements on a scale ranging from one (completely disagree) to five (completely agree).

As Table 2 shows, innovativeness was seen generally as more widespread than ten years previously, although the respondents thought that R&D activities should be more strongly directed towards new products, and that climate change should be taken into account more in R&D strategies. Perceptions on taking into account end-customer needs varied.

Representatives of academia perceived the industry situation less positively than the other two groups, suggesting that climate change and end-customer needs were not taken well enough into account, and that R&D should be more strongly directly towards new products. Members of the groups gave quite similar answers, except to the question concerning end-customer needs: the industry experts scored customer orientation most highly. When asked about current R&D investment, almost all the respondents responded that the level of investment was too low. Given their expectation that new products would generate about 40 percent of turnover in 2030, it is clear that further investments in R&D are needed to achieve this target.

4.2. Value creation potential in 2030

Next we asked the experts to describe the PPI in Europe in 2030 in terms of industry structure, competition, business profitability, long-term survival and business vitality. Many of them suggested that consolidation would continue, and hence the industry would be further concentrated, and the majority expected the PPI to be as large or smaller in terms of employees in Europe. Many of the respondents thought there would probably be larger mills and companies, but at the same time also opportunities for smaller-scale, specialized producers serving niche or geographically limited local markets. The question concerning competition divided opinions. Many of the respondents expected it to be tough in 2030, but some thought that there might be less competition due to increased differentiation, for example. Some of the experts thought that more competition would come from outside Europe, among other things because the European industry would no longer have technological advantage compared to Asia and other emerging markets. However, some also pointed out that European producers would focus on smaller-scale specialized production, whereas large-scale manufacturing would take place closer to the growing markets.

Overall, the profitability level of the industry in 2030 was expected to be quite positive. However, the profitability of companies depends on their ability to change their business logic, as the following citations clearly show:

"*Some segments might have better profitability than today, especially those succeeding in bringing high-value products to the market. The more traditional segments perform as today. Those clinging to traditional business models and cost structures perform worse than now, if they can survive until 2030*."

"*It uses different business models than today, in order to retain control over the material. Shifting from bulk material producer towards more involved in the supply chain to deliver solutions. The companies that succeed in this transition will be more profitable, and have better relations with customers and end-users*."

The responses concerning long-term business survival and vitality reflected the belief that the industry's future depended on its ability to utilize the raw-material base and pulp innovatively, and to create new businesses and value streams. Two experts described this well:

"*Long-term viability of pulp industry is likely to be secured, if innovation and research have been fruitful and several new applications for pulp are found. Pulp, as a renewable product, has secured its position as multipurpose raw material in several industries*."

"*I wouldn't talk about traditional pulp and paper industry. Instead there will be more specialized business with new products in Europe. Future for these businesses can look rather good*."

We further asked the respondents to estimate how big a proportion of turnover in 2030 would come from the current (2014) products. Fourteen of them gave their estimates in percentages, ranging from 30 to 75, the average being 61. Almost all representatives of the industry association and other experts, as well as the industry experts, mentioned a figure of at least 60 percent, whereas members of the third group (i.e. representatives of academia) gave the most diverse estimates, ranging from 30 to 75 percent. In the second round we asked how large a proportion of these new products would the existing

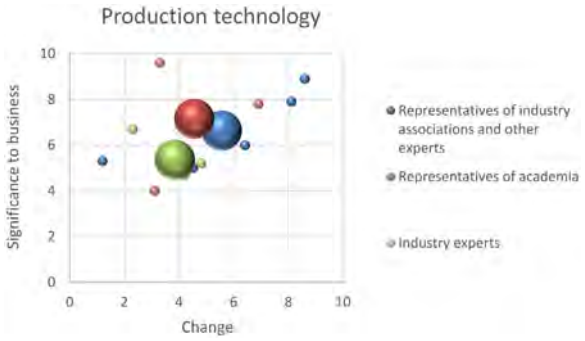

Fig. 3. The predicted change in production technology by 2030 and the significance of the change to the business.

technology and known technical solutions cope with. The responses ranged from 12 to 75 percent, the average being 50 percent. The ambivalence among the groups demonstrates high uncertainty regarding the future of the sector. According to the panelists, in addition to the traditional PPI products (pulp, paper, board, packaging, and tissue), the main sources of revenue in 2030 would include energy, biofuel, composites, bio-chemicals and bio-materials, paper and packaging products with intelligent properties, and fiber-based innovations. As main drivers of competitiveness they referred especially to energy and material efficiency, sustainability, and new innovations in processes and products that meet specific customer needs.

Next we asked about potential sources of value creation concerning raw material, technology, new markets, and new partners and industrial sectors. None of the areas was especially emphasized in the responses, indicating that the experts did not expect all the actors to follow similar paths in the search for future competitiveness. They varied widely in their perceptions of future business opportunities, reflecting expected further fragmentation within the industry. Examples of opportunities included finding new uses for re-modeled and non-wood fibers, advanced biorefineries, new process techniques, and collaboration with the chemical, food and textile industries.

4.3. Expected changes in the key factors by 2030, and the assessed significance of the changes to the business

In the third round we asked the respondents to assess from the overall industry's perspective how much the different factors – production technology, raw-material base, products, markets, sustainability investments, strategic partners, and specialization – would change by 2030, and how significant these changes would be for the business. For example, as regards the production technology, the respondents were asked to assess how much the production technology will change until 2030 on a scale from zero ("no change") to ten ("substantial change"). Second, they were also asked to assess the significance of the change *to business* on a scale from zero ("not significant") to ten ("very significant"). Thus, our aim was to study what kind of changes are expected within the industry until 2030. And with the second question (significance of the change to business) our objective was to discern whether these changes have small or significant impact to the business. Overall, the panelists predicted change in all of the listed factors, on average, ranging from four to seven on the scale, whereas the scores concerning the significance of these changes to the business ranged from six to eight. Next we describe these results in more detail.

In terms of *production technology* (Fig. 3) the perceptions of the experts are quite dispersed. The industry experts showed most consistency, whereas the opinions of the representatives of industry associations and other experts were the most divergent[1]. Overall, all of the respondent groups foresaw a moderate change in production technology (average 4.8). The industry experts were the most consistent in predicting moderate change, whereas the representatives of industry associations and other experts expected the biggest changes. All the groups were in agreement in assessing the significance of change in production technology as very high (average 6.4).

The respondents' opinions concerning the *raw-material base* (Fig. 4) diverged heavily. The industry experts predicted quite a minor change (average 2.6), whereas the opinions of the other groups were more diverse. One possible explanation for the divergence in opinions about both the change and its significance could be that the experts interpreted this question rather differently. The industry experts seemed to think that the raw material itself would not change very much, but that the changes that would be realized in terms of availability, usability, quality, and price would be important to the business (average 6.7). However, some experts from the other two groups rated the significance of the change quite low, which may reflect the belief that the value (what and how) created from the raw material matters more than what it consists of. However, more than half of these experts also thought that the raw-material base would change somewhat. The responses to

[1] In Figs. 3–9, the big bubbles represent the average mean values of each expert group whereas the small bubbles mark individual answers of the respondents.

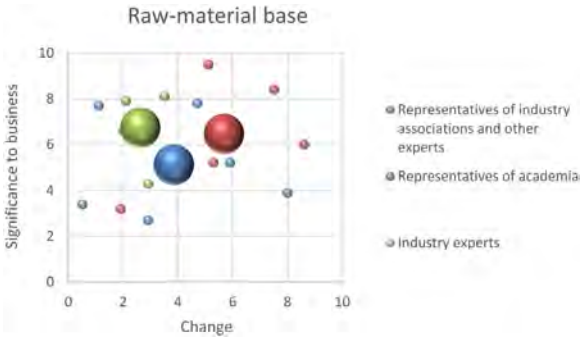

Fig. 4. The predicted change in the raw-material base by 2030 and the significance of the change to the business.

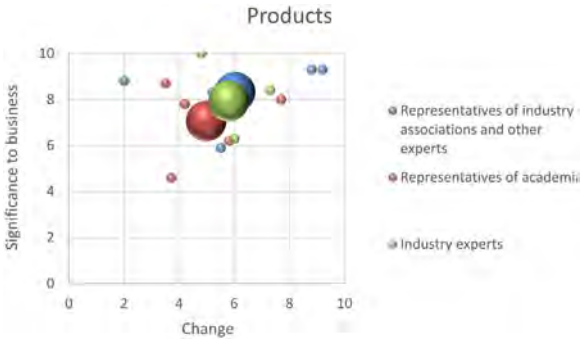

Fig. 5. The predicted change in products by 2030 and the significance of the change to the business.

the other questions in the three Delphi rounds gave the impression that this opinion could be related, in part, to the sourcing of alternative fibers or paper recycling.

With regard to *products* (Fig. 5) the respondents thought quite consistently that the change would be rather large (average 5.6), but that its significance would be even greater for the future business (average 7.8). This result is in line with the responses concerning the proportion of turnover coming from new products in 2030 (in the first round), which was expected to be around 40 percent.

Of particular note in the data on *markets* (Fig. 6) is that the industry experts appeared consistently to be of the view that the markets would have changed quite substantially by 2030. The average expectation is as high as 6.1 even though the other expert groups anticipated somewhat less radical change in this respect. It thus seems that the industry experts expected market change to be a key issue in the near future (average 7.8). The overall significance of the change was rated 7.5, on average. In general, the market issues that arose in the other Delphi rounds were related, among other things, to the role of Asia and the increasing environmental awareness of consumers.

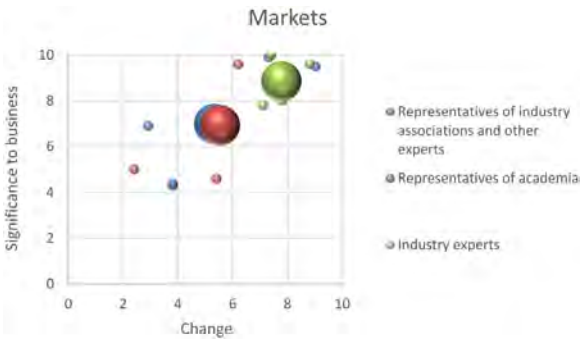

Fig. 6. The predicted change in markets by 2030 and the significance of the change to the business.

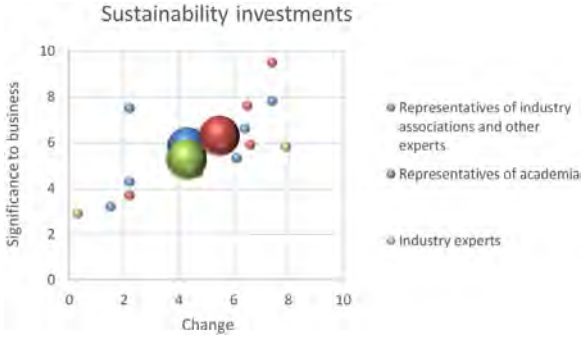

Fig. 7. The predicted change in sustainability investments by 2030 and the significance of the change to the business.

Fig. 8. The predicted change in strategic partnerships by 2030 and the significance of the change to the business.

The responses related to *sustainability investments* (Fig. 7) are interesting in terms of their range. The respondents differed strongly in their assessments of the degree of change (average 4.7), and their divergent opinions are also reflected in the expected significance of the changes for the business (average 5.8). This could indicate that some of the respondents see that the industry in Europe has already invested quite heavily in sustainability and may think that the current level of investment is good.

The industry experts expressed the most unanimity in assessing change in *strategic partnerships* (Fig. 8). On average, they thought that there would be quite substantial changes (average 5.6) in the role of these partnerships, and rated the significance of these changes to the business as even higher (average 7.7). The representatives of industry associations and other experts foresaw even greater change (average 6.8), which they also rated as significant for the business (average 6.7). The responses of the representatives of academia were the most divergent.

The groups differed in their views on *specialization* (Fig. 9), but were fairly unanimous internally. The representatives of industry associations and other experts anticipated less change (average 3.6), whereas the representatives of academia

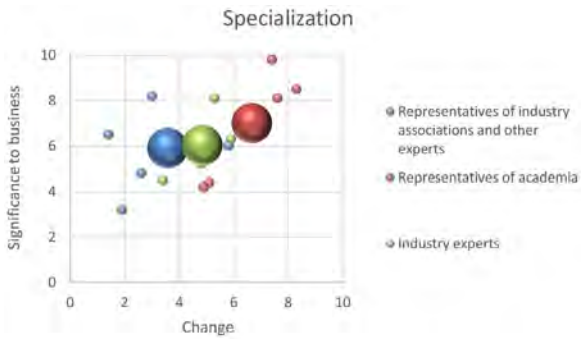

Fig. 9. The predicted change in specialization by 2030 and the significance of the change to the business.

Table 3
Future scenarios presented thematically.

Themes	Key points	Quotations
Resources, raw material and energy	- increasing competition for raw material - resource efficiency - energy efficiency	"The competition over a scarce yet renewable raw material will increase if all expectations loaded for raw material will materialize in relatively short period of time." [1]* "Increased demand for recycled fiber . . . " [2] "Energy efficiency is a key issue in Europe 2030, so the PPI should produce its own energy and not be dependent on the energy market. PPI will produce its energy at its plants, but also in co-owned wind, solar power, and waste power plants. The forests will not be used massively for energy, as they are too valuable for that either as fibre or as forest stands." [2]
RDI, technology, products	- more diversified product variety - emphasis on niche, high-value-added products - less volume, but more value	" . . . smaller production scales in part of the industry [. . .] open up opportunities for innovation, normally off-limits by the high capital lay-out of large mills." [2] " . . . the industry will further diversify into what is called 'bio-economy' and focus on very high added -value bio-based products." [1] " . . . integrated mills will play a more prominent role in the bio-based economy converting part of the now excess wood to valuable chemicals." [2]
Value chain and strategic partnerships	- significance of strategic partnerships with other sectors (e.g. chemical industry) will increase - the transition towards bio-economy	"The PPI and other forest-based industry will together [form] new strategic alliances with other industries which will develop new business models and value chains based on biomass from the forest and by-products from the forest-based industry." [1] " . . . sufficient level of R&D should take place because the bioeconomy discussion will be diverted from plain bioenergy." [1]
Consumers	- more consumers who are environmentally aware	"Consumers are becoming more and more environmentally aware, so consumer behavior will have a greater influence on the PPI environmental performance than we see today." [3] " . . . more consumers understand benefits of bio-based materials." [3]
Competition (geography)	- the role of Asia - resource and energy efficiency as competitiveness factors	"Competition from Asia will drastically diminish the production of pulp for paper as well as graphic paper, in addition to the reduction brought about by the competition from electronic ICT. Companies that prevail in Europe will to an increasing extent rely on the production of niche products." [2] "The Asian countries are already more important to us than they used to be, and I expect them to become even more important as there is a huge growth. Asian companies will of course also increase/start new capacity, but I think it will not fill the need of products in Asia." [3] "Asian competition is tough, but they have lost part of their cost competitiveness due to e.g. higher salaries." [3] "A more resource and energy-efficient European industry is able to capitalize on the increasing demand for sustainable products, while at the same time increasing its competitiveness with other regions." [2]
Policy and regulations	- the stabilization of environmental regulation - multiple policy targets create competition for raw material	"In the policy discussion it should be recognized [that] there are multiple targets set for developing forest based industry. This will result in challenges." [1] " . . . we may expect a slowdown in the regulatory approach toward environment protection/performance . . . " [1] "Environmental regulation has hopefully found more reasonable terms in Europe, or the other way round the other parts of the world have tightened their regulation too." [3]
Sustainability	- the expanding role of sustainability (mainly market-driven)	"While we may expect a slowdown in the regulatory approach toward environment protection/performance, the industry will keep improving its overall sustainability, possibly with a bit more focus on social sustainability." [1] "But the headline for the future scenario is probably about acting sustainably to ensure a strong position while meeting growing needs as well as competition from markets outside Europe." [3]

*) [1] = Representatives of the industry association and other experts, [2] = Representatives of academia, [3] = Industry experts.

expected the biggest change in this factor (average 6.7). However, on average all the groups rated the significance of the change rather similarly (average 6.3). With regard to future scenarios (which are discussed in the next section), the panelists pointed out the need to diversify the product portfolio, and put more emphasis on niche markets and high-value-added products. In our view this is in line with Fig. 9.

4.4. Future scenario

In the third round we asked the respondents to describe *a likely scenario of European PPI in 2030,* taking into account the aspects brought out in the previous Delphi rounds such as resource scarcity, competition, and increasing product variety. We analyzed the data in two phases. First, the members of the research team individually coded the scenarios defined by the

panelists. The responses were compressed and grouped under themes specified by each member. The classifications were compared in the second phase and then the final classification was created. Table 3 below describes the future scenario by themes, including the key points and representative quotations from the responses.

To summarize the scenario presented in Table 3: in 2030 the European PPI will be more resource and energy efficient, produce more diversified products, will also serve niche markets, and will focus on high added-value and environmental sustainability. The role of strategic partnerships as well as the environmental awareness of consumers will increase. Under the likely vision of the future of the industry, the importance of Asian companies and markets will continue to increase, and regulation will level off between Europe and Asia. We will discuss the implications for industry renewal strategies and future research needs in more detail below.

5. Conclusion

Contribution of this study is for the first time to consider the future of the European pulp and paper industry in bio-economy from a strategic viewpoint, covering the full spectrum of aspects ranging from industry structure, technology and innovations to competition in product and raw-material markets. Previous futures studies in the field have also more dominantly focused on bio-energy (Pätäri, 2009) or bio-refining (Näyhä & Pesonen, 2014), while bio-energy driven businesses have only limited potential in capturing value towards higher end products or services (Näyhä et al., 2015; Roos & Stendahl, 2016).

We studied the current situation of the PPI in terms of industry structure and the potential for value creation in 2030, using a three-round dissensus-Delphi approach. According to the panelists, the current level of profitability and competitive situation in the European PPI is largely product-segment-specific. Although profitability in some product segments was assessed as being better than in others, the overall profitability was generally perceived as rather low. Some of the panelists expected competition from other parts of the world to continue to have a strong influence on the European industry in the future, especially when producers in emerging markets have caught up with the European level of technology, whereas others referred to the major strengths of the European industry, such as the quality of education and know-how. The sustainability investments that have been made were seen as a further strength, and as a basis on which to contribute to a bio-based economy.

The solutions to ensure long-term industry survival and vitality divided the panelists in their opinions. Although some experts foresaw further cost cutting as a necessity, the higher-level opportunities of the industry were seen to lie especially in substituting fossil-based with bio-based products. The industry's future appeared to rely heavily on its capability to innovate and develop new bio-based products. Expectations in this respect were reflected, for example, in the prediction that an average 40 percent of the turnover in 2030 would come from new products, but either the need for or the expectation of RDI and new products also came up repeatedly in different forms in the answers to the various open questions. This finding is fairly well in line with the industry-driven roadmap for the Finnish forest cluster (2010), in which 50 percent of turnover is predicted to derive from products that were not on the market in 2006. However, the high level of diversity between the groups on the perceived industry capacity to realize the new products and services in their 2030 turnover demonstrates the high degree of uncertainty regarding the future of the sector.

More radically, some panelist expected that the businesses' chances of operating profitably in 2030 required changes not only in the products but also in business logic. Clearly, breaking free from the dominant industry logic (see Prahalad & Bettis, 1986) requires the reconfiguration of established norms and beliefs, and a shift in focus from incremental innovations and the maximum utilization of existing assets towards the search for more radical and novel solutions in order to capture value. In this particular industry context, and fueled by ambitious European climate and energy policies and the concept of bio-economy, there is a strong call for the establishment of cross-sectorial collaboration in R&D aimed at developing renewable bio-based materials to replace traditional paper products, chemicals and bio-fuels. Applying the new concepts in the process of developing new products, integrating into new value chains, and starting commercial-scale businesses will require a fundamentally better understanding of the new markets and customers, and of managing change, R&D and technical expertise: it will also require sufficient financial resources (see also Näyhä et al., 2014). The European paper industry has recently been actively developing a Public-Private Partnership on bio-based industry to boost innovations, perceiving itself as a solution provider in sustainability and a strategic actor in the EU economy. According to the assessments of the Delphi panel, there seems to be scope for further prioritizing actions and developing comprehensive research agendas that go beyond technological innovations and take into account markets, consumers, and the whole institutional context. Developing more diversified and competitive businesses in PPI also includes inevitably some switching costs. There is also a need for addressing sustainability challenges in the transformation to bio-economy and development of better quality standards. These all call for solid leadership and management capabilities in the industry, and a more proactive stance, as also emphasized by Roos and Stendal (2016).

With regard to the industry structure, many of the panelists expected the consolidation to continue. However, they also thought that there would be more room in the industry for smaller-scale, specialized businesses targeting niche markets, which would reflect the competitiveness of such companies. More generally, the respondents predicted that the main drivers of competitiveness in 2030 would include energy and material efficiency, sustainability, as well as the already mentioned new innovations in processes and products that would meet both regulatory requirements (such as carbon neutrality) and changing customer needs. The role of the regulatory environment and political uncertainty comprised a factor that was not

expected to appear as strongly as it did among the Delphi panelists as a major issue that will shape the future of the European PPI.

Overall, the findings of the Delphi study indicate that the actors in the industry are faced with several parallel changes in their business environment that are driven by goals arising from the need for sustainability and for maintaining the industry's competitiveness. The pulp and paper sector's potential to align itself with the changes largely depends on the ability of management to see the longer-term opportunities. No strategic renewal will take place if the industry continues on its path of incremental investment and short-termism, with a strategic focus on improving cost efficiency: such a strategy could also prolong its profitability problems.

It is also interesting to compare our results with those reported by Darkow and von der Gracht (2013), who used a Delphi approach in building scenarios for the European chemical industry. Their findings also emphasize sustainability and resource dependency as the two main factors shaping the industry up to 2030, and contributing to its competitive advantage. They also discussed the role of the regulatory framework in driving innovation, the strengthening competition from Asia and the need for diversification in business models. All these aspects were also identified as applying to the pulp and paper industry, which is understandable given the structural similarity between the two capital-intensive and mature process industries operating in global markets with high price volatility.

In terms of limitations, the number of respondents and their country of origin could have affected the results of this study: a different combination of panelists may have emphasized the change factors differently. However, given that Delphi has proved to be a suitable method for exploring complex phenomena lacking exact data, and that the panelists were high-level industry experts, it is feasible to assume that the results reflect the current and expected future situation fairly well. Further research could focus on what changes, in terms of strategic investments for example, are required in the industry for it to achieve and maintain global competitiveness in the future. From the sustainability perspective, an interesting future avenue would be to combine futures research with studies on business models, as recognized among transition theorists (e.g. Loorbach & Wijsman, 2013) and in the field of organizational management (Zollo, Cennamo, & Neuman, 2013).

Acknowledgements

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Appendix A. Titles of the expert panelists.

(1) Representatives of industry associations and other experts	Leading Consultant; Innovation and Bioeconomy Director; Environmental Director; Forest Director; Principal; International Development Expert
(2) Representatives of academia	Professors (2); Senior Researchers (2); Associate Professor; Researchers (3)
(3) Industry experts	Sustainability Manager; Environmental Manager; Senior Specialist, Environment and Responsibility; Manager, Quality and Environmental Information; Manager, Sustainability and Corporate Affairs

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Carbon Nanotube Paper as Anode for Flexible Lithium-Ion Battery

Xiaogang Sun, Zhenhong Liu*, Neng Li†, Xiaoyong Wu*, Yanyan Nie*, Zhipeng Pang*, Lifu Yue* and Hao Tang†,‡*

In this article, cellulose fibre was used to form a matrix to support carbon nanotubes. The composite sheet was produced using a papermaking filtration process. The concept showed excellent potential as a flexible anode material for lithium-ion battery technology, in particular being applicable to wearable technology applications.

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Carbon Nanotube Paper as Anode for Flexible Lithium-Ion Battery

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In this investigation, multiwalled carbon nanotube (MWCNT) paper consists of MWCNTs and cellulose was fabricated by traditional paper-making method. It was applied directly as negative electrode in flexible lithium ion battery to replace ordinary electrode which is combined with anode material and current collector. The electrochemical performances of the as-produced MWCNT paper (AMP) and carbonized MWCNT paper (CMP) were evaluated in this study. The morphology and structure of the MWCNT papers were observed by scanning electron microscopy (SEM). The electrochemical performance of the battery was operated by cell test and electrochemical impedance spectroscopy (EIS) measurement. The charging and discharging results indicated that the CMP behaves with higher capacity than AMP. And the EIS analysis showed that a lower charge transfer resistance can be obtained in the CMP. The excellent electrochemical performance verifies the feasibility of MWCNT papers as a promising candidate for the anode in flexible lithium ion battery.

Keywords: Multiwalled carbon nanotubes; flexible lithium ion battery; cellulose; negative electrode; anode.

1. Introduction

The flexible lithium ion battery has attracted great attentions with the development of wearable and portable electronics, such as bracelet and cellular phone. Some progresses have been achieved in flexible electrode materials based on carbon nanotubes,[1–11] graphene,[12,13] carbon paper,[14–19] conductive paper,[20–22] textile and other low-dimensional materials.[23] The flexible electrode materials are core components for fabricating flexible lithium ion battery. Carbon nanotubes (CNTs) have unique features of one-dimension, large surface area and high conductivity, which will make a contribution to electrochemical performance in a cell.[24–26] Thus, many investigations in terms of electrode materials are focused on CNTs. CNT film used as negative electrode or anode current collector was applied in flexible lithium ion battery in many researches.[27,28] The binder free CNT film consisting of continuous CNT bundles is flexible and

conductive. Sora *et al.* proposed a direct spinning process to fabricate CNT film. It was used as both active material and current collector. And the battery maintained a reversible specific capacity of 446 mAh/g at a current density of 165 mA/g.[15] Ng *et al.* used a light weight free standing bucky paper in lithium ion battery. At a high current density of 3000 mA/g, the cell maintains a reversible specific capacity of 200 mAh/g.[25] Most of the fabricating methods of CNT film or CNT paper are complicated, such as the chemical vapor deposition (CVD) method and spinning method. In addition, the CNT films and CNT papers are formed all by CNTs, which will cause a high cost when applied in lithium ion battery.

In this study, a multiwalled carbon nanotube (MWCNT) paper consists of 50% MWCNTs and 50% cellulose was prepared by a traditional papermaking technology. The MWCNT paper displayed good electrical conductivity. The porous structure of the MWCN papers increased the interface areas and improved the electrolyte absorption capacity. This work aimed to evaluate the performance of the battery with MWCNT paper as anode.

2. Experiment

2.1. *Preparation of MWCNT paper anodes*

The cellulose was applied as matrix material, and MWCNTs supplied by Whisker Nanotech Co. Ltd in China served as anode active material. Both were fully dispersed and mixed by high-speed shear and sand-milling in deionized water to form a suspension with a ratio of 1:1. Then the MWCNT paper were obtained by filtrating the suspension with a vacuum pump. And the as-produced MWCNT paper (AMP) was obtained by peeling it off from the filter paper after drying for 12 h. The carbonized MWCNT paper (CMP) was prepared by carbonization treatment in a vacuum oven at a temperature of 1460° for 8 h. The MWCNT papers were rolled and tailored to a disk of 14 mm to be used as an anode electrode directly in lithium ion battery.

2.2. *Characterization of MWCNTs and MWCNT paper*

MWCNTs were observed by field emission scanning electron microscopy (SEM, JSM-6701F) and Transmission electron microscopy (TEM, JEOL JEM-2010FEF). While Raman (SENTERRA) and X-ray diffraction (XRD, XRD DI SYSTEM) were employed to identify the structure of MWCNTs. The morphology of the MWCNT papers was evaluated by a scanning electron microscope (SEM, JEM-3010) to analyze the interface structure of the MWCNTs and cellulose. The MWCNT sheet resistance was measured by four-probe method with a multi-electrical measurement system (St2258C). Thermal gravity analysis (TGA) test was also performed to analyze the content of MWCNTs in the paper. And the surface area was precisely evaluated by the Brunauer–Emmett–Teller (BET) analysis.

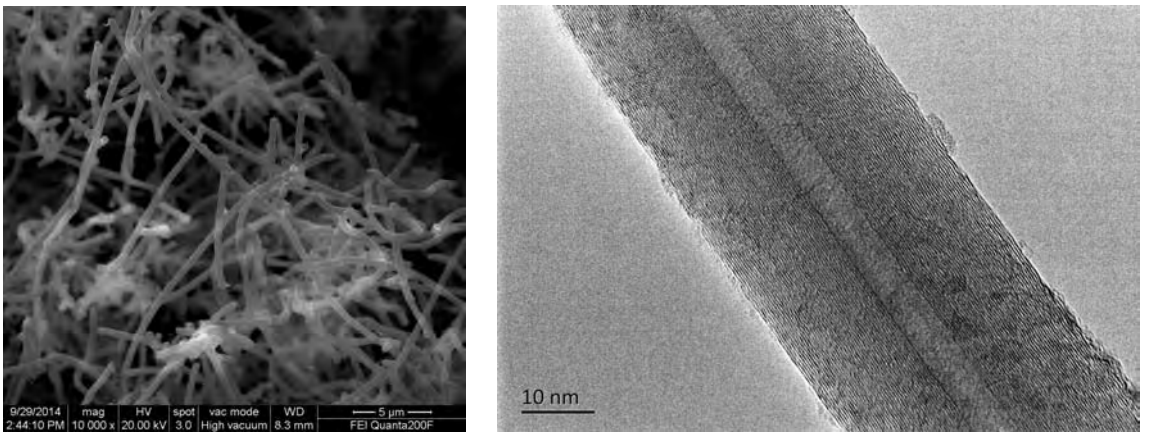
2.3. *Assembling of cell and electrochemical measurements*

The tailored MWCNT papers were used as working electrodes, and Li metal plate was used as the counter electrode. CR2025 coin-type cells were assembled in an Ar filled glove box (MBRAUN LABSTAR, Germany) by stacking a porous polypropylene separator. The liquid electrolyte was 1 M $LiPF_6$ dissolved in a mixture of ethylene carbonate (EC) and dimethyl carbonate (DMC) (1:1 in weight). The electrochemical characterization of the batteries was measured by cell tester (CT-3008W-5V5mA-S4), and electrochemical impedance spectroscopy (EIS) were operated on an electrochemical workstation (CHI 660B). The specific capacity was calculated according to the mass of the MWCNTs in the MWCNT paper. With a cut-off voltage window from 0 V to 0.5 V, the charging and discharging current density was set at 40 mA/g for gravimetric specific capacity measurement.

3. Results and Discussion

The SEM image in Fig. 1(a) shows that the MWCNTs have distinct one-dimension structure. TEM image of the MWCNTs is shown in Fig. 1(b). It can be observed that the MWCNTs have a straight and clear texture, which indicates high crystallinity.

The XRD patterns of the raw and graphited MWCNTs are shown in Fig. 2(a). According to Bragg's equation, 002 peak and 101 peak are the characteristic graphite diffraction peaks of CNT. After graphitization at 2800°C, the graphited MWCNTs display a sharp carbon peak (002), which



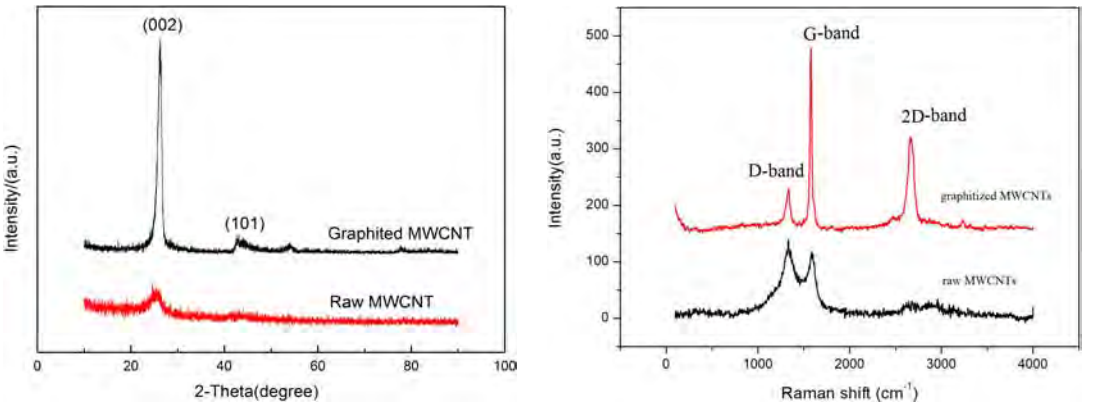
(a) (b)

Fig. 1. SEM (a) and High Resolution Transmission Electron Microscopy (HRTEM) (b) images of MWCNTs.

indicates high degree of crystallinity. The Raman spectra [Fig. 2(b)] can be used to analyze the crystalline qualities of MWCNTs. The intensity ratio of the G-band to the D-band (I_G/I_D) is to evaluate the degree of crystalline perfection.[29] The value of I_G/I_D for the graphitized-MWCNTs is 4.16, which is much higher than that of 0.67 of the raw MWCNTs. This result is in good agreement with XRD and TEM. In the study, highly graphitized multiwalled carbon nanotubes(G-MWCNTs) were adopted.

Figure 3(a) shows a web-like network structure of AMP. It indicates a good interconnection of MWCNTs in the cellulose networks. The organizations of both paper fibers and MWCNTs are random-in-the-plane of swirled fibrils. And the CMP is shown in Fig. 3(b). The paper fibers were dehydrated in the vacuum oven of 1465° and turned to crisp charcoal. And the MWCNTs in the CMP became cleaner and straighter after the heat treatment. It can be inferred that the crystallinity of the MWCNTs has been improved by carbonization process. And the CMP still displayed flexibility in Fig. 3(d) and sufficient strength for making an electrode in the battery. The SEM image of CMP electrode after 50 cycles is shown in Fig. 3(c), MWCNTs are tightly interlaced. The electrode keeps firmly after charging and discharging.

After heat treatment in vacuum oven at 1460°C for 8 h, the specific surface area of the CMP is decreasing according to the BET analysis (Fig. 4). The CMP displayed a lower surface area of 23.23 m^2/g



(a) (b)

Fig. 2. XRD patterns (a), Raman spectra (b) of raw and graphitized MWCNTs.

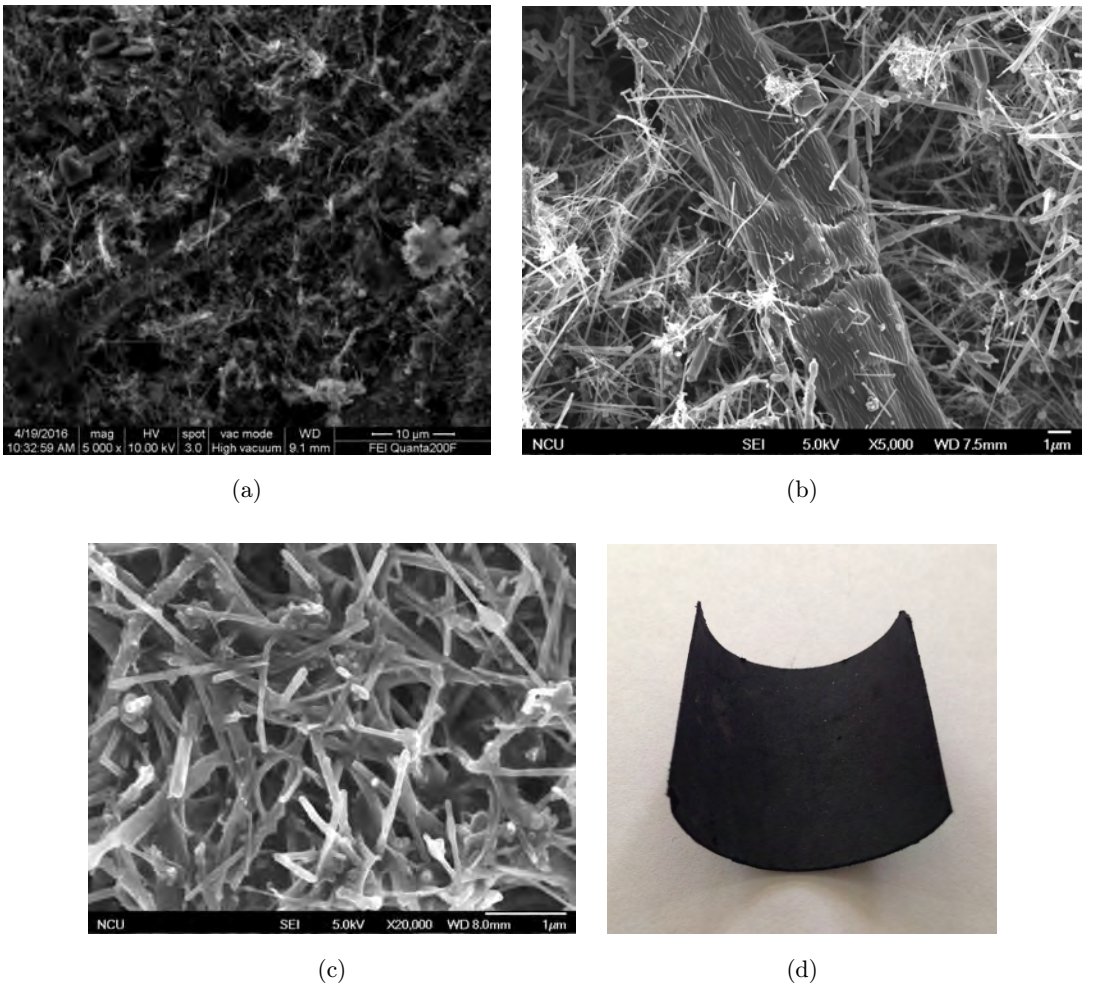


Fig. 3. SEM images of AMP (a), CMP (b), CMP after cycles (c), photograph of bending CMP (d).

than the AMP of 25.69 m^2/g. Though the pores of the two samples presented a similar distribution, the average pore diameter of AMP is 23.36 nm, and 17.95 nm for CMP. The number of greater-sized pores on the surface was decreased after the carbonization treatment, while the number of tiny-sized pore on the surface was increased according to the BET. The increasing tiny-sized pores might improve the capacity of battery with the CMP.

The nonisothermal experiment was operated under air atmosphere. The temperature was set from ambient temperature to 1000° at a heating rate of 5°/min. The TGA curves of the AMP and CMP were shown in Fig. 5. CMP curve (b) indicated that the MWCNTs were oxidized from 630°. Before the oxidation temperature, the loss of the sample resulted from oxidation of amorphous carbon which was deposited in carbonization process. TGA for AMP (curve a) exhibited four stages during combustion process. Below 280°, 2.5% mass loss happened owing to the evaporation of water in the paper. The second stage (from 280° to 350°) presented the thermal degradation of paper fiber which resulted in the formation of solid char and the evaporation of organic materials. The third stage (350–470°) was attributed to the oxidation of the chars. The weight loss reached 51% in this stage at 470°. Thus, it can be calculated that the weight content of cellulose in the AMP is about 46.5%. The fourth stage presented the combustion of MWCNTs. The residue only holds a 3.4% after 1000°. The residue mainly contained metallic oxides. It can be concluded that AMP only contains 48.6% weight content of MWCNTs. The CMP shows higher thermal stability than AMP.

After 5 cycles of discharging and charging, EIS was performed under a fully discharge state by applying a sine wave of 5 mV amplitude over a

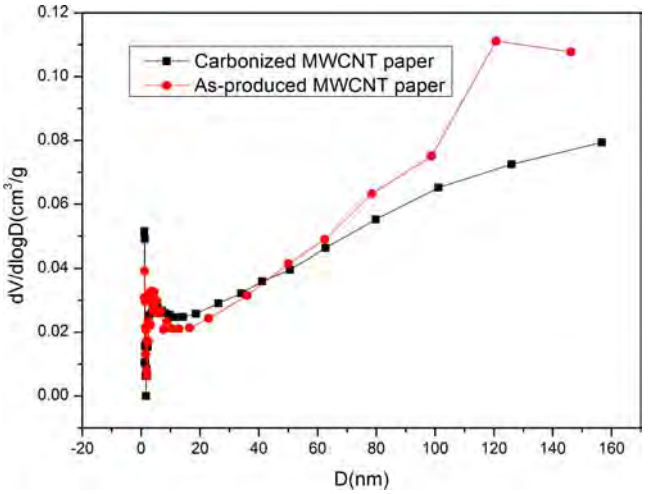


Fig. 4. BET test for the AMP and the CMP.

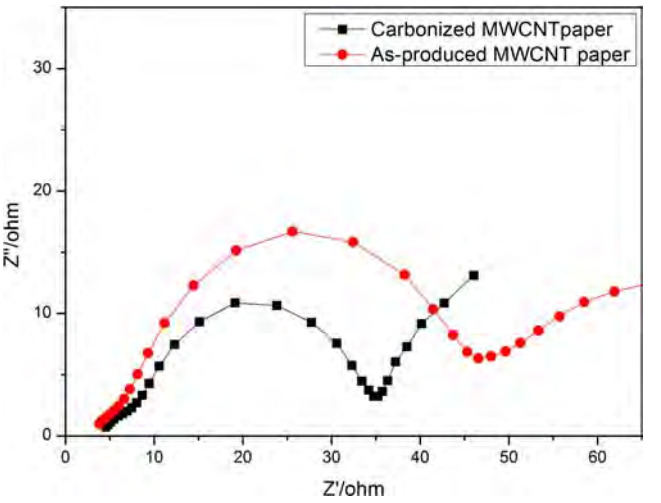


Fig. 6. The EIS of the CMP and the AMP battery after being fully lithiated.

frequency range from 10 000 Hz to 0.01 Hz. Figure 6 shows the EIS graphs of the two electrodes. Obviously, only one evident semicircle appeared in the middle frequency area which presents charge transfer resistance (R_{ct}). And the radius of the CMP was smaller than the AMP, which demonstrated that the R_{ct} of the battery with CMP is smaller compared to the battery with AMP. It might be the result of that the insulated cellulose turned to electric carbon by the carbonization treatment. And the diffusion of Li ions became easier as the impedance of an electrode decreased, thus the electrochemical performance be improved.

Figure 7 shows the galvanostatic charge–discharge curves of batteries with MWCNT paper as negative electrode. There was a discharge voltage plateau at 1.2 V in the first time, which is the characteristic plateau of lithium ion inserting into CNTs. The AMP and CMP electrodes exhibited the first specific capacity of 379 mAh/g and 875 mAh/g, respectively, and a reversible specific capacity of nearly 220 mAh/g and 500 mAh/g, respectively. It was considered that lithium ions can intercalate into the MWCNTs bundle staying either inside the tube of the MWCNTs or in the space between MWCNTs. Li ions between neighboring MWCNTs have strong adsorption potential. The potential is four times larger than that for the Li ions located along the central axis of the MWCNT. This suggests that Li ions located among neighboring MWCNTs would be very difficult to deintercalate, thus resulted in a considerable irreversible capacity.[30] Via the process of heat treatment, the paper fibers turned to amorphous carbon. Though the amorphous carbon do not make contribution to the storage of lithium ion, the amorphous carbon make the CNT paper more conductive. Therefore, the lithium ion will be easier to be diffused and inserted into the MWCNTs. That is the reason why the battery with CMP had a higher first specific capacity and a higher irreversible specific capacity than the AMP battery. Although the CMP battery had larger irreversible specific capacity, its reversible specific capacity still reached about 500 mAh/g, which was 50% higher than commercial graphite anode (about 330 mAh/g). As we know, the high irreversible capacity will consume a large amount of lithium ion from the cathode material. Pre-lithiation of MWCNT method can be employed as a valid

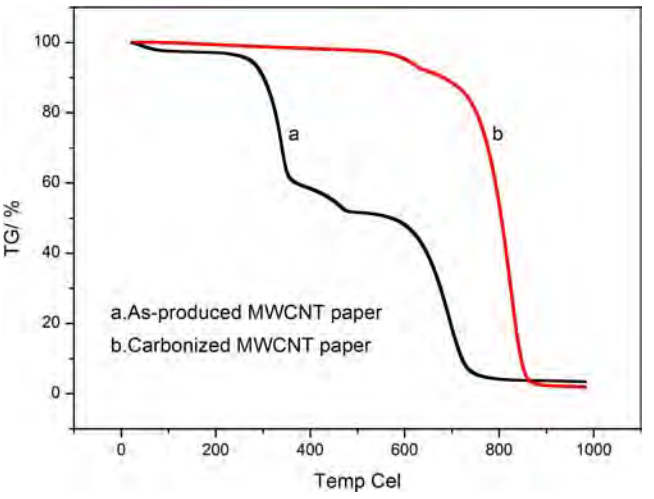
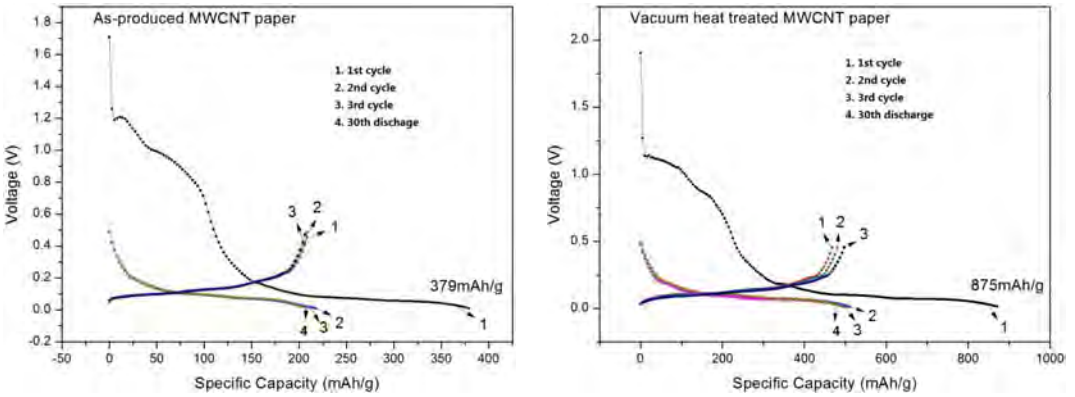
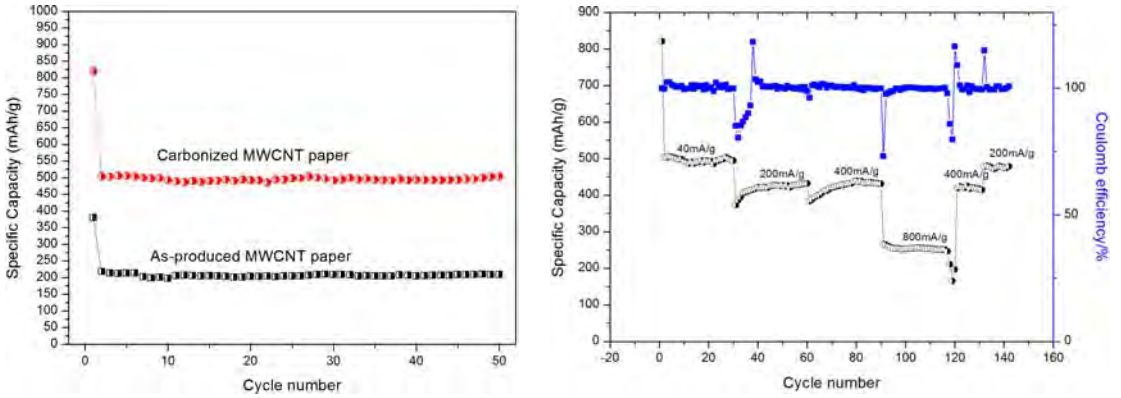


Fig. 5. TGA curves of AMP and CMP.



(a) (b)

Fig. 7. The galvanostatic charge–discharge curves at 40 mA/g of AMP (a) and CMP (b).



(a) (b)

Fig. 8. Cycle performance of AMP and CMP at current density of 40 mA/g (a), rate capability performance of CMP at different current densities (b).

process to mitigate the adverse impact of applying MWCNTs as anode material.

Figure 8(a) shows the galvanostatic discharge specific capacity versus the cycle number for the battery made from the AMP and CMP electrodes. The specific capacity was greatly improved by adopting the CMP as negative electrode. Due to the fact that the electrode structure was improved by turning the cellulose to amorphous carbon, the resistivity of electrode was greatly decreased from $0.651\,\Omega \cdot \mathrm{cm}$ to $0.150\,\Omega \cdot \mathrm{cm}$ with carbonization treatment. After 50 cycles, the CMP battery still maintained a high specific capacity of around 500 mAh/g. The electrochemical cycling behavior of the CMP battery at different current densities from 40 mA/g to 800 mA/g is shown in Fig. 8(b). A discharge specific capacity of around 500 mAh/g is obtained at 40 mA/g after 30 cycles. And a slight loss appeared at current density of 200 mA/g and 400 mA/g. When the current density of 800 mA/g was applied, the specific capacity decreased to around 200 mAh/g, which is close to the capacity of the AMP battery at 40 mA/g. When reducing the current density, the specific capacity easily recovered. The CMP electrode exhibited good cycle performance and high current impulse withstanding capability. The result also indicated a high Coulomb efficiency of nearly 100% at all current rates in Fig. 8(b).

4. Conclusion

MWCNT paper was made up of 50 wt.% MWCNTs and 50% cellulose. It showed the property of lightweight, flexibility and good conductivity. The MWCNT paper can be manufactured easily by

traditional paper-making technology. The thickness, density and size can also be tailored arbitrarily. In the study, MWCNT paper was applied directly as negative electrode without any substrate or binder. Since the carbonization process turned the fiber paper to amorphous carbon, the degree of purity and the conductivity of the MWCNT paper improved significantly. The reversible specific capacity of the CMP battery increased to 500 mAh/g from 220 mAh/g. And it maintained stable cycle performance at different current densities. The MWCNT paper electrodes exhibited a strong absorption of electrolyte, good conductivity and special micro-pores structure which greatly enhanced electrons and lithium ions migration. The primary studies revealed that the CMP can be used directly as negative electrode for lithium ion battery and have great potential as a flexible cell for wearable and portable electronic devices.

Acknowledgments

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Detailed Analysis of the UV-Adjustment Techniques Used in Paper and Graphic Industries

Li Yang

Around two decades ago a single-point method for adjusting the UV content of incident light in spectrophotometers was introduced. This allowed instruments from different manufacturers and in different laboratories around the world to measure fluorescent properties similarly. However, questions arose about the validity of single-point calibration / verification procedures; this article looks at the validity of these assumptions by assessing the entire spectrum – not just the UV region.

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Detailed Analysis of the UV-Adjustment Techniques Used in Paper and Graphic Industries

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Abstract: Many commercial materials (papers and boards) contain optical brightening agents also known as fluorescent whitening agents. Adequate adjustment of the UV content of a measurement device (e.g., spectrophotometers) is essential for accurate color measurement. As specified in the ISO standards, the UV content is adjusted against an assigned value of an international reference transfer standard, for example, CIE whiteness (D_{65}/10°) for the CIE illuminant D_{65} or ISO brightness for the C illuminant. Because of the simplicity, these approaches have gained great popularity in papermaking industry. Yet, there has been little evidence indicating how accurate the total spectral radiance factor corresponding to the single assigned value is reproduced. Hence, we present a method that quantitatively evaluates the accuracy of the UV-adjustment technique, through comparing the total spectral radiance factors obtained from UV adjustment with the assigned ones. This method has been applied to three second-level international reference transfer standard illuminated by three standard illuminants, D_{65}, C, and D_{50}. We found that the major differences between the assigned spectra and those obtained from the UV adjustments occur in the blue band where fluorescence is strong. At a few wavelengths, the differences may be up to 4–5%. Nevertheless, their color differences corresponding to the assigned spectra and those obtained from the UV adjustments are still smaller than unity (1 ΔE) for all of the illumination conditions. Two instruments using the representative UV adjusting techniques, for example, the conventional UV-adjusting with an adjustable (GG395) UV filter and the numerical UV-filtering, have been studied.* © 2016 Wiley Periodicals, Inc. Col Res Appl, 42, 19–26, 2017; Published Online 13 January 2016 in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/col.22015

Key words: color measurement; fluorescence; reflectance; UV adjustment; optical calibration

INTRODUCTION

Whiteness and brightness are important properties of paper products. CIE whiteness is a quantity depending on the total spectral radiance factor in the entire visible spectral range, whereas brightness is only in the blue band between 400 and 510 nm with the top contribution around 457 nm. There are four possible ways[1] to improve paper's whiteness: bleaching, adding fillers, using shading dyes, and adding optical brightening agents (OBAs). Brightness can also be improved by bleaching, adding fillers, and OBAs but not by using shading dyes. Unlike bleaching or using fillers, which reduces light absorption or enhances light scattering, OBAs convert invisible UV radiation to visible blue fluorescence and improve total spectral radiance factors especially in the blue spectral band. By this method, the paper gains a blue tint that is perceived as white. OBAs occur in nearly all white paper products in Europe today, such as office paper, coated paper, and coated carton board.[2,3] It is common that an OBA-containing paper of which the total spectral radiance factor in blue is 30 or 40% higher than the ideal white (reflectance = 100%), when measured under UV-rich light illuminations, such as CIE D_{65}. However, unlike the other three ways, the whiteness improvement by using OBAs depends on the UV content or more precisely the spectral power distribution (SPD) of the illumination source.

Standard illuminants, D_{65} and C, are the standard illuminations in paper industry, mimicking outdoor and indoor daylight conditions. Correspondingly, in graphic

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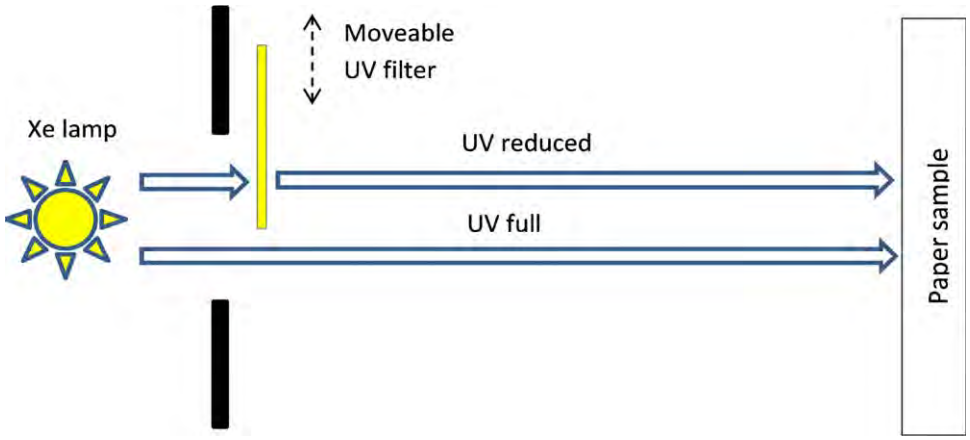

Fig. 1. Schematic illustration of the conventional UV-filtering and -adjustment techniques. The UV amount is regulated by moving the GG395 UV filter in and out of the optical path. The light beam that passes through the UV filter has wavelengths longer than 400 nm.

industry, the standard illuminants are D_{50} and A. These illuminations have different UV contents; D_{65} is the strongest followed by D_{50}. When the SPDs are normalized at $\lambda = 370$ nm around which the excitation efficiency peaks, the C illuminant has the lowest UV content,[4] lower than the A illuminant. It is obvious and natural that the same print is perceived very differently when viewed under different illuminations, provided there are OBAs involved.

According to the ISO standards applicable for papermaking industries,[5–8] adjustments of the UV contents of the standard illuminants, C and D_{65}, are achieved by matching to single-assigned values, namely, ISO brightness for C and CIE whiteness for D_{65}, respectively. The reasons CIE whiteness was chosen as the UV-adjustment criteria were given by Bristow,[9] as it is simple and reasonably accurate in reproducing the spectral radiance factor corresponding to the assigned CIE whiteness value. However, these methods have intrinsic weaknesses, for instance, fluorescent metamerism. Jordan *et al.*[4] pointed out that a true D_{65} colorimetry of fluorescent paper requires matching the SPD of the illumination because the detailed shape of the emission spectrum depends on the joint features of the UV spectrum of the illumination weighted by the corresponding excitation spectrum. Hence, the one-point-matching technique can hardly ensure that the adjusted illumination is equal (or close) to the standard illuminant, D_{65} or C, in papermaking industries. In other words, two illuminations of different UV spectroscopic characteristics may still result in identical CIE whiteness or ISO brightness, which is known as fluorescent metamerism.

Optical brightening agents contribute not only to paper properties, for example, whiteness and brightness, but also affect printed colors. Fluorescent light emitted by OBAs enhances optical dot gain and leads to more saturated color print.[10,11] In graphic industries, D_{50} and A are the standard illuminants according to ISO standards.[12–14] However, despite significant UV content of the D_{50} illumination, which strongly impacts color measurement, there is no well-documented method for the adjustment of the UV content.

The objective of this work is to examine how effective or reasonable the one-point-matching UV adjustment is in colorimetric measurements standardized by ISO 5631-1, −2, and −3.[15–17]

UV-FILTERING AND -ADJUSTMENT TECHNIQUES

According to the ISO standards, the standard illuminants used in papermaking and graphic industries are CIE D_{65} and C and D_{50} and A, respectively. From the colorimetric point of view, illuminant A gives more fluorescence contribution than illuminant C. However, it is still reasonable to focus on illuminants D_{65}, D_{50}, and C, because illuminant A is realizable by an incandescent lamp and needs no UV adjustment. To generate different illuminations having different UV contents within a spectrophotometer, UV-filtering technique is used, often with only one or a few UV filters.

Spectrophotometers used in paper industries apply basically two major types of UV-adjustment techniques[18]: the traditional filtering method introduced by Gärtner and Griesser[19] in the 1970s, and the numerical UV-filtering technique introduced by Imura *et al.*[20] in 1990s. These two techniques are further explained in detail.

Conventional UV-Adjustment Technique with Adjustable Filters

Typically, a spectrophotometer based on the conventional UV-adjustment technique (used in papermaking industry) is equipped only with one xenon lamp as the light source. The standard illuminations are, in practice, obtained by applying the adjustable UV filter, as shown in Fig. 1. The most commonly used is GG395 UV filter with the cutoff wavelength at 400 nm. This filter removes (absorbs) UV radiations below 400 nm.

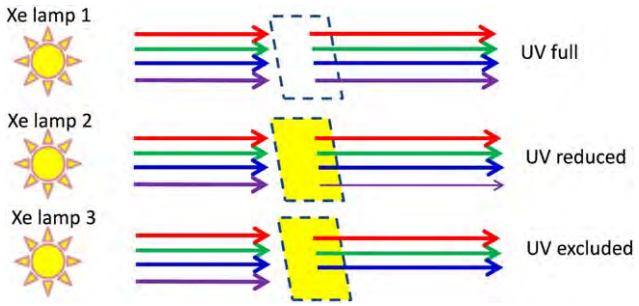

Fig. 2. Schematic diagram of the numerical UV-filtering technique. A spectrophotometer equipped with three lamps. Light beams from lamps 2 and 3 are filtered by the GG395 and 420 nm cutoff filters. The total spectral radiance factors of the paper sample (not shown) are measured under the exposures of each of the light beams.

As shown in Fig. 1, the UV content of an illumination is controlled by the position of the adjustable filter. For the light beam that passes through the GG395 filter, the UV radiations below 400 nm from the lamp are removed by the filter, whereas the rest (radiations of longer wavelengths) pass freely through the filter and reach the paper sample. Naturally, the UV content of the light that reaches the paper sample depends on the portion of the light that passes through the GG395 filter. The mathematical expression for this kind of UV content adjustment is given in the "Simulation of the Total Spectral Radiance Factor Measurements" section. The spectrophotometers also equip with another UV filter having the cutoff wavelength at 420 nm. When this filter is fully engaged, all the UV radiations from the lamp are absorbed by the filter and only the visible light reaches the paper sample.

Numerical UV-Filtering Technique

The numerical UV-adjustment technique was introduced in 1997. One of the spectrophotometer that uses this technique is Minolta CM3630d. Instead of using one lamp and one adjustable UV filter, three xenon lamps are mounted in a row inside the integration sphere. Two of the lamps are completely filtered either by the GG395 UV filter or the UV cutoff filter (420 nm), respectively (see Fig. 2). The lamp with GG395 UV filter emits light of reduced UV content, whereas the one with 420 nm cutoff filter emits light having essentially no UV content. The third lamp has no UV filter coverage. Flashing individually with these lamps, one lamp at a time generates illuminations of full UV content, UV-reduced, and UV-excluded, respectively. Corresponding to these illuminations, one obtains three total spectral reflectance factors, $R_{\text{uv-full}}$, R_{GG395}, and R_{uvx}. The total spectral radiance factor under a specific standard illuminant, such as CIE D_{65}, is expressed as a linear superposition of two of the spectral radiance factors, as explained below in detail.

METHODS

In this study, we present a method that exactly simulates the UV-adjustment technique with a physical spectrophotometer. Two commercial spectrophotometers, CM3630d from Konica Minolta and CT2 from Technidyne, have been simulated in this study. These two instruments use two different types of UV-filtering techniques: the CM3630d uses the numerical UV filtering, and the CT2 uses the conventional UV filtering with an adjustable UV filter.

IR2 Reference Standards and the Total Spectral Radiance Factors

Two carefully selected paper pads, one nonfluorescent and one fluorescent, were sent to the Standardizing Laboratory at NRC for calibration. These paper pads with the assigned values are the second-level international reference standards (IR2s) in the ISO hierarchy of calibration. According to the ISO standards, the assigned values for the nonfluorescent IR2 are the spectral reflectance factors, whereas for the fluorescent IR2s, three assigned values were given to the same fluorescent paper pad thereby actually three IR2s corresponding to three standard illuminants, D_{65}, D_{50}, and C. These assigned values are CIE whiteness ($D_{65}/10°$), CIE whiteness ($D_{50}/2°$), and ISO brightness (illuminant C). In addition, the total spectral radiance factors, denoted as the assigned total spectral radiance factors, corresponding to these assigned values were also given. The NRC facility used for calibrating the fluorescent IR2s is a two-monochromator reference spectrophotometer that is capable of providing high-accuracy total radiance factor measurements.[21,22]

The measurement scales of the instruments were calibrated against the assigned spectral reflectance factors of the nonfluorescent IR2. After the calibration, these apparatuses were used to measure the total spectral radiance factors of the fluorescent paper pad corresponding to three distinct UV content levels, that is, $R_{\text{uv-full}}$, R_{GG395}, and R_{uvx}. Here, $R_{\text{uv-full}}$ stands for illumination directly from the lamp with the full UV content, R_{GG395} for the reduced UV content with full engagement of the GG395 UV filter, and R_{uvx} with the full engagement of the UV cutoff filter up to 420 nm, respectively.

Simulations of the Total Spectral Radiance Factor Measurements

In this subsection, we explain how physical measurements with CT2 or CM3630d can be "performed" by numerical means. We begin with the CT2 apparatus that has an adjustable UV filter (GG395). Assuming that the area percentage of the GG395 filter setting into the optical path is α and the rest $1-\alpha$ (see Fig. 3), the total spectral radiance of the incident light that reaches the sample may be written as follows:

$$I_{\text{in}}(\mu)=(1-\alpha)I_{\text{uv-full}}(\mu)+\alpha I_{\text{GG395}}(\mu), \qquad (1)$$

where the variable μ stands for wavelength in both UV and visible spectral range, and the symbol λ is reserved for visible light only. In the expression, the first term on the right-hand side stands for the portion of light that does not pass through any UV filter hence with the full

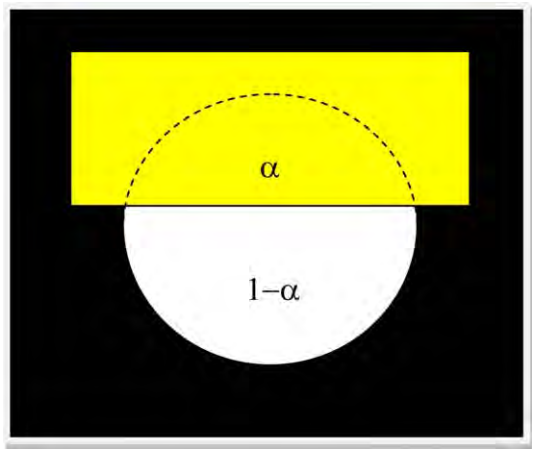

Fig. 3. Illustration of the conventional UV-filtering technique with one moveable UV filter (in yellow). The UV content of the illumination is adjusted by changing the portion (area) of the UV filter.

UV radiations, and the second term for the light flux that passes through the GG395 filter. The quantity, α, takes different values when adjusted to illuminations of different UV contents. In a modern spectrophotometer, the UV filter is motor-driven, and the quantity, α, is defined by the motor position.

To elucidate the principle behind the UV-adjustment technique, we demonstrate how the expression for the total spectral radiance factors of a luminance specimen is derived, before going into details on how to determine the parameter, α, from the assigned values.

When the luminance specimen is illuminated by a light source that contains UV, the radiance of the specimen consists of two portions. One of the portions comes from the ordinary light reflection and another from fluorescent emission. When only the visible spectrum is considered, that is, $\lambda > 400$ nm, the total spectral radiance of the specimen can be expressed as follows[23]:

$$I(\lambda)=I_{\text{in}}(\lambda)R_{\text{S}}(\lambda)+I_{\text{in}}(\lambda)R_{\text{L}}(\lambda), \tag{2}$$

where

$$R_{\text{L}}(\lambda)=\frac{\int_{\mu<400\text{nm}} I_{\text{in}}(\mu)f(\mu,\lambda)d\mu}{I_{\text{in}}(\lambda)} \tag{3}$$

is the luminance radiance factor with the quantity, $f(\mu,\lambda)$, corresponding to the quantum efficiency of the fluorescent whitening agents (FWAs) that convert UV light into visible. The quantity, $R_{\text{S}}(\lambda)$, is the spectral reflective radiance factor.

By inserting Eq. (1) into Eqs. (2) and (3), one obtains the following equation:

$$\begin{aligned} I(\lambda)&=(1-\alpha)I_{\text{uv-full}}(\lambda)\left(R_{\text{S}}(\lambda)+R_{\text{L,uv-full}}(\lambda)\right)\\ &\quad+\alpha I_{\text{GG395}}(\lambda)\left(R_{\text{S}}(\lambda)+R_{\text{L,GG395}}(\lambda)\right)\\ &=I_{\text{in}}(\lambda)[(1-\alpha)\left(R_{\text{S}}(\lambda)+R_{\text{L,uv-full}}(\lambda)\right)\\ &\quad+\alpha\left(R_{\text{S}}(\lambda)+R_{\text{L,GG395}}(\lambda)\right)], \end{aligned} \tag{4}$$

where

$$\begin{aligned} R_{\text{L,uv-full}}(\lambda)&=\frac{\int_{\mu<400nm} I_{\text{uv-full}}(\mu)f(\mu,\lambda)d\mu}{I_{\text{uv-full}}(\lambda)}\\ &=\frac{\int_{\mu<400nm} I_{\text{uv-full}}(\mu)f(\mu,\lambda)d\mu}{I_{\text{in}}(\lambda)}, \end{aligned} \tag{5}$$

and

$$\begin{aligned} R_{\text{L,GG395}}(\lambda)&=\frac{\int_{\mu<400nm} I_{\text{GG395}}(\mu)f(\mu,\lambda)d\mu}{I_{\text{GG395}}(\lambda)}\\ &=\frac{\int_{\mu<400nm} I_{\text{GG395}}(\mu)f(\mu,\lambda)d\mu}{I_{\text{in}}(\lambda)}. \end{aligned} \tag{6}$$

Here, we have assumed that the GG395 filter only removes UV light of wavelengths shorter than 400 nm and is ideally transparent above 400 nm. Hence,

$$I_{\text{in}}(\lambda)=I_{\text{uv-full}}(\lambda)=I_{\text{GG395}}(\lambda). \tag{7}$$

Then, the total spectral radiance factor is given as follows:

$$R(\lambda)=\frac{I(\lambda)}{I_{\text{in}}(\lambda)}=(1-\alpha)R_{\text{uv-full}}(\lambda)+\alpha R_{\text{GG395}}(\lambda), \tag{8}$$

where

$$\begin{aligned} R_{\text{uv-full}}(\lambda)&=R_{\text{S}}(\lambda)+R_{\text{L,uv-full}}(\lambda),\\ R_{\text{GG395}}(\lambda)&=R_{\text{S}}(\lambda)+R_{\text{L,GG395}}(\lambda). \end{aligned} \tag{9}$$

Equation (8) indicates that the total spectral radiance factor, $R(\lambda)$, is a superposition of the total spectral radiance factors measured under the UV-full and the UV-reduced illumination condition filtered by the GG395 filter. This equation is the corner stone of the UV-filtering techniques.

For a spectrophotometer using an adjustable filter, one should bear in mind that all the factors, α and $(1-\alpha)$ in Eq. (8), are neither negative nor greater than unity, as they represent the area percentages. Hence, the quantity, α, in Eqs. (1) and (8) subjects to the following constraint:

$$0 \le \alpha \le 1. \tag{10}$$

This is an important difference when compared with an instrument using numerical UV-filtering technique, as described below.

The total spectral radiance factors of the luminescent sample, when measured with the CM3630d, are actually the superposition of two separate measurements:

$$R(\lambda)=\beta R_{\text{uv-full}}(\lambda)+(1-\beta)R_{\text{GG395}}(\lambda), \tag{11}$$

where the $R_{\text{uv-full}}$ and R_{GG395} are the total spectral radiance factors of the luminescent sample when illuminated by the lamp without any UV filter coverage and the lamp fully covered by the GG395 filter, respectively. Equation (11) shares exactly the same mathematical form as Eq. (8). Nevertheless, the quantity β in Eq. (11) has no

longer any physical meaning as it does in Eq. (8) in the case of the conventional UV-filtering technique. Rather, it only quantifies the relative portions of the contributing spectral components. Hence, this quantity β in Eq. (11) does not have to satisfy the physical constraint expressed in Eq. (10), and it may take any values, even negative or greater than unity. Yet, for the sake of convenience, we do not distinguish β from α or we simply redefine $\beta = \alpha$.

UV Content Adjustment for a C Illuminant

The UV content adjustment method for a C illuminant is specified in the ISO standard, ISO 2470-1:2009. It relies on a single assigned value, ISO brightness, to define the quantity, α, that is, the portion of light passing through the GG395 UV filter. The task of UV adjustment is then to determine the quantity, α, by matching the measured value of the IR2 to the assigned ISO brightness value. Once this quantity is set, one can use it to simulate a physical measurement of any fluorescent sample, using Eq. (8) or (11).

Here, we explain how the UV adjustment is achieved in a practical sense. For convenience of the explanation without losing generality, we use the apparatus having an adjustable filter as an example. Assume that the area portion of the GG395 filter is α. From the expression for the spectral radiance factor given in Eq. (8), one can easily obtain the expression for ISO brightness as follows:

$$B = \alpha B_{\text{GG395}} + (1-\alpha) B_{\text{uv-full}}, \tag{12}$$

where $B_{\text{uv-full}} = \int b(\lambda) R_{\text{uv-full}}(\lambda) d\lambda$ and $B_{\text{GG395}} = \int b(\lambda) R_{\text{GG395}}(\lambda) d\lambda$ and $b(\lambda)$ is the brightness weighting function. With the assigned ISO brightness, B_{Ass}, of the IR2 fluorescent paper pad, one can obtain the following equation:

$$\alpha = \frac{B_{\text{uv-full}} - B_{\text{Ass}}}{B_{\text{uv-full}} - B_{\text{GG395}}}. \tag{13}$$

In the case of motor-driven GG395 filter as is the case of CT2 apparatus, the quantity α corresponds to the motor position at which the reading matches the assigned value.

UV Content Adjustment of the CIE D-Type Illuminants

The UV-adjustment methods for the D types of illuminants, D_{65} and D_{50}, are specified in the ISO standards. Their UV content adjustments rely on single assigned values, CIE whiteness ($D_{65}/10°$),[5,16] and CIE whiteness ($D_{50}/2°$),[17] respectively. According to the definitions, the CIE whiteness values are given as follows:

$$W = Y + 800(x_n - x) + 1700(y_n - y), \tag{14}$$

where x_n and y_n are the chromaticity coordinates of the standard illuminants. From Eq. (8) or (11), one receives the expressions for the CIE–XYZ color coordinates of a fluorescent sample as follows:

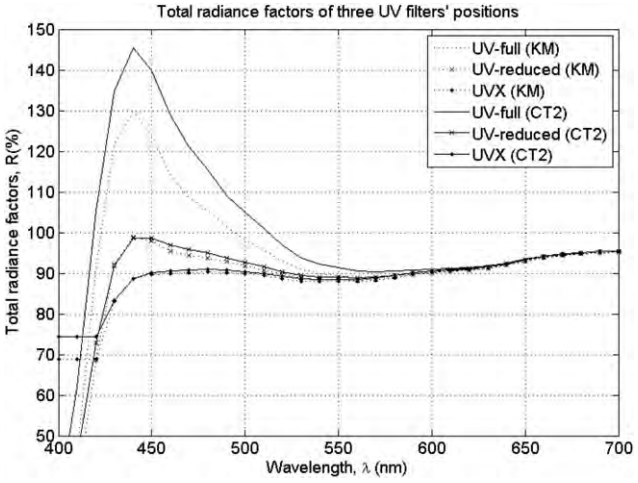

Fig. 4. The total spectral radiance factors measured with two spectrophotometers: CM3630d (dotted lines) and CT2 (solid lines). UV-full: no UV filter is engaged; UV-reduced: full engagement of the GG395 filter; and UVX: full engagement of the cutoff filter (420 nm).

$$\begin{aligned} X &= k\int S(\lambda)R(\lambda)\bar{x}(\lambda)d\lambda = (1-\alpha)X_{\text{uv-full}} + \alpha X_{\text{GG395}} \\ Y &= k\int S(\lambda)R(\lambda)\bar{y}(\lambda)d\lambda = (1-\alpha)Y_{\text{uv-full}} + \alpha Y_{\text{GG395}}\,, \\ Z &= k\int S(\lambda)R(\lambda)\bar{z}(\lambda)d\lambda = (1-\alpha)Z_{\text{uv-full}} + \alpha Z_{\text{GG395}} \end{aligned} \tag{15}$$

where $T_{\text{uv-full}} = k\int S(\lambda)R_{\text{uv-full}}(\lambda)\bar{t}(\lambda)d\lambda$ and $T_{\text{GG395}} = k\int S(\lambda)R_{\text{GG395}}(\lambda)\bar{t}(\lambda)d\lambda$ with $T = X, Y, Z$ and $\bar{t} = \bar{x}, \bar{y}, \bar{z}$. The chromaticity coordinates of the fluorescent sample are given as follows:

$$\begin{aligned} x &= \frac{X}{X+Y+Z} = \frac{X_{\text{uv-full}} - \alpha[X_{\text{uv-full}} - X_{\text{GG395}}]}{\sum_{T=X,Y,Z} T_{\text{uv-full}} - \alpha \sum_{T=X,Y,Z} [T_{\text{uv-full}} - T_{\text{GG395}}]} \\ y &= \frac{Y}{X+Y+Z} = \frac{Y_{\text{uv-full}} - \alpha[Y_{\text{uv-full}} - Y_{\text{GG395}}]}{\sum_{T=X,Y,Z} T_{\text{uv-full}} - \alpha \sum_{T=X,Y,Z} [T_{\text{uv-full}} - T_{\text{GG395}}]} \end{aligned}. \tag{16}$$

With the assigned CIE whiteness, W_{Ass}, for the fluorescent IR2s, one can rewrite Eq. (14) as follows:

$$W_{\text{Ass}} - 800x_n - 1700y_n = Y - 800x - 1700y. \tag{17}$$

Obviously, Eq. (17) is a quadratic equation of the unknown quantity, α, which is analytically solvable.

RESULTS AND DISCUSSIONS

Figure 4 shows the total spectral radiance factors of the fluorescent IR2s, measured with two spectrophotometers, CT2 (solid lines) and CM3630d (dotted lines). The illuminations used in the measurements are of different UV contents, UV-full, UV-reduced with the full engagement of GG395, and UVX (UV-excluded) with the UV cutoff filter (420 nm). When directly illuminated by the bare

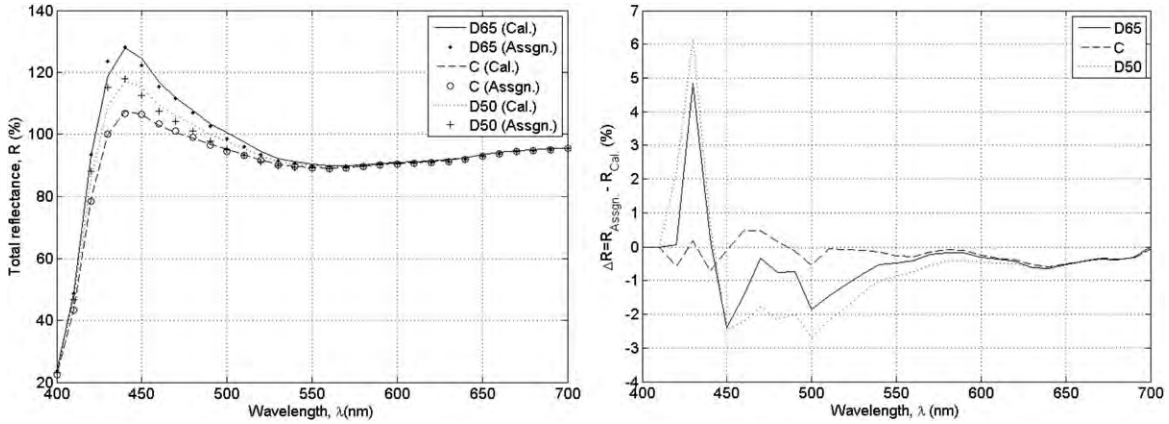

Fig. 5. Total spectral reflectance factors of the IR2 reference standards, for standard illuminations, D_{50}, D_{65}, and C. The solid lines are the values computed with the factors listed in Table I (CT2), and the assigned values are denoted by different symbols, that is, "*," "o," and "+."

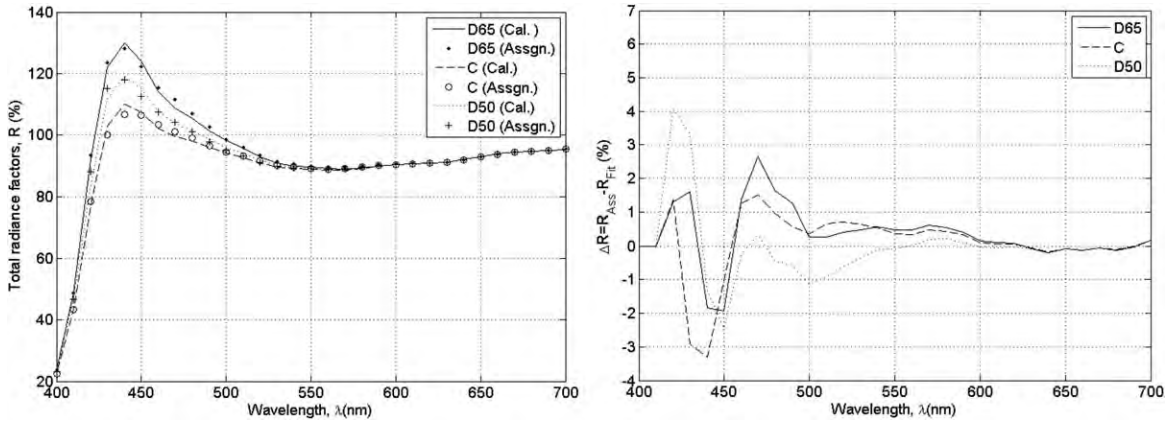

Fig. 6. Total spectral reflectance factors of the IR2 reference standards, for standard illuminants, D_{50}, D_{65}, and C. The solid lines are the values computed with the factors listed in Table I (CM3630d), and the assigned values are denoted by different symbols, that is, "*," "o," and "+."

Xenon lamp (UV-full), the CT2 gives a significantly higher reading than that by the CM3630d in the fluorescence-intensive spectral range from 400 to 500 nm. There are a couple of possible origins that cause the difference. First, the Xe lamp in the CT2 may operate in a higher electric voltage and has significantly higher UV emissions than that in the CM3630d. Even though a higher voltage does not affect the SPD of Xe flash radiation, it does increase the UV radiation flux. Unlike ordinary light reflection that is independent of its incident light flux, the fluorescent component [Eq. (3)] increases with stronger UV radiation. Second, it may also be attributed to a visible-suppressing filter often inserted in the illumination flux of Gärtner–Griesser method (applied in CT2) to guarantee the match with the illuminant D_{65} in the condition of $0 < \alpha < 1$ even after aging of Xe lamp. Obviously, both cases can cause differences in the total spectral radiance factors as shown in Fig. 5 and in the colorimetric values shown later in this section. The plots also suggest that these spectrophotometers are equipped with similar UV-reducing and UV-cutoff filters, as their spectral radiance factors of UV-reduced (400 nm) and UVX (420 nm) have only marginal differences at all wavelengths.

The weighting factors representing the filter combinations corresponding to the three standard illuminations, C, D_{65}, and D_{50}, are given in Table I. As previously explained, the factor α denotes for the portion of the UV-reduced illumination by the GG395 UV filter. Hence, the UV contents of these illumination conditions come, above all, from the UV-full, represented by the magnitude of $1 - \alpha$. As expected, the D_{65} illuminations of the both apparatuses possess the highest UV contents, followed by the D_{50} and the C illuminations. With the CT2, the respective contributions from UV-full are 63%, 41%, and 19%. As the UV-full from the CM3630d has lower UV content, it actually needs more than 100% of the UV-full to match the UV content of the D_{65} illumination. Consequently, the factor α takes a negative value. The D_{50} has also significant UV content as it comprises more than 66% of the UV-full in CM3630d. Relatively speaking, the C illumination has the lowest UV content as the UV-reduced (represented by the factor α) is the biggest, 64% in the case of CM3630d. All of these are in line with expectations.

TABLE I. The weighting factors for standard illumination conditions.

Instruments	Illuminations	α for UV-reduced	$1-\alpha$ for UV-full
Konica-Minolta	D_{65}	−0.0051	1.0051
	C	0.6382	0.3618
	D_{50}	0.3351	0.6649
Color-Touch 2	D_{65}	0.3719	0.6281
	C	0.8109	0.1891
	D_{50}	0.5931	0.4069

TABLE II. Differences between the chromatic coordinators.

Instruments	Illuminations	$L^*_{Ass}-L^*_{Cal}$	$a^*_{Ass}-a^*_{Cal}$	$b^*_{Ass}-b^*_{Cal}$	ΔE^*
CM3630d	D65	−0.195	0.365	−0.140	0.437
	C	−0.170	0.700	−0.637	0.959
	D50	0.079	−0.344	0.063	0.359
Color-Touch 2	D65	0.248	−0.490	0.248	0.603
	C	0.080	0.046	0.133	0.162
	D50	0.228	−0.125	0.129	0.290

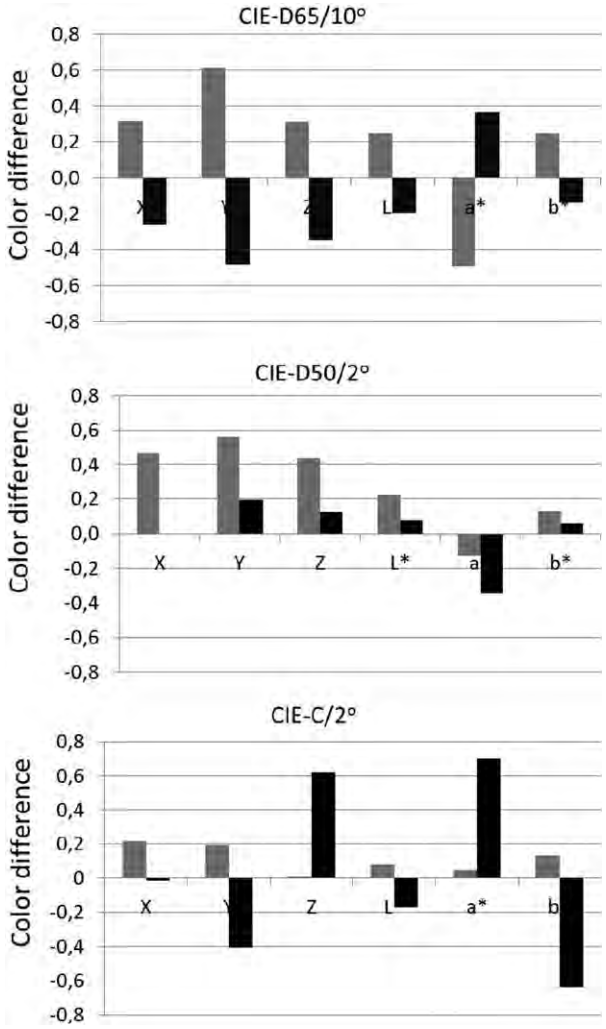

Fig. 7. Differences of the color coordinators, CIE XYZ and CIELAB, calculated from the assigned total spectral radiance factors and the ones obtained by matching the assigned whiteness and brightness values of the standard illuminants, D_{65}, D_{50}, and C. In the figures, the gray bars represent the CT2, and the black bars represent the CM3630d.

The numerical UV-filtering and -adjustment technique offers a number of advantageous flexibilities when compared with the conventional UV-adjustment technique with a moveable UV filter (GG395). First, it allows the device to "act" beyond its upper or lower physical limits. For instance, it enables the device to have more than 100% of UV-full ($1-\alpha>1$) or to have negative ($\alpha<0$) contributions when composing (matching) the standard illuminations. Second, it eliminates the need for lengthy and repeated filter-position adjustments to ensure both correct reflectance scale and the UV content. Third, this also makes it possible that the UV content be adjusted not only to have the best agreement for the whiteness but also for the tint value (which, in case of the adjustable filter is not possible).

Figures 5 and 6 depict the spectra of the IR2 reference standards, measured under the three standard illuminations, C, D_{50}, and D_{65} and with the two spectrophotometers, CT2 and CM3630d, respectively. In the figures on the left, the solid, dashed, and dotted lines represent the calculated spectra of the respective illumination conditions, using Eq. (8) or (11) and with the weighting factors listed in Table I. The corresponding values assigned by NRC are denoted as "+," "*" and "o," respectively. The figures on the right hand side show the differences between the assigned spectra and the calculated ones. As shown, the calculated spectra and the assigned ones are largely in good agreement, except for the wavelengths around 430 nm. Moreover, the differences between the assigned values and the calculated ones decrease quickly toward longer wavelengths. Consider the fact that only single assigned values were used in the UV content adjustment, such an agreement is reasonably satisfactory. When the spectra are known, one can calculate all kinds of optical and chromatic quantities, for instance, CIE whiteness and ISO brightness values. The maximal difference between the CIE whiteness ($D_{65}/10°$) value calculated with the assigned spectra and the calculated ones is 0.005. For ISO brightness (C), the corresponding value is 0.062. These differences are (much) smaller than tolerances required by the ISO standards based on the one-value UV content adjustment techniques.

Figure 7 depicts the differences of the color coordinators calculated using the assigned spectra and the calculated ones corresponding to the three standard illuminations. As the major discrepancies between the assigned and the obtained spectra occur in the blue spectral band where the fluorescence contributes most, it is natural that the biggest color differences are for the b* and a* coordinators. The differences between the corresponding chromatic coordinators calculated from the assigned spectra and the simulated ones are listed in

Table II. Even their respective color differences for the instruments are also listed. The color differences between the assigned values and the simulated ones, in the case of the D_{65} illumination, are 0.44 ΔE^* and 0.60 ΔE^* for CM3630d and CT2, respectively. These values are either close or slightly bigger than the required limit defined in ASTM E991,[24] namely, 0.5 ΔE^*.

SUMMARY

The objective of this work is to examine the efficiency and the accuracy of the UV content adjustment methods adapted in the ISO standards, relying on the so-called one-point-matching technique. We present a method that quantitatively evaluates the accuracy of the UV-adjustment technique, through comparing the total spectral radiance factors obtained from the UV adjustment with the assigned ones. This method enables one to perform UV content adjustment in exactly the same manner as with a physical spectrometer. This study involves three second-level international reference transfer standards (IR2s) illuminated by three standard illuminants, D_{65}, C, and D_{50}, and two commercial instruments using the representative UV adjusting techniques. The CT2 uses the conventional UV-adjusting technique with an adjustable (GG395) UV filter, and the CM3630d uses numerical UV-filtering. We found that the major differences between the assigned spectra and those obtained from the UV adjustments occur in the blue band where fluorescence is the strongest. At a few number of wavelengths, the differences may be up to 4–5%. Nevertheless, their color differences corresponding to the assigned spectra and those obtained from the UV adjustments are still smaller than unity.

Although the results obtained in this study are based on the fluorescent IR2 standards, the conclusions are valid even for fluorescent IR3s as they are made of papers from the same batch. As a part of the harmonizing procedures, all the Authorized Laboratories who issue the IR3s use papers from the same batch since 2012.

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Impact of User Behaviour in Office Building on Energy Reduction Strategies

Onyango J (1) and Ciaran R (2)

Energy use in non-domestic buildings (offices and factories) in the UK contributes an estimated 17% of total emissions. With smart-metering it should be possible to decrease this by 70-75% by 2050. However, research shows actual energy demands in offices are typically higher than modelling suggests is needed, due to idiosyncrasies of individual behaviour. This article features a case study in a library, and highlights the need to share energy data and energy management strategies with all users.

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Impact of User Behavior in Office Building on Energy Reduction Strategies

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Abstract

There has been a lot of emphasis placed on the assessment of energy use in buildings as a means to the reduction in CO_2 emissions. Smart meter technology that captures and displays not only the energy usage but also the quality of indoor environment are currently used widely within the UK, however, there exists a disconnection between the energy management systems (EMS) technology and the user behavior that could potentially affect the consumption profile. This study was carried out in Northern Ireland and revealed that energy data was hardly shared with the users, which affected their energy conservation strategies.

Keywords: Energy management system; Sustainability; Carbon dioxide emissions; Energy usage; User profile; Northern Ireland

Introduction

Over the last couple years there has been interest s in the creation of a Low carbon Society (LCS). The concept of Low Carbon Society, (LCS) first appeared in use in Japan in 2007 to mean one that aspires to make an equitable contribution to the global effort of reducing greenhouse gases to a safe level combining both a high level of energy efficiency and security [1]. Prior to the use of the LCS concept the UK government had published an Energy White Paper "Our Future Energy: Creating a Low-Carbon Economy" (DTI, 2003) [2] that argued for a strategy of achieving more economic outputs and better quality living standards, that results in less environmental pollution and minimizes the use of natural resources. Strachan, Foxon & Fujina, [1] point out LCS could be achieved through the choice of use of low carbon technologies and changes to social models and lifestyles that target energy efficiency and requires consumer responses, very much similar to those in the DTI white paper of 2003.

In practical terms, the emphasis on the assessment of energy use in buildings as a means to the reduction in CO_2 emissions is one of the outcomes of LCS strategy. Smart meter technology that captures and displays not only the energy usage but also the quality of indoor environment are currently used widely within the UK, however, there exists a disconnect between the energy management systems (EMS) technology and the user behavior that could potentially affect the consumption profile, which is another important strategy of the LCS concept.

The United Kingdom, UK is a signatory to the Kyoto Protocol and has made great efforts towards the targets set under the Protocol post 2012. The Climate Change Act (2008) [3] proposes to lower net Green House Gas, GHG emissions by 80% or less by the year 2050 based on 1990 baseline levels. Figure 1, illustrates the respective GHG emission reduction targets for the UK as a whole and the sub targets for Scotland, Wales and Northern Ireland respectively (DECC, 2011b) [4].

The initial estimates of GHG emissions for 2009 and 2010 as indicate notable reduction of 28.3% from the baseline and are indicative of possible targets being met, in the meanwhile, over the same period there was a reduction in CO_2 emissions of 19.4% as indicated in Figure 2 above.

Energy efficiency in non-domestic buildings

Literature review reveals that there are 1.8 million non-domestic buildings in the UK contributing an estimated 17% of the total emissions (UKGB, 2011) [5] and the Carbon Trust (2009) [6], argue that it is possible to achieved 70-75% reduction in CO_2 emissions of by 2050 at minimal or zero net costs if systems that employ intelligent metering were in place. They however, ignore the impact of occupier behavior and control related issues, a view supported by Bordass et al. [7], Steemers and Manchanda [8] who found out that actual energy demands in office buildings are typically significantly higher than modeled and the annual CO_2 emissions are often two to three times the expected values [9] (Figures 1 and 2).

The UK government set in place a roll out schemes for smart meters from 2014 to 2019 for both domestic and non-domestic buildings, despite the fact that the there is dearth of research on feedback on their impact on building performance in use as aptly pointed out by Stevenson & Leaman:

"…it makes it difficult to ascertain whether targets are being achieved in reality, whether the design, procurement, and management strategies are actually working and whether occupants are actually reducing their demands and expectations (particularly in relation to so-called 'efficiency gains')…" (2010, 437)

Darby [10] agrees and pointed out that primary cause of much of energy wastage was the invisibility of its consumption and that consumer behavior could be affected by effective feedback that included support in both interpreting the information as well as advice on the what to do with it. It is estimated that this is likely to result in reductions in the range of 5-15% however; other studies have shown that there is a distinct decrease in level of energy savings that was originally made after a few months if habits are not formed [11].

Consumer behavior is affected by culture; for example, a study by Isaacs, Saville-Smith, Camilleri and Burrough [12] in New Zealand

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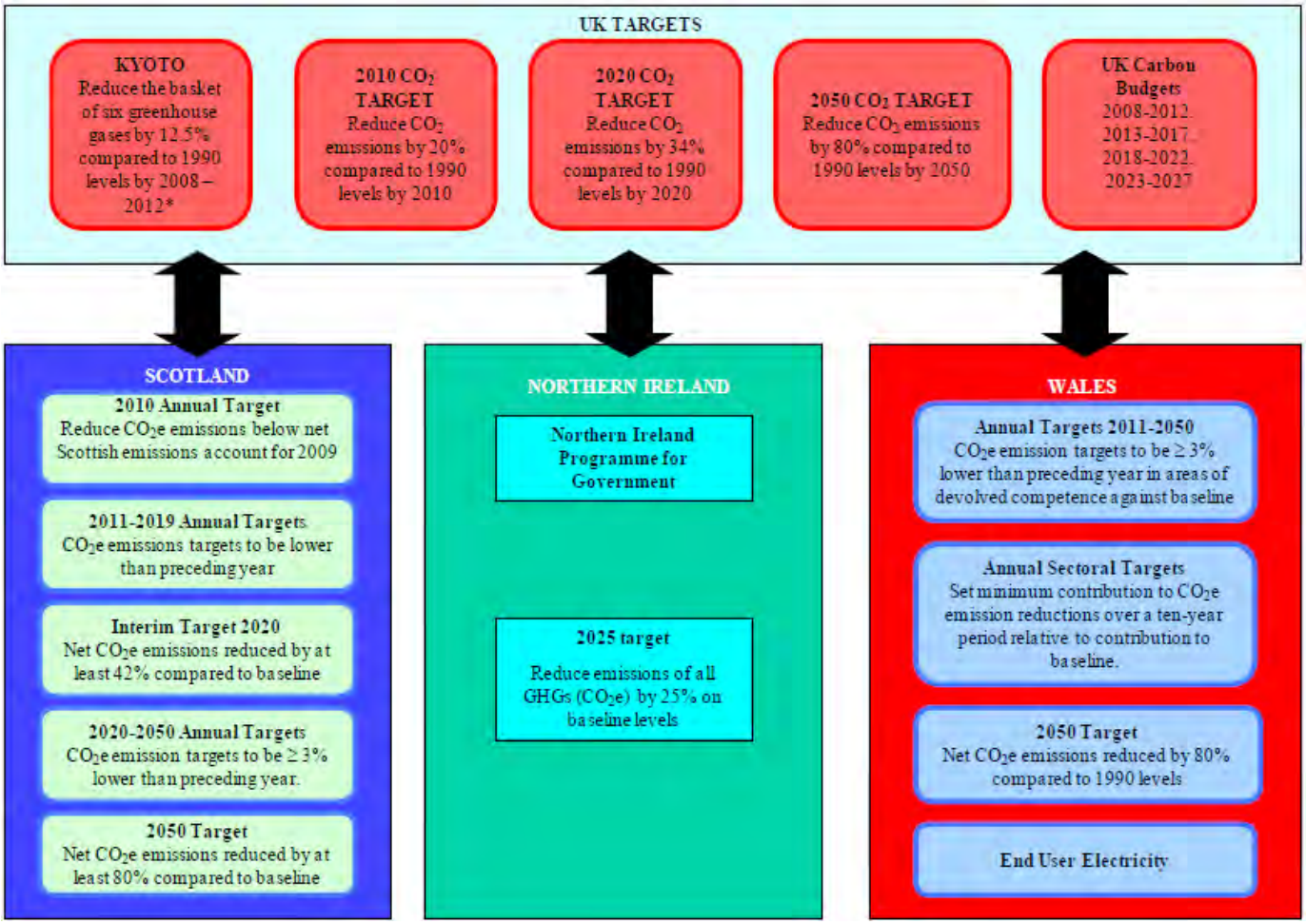

Figure 1: GHG emissions reduction targets: UK, Scotland, Wales and Northern Ireland (DECC, 2011b).

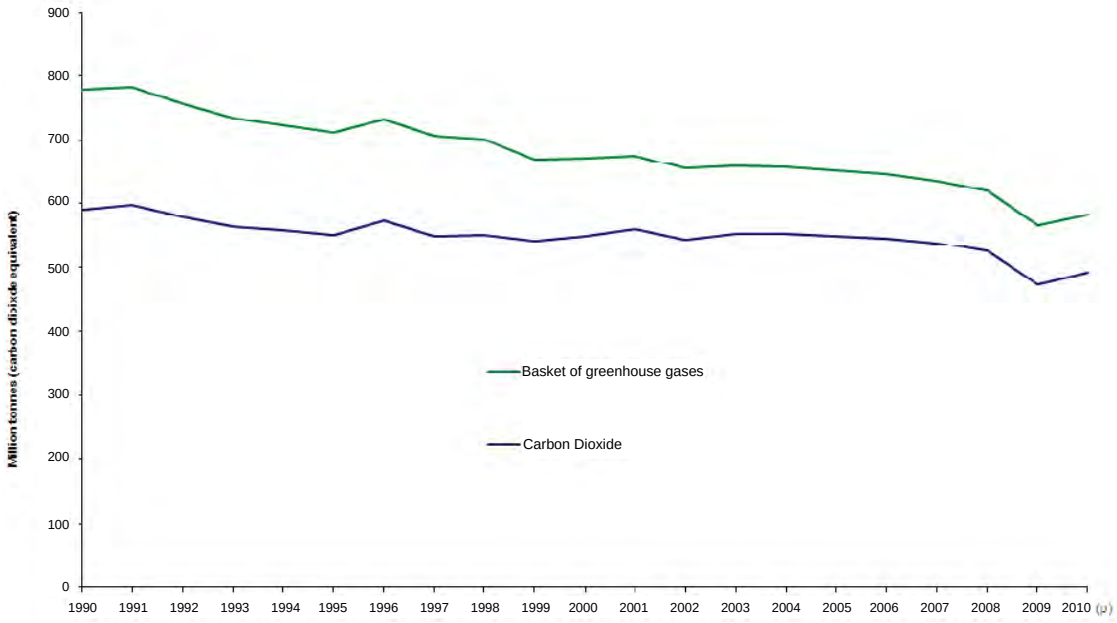

Figure 2: Emissions of greenhouse gases, 1990-2010 (provisional) (DECC 2011a).

indicated that people there are comfortable living in rooms with lower temperatures in comparison to other parts of the world. Another study of the high performances residential development by Ajzen [13] revealed that behavior had a significant impact on resource consumption within same housing type; suggesting that more attention needs to be given to behavior in comparison to intelligent physical systems than is currently done. Gram-Hanssen [14] concur pointing out that energy consumption in two different housing of same type and size can vary by up to three times or more, thus pointing to user behavior as ultimate game changer beyond efficient fabric.

Metering technology and EMS

The importance of the quality of feedback cannot be understated and it forms part of good management practices and structure within any organization and are critical in influencing positive energy usage behavior (TSB, 2009; MBEKTN, 2010) [15,16]. There are several metering technologies that have been adapted to measure energy usage in buildings, including a sub meter, an advanced meter and a smart meter. The first is normally location based and is used to obtain part of total energy load of the building; the second are placed in building but read remotely and at frequent intervals and can be placed within the main meter or sub meters with the capability to store and transmit readings every half hourly. The last type, the smart meters, allow for two way communication between the utility company and the consumer building, unlike the first two that are one way communication tools hence, is an intelligent metering technology. Sub-metering technology is cheaper, easy to use and allow for good energy management to take place and could potentially contribute to positive behavioral change of the users of the zone where energy is read if feedback is shared appropriately.

Research Methodology

This paper examines the use of existing sub metering technology in attempt to increase energy efficiency in a non-domestic building environment and whether the data gathered was used to effectively impact positively on the behavior of the energy user. Mixed methodology was used to evaluate data gathered from semi-structured interviews with three professionals involved with the design and control of the energy management system and another questionnaire that was distributed to the users at the case study building. The questionnaire was based on Likert scale, giving the respondents five options to pick from in relation to the issues of feedback from sub-metering energy technologies in the building. The questions were arranged under three themes; working environment, working practices and Energy Management system as indicated in (Tables 1a-1c).

Case Study: McClay Library at Queens University Belfast

The £50 million McClay Library at Queens University Belfast was opened in 2009 and is located on the environs of the scenic Botanic Park on the University's main campus, it is a four-story structure with a floor plan of 17,400 m^2. It was the winner of the Most Sustainable Building in the 2010 Royal Institute of Chartered Surveyor's (RICS) Awards Scheme. In addition, significant capital investment was spent with the intention of producing energy efficient building that included Building Management System controlled window openings to provide natural ventilation, and window blinds that work in tandem with the lighting controls adapted according to available daylight (Figure 3).

Monitoring energy usage in the building is a key component in maintaining an efficient operational building environment with energy use target set within 140 kWh/m^2/annum and emission of less than 1007 tons of CO_2/per year. The building has sub metering technology to monitors gas and electricity consumption at quarter-hour intervals allowing the building manager to assess whether the building was on course to meeting the targets. In addition, the data center within the McClay is sub metered separately due to the large number of high-energy demand computer processes and other plant and hardware equipment (RICS, 2010) [17].

The metering data combined with the "footfall" i.e. number of people within the building at any one time, allows the identification of direct links between user behavior and energy usage allowing for opportunities to reduce energy load. A strategic response to this is the limiting of the opening hours on certain floors of the library or reducing the number of computers in operation at any one.

S1	The building(s) in which you work has/have been designed in a manner which promotes an energy efficient outlook among its users.
S2	The appliances that are used by employees (e.g. computers, printers etc.) on a daily basis are energy efficient/can be set by users to be energy efficient without affecting their level of performance.
S3	There are a sufficient number of notices/ guides/reminders regards energy efficient practices within the working environment (including appliances) to influence the user so that they are conscious of their energy use.
S4	Your employer places great value on energy efficiency within the workplace and has invested sufficient resources to implement energy efficiency policy.
S5	Your employer has provided sufficient additional training and education regards how to interact with any energy management system technology that exists within this building (or others owned by your employer in which you work).
S6	Your supervisor/manager sets a positive example in terms of being „energy conscious" and actively promotes the benefits of being energy efficient.
S7	You view your working environment as contributing positively to global efforts to mitigate the effects of climate change and/or your working environment is a positive example of how non-domestic buildings can be energy efficient environments.
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S7	You view your working environment as contributing positively to global efforts to mitigate the effects of climate change and/or your working environment is a positive example of how non-domestic buildings can be energy efficient environments.

Table 1a: Statements of Working Environment.

S1	You find it difficult to relate to your working practices having a significant impact on the energy demand of the building(s) in which you work.
S2	You are given updates at sufficient intervals from your supervisor/ manager regards how any changes in your work practices are impacting on the energy demand of the building(s) in which you work. .
S3	These updates influence you regards being more energy efficient in terms of your future work practices.
S4	Being „energy conscious" is a key requirement for your employer regarding your day-to- day working practices and is a criterion for judging your working performance.
S5	Most of your work involves the use of some sort of electronic appliance such as a computer, printer etc. and therefore you believe you are limited in terms of how energy efficient you can be without affecting your productivity.
S6	There is a difference in understanding between general employees and management/owners regards how work practices can be conducted in an energy efficient manner.
S7	You lack motivation to be energy efficient within your working environment as there are no benefits to you as an individual.
S8	There is not enough cooperation between employees in terms of trying to save energy within the working environment

Table 1b: Statements of Working Practices.

S1	You are familiar with how the energy management system within your working environment operates and affects your energy use in terms of your working practices.
S2	You can easily interact with any technology that forms part of the buildings energy management system in your working environment, without interfering negatively with your working practices.
S3	You are aware of working practices that will interfere with and negatively affect the operation of the energy management system.
S4	You are too reliant on the energy management system in place within your working environment to manage the building's energy use and/or could take more responsibility for the impact your work practices has on the energy demand of the building.
S5	You are aware if there is a fault/error with the energy management system based on unusual changes in the behavior of appliances and/or temperature regards your working environment.
S6	You are aware of who to direct queries to within the workplace regards the operation of the energy management system.
S7	Management presents the data from the energy management system to all employees within the working environment to highlight the environmental, economic and social benefits of energy efficient work practices.
S8	The data produced from the energy management system is easily communicated to you in the form of visual displays and/or other methods.
S9	The greater fault with energy management systems is not technical issues but rather ineffective human interaction with the technology.

Table 1c: Statements of energy management systems.

[a] [b]

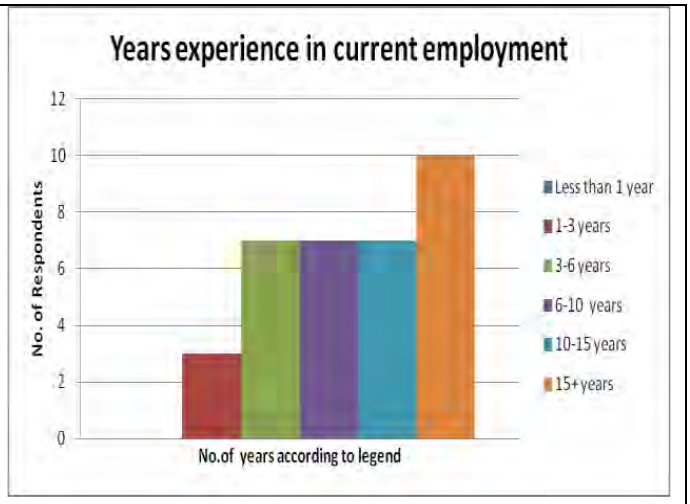
Figure 3: [a] View of McClay Library, [b] View of Light and Ventilation activated blinds and Lighting (authors).

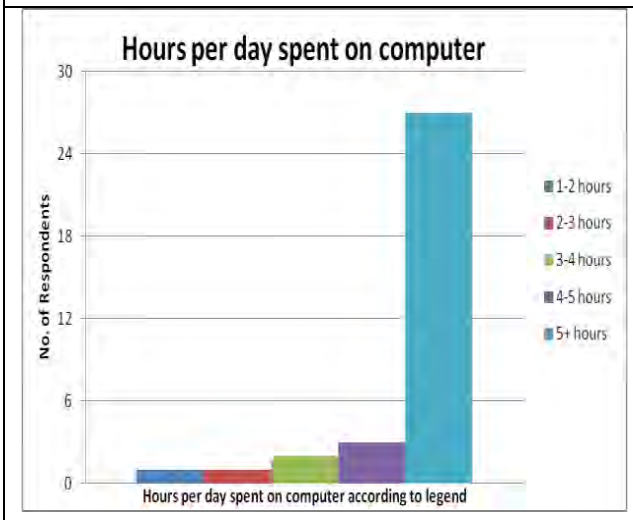
Results

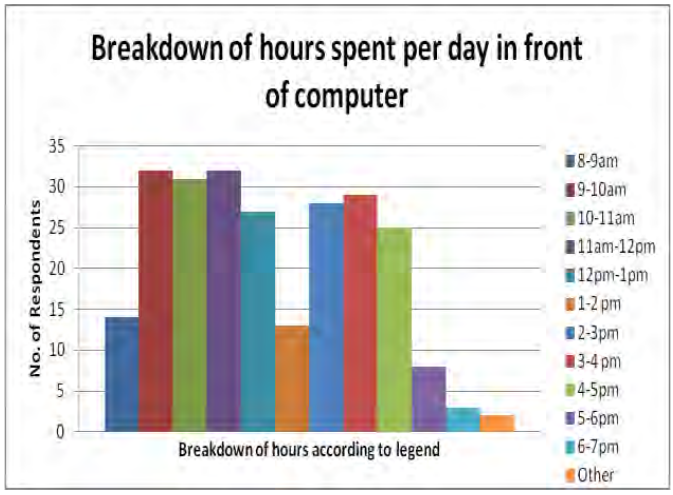
Detailed results of the questionnaire, issued to employees in the case study building, are available on request and displayed here are the breakdown of responses with respect to each statement contained within the questionnaire. The following pages display figures detailing the breakdown of data gathered from respondents in the McClay library, with respect to the structure of the questionnaire. The first selection of graphs, seen in Figure 4 details the breakdown of characteristics of employees in the McClay library, including status of employee, years experience in current position and time spent in front of a computer screen each day.

The sample consisted of 237 questionnaires were sent via email and followed up with hard copies to workers in the Administration Building and 70 responses were received. The questionnaires targeted women and men over 18 years of age, but did not collect data on income of respondents, as most people are typically not willing to disclose this or would lie. The breakdown of respondents is as given in Figure 4 above. The data was gathered over a 4-week period .The interviews focused on a set of 26 questions. The data collected through questionnaire surveys had numerical value. The data was entered and analysed using *Statistical Package for Social Sciences*: SPSS. This application helped to conduct a classic analysis by using descriptive analysis and associated selection techniques. The goal was to use a descriptive and correlation analysis to study relationship between variables.

Figure 4 above, revealed that the most employees (79.4%) employees spend in excess of 5 hours on their computers each day, in addition, the vast majority of the respondents used the computers between the times of 9 am-1 pm and 2-5 pm. Figure 3a and 3b revealed that most employees regarded the library as designed and built to promote energy efficiency to users as well as were felt that the electrical







Profile of Questionnaire Respondents

Age Bracket	Male	Female	Both Male and Female
20 -29 years	2.9%	11.4%	14.3%
30-39 years	22.9%	14.3%	37.1%
40-49 years	14.3%	18.6%	32.9%
over 50 years	5.7%	10.0%	15.7%

Figure 4: Profile of Respondents, (Ryan, 2011).

appliances they used daily were energy efficient. However, when asked if there was sufficient notices/ guides or reminder on best energy efficient practices that would influence their behavior almost two-thirds (70.58%) were not convinced a stack reminder of importance of appropriate feedback system (S3). Further examinations of the attitude to energy efficient practice (S6) revealed that there was mixed attitude towards feedback from employer. Equally when asked if the working environment contributed positively towards global efforts in militating against climate change, (S7), almost half (52.94%) were not convinced with the effort by the employer. It suggests that the investments in use of high technology and costs may not have had the desired effect (Figure 5).

Figure 6 below are results from data on Working Practices and they reveal interesting characteristics. When respondents were asked if they were given sufficient updated by their supervisor/ manager regarding how any changes in their working practices impacted the energy demand on the building (S2), 52.94% strongly disagreed or disagreed and when this was added to those unsure, the it revealed that almost four-fifths (79.41%) thought the feedback was insufficient to impact their behavioral practices. In addition, it revealed that half (50%) thought that energy consciousness was not instilled or required of them in comparison to only 17.64%. Most employees also felt that there was a big difference between them and the managers with regard to energy efficient practices (S6), and that most employees (79.41%) individually lacked the motivation to be energy efficient (Figure 7).

The focus of the UK government with regard to reduction in energy use and climate change emissions has been on physical and intelligent systems with less emphasis on human behavior. Table 1 shows interesting attitudes and beliefs of the users of a building that has won awards as most energy efficient building yet so far reveals otherwise. It revealed that only a third (34.29%) was familiar with energy management system and how it affected their energy use within the building. Literature review consistently pointed to importance of feedback on energy use in buildings, (Figure 7-S7 and 7-S8) revealed that when respondents were asked if the management presented them with energy use data; almost two thirds, 61.76%, disagreed or strongly disagreed. In addition only one tenth, 11.76% have ever received the data communicated to them in visual or other easily understood methods. Most respondents 58.88%, regarded failures in energy management systems as caused by ineffective interaction between humans and the technology [18].

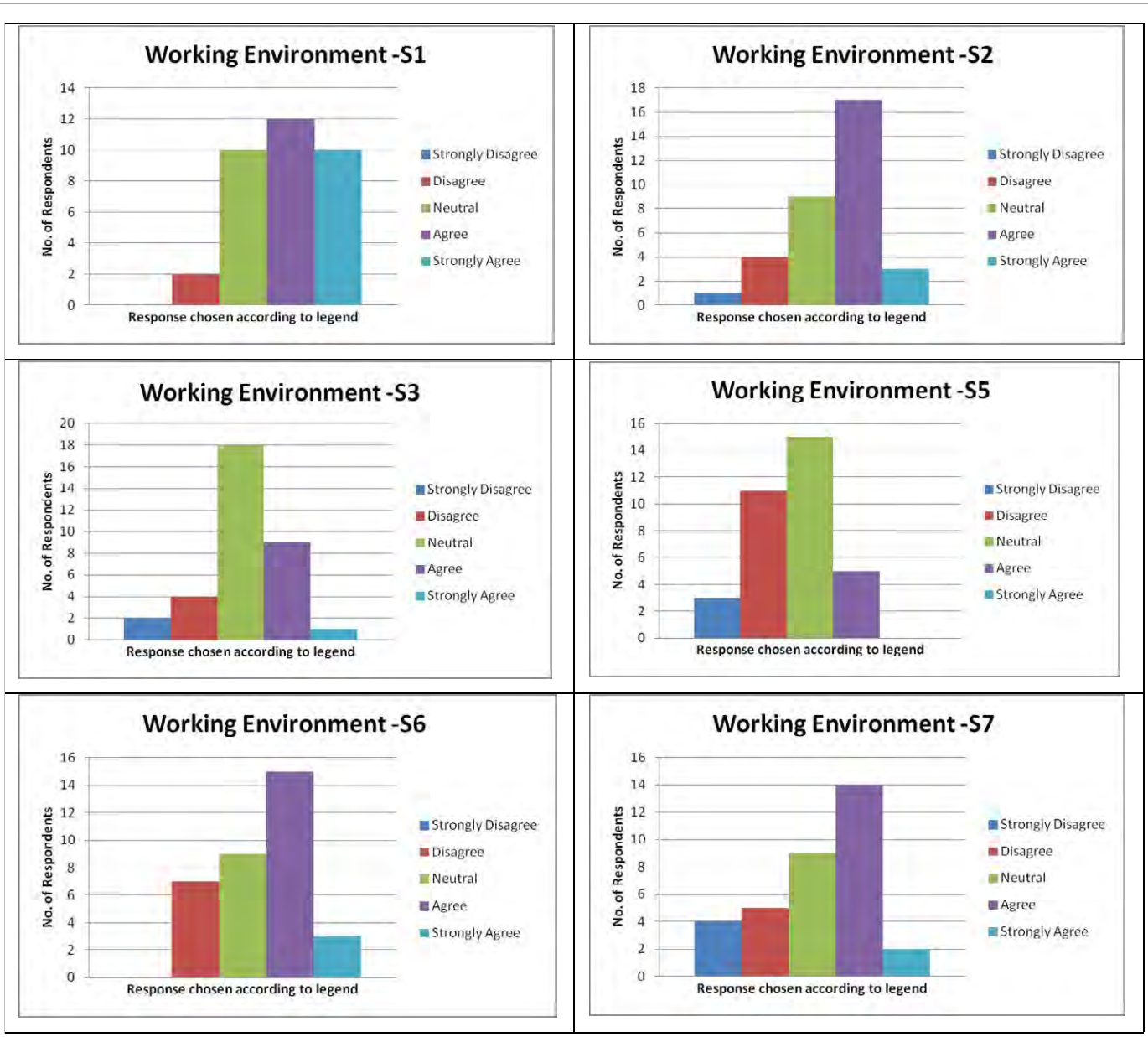


Figure 5: Analysis of Working Environment, (Ryan, 2011).

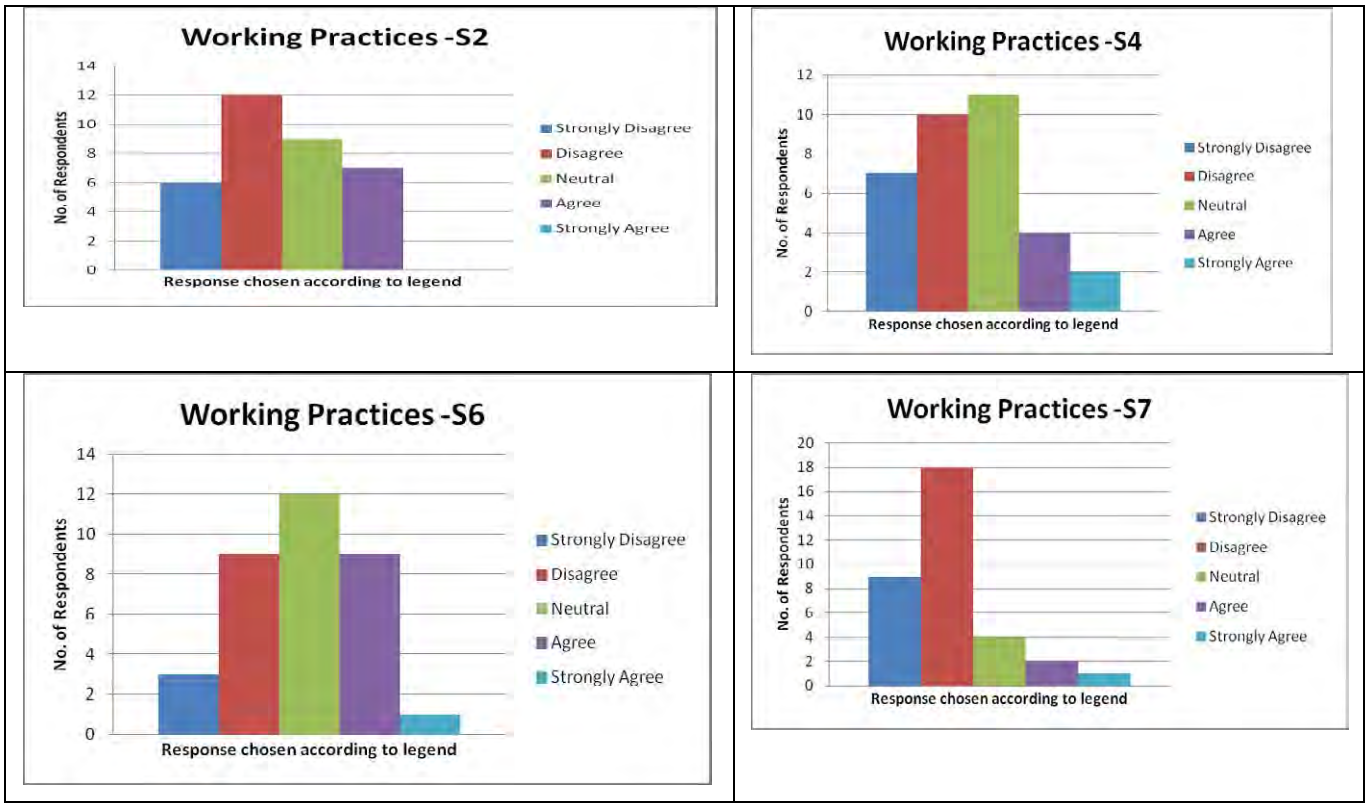


Figure 6: Working Practices of employees, (Ryan, 2011).

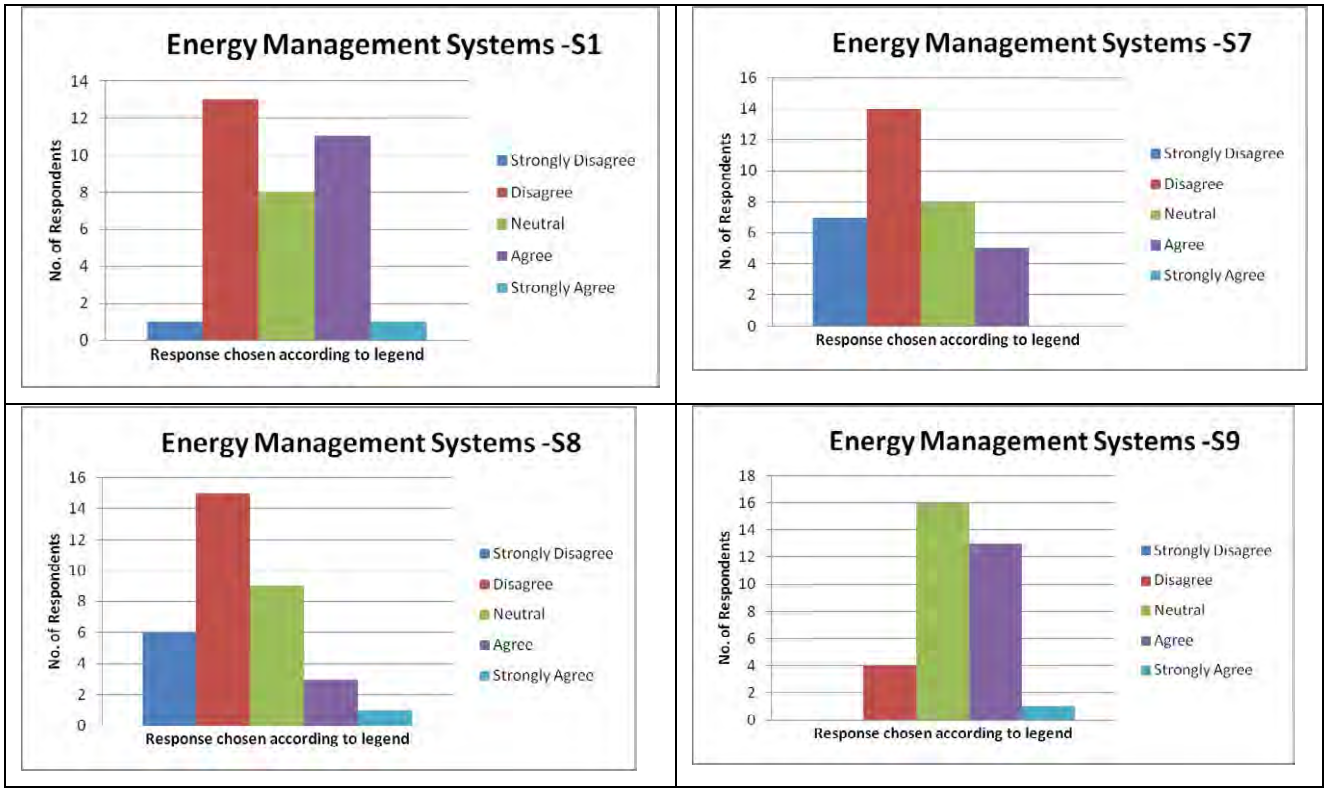


Figure 7: Energy Management Systems, (Ryan, 2011).

Conclusion

The work examined the use of sub metering technology with aims of reducing energy use in the building and whether its use affected user behavior. It revealed firstly, that most users who spent most of their working day in the building were not familiar with the workings and benefits of the EMS technology. However, most revealing was the fact that the users of the energy in the building were not provided with feedback and when provided it was not in a user friendly and understandable manner that would affect their working practices or behavior. There was no attempt by the management to communicate and support or reinforce what would have emerged as best practices working behavior that reduced energy consumption, in addition, the employees lacked the motivation to change their behavior to be more energy efficient. The analysis further revealed that there was underlying lack of involvement of the employees in the decisions about the investment in energy efficient technologies, and the importance of changes to their working practices. The decision by the institution to invest in an "energy efficient" building seems to have stemmed from responses to future changes that were coming to the building regulations and also in attempt to shore "corporate responsibility." If there were any reduction in energy consumptions and CO_2 emissions, it is difficult to attribute them to occupants actually reducing their demands and expectations (particularly in relation to so-called 'efficiency gains') as pointed out by Stevenson and Leaman [11].

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A Powerful Leadership Indicator That You Shouldn't Ignore

All organisations require both 'leaders' and 'followers'. This short item describes the different behaviours required of each group.

Balancing the Need for Leaders and Followers

Leading is courageous. So is following. How do we balance the need for leadership and followership? Good leadership is a polarity; it involves a leader who accepts accountability and followers who accept responsibility. Tied together with the energy of courage, this polarity is a powerful indicator of the health of any organization.

Let's begin with what a polarity is. According to Barry Johnson, a polarity is also known as a wicked problem, dilemma, chronic tension, duality, or dichotomy. According to Barry, they are interdependent pairs of values, competencies, and/or objectives that support each other and a greater purpose. Polarities are ongoing, unstoppable, and indestructible.

An easy example of polarity is breathing. When you breathe in, you must breathe out. What happens when you do one and not the other? That's right — you fail. That is the dilemma. Even though we would only like to focus on leading or following, we have to focus on leading and following. That is what moves this issue from a problem to a dilemma.

The difference between a dilemma and problem? ***And***. If it is a problem, I can fix it — that is an "either/or." It is either one thing or another, but not both. A polarity offers a Gordian knot of challenges, one that can only be managed, not solved. This is why we must discuss the issue as leadership and followership. You need both, not just one or the other.

So what is leadership? James McGregor Burns writes that leadership is a relationship between the leader and the led. He adds that each plays an important role, and that each has made a conscious and courageous choice in their role to the other.

Thus, if leadership is a relationship, then to choose to lead is to volunteer to be held accountable. If you are a person of integrity and truly believe in your people and your cause, you engage in an ongoing dialogue about the direction you take, the follower's alignment with it, and seek to constantly earn and re-earn the active engagement of your followers every day.

True leaders — those whose first and last thoughts are of the people and ideas they represent — volunteer to lead. They are not elected, chosen, or appointed.

We have seen many people with titles, offices, and power who are in leadership positions, but choose not to lead. They choose to manage, to command, to direct, and to order, but not to lead. If you are truly leading, you are in a constant dialogue of accountability for the actions you take as a leader.

When you make the choice to lead, then you are opening yourself to the need for your followers to ask, to critique, and to judge. Your role is to help them make the choice to follow. Unless you want compliance and not commitment, blind faith and not informed judgment.

So leadership is all about accountability. What is followership? Like leadership, you also make a choice to follow. Followership is a position with clear requirements, too. Followership is to choose, implicitly or explicitly, to align ourselves with another's ideas and thoughts, perhaps committing ourselves to what we believe is a greater good.

If leadership is a relationship of accountability, followership is responsibility in action. To choose to follow is to hold ourselves and others responsible. As followers, we must be responsible for our thought process, accepting and acting on our choice to follow the leader's direction. It means being responsible for the legacy you leave as a follower.

Leaders are accountable. Followers are responsible.

And if you are a follower, how do you exercise that responsibility? How do you hold leaders accountable and yourself responsible?

With great courage. Courage comes from the Latin — cor or heart. It is the same root word as the Spanish "corazon" (heart) and the French, cor. In French, courage — simply stated — means from the heart. Courage is the energy surrounding leading and following. The courage to volunteer to be accountable as a leader and the courage to be held responsible as a follower.

So check out your organization. Do leaders hold themselves accountable? Do followers choose responsibility? If so, why? If not, how might you act with courage to change the situation?

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How Sleep Can Make You a Stronger Leader

The importance of adequate rest and relaxation to a healthy lifestyle and successful work performance.

Dr. Elena Svetieva, Dr. Marian Ruderman, and Dr. Cathleen Clerkin

Meet Sue, a charismatic CEO. She addresses all employees in a fiscal year-end meeting. In lauding their hard work and efforts, she comments on her delight in reading the budget reports upon awaking at 4 a.m. that morning.

***

Then there is Jose, a rising star in his organization. He prides himself on being available to his team day or night, and tries to use all his spare moments in the day thinking of new strategic initiatives and better ways to solve current problems.

***

Finally there's Alexandra, a leader of a small team of motivated high performers. Alexandra wants to lead a full, productive life, getting up early to exercise and plan a full workday. She helps her family start their days, leads her team at work effectively, and then volunteers with a local charity. Exhausted, Alexandra slumps into bed late at night and is comforted by the idea that she has not let anyone down.

***

Do you identify with Sue, Jose, or Alexandra? Do their sleep patterns seem familiar? If yes, how well is this style working for you? If not, do these leaders sound like anyone you know?

Myths and Facts

Many applaud the sleeping habits of individuals like Sue, Jose, and Alexandra. Indeed, many people believe that top leaders set good examples for their teams by demonstrating a strong work ethic and showing that they work late into the night and early in the morning. After all, we need to make sacrifices to get ahead, and perhaps this might just impact the number of hours we spend nestled under the covers.

Hard work and long hours equal success, right? Actually, these are all false assumptions. Here is a breakdown of why that's the case.

Myth #1: Cutting down on sleep is one way to be more productive.

Belief behind the myth: Sleeping less provides time to progress on our work. Hustle, hustle, hustle at all costs!

Reality: Research suggests that even small amounts of sleep deprivation take a significant toll on our health, mood, cognitive capacity, and productivity. A lack of sleep is associated with preventable accidents, medical errors, and motor vehicle crashes.

It diminishes concentration, impairs memory, reduces the ability to communicate, lowers creativity, triggers moodiness, and increases stress. In contrast to the myth, sleep deprivation can hold you back. In the long term, it does not push you forward.

Myth #2: Top executives sleep less than other employees to stay ahead.

Belief behind the myth: High-performing executives with many demands on their plates are sleeping less than the average employee — it's part of the job. To reach the top levels of an organization, you need to sacrifice sleep. Once there, you need to maintain this lifestyle to keep up with the demands of work.

Reality: We conducted a global survey of leaders' sleep experiences. We asked 384 men and women — from professionals in non-managerial positions to C-level executives — all about their sleep habits, patterns, rituals, and problems.

On average, people think that the typical high-performing executive gets 42 minutes less sleep than the average employee. People believe, too, that the typical high-performing executive gets 27 minutes less rest than they themselves do. The reality is different.

In fact, there were no differences in self-reported sleep across all our respondents — consultants, CEOs, managers, and professionals in non-managerial positions all report getting similar hours of sleep.

Executives were also some of the least likely to endorse such statements as "I think of high performers as energetic people who don't need much sleep" or that "putting in long hours and sacrificing rest is a necessary trade-off to get ahead at work." When it comes to sleep, the view of the top does not match the view from the top.

Sleep Challenges in a Complex Business Environment

Today's work environment requires a new type of leader. It is no longer enough for leaders to be qualified and knowledgeable. Leaders must be focused, adaptable, and resilient in order to be effective amid the increasingly distracting and chaotic organizational world.

There is a clear correlation between the benefits of good sleep and the needs of our current business environment. Restorative sleep is a critical component to reaching optimal leadership potential and the easiest way to improve productivity.

Unfortunately, there are barriers to getting a good night's rest. We asked leaders what keeps them awake at night.

A significant portion of our leadership sample reports tossing and turning nightly — nearly 1 in 3 said they have trouble sleeping at least a few nights a week. There are certain disturbances that, although annoying, are considered a normal part of life: pets, children, snoring partners, and loud noises.

Also not surprising, there were a number of people whose sleeping is interrupted by physiological problems. However, troubled sleep often accompanies issues related to our careers.

Of the respondents, 25% reported that work-related thoughts often interfere with their sleep. Work looms larger in people's minds, whether it be going over past events or planning and worrying about upcoming tasks. For many leaders, problems from the day resurface in the middle of the night.

When we probed deeper into how work-related issues disturb rest, we found much of it had to do with how leaders experienced the boundaries between work and personal life. We found that dissatisfaction with how leaders manage the transition between work and personal time is associated with sleep problems.

For example, individuals who were more likely to feel like they are always working, whether they are at work or not, were also more likely to have symptoms of insomnia. Being unable to unwind from work is a serious impediment to sleep.

What Can You Do?

Individually, here are 8 practices to help you reach the point of restorative sleep:

1. **Set a regular schedule**. Going to bed and waking up at the same time every day (even on weekends) reinforces a consistent sleeping cycle. Set a sleep schedule that allows you to get the hours of sleep you need. Although some people need less and some more, the average adult needs 7 to 8 hours, according to the National Sleep Foundation.

2. **Create a relaxing environment**. Adults are great at creating relaxing environments for children, but not everyone realizes that they should do the same for themselves. Adjust the temperature, lights, and sounds in the room so they are as conducive to sleeping as possible. Some people have a relaxing ritual such as taking a warm bath or applying lotion. Use earplugs or blackout curtains if necessary.

3. **Use fitness wearables to understand your individual needs**. Most have sleep-tracking functionality that will help you gain insight into how much you're sleeping and the kinds of activities that impair or promote good sleep.

4. **Exercise — but not right before bed**. Exercise promotes good sleep, but if it is done too close to bedtime, it can act as a stimulant.

5. **Disconnect from your electronic devices**. Park your devices before going to bed. The combination of constant connectivity and blue light is known to interfere with sleeping.

6. **Put your work aside before you go to bed**. Ruminating about work won't help anything. Mindfulness practices and other stress-reduction techniques are helpful for learning how to relax your mind.

7. **Keep tabs on alcohol and caffeine**. We all know that caffeine can interfere with rest, but people are less aware that alcohol does as well. Alcohol may help you fall asleep but it can decrease the quality of your sleep, and wake you up when it wears off.

8. **Understand and honour your sleep needs**. We all have a particular chronotype based on our circadian rhythms. Some of us are night owls and do our work best late at night, while others are morning larks and most productive in the morning. Honour your natural inclinations as it relates to your chronotype and put yourself in the best position to thrive. Pay attention to what times of day you feel most alert and plan to do the most difficult or challenging tasks during those "on" times.

What You Can Do as an Organization

Uber, PwC, Google, NASA, and Ben & Jerry's have all integrated healthy sleep practices into their organizations. Here are components of sleep-friendly organization practices:

1. **Provide sleep education**. There is a real lack of knowledge about the role of sleep in health. Organizations can address this gap by providing basic sleep education. Challenge the culture of sleep deprivation.

2. **Encourage role models**. This article began with an example of Sue, the leader of the organization who "innocuously" shared that she woke up at 4 a.m. to begin work. This completely sets the wrong example. Instead, top leadership and different ambassadors have a role to play in communicating the message that sleep supports the performance and well-being of leaders and the organization as a whole.

3. **Support boundaries between time for work and time for leisure**. This entails allowing for transition time between home and work and supporting unavailability during vacations.

4. **Encourage sleep at work**! Forget the notion of "don't sleep on the job." Instead, send the message that sleep is valued and leads to optimal performance. Provide nap rooms, energy pods, or comfortable chairs, and don't forget to educate employees about how to best benefit from such resources. In fact, if you don't show employees how to benefit, you'll find these resources unused!

5. **Accommodate schedules**. As highlighted earlier, different individuals work better at different times (morning larks versus night owls). When possible and practical, consider offering flexible hours and telecommuting to allow employees to work when they are most likely to function at their best.

As you think about sleep and optimal results — both at the individual and organizational levels — arm yourself with statistics and facts rather than preconceived myths. Then put in place the related habits and mechanisms. If you lack clarity about next steps, consider sleeping on it!

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5 Tips for Better Telephone Skills

The telephone is a necessity for effective business and social communication. Some simple pointers can improve our ability to use this more effectively.

Anne M. Obarski

When the phone rings, are you annoyed at the interruption? The way you and your employees answer the phone sets the stage for your customers' experience with you. Here are five tips for ensuring your phone skills give a good impression.

I have to admit I really don't like the telephone. Maybe it is because it is an interruption in an already "overscheduled" world. Even if it is someone I really want to talk to, it sometimes feels like a chore "to be nice"! With the amount of spam phone calls I still seem to receive, even after being on the "Do not call list", I must admit I make assumptions when I pick up the phone. If there is a nano-second of a pause when I pick up the phone, I immediately assume I am on someone's computer list just waiting to pounce if they here a real person on the other end of the phone.

However, when I am initiating the call I really "want" another human on the other end of the line. I don't want to be put in "voice mail jail" and being warned that the phone calls are taken in the order they are received and if I hang up and call back I may be waiting until doomsday to get to someone. I must admit I have stayed "on the line if you have a rotary phone for the next available agent"; not really remembering when I last SAW a rotary phone. Want to have a real laugh? Ask a teenager what a rotary phone is. It will either make you laugh or maybe cry at their response!

No matter which type of phone caller or business owner you happen to be, this communication tool, no matter how big or small is here to stay. It is important to know how to use it efficiently and effectively. With so much cell phone usage, right or wrong, that adds another dimension to the mix.

Regardless how fancy your Bluetooth, or cell phone or rotary phone with, heaven help us, a cord, is, it is important to address and put into practice, correct phone techniques.

I challenge businesses to think that every time their phone rings, it is their paycheck calling. I also challenge businesses to look at their phone with as much respect and interest as they look at their merchandise, their marketing, and their employees; it is a reflection of their "brand". Dr. Janelle Barlow, in her book, "Branded Customer Service" says, "Reinforcing a brand through every customer touch point, therefore, can provide the repetition necessary to inspire repeat purchasing decisions".

She also spends a great deal of time discussing being "on brand" or "off brand". In other words, you may say in your advertising literature and in store signing that the customer is number one, but if your customer can never get someone to answer the phone when they call, then your standards for answering the phone are "off brand".

When you think about your phone calls that way, you are more apt to answer the phone with a little more expectation in your voice rather than disgust. If you train your employees to do the same, you will start looking at your phone as a sales building tool. There are interesting statistics that show people develop a perception about you within the first 30 seconds of a phone conversation and their final opinion of you in the last 30 seconds. Let's look at some phone tips that will boost that final opinion to one of an on-going, on brand, positive relationship!

1. Breathe! Before you pick up the phone, take a deep breath. Most of us are what they call "shallow breathers". We take small breathes in and out and therefore, sound tired when we answer the phone. The goal is to sound like you like your job and you are glad they called.

Practice taking a very big breath and answering the phone at the top of that breathe. You will continue speaking on the exhale of that breath and the caller will hear energy in your voice! You can also practice it when you are making a call and start your breath as the phone is ringing on the other end. You'll be surprised how you feel when you use this technique. You may try it the next time your mother-in-law calls!

2. Identify yourself. Give your full name and function and or the name of your company. Since they have taken the time to call you, you may answer the phone this way; "Thank you for calling Merchandise Concepts, this is Anne Obarski, how can I make it a great day for you?" Hokey, maybe; memorable, maybe; friendly, you bet. Since I have an unusual last name, this helps me say it first so that the caller doesn't have to fumble with the pronunciation. One tip that I seem to always repeat, is that of slowing down when you answer the phone or when you call to leave a message. How many times have you had to re-play your answering machine to understand what the person was saying or the phone number that rattled off too fast?

3. Be Sincere. If we are honest with ourselves, we are all "problem solvers" in some way. People call us on the phone to have a problem answered. Whether it is to get driving directions, or hours of operation or questions about our merchandise, they have a question and want it answered quickly, intelligently and politely.

It is important to put the customer's needs ahead of ours. Have you ever been in a store and you were just about ready to put your things down on the counter to pay for them and the employee says, "You'll have to go to another register, I am going on break now". A customer will remember how attentive you were to their needs when they are asked to make a referral!

4. Listen attentively. Put everything down when you answer the phone! Easier said than done, isn't? How many times have you been in your office answering email, talking on the phone, listening to your ipod and sipping on a Starbucks? Me too. Shame on us. Customers don't like to be ignored and by multitasking, we are not focused on the customer's wants and needs.

Visualize the person, even if you don't know them so that you remind yourself you are engaged in a two-way conversation. If you still have trouble listening, start taking notes on what they are saying. Use a headset if possible, to keep your hands free. By taking notes you can verify with them as well as yourself, the important points of the conversation and the action items that needed attention.

5. Outcome. If the phone call has been successful, the first 30 seconds established a positive perception about you through voice, and tone and focus. The last 30 seconds will be when the caller finalizes their opinion about you. You can make that a positive experience by thanking them for calling, reviewing the problem you were able to solve and then most importantly, thanking them for their continued business.

I find myself on airplanes frequently with my speaking schedule. Recently I have noticed that no matter what airlines I am flying that the pilot has "air time" with the passengers on each flight. The words are all about the same. They share the weather in the city we are headed to, the time we should be arriving, the details about the lavatories and not to congregate in the aisles, as well as the great flight attendants, and then they always say something like this, "We know you have a choice when you travel and we are happy that you have chosen to fly with us, and we appreciate that. We ask that if your future travel plans involve flying that you will think of us first. So sit back, relax and enjoy the on-time flight to wherever."

The pilot set up the outcome in the passenger's minds by stating it up front. He started by building a trusting relationship with the passengers that he couldn't see, by coming across as very approachable. Then he told us the important things we should know about the flight and who would help us if we had a problem and then in conclusion, he asked for our repeat business. Trust for me is built on the sound and the sincerity of the pilot's voice.

That isn't that much different than when your employees talk to your customers. To build a strong business, you need to have repeat and referral business. What easier way than to ask for their continued business at the end of each and every phone call.

The way you speak over the telephone conveys 85 percent of your message, so by focusing on the previous 5 tips you and your employees can make it a smooth flight in your business each and every time your phone rings.

PAPERmaking!
FROM THE PUBLISHERS OF PAPER TECHNOLOGY
Volume 3, Number 1, 2017

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Writing Effective Emails:

Getting People to Read and Act on Your Messages

Email is a widely used tool for business communications, but a 2013 survey by Sendmail, Inc., found that it has caused tension, confusion, or other negative consequences for 64 percent of working professionals.

So, how can you avoid your emails doing this? And how can you write emails that get the results you want? This article looks at strategies you can use to ensure that your use of email is clear, effective and successful.

Writing Effective Emails

The average office worker receives **around 80 emails each day**. With that volume of mail, individual messages can easily get overlooked. Follow these simple rules to get your emails noticed and acted upon.

1. Don't over-communicate by email.
2. Make good use of subject lines.
3. Keep messages clear and brief.
4. Be polite.
5. Check your tone.
6. Proofread.

1. Don't Over-communicate by Email

One of the biggest sources of stress at work is the sheer volume of emails that people receive. So, before you begin writing an email, ask yourself: "Is this really necessary?"

As part of this, you should use the phone or IM to deal with questions that are likely to need some back-and-forth discussion.

Also, email is not as secure as you might want it to be, particularly as people may forward emails without thinking to delete the conversation history. So avoid sharing sensitive or personal information in an email, and don't write about anything that you, or the subject of your email, wouldn't like to see plastered on a billboard by your office.

Whenever possible, deliver bad news in person. This helps you to communicate with empathy, compassion, and understanding, and to make amends if your message has been taken the wrong way.

2. Make Good Use of Subject Lines

A newspaper headline has two functions: it grabs your attention, and it summarizes the article, so that you can decide whether to read it or not. The subject line of your email message should do the same thing.

A blank subject line is more likely to be overlooked or rejected as "spam," so always use a few well-chosen words to tell the recipient what the email is about.

You may want to include the date in the subject line if your message is one of a regular series of emails, such as a weekly project report. For a message that needs a response, you might also want to include a call to action, such as "Please reply by November 7."

A well-written subject line like the one below delivers the most important information, without the recipient even having to open the email. This serves as a prompt that reminds recipients about your meeting every time they glance at their inbox.

Bad Example	Good Example
Subject: Meeting	Subject: PASS Process Meeting - 10 a.m. February 25, 2014

If you have a very short message to convey, and you can fit the whole thing into the subject line, use "EOM" (End of Message) to let recipients know that they don't need to open the email to get all the information that they need.

Example

Subject: Could you please send the February sales report? Thanks! EOM

(Of course, this is only useful if recipients know what "EOM" means.)

3. Keep Messages Clear and Brief

Emails, like traditional business letters, need to be clear and concise. Keep your sentences short and to the point. The body of the email should be direct and informative, and it should contain all pertinent information.

Unlike traditional letters, however, it costs no more to send several emails than it does to send just one. So, if you need to communicate with someone about a number of different topics, consider writing a separate email for each one. This makes your message clearer, and it allows your correspondent to reply to one topic at a time.

Bad Example

Subject: Revisions For Sales Report

Hi Jackie,

Thanks for sending that report last week. I read it yesterday, and I feel that Chapter 2 needs more specific information about our sales figures. I also felt that the tone could be more formal.

Also, I wanted to let you know that I've scheduled a meeting with the PR department for this Friday regarding the new ad campaign. It's at 11:00 a.m. and will be in the small conference room.

Please let me know if you can make that time.

Thanks!

Monica

Good Example

Subject: Revisions For Sales Report

Hi Jackie,

Thanks for sending that report last week. I read it yesterday, and I feel that Chapter 2 needs more specific information about our sales figures.

I also felt that the tone could be more formal.

Could you amend it with these comments in mind?

Thanks for your hard work on this!

Monica

(Monica then follows this up with a separate email about the PR department meeting.)

It's important to find balance here. You don't want to bombard someone with emails, and it makes sense to combine several, related, points into one email. When this happens, keep things simple with numbered paragraphs or bullet points, and consider "chunking" information into small, well-organized units to make it easier to digest.

Notice, too, that in the good example above, Monica specified what she wanted Jackie to do (in this case, amend the report). If you make it easy for people to see what you want, there's a better chance that they will give you this.

4. Be Polite

People often think that emails can be less formal than traditional letters. But the messages you send are a reflection of your own professionalism, values, and attention to detail, so a certain level of formality is needed.

Unless you're on good terms with someone, avoid informal language, slang, jargon, and inappropriate abbreviations. Emoticons can be useful for clarifying your intent, but it's best to use them only with people you know well.

Close your message with "Regards," "Yours sincerely," or "All the best," depending on the situation.

Recipients may decide to print emails and share them with others, so always be polite.

5. Check the Tone

When we meet people face-to-face, we use the other person's body language, vocal tone, and facial expressions to assess how they feel. Email robs us of this information, and this means that we can't tell when people have misunderstood our messages.

Your choice of words, sentence length, punctuation, and capitalization can easily be misinterpreted without visual and auditory cues. In the first example below, Emma might think that Harry is frustrated or angry, but, in reality, he feels fine.

Bad Example	Good Example
Emma, I need your report by 5 p.m. today or I'll miss my deadline. Harry	Hi Emma, Thanks for all your hard work on that report. Could you please get your version over to me by 5 p.m., so I don't miss my deadline? Thanks so much! Harry

Think about how your email "feels" emotionally. If your intentions or emotions could be misunderstood, find a less ambiguous way to phrase your words.

6. Proofreading

Finally, before you hit "send," take a moment to review your email for spelling, grammar, and punctuation mistakes. Your email messages are as much a part of your professional image as the clothes you wear, so it looks bad to send out a message that contains typos.

As you proofread, pay careful attention to the length of your email. People are more likely to read short, concise emails than long, rambling ones, so make sure that your emails are as short as possible, without excluding necessary information.

Key Points

Most of us spend a significant portion of our day reading and composing emails. But the messages we send can be confusing to others.

To write effective emails, first ask yourself if you should be using email at all. Sometimes, it might be better to pick up the phone.

Make your emails concise and to the point. Only send them to the people who really need to see them, and be clear about what you would like the recipient to do next.

Remember that your emails are a reflection of your professionalism, values, and attention to detail. Try to imagine how others might interpret the tone of your message. Be polite, and always proofread what you have written before you click "send."

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COMPRESSIVE YIELD STENGTH TESTER

The L&W S-Tester is based on a new, quick test method for determining the quality of fluting medium in corrugated packaging material. It expands ABB's laboratory quality measurement offering to help paper producers improve quality and reduce costs.

The S-test method was developed by a group of fluting producers (CCB-CEPI) to provide a more reliable and easy measurement method than the time-consuming flat crush of corrugating medium CMT test (Concora Medium Test). This new test method can be fully automated.

The new S-test method correlates well with the compressive yield strength potential of fluting medium in a CMT test. This yield strength is more relevant than standard CMT when predicting the ability of fluting medium to keep the liners apart, without losing its own strength in a corrugated board construction.

The L&W S-Tester will provide quick and accurate feedback; it can also perform automated S-tests in L&W Autoline (complete paper quality measuring system) to add even more impact to mills producing fluting-medium when it comes to saving production costs. These measurements will help to reduce energy consumption through the elimination of over-refining, optimize the use of starch additives, and improve overall quality by generating a uniform paper product.

Benefits/Features

- Quicker and easier method (s-test) for strength classification of fluting medium (than standard CMT measurements)
- No need of corrugating and taping of test pieces
- Reports test results within some seconds
- Designed and produced using long experience of manufacturing measuring units for L&W Compressive Strength Tester STFI
- Ease of use:
  - Auto-start, a photocell detects the presence of a sample and automatically initiates a measurement sequence, thus allowing hands-free operation measurements
  - Large touch screen for good overview
  - Intuitive user interface

http://new.abb.com/pulp-paper/abb-in-pulp-and-paper/products/lorentzen-wettre-products/laboratory-paper-testing/l-w-s-tester

CORIOLIS FLOW METER

Introducing the RCT1000 Coriolis mass flow meter, the latest addition to Badger Meter USA's growing product portfolio.

RCT1000 meters are especially suited to the precise measurement of high viscosity fluids, aggressive media and contaminated fluids as well as high density gases, whilst maintaining a wide turndown ratio. Typical applications for these mass flow meters will include filling or dosing oils, solvents and chemicals and measuring adhesives or binding materials, coatings and hardeners, dyes, vitamins and other additives.

Renowned for their outstanding accuracy and versatility in measuring challenging flow applications, Coriolis principle flow meters have been employed in a wide variety of industries and applications. Coriolis flow meters are true multi-variable instruments, which means that they provide simultaneous measurement of mass flow, density, temperature and volume flow.

A valuable feature of this design is the lack of internal moving parts, enabling the flow meter to experience little or no mechanical wear, resulting in a long operational life expectancy. These meters offer low cost maintenance operation and flexible integration options.

The RCT1000 is capable of controlling equipment, such as valves and pumps with PID and batch control signals. The transmitter features a user-lock feature to prevent accidental activation as well as a local LCD display with optical buttons which allow the operator to navigate the display through the glass without opening the enclosure.

Network communications options for this model include; EtherNet/IP, 4-20mA HART, Modbus TCP and Modbus RTU. The RCT1000 meters feature mass flow accuracy of -/+ 0.1% with a pressure range up to 2150 PSI (148 bar) and options for use in hazardous areas.

For more information on this Coriolis meter range, contact Bell Flow Systems on **sales@bellflowsystems.co.uk** or **0800 027 7786**.

Contact Details:
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www.bellflowsystems.co.uk
sales@bellflowsystems.co.uk
01280 817304

CORROSION INHIBITOR FOR MULTIPLE APPLICATIONS

VpCI®-649 BD is a unique, concentrated liquid formulation that protects ferrous and non-ferrous metals from corrosive solutions. In addition, this product is designed to provide long-term protection in fresh water, steam and glycol closed loop systems. VpCI®-649 BD also includes preservatives against biogrowth. It is effective as a replacement for nitrite/chromate-based formulations. The product combines contact and volatile corrosion inhibitors along with anti-scalants in a non-toxic formulation.

This readily water-soluble liquid for easy application helps solve the problem of disposal, particularly for large quantities of water. It is effective for a broad range of multimetal applications to stop aggressive corrosion in systems containing fresh water, glycol coolants, etc. The product is very cost convinient since low concentration effectiveness provides economical treatment. Being environmentally safe VpCI®-649 BD does not contain nitrites, phosphates, chromates or heavy metals.

VpCI®-649 BD contains molybdate tracer (for product without molybdate order VpCI-649 BD MF). The product contains an acrylic polymer to prevent scale formation.

TYPICAL APPLICATIONS
- Inhibitor for Close loop cooling systems
- Fire extinguishing systems
- Inhibitor for hydrostatic testing of pipelines, casings, tanks and valves
- Inhibitor for packer fluid applications
- Prevents water-bottom corrosion in oil storage tanks
- Alkanolamine sweeteners
- Pulp and paper process equipment
- Mines, mining and earth moving equipment
- Inhibitor for lay-up application of cooling towers

www.cortecvci.com

DEPOSIT CONTROL CHEMISTRY

Archroma, a global leader in color and specialty chemicals, launches Cartaspers® PLH liquid, a single-product breakthrough enabling easy and highly-effective control of pitch and stickies deposition especially in soft water pulp and papermaking environments. Pulp mill tests already report easier application, better performance and significant cost savings compared to alternative deposit control systems.

Pitch, occurring from natural resins in virgin pulp, and stickies in recycled paper fibers, pose a major challenge to pulp and paper producers because of their negative influence on papermaking productivity and paper quality. Packaging and tissues machines lose the equivalent of 4% of their output per day due to machine contamination and sheet breaks caused by deposits. They contribute to holes in the sheet, specks and printability issues, in addition to causing machine downtime and cleaning time.

New Cartaspers® PLH is an anionic pale yellow, low viscosity liquid that is very effective in attracting non-polar (hydrophobic) substances like stickies and natural pitch. It helps to passivate contamination and prevent agglomeration and deposition, without any impact on cellulosic material. The organic additive performs across all water hardness levels and complies with food contact regulations such as BfR and FDA.

Its advanced performance, especially in soft water environments, leads to significant reduction in downtime and cleaning time that can enable higher yield during the process, plus there is reduced need for cleaning agents. In addition, Cartaspers® PLH liquid provides specific performance and productivity advantages over alternative deposit control systems in soft water environments.

The one-product, organic additive eliminates the need for an inorganic absorbent and dispersant to control pitch in the pulping sector, therefore contributing to a reduction in cost and complexity.

Compared to talc powder, the liquid is easier to handle as well as to disperse, and it has consistent quality. Importantly, Cartaspers® PLH does not cause scale deposits in evaporators or contribute to ash content in finished pulp which reduces pulp quality.

Cartaspers® PLH liquid is suitable for use with brown stock and can be applied throughout the pulping process, as a washing aid or to passivate remaining particles in finished pulp.

Cartaspers® PLH liquid has no foaming potential which means that washing efficiency is maintained.

Furthermore, the package of performance benefits offered by Cartaspers® PLH creates possibilities to use a higher ratio of recycled paper in paper machine systems.

Customers who have tested Cartaspers® PLH liq at two different pulping mills - one in Europe, one in Latin America - reported improvements in application, better performance in soft water and significant cost savings as a result of using one instead of three deposit control products.

www.archroma.com

FULL-SHEET DIRT COUNT SYSTEM

ABB's HPINet WIS dirt count system provides full web width inspection, imaging and identification in real-time to improve pulp quality and production yield, as well as customer satisfaction.

Accurate dirt detection, imaging and classification all play a crucial role in quality control and process improvement for pulp production. ABB's dirt count web imaging system meets today's demands for increased quality and runnability, with 100% inspection of pulp and reduced customer claims.

Using high resolution, complementary metal-oxide semiconductor (CMOS) digital cameras together with advanced machine vision tools to improve performance, the dirt count system provides an exceptional level of real-time defect detection on the fastest and widest width modern paper machines. Real-time detection of dirt and shives in pulp allows operators to take corrective actions earlier, resulting in improved production yield and quality and reduced customer claims.

Dirt detection and analysis are performed by specialized, high-speed field-programmable gate array (FPGA) devices. Automated detection and counting yields consistent and repeatable results leading to improved grading of production. Defects as small as 0.02mm^2 (less than half of the width of a human hair) may be detected which enables ABB's dirt count system to fully comply with all defect size classifications in the ISO/TAPPI/ANSI standards. Connectivity to mill-wide systems and integration with ABB pulp and paper automation systems ensures that defect data can be acted upon at the quality management and process control levels.

Unlike older technology that attempted to count dirt based on single sheets or narrow webs, ABB's full web dirt count system can detect and classify information across the entire web in real-time. The system can be configured with either transmission or reflection illumination methods.

ABB's dirt count system sets the new standards in web imaging systems to optimise product quality for the paper industry. Since the 1970's, ABB has delivered over 1,300 web imaging systems around the world. The system is backed by ABB's longstanding commitment to support its products over an extended lifecycle and by ABB's dedicated global network of highly trained service personnel.

For more information please contact:

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GEAR PUMPS FOR HANDLING VISCOUS FLUIDS

The GVR range of Gear Pumps which are ideally suited to transferring a wide range of viscous fluids such as fuel, gear and lubricant oils, varnishes, molasses and cosmetics, now includes an option for face mounting on B3/B14 motors in addition to the standard B3/B5 flange mount.

The new flange arrangements make it quicker to fit as the motor feet can be used for mounting avoiding the need for packing, for example when used on booster sets for all OEM applications which require duty standby operation. In addition larger models are now available in the 10 Bar BFC range and in the 20 Bar AFP range increasing the flow rates up to 70lit/min and 80lit/min respectively.

Available through PUMP ENGINEERING, these self-priming, volumetric flanged gear pumps are ideal for handling viscous fluids (without suspended solids) and feature as standard a durable, robust cast iron construction with gears and shafts in steel. Other versions are available in bronze or AISI 316 stainless steel.

GVR gear pumps have standard BSP threaded connections with larger pumps having flanged connections. They can be supplied complete with an internal safety relief valve while standard models are fitted with mechanical seals in ceramic, graphite and Viton, or with other mechanical seals if required. ATEX versions are also available as are options for protection to IP56.

Further details are available from:
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IMPROVE PRODUCTION WITH CENTRAL PLANNING SOLUTION

Pyroll Converting recently appointed Greycon to implement their central planning solution, opt-Studio, across 4 of Pyroll converting locations in Europe. The implementation started at the beginning of February 2017 with a pilot mill in the Netherlands and is due to go live by the end of May 2017. Greycon will install opt-Studio at a further 3 mills by the end of 2017.

Pyroll Group is one of the leading paper, cardboard, paperboard, and plastic converters in the Nordic countries, with operations spanning fourteen locations. Pyroll converting provides sheeting and rewinding services handling over 300,000 tons of paper and paperboard annually. Pyroll is the leader in its field in Europe and a pioneer even globally.

Jarmo Sara, Production Director, at Pyroll Converting commented “We are looking forward to complete the implementation of Greycon’s solution and the improvements it will allow for our production. Pyroll looks forward to the already justified improvements in overall production efficiency and thus an increase in production capacity. The multisite schedule optimisation capability allows Pyroll to utilise centralised production planning to support global customer service. Integrating Greycon’s planning solution with our current ERP system will bring our planners and management the extra time needed for moving from reactive-based decision making to proactive-based instead.”

Before the implementation Greycon and Pyroll executed a comparison in order to find out how the schedules created by opt-Studio would compare with the current system at Pyroll. Substantial savings were identified in this head to head comparison convincing Pyroll management to progress to solution implementation and further roll-outs.

Jari Kaukiainen, Business Development manager, EMEA, at Greycon says: “The implementation of opt-Studio will bring multiple benefits to Pyroll. The optimised schedules will improve the production throughput and will allow Pyroll to accept extra sheeting capacity for the customers. Since the system will manage the scheduling of the orders automatically, the effort of the planners will go towards analysing and optimisation instead of the routine work to feed orders and sequence them into the ERP-system.”

About Greycon
Greycon is the world’s leading provider of production planning, scheduling and manufacturing execution systems that have been designed specifically for coil-based & flat sheet industries. Greycon operate throughout the world. Greycon’s strength is the extensive range of specialist software solutions for Paper & Board, Plastic Films & Flexible Packaging, Nonwovens, Metals and Converting industries supported by powerful optimisation algorithms and a highly experienced team of consultants.

www.greycon.com

LEAK-FREE MAG-DRIVE CENTRIFUGAL PUMPS

The significant benefits of using magnetically driven pumps such as zero leakage, no wastage or environmental hazards along with extended pump life with longer service intervals, are being appreciated by many end-users in the process and chemical industries. A good example of these types of pumps is the extensive range developed by M Pumps and available exclusively in the UK through pumping specialists MICHAEL SMITH ENGINEERS. The range includes magnetically coupled centrifugal, vane, turbine and side-channel pump options, which are meeting the demands of challenging applications.

With technology advancing so are the demands from end-users in the process and chemical industries seeking effective pumping solutions for handling higher pressures, higher temperatures with improved energy-efficiency. In response to these demands M Pumps has focused attention on improving the energy efficiency of their centrifugal pumps which has led to the development of an innovative rear containment shell and now fitted as standard on their CN MAG-M Series of centrifugal process pumps.

This unique patented hybrid containment shell combines the reliability and chemical resistance of a standard inner metallic shell with the strength of a carbon fibre outer shell and can be selected for applications with liquids at temperatures up to 200ºC and system pressures up to 50 Bar. With a choice of either titanium or hastelloy C inner shell, the M Pump Hybrid Containment Shell has played a significant role in enhancing the operational efficiency and competitiveness of these pumps compared to other standard mag-drive pumps. The operating principle of mag-drive pumps involves a rotating magnetic field which is separated by a stationary metallic barrier which cuts the magnetic field and generates eddy currents that in turn generate heat. The amount of heat generated depends on the material of the barrier. Hastelloy C and titanium generate less eddy current than stainless steel while non-metallic materials generate minimal losses.

Also, the strength of a magnetic field reduces in proportion to the square of the distance from it, so the closer together the magnets, the more efficient the coupling. The M Pumps hybrid solution minimises magnetic losses by featuring a very thin barrier in either hastelloy or titanium, with a thin carbon outer shell thereby reducing the amount of heat from eddy currents and the distance between the rotating magnets. Consequently for a given duty, M Pumps hybrid technology will consume less power in operation enabling a smaller motor to be installed compared to a pump with a traditional containment shell.

Close coupled versions are also available which reduces possible alignment issues and minimises on-site space requirements. Furthermore, a choice of chemically resistant wetted materials helps to extend pump life and increase time between servicing. For critical applications secondary containment options are available.

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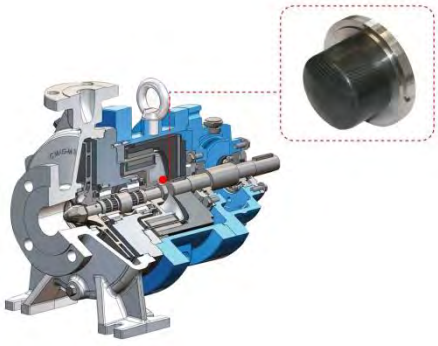

PILZ LAUNCHES MACHINE SAFETY WEBINAR SERIES

Pilz Automation Technology is proud to launch its brand new webinar series for those involved with machine safety across the UK and beyond.

The webinar series is dedicated to sharing the essential facts and updates on a range of key machine safety topics, including a range of industry standards, human-robot collaboration and Industrie 4.0 to name just a few. Each webinar highlights a sole subject relevant to your company's machine safety, compliance and operational needs.

Jamie Walton CMSE®, Services Manager at Pilz, explains:

"There is a constant need in industry to keep up to date on the issues surrounding machine safety; however we understand that people don't always have the time for a full day session out of the office. With our webinars, we hope to deliver the essentials in 'bite-sized' chunks, with the added opportunity to get instant support for specific questions."

Adding to Pilz' portfolio of popular machine safety seminars and training courses, the webinars will run fortnightly at 9:00 GMT, in half hour sessions. Pilz kick-started the series on Friday 31st March with David Collier CMSE® presenting 'Understanding EN ISO 14119', which looks into the types of interlock devices covered by this standard, preventing the defeat of interlocks, the use of fault exclusions, and the cause and the cure of fault masking.

For the full 2017 webinar schedule, further details of each topic and to register, please visit Pilz Events webpage, **email marketing@pilz.co.uk**, or call Pilz on **+44 1536 460766**.

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MEASURE / CONTROL LOW CONSISTENCIES AND RETENTION

In-line and by-pass sensors
KPM's optical consistency transmitters for in-line and by-pass installations offers a full range for low consistency applications in the pulp and paper industry, including saveall and waste water applications.

Optical consistency transmitters are the best choice for a measurement range of 0–2% Cs, measuring fibres and particles starting from 0.01%.

Robust design in SS316 steel
To withstand the most aggressive media the sensors are constructed of stainless steel 316SS. They have no moving parts which means low maintenance. The new display and the user-friendly interface makes easy to operate, and the single-point calibration designates carefree installation and start-up.

Retention measurement system for monitoring and control
KPM also offers a retention measurement system for monitoring and control of paper machine retention, applicable for paper and board machines with or without ash addition. The measuring principle is based on the ability of fibres to depolarize light to a much greater degree than denser solid particles.

KPM KRT retention package measures total consistency of the headbox and whitewater sample with a measurement range of 0–1.5% Cs. Whitewater sensor can be equipped with pump, backflushing unit and deaeration tank.

Benefits
No moving parts – low maintenance
Single point calibration – easy start-up
New display – user-friendly interface
Automatic flushing for contaminated applications

Easy installation of sensors:
Bypass-sensor with hard piping over the pump.
In-line sensor have the same saddle installation as blade consistency transmitters.

For more information on KPM products.
- Data sheet
- Portfolio pulp instruments

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NETWORK PLATFORM 800 (NP800) SCANNER

The Network Platform 800 (NP800) is a completely new scanner design which provides pulp and paper customers with a perpetual foundation on which to evolve their ABB quality control (QCS) systems

NP800 is a high-performance scanner right-sized for today's small-to-mid size paper machines of up to 6.2 meters (244 inches) sheet width. When combined with ABB's leading-edge paper sensors and controls, NP800 is a critical component of the QCS system for improving paper quality, optimising paper machine stability and improving process efficiency.

NP800's combination of powerful processing and real-time data acquisition provides precise sensor and frame coordination, fast signal processing and world-class measurement accuracy.

ABB has used its extensive Pulp and Paper product and service experience to design a scanner for easy expansion, robustness, reliability and serviceability. All system electronics and moving parts are fully integrated into the end columns and completely accessible from off the paper machine for easy and safe maintenance. No water cooling is required for either the scanner or any of its sensors. These features minimise installation down-time, start-up requirements and utility costs - reducing overall system lifecycle costs.

NP800 is a robust, reliable and stable platform, consisting of reinforced carbon steel "A"-beam construction with rigid end-columns that provide superior vertical, horizontal and torsional rigidity. This stable structure is critical for the precise alignment of sensor source and detector heads in harsh environments without the need for measurement profile compensation. The NP800's smooth exterior design with no external openings, covers, exposed hardware or cables minimizes the possibilities for external contamination.

Integration with ABB's 800xA and AC450-based QCS systems is supported along with a full range of engineering tools for configuration, monitoring and local and remote diagnostics. On-board diagnostics include spectral analysis capabilities that can provide further process insight. By studying the frequency of disturbances in the paper machine, changes in the performance can be linked to process upsets, helping customers to identify and eliminate sources of variation.

The NP800 is supported by ABB's commitment to service our products over an extended lifecycle and by an unmatched global network of highly trained personnel.

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PROPORTIONAL SOLENOID CARTRIDGE VALVES

Power management company Eaton has introduced its ESV9 series of proportional solenoid cartridge valves which help offer a more cost effective, general-purpose solution when compared to industrial-rated valves. The ESV9 valves are also smaller, reducing the manifold size and cost, and allow increased flexibility during installation. The valves offer control with optimised linearity, operational efficiency and low hysteresis less than 7%. Broader ramp changes also allow greater resolution.

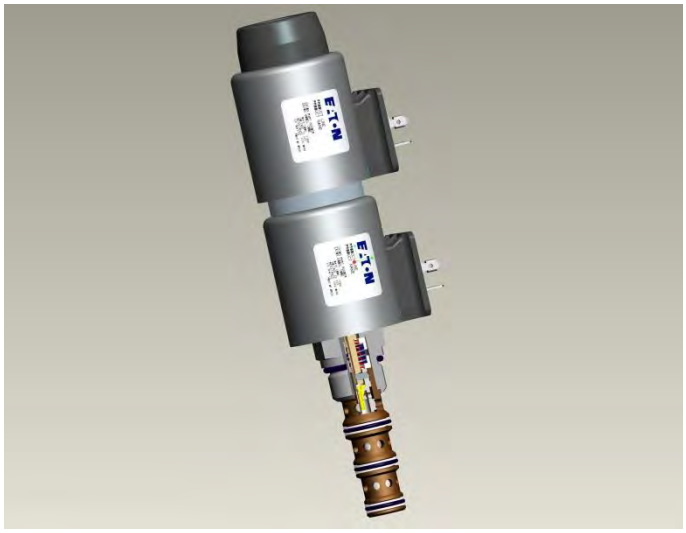
The size 10 ESV9 is a 4-way 3-position screw-in cartridge and is available with either a type E or F spool configuration. The E-spool type solenoid valve has all the ports closed in the de-energised position. This valve is ideal for moderate flow applications where an actuator needs to be proportionally controlled in both directions and stopped in any position. The F spool in the de-energized condition ports 2 and 4 are open to tank with the inlet port 3 blocked. This allows the service ports to decay to tank pressure in the de-energised condition. The size 10 ESV9 valve has a rating of up to 22 litres per minute and up to 250 bar.

“The introduction of the ESV9 series will help provide significant up-front cost savings to our customers, complementing Eaton’s Cetop 3 industrial-rated, high-flow KDG4-V3 series”, says Andreas Kling, Product Marketing Manager Power & Controls Products EMEA at Eaton. "The smaller package size of the ESV9 series also reduces the manifold size and cost.”

As an option, the valves are available with a manual override and additionally be fitted with or without the IP69K compatible “L Series” Large ToughCoils™. 12V or 24V DC coil voltages, with or without a diode, can be selected, along with a number of housing materials (steel or aluminium) and port sizes.

Applications include construction machinery, agricultural, material handling as well as a broad range of general equipment.

To learn more about Eaton's proportional valve products visit **www.eaton.com/hydraulics**.



PAPERmaking!

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Volume 3, Number 1, 2017

Paper Industry Technical Association

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Installations

The following pages contain a summary of the various installations and orders from around the world of papermaking, wood panel and saw mills, and bio-power generation, received between November 2016 and April 2017.

COMPANY, SITE	SUPPLIER	DESCRIPTION	START-UP
Altri Group, Celbi Mill, Portugal	Andritz	To upgrade the brown stock washing process in the fibreline	Q3 2017
Anhui Shanyin Paper Industry Co. Ltd., Ma'anshan, Anhui Province, China	Valmet	To supply an online condition monitoring system to be installed on PMs1, 2, 3, 5 and 6	Q1 2017
Anon, USA	Valmet	To supply three board machine rebuilds	2017-2018
APP (sites not stated)	Toscotec	To supply eight Tissue Machines	Q3 2017 to Q2 2018
Ariete S.r.l., Cava dei Tirreni (Salerno), Italy.	Toscotec	To supply new tissue machine	2017
Arkhangelsk Pulp and Paper Mill, Novodvinsk, Russia	Valmet	To supply an evaporation plant including two new evaporation trains and a new automation system to control the processes	2019
Arkhangelsk Pulp & Paper Mill, Russia	Valmet	To supply an extensive board machine and automation rebuild for BM2	H2 2018
Bedford Paper, De Pere facility, Wisconsin (USA)	PCMC	To supply tissue converting and packaging line	
BillerudKorsnäs, Gruvön Mill, Sweden	GL&V	To supply a complete Refiner and Deflaker system and a combined Save-All/Broke Thickener together with Duflo® Pump technology to the new Board Machine	Q1/Q2 2019
BillerudKorsnäs, Gruvön Mill, Sweden	Voith	A fully equipped XcelLine board machine (8.8m, 1200m/min, 550,000tpy)	Q1 2019
Burgo Avezzano, Italy	Andritz	To rebuild and convert PM2, a printing and white writing paper machine, and its approach system, into a modern brown packaging paper machine	Q4 2017
Cartiere Modesto Cardella, San Pietro a Vico (Lucca), Italy	Toscotec	Enhancing drying section of PM4	H2 2017
Cartiera Olona srl, Gorla Minore, Varese, Italy	Toscotec	To rebuild dryer section of coreboard machine (capacity 50,000 tpy)	Q2 2017
Cartulinas CMPC, Maule, Chile	Andritz	To upgrade the complete bleaching system for the production of softwood BTMP	Q4 2017
CENIBRA, Belo Oriente Pulp Mill, Brazil	Valmet	To supply new bleaching plant	Q2 2018
Consorzio Cartiere, Tivoli, Italy	Andritz	To upgrade board machine and related stock preparation line	Q1 2018
Correll Tissue, Durban, South Africa	Toscotec	To rebuild PM1 tissue machine (2.5m width)	H2 2017
Daio Paper Co Ltd, Mishima Pulp Mill, Japan	Valmet	To supply a white liquor pressure disc filter	Q3/Q4 2017
Delfortgroup, Dunafin Mill, Dunaújváros, Hungary	Savcor Forest Oy	To supply Savcor Wedge™ Process Diagnostics System	

COMPANY, SITE	SUPPLIER	DESCRIPTION	START-UP
Fibria Celulose S/A, Três Lagoas, state of Mato Grosso do Sul, Brazil	Praxair	To undertake a long-term agreement expanding its supply of oxygen	H2 2017
First Quality Tissue (FQT), USA	Valmet	To supply a 70,000tpy TAD tissue machine	Q2 2018
Fujian NanFang Textile Co. Ltd., NanPing, Fujian Province, China	Andritz	To supply two spunlace lines (capacity 20,000tpy each)	Q1 2017
Gomà-Camps Group, Ejea de los Caballeros, Spain	Voith	To deliver new 34000tpy tissue line	Q1 2018
Green Forest (QingXin) Paper Industrial Ltd., Qingxin County, Qingyuan, China	Valmet	To supply a headbox upgrade	Q3 2017
Grupo Corporativo Papelera S.A. de C.V., Mexico	A Celli Paper	To supply a new tissue machine (capacity 34,000tpy)	
GuangDong ShaoNeng Group Co. Ltd., China	A Celli Paper	To supply a 26,000tpy Tissue Machine line	H2 2017
Hengan Group, Changji Mill, Xinjiang Autonomous Region, China	Toscotec	To supply two MODULO-PLUS ES tissue machines (30,000tpy)	2017
INOVYN, Stenungsund, Sweden	Valmet	To supply an automation system for chlorine plant	Q3 2017
Irving Consumer Products, site TBC, USA	Valmet	To supply TAD tissue machine	2018
IPUSA Uruguay	Cellwood Machinery AB	Supply a Grubbens high consistency pulper and a Grubbens reject separator	
ITC, Tribeni Plant, West Bengal, India	Voith	To supply a new decor paper machine (Chandrahati PM4)	
Ittihad International Investment L.L.C., Abu Dhabi, UAE	Valmet	To supply a greenfield production line (PM1) with automation package for producing high-quality P&W grades	Q4 2018
J.D. Irving Company, Lake Utopia Paper, New Brunswick, Canada	GTI Geomembrane Technologies Inc	Awarded a contract to cover a large anaerobic digester with a gas collection cover	2017
Jiangxi Taison Paper, Jiujiang, Jiangxi Province, China	Valmet	To supply automation technology to four new tissue machines, TM7, TM8, TM9 and TM10,	
JSC, Ilim Group, Bratsk Paper Mill, Russia	Clean Combustion	To deliver multi-fuel burner with command and control systems and peripheral equipment	Q2 2017
Kama Karton LLC, Krasnokamsk, Russia	Andritz	To deliver FBB production line (220,000tpy) including a new BCTMP line and stock preparation line	Q1 2019
Kemira, Joutseno, Finland	Valmet	To supply an automation system for new sodium chlorate production line	Q2 2017
Kinleith and Tasman Pulp and Paper Mills, near Tokoroa and Kawerau , New Zealand	Maintenir	Pulp mill maintenance contract	From Q2 2017
Kotkamills, Finland	Valmet	To supply extensive automation service agreement	

COMPANY, SITE	SUPPLIER	DESCRIPTION	START-UP
Kronospan Group, Russia (several sites)	Holtec	To supply wood yard for new OSB mill and extension to Bashkortostan mill in Ufa	
Kyiv CPM, Ukraine	Bellmer	Modernisation of machine coater	Q1/Q2 2017
Luso Finsa, Portugal	Valmet	To deliver a defibrator system to fibreboard production plant	Q2 2017
Mariyski CBK, Russia	Papcel	To supply press rebuild and modification of wire table for PM1	
Matías Gomá Tomás S A, La Riba Board Mill, Catalonia, Spain	Valmet	To supply a capacity increase project, including new pick-up felt loop, perforated uhle box covers, hood ventilation upgrade, steam and condensate system upgrade and additional drying cylinders	Q4 2016 to Q1 2017
Metsä Fibre, Äänekoski, Bioproduct Mill Finland	SKF	To provide lubrication technology and system engineering support	Q3 2017
Metsä Tissue AB, Nyboholm, Sweden	KPA Unicon Oy	To deliver 8MWth biomass-fired steam boiler plant	Q4 2017
Mondi Dynäs, Sweden	SPM	Supply new online system for vibration monitoring	
Nepa Limited, India	Valmet	To supply automation technology for two refurbished paper machines and new deinking plant	Q1 2017
Nine Dragons Industries Co. Ltd., Chongqing, China	Valmet	To supply containerboard production line and related automation systems (PM40)	2018
Nine Dragons Industries Co. Ltd., Quanzhou, China	Valmet	To supply containerboard production line and related automation systems (PM39)	2018
Papier- und Kartonfabrik Varel, Germany	Andritz	To supply new processing line for pulper rags	
Pro-Gest Group, Mantova, Italy	Andritz	To deliver recycled paper plant and PM approach system	Q3 2017
Quansen Wood Co. Ltd., Mengcheng County, Anhui Province, China	Valmet	To deliver a defibrator system to new fibreboard line	Q3 2017
Rotocart, Castelminio di Resana, Italy	Valmet	To deliver rewinder unit for new converting facility	
Sappi, Maastricht, The Netherlands	Valmet	To supply a paper machine rebuild for PM6, to improve the existing graphical board products and move into producing high quality solid bleached board (SBB) and folding box board (FBB) grades	H1 2018
Sappi, Ngodwana pulp mill, South Africa	Valmet	To supply an evaporation line (no.3)	H2 2018
Sappi, Somerset Mill, Skowhegan, Maine, USA	Andritz	To upgrade debarking line and woodyard equipment	Q4 2017

COMPANY, SITE	SUPPLIER	DESCRIPTION	START-UP
Sappi, Somerset Mill, Skowhegan, Maine, USA	Valmet	To supply an extensive paper machine rebuild for PM1 so it can produce both coated paper and a variety of consumer packaging products	H1 2018
Scottish and Southern Energy, Ferrybridge, Knottingley, West Yorkshire, UK	Valmet	To supply automation to this new waste-to-energy facility	H1 2017 to H2 2019
Shandong Chenming Paper Ltd., Zhanjiang site, Guangdong Province, China	Valmet	To supply a winder for BM4 producing FBB	2018
Shanghai Shidongkou, China	Valmet	To supply total solids measurement technology to wastewater treatment plant	Q1 2017
Shanghai Taison Pulp-Making (Group) Co. Ltd., Jiangxi Jiujiang mill, China	A Celli Paper	Ordered 4 Tissue Rewinders	2017
Södra Cell, Mönsterås Pulp Mill, Sweden	SPM Instrument AB	To supply online system Intellinova Compact to monitor five wash presses	
Sofidel, Circleville, Ohio, USA	A Celli Paper	To supply a latest-generation rewinder model E-WIND®	Q1 2018
Solikamsk, Russia	Wärtsilä	To supply equipment for a 55MW combined heat and power plant	H2 2018
ST Tissue, Franklin, Virginia	Toscotec	To supply the widest Steel Yankee ever to be manufactured to the dry-end section and redesign the F-5 machine to convert it to dry crepe tissue (PM5)	
Star Paper Mill Ltd, Abu Dhabi	Recard	To supply a turnkey plant for the production of high quality tissue	Q1/Q2 2018
Sun Paper, Arkansas, U S Shandong Sun Paper Industry Joint Stock Co., Ltd	Pöyry	Awarded environmental permitting and pre-engineering assignment new biorefinery project	
Sun Paper, Muang Phin Mill, Savanakhet Province, Laos	Valmet	To deliver key technology for a new green field dissolving pulp mill	Q2 2018
Sun Paper Holding Lao Co. Ltd., city of Xepon, Lao People's Democratic Republic	Andritz	To supply main production technologies and equipment for a new pulp mill	Q2/Q3 2018
Taison Pulp-Making, Taison Group, Jiangxi Jiujiang, Shanghai, China	A Celli Paper	To supply four tissue rewinders	2017
Thai Paper Co. Ltd., Wangsala Pulp Mill, Kanchanaburi, Thailand	Andritz	To upgrade the wet lap plant	Q3 2017
Twinsaver Group, Kliprivier site, Gauteng, South Africa	Toscotec	To deliver a new tissue line (TM5)	H2 2017
Vinda Paper (Zhejiang), Longyou Mill, China	Toscotec	To supply two tissue machines, (TM 3 and 4) capacity 30,000tpy each	Q2/Q3 2017

COMPANY, SITE	SUPPLIER	DESCRIPTION	START-UP
Wepa Professional Hygiene, Piechowice, Poland	ABB	To expand the energy efficiency with a new 110/20 kV substation	
Zhe Jiang Huachuan, Yiwu Mill, Zhejiang Province, China	PMP	To supply a new PM8 to produce glassline papers	H2 2017

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Research Articles

Most journals and magazines devoted to the paper industry contain a mixture of news, features and some technical articles. However, very few contain research items, and even fewer of these are peer-reviewed.

This listing contains the most recent articles from the five main journals that publish original research:

- *APPITA JOURNAL*
- *IPPTA JOURNAL*
- *J-FOR*
- *NORDIC PULP & PAPER RESEARCH JOURNAL*
- *TAPPI JOURNAL*

The Paper Industry Technical Association (PITA) is an independent organisation which operates for the general benefit of its members – both individual and corporate – dedicated to promoting and improving the technical and scientific knowledge of those working in the UK pulp and paper industry. Formed in 1960, it serves the Industry, both manufacturers and suppliers, by providing a forum for members to meet and network; it organises visits, conferences and training seminars that cover all aspects of papermaking science. It also publishes the prestigious journal *Paper Technology* and the *PITA Annual Review*, both sent free to members, and a range of other technical publications which include conference proceedings and the acclaimed *Essential Guide to Aqueous Coating*.

***APPITA JOURNAL*, Vol.70 No.1 – Jan-Mar 2017**

1. Influences of the characteristics of printing inks on the effects of blister packaging
2. Monitoring dissolved COD in a pulp mill wastewater treatment plant by measuring total dissolved solids with a refractometer
3. Conditions of relative humidity and temperature for paper testing in Australia
4. Compression and stacking strength of corrugated fibreboard containers
5. A review of Australian R&D into corrugated box performance and the evolution of on-machine measurement of Ring Crush

***J-FOR*, Vol.5 No.5 – 2016**

1. Big Data in the Forest Bioeconomy: The Good, the Bad, and the Ugly
2. Impact of Timber Volume and Grade Estimation Error on the British Columbia Coastal Supply Chain
3. Hybrid Simulation and Optimization Approach to Tackle Supply Chain Complexities: A Review with a Focus on Forest Products Supply Chains
4. Managing Unforeseen Events in Forest Transportation
5. A Comprehensive Framework for Developing Inter-firm Collaboration — A Study of the Forest-based Supply Chain
6. Analysis of the Drivers and Factors Influencing Partnership Performance in British Columbia's Forest Products Supply Chain

***J-FOR*, Vol.5 No.6 – 2016**

1. Rapid Prediction of the Chemical Composition of Hybrid Poplar Using Near-infrared Spectroscopy
2. Rendering Packaging Paper Antimicrobial with Functional-modified Starch: Pilot Paper Machine Trial at FPInnovations
3. Performance and Benefits of Fibre Orientation CD Control
4. Understanding NOx Formation in Pulp Mill Boilers
5. New Source of Caustic for Kraft Mills from the Electrolysis of Sodium Sulphate: Preliminary Economics

***J-FOR*, Vol.6 No.1 – 2017**

1. Power dissipation profiles determined from force measurements in a High-consistency TMP refiner
2. Potassium hydroxide pulping of saccharum spontaneum (KASH)
3. Troubleshooting a black liquor concentrator solids control problem via modelling and simulation

***J-FOR*, Vol.6 No.2 – 2017**

1. Rheology of dispersions of spheres and cellulose nanofibrils
2. Some process aspects on acid sulphite pulping of softwood
3. The impact of wet end chemistry on paper machine performance - fundamentals revisited

***NORDIC PULP & PAPER RESEARCH JOURNAL*, Vol.32 No.1 – 2017**

1. BIOREFINERY - An eco-friendly scheme to eliminate silica problems during bamboo biomass fractionation
2. CHEMICAL PULPING - Increased pulp yield by prolonged impregnation in softwood kraft pulping (OPEN ACCESS)
3. CHEMICAL PULPING - The Arrhenius Equation is Still a Useful Tool in Chemical Engineering (OPEN ACCESS)
4. CHEMICAL PULPING - Characterization of a dusting lime kiln - A mill study (OPEN ACCESS)
5. MECHANICAL PULPING - CTMP process optimization Part I: Internal and external variables impact on refiner conditions
6. MECHANICAL PULPING - Process Considerations and its demands on TMP property measurements - a study on tensile index
7. MECHANICAL PULPING - Strong paper from spruce CTMP - Part I
8. MECHANICAL PULPING - Low dosage sulfite pretreatment at different refining temperatures in mill scale TMP production (OPEN ACCESS)
9. MECHANICAL PULPING - ATMP pulping of Norway spruce - pulp property development and energy efficiency
10. PAPER CHEMISTRY - Refining of birch kraft pulp before or during xylanase treatment - effect on carbohydrate release and retention behavior (OPEN ACCESS)
11. PAPER CHEMISTRY - Comparison of optical instruments for fines and filler characterisation
12. PAPER PHYSICS - On the net refining energy and tensile development of nbsk pulp in a low consistency refiner
13. PAPER PHYSICS - Effect of fiber length on formation and strength efficiency in twin-wire roll forming (OPEN ACCESS)
14. PAPER PHYSICS - Evaluation of the in-plane shear strength of paper measured by tensile-loaded shear test
15. PAPER PHYSICS - Modelling of concentrated fibre suspension pipe flow with low-reynolds-number k-ε turbulence models: new damping function
16. RECYCLING - Effects of Fractionation and Mechanical Treatments of Korean OCC on Paper Properties
17. RECYCLING - A new potential paper resource; recyclability of paper cups coated with water-soluble polyacrylate-based polymer

***TAPPI JOURNAL*, January 2017**

1. Physical handsheet properties of pulp furnishes containing attritor-treated fibers
2. Removal of silicon from green liquor with low-temperature precausticizing
3. Paper coated with sonochemically synthesized zinc oxide nanoparticles: Enhancement of properties for preservation of documents
4. Cellulosic ethanol byproducts as a bulking agent

***TAPPI JOURNAL*, February 2017**

1. Guest Editorial: From rocket science to innovation in bioenergy & bioproducts
   Removal of silicon from green liquor with low-temperature precausticizing
2. Low-temperature precausticizing — a hopeful approach for green liquor desilication
3. Understanding conductivity and soda loss
4. Fractional pulping of packaging board in high consistency drum pulping
5. Estimating limits of wet pressing on paper machines

***TAPPI JOURNAL*, March 2017**

1. Editorial: Lignin: Today and tomorrow
2. Lignin carbon fiber: The path for quality
3. Melt-blown compostable polyester films with lignin
4. Accelerated aging of bio-oil from lignin conversion in subcritical water
5. An easy and reliable method for syringyl:guaiacyl ratio measurement
6. Analysis of economically viable lignin-based biorefinery strategies implemented within a kraft pulp mill

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Technical Abstracts

The general peer-reviewed scientific and engineering press consists of several thousand journals, conference proceedings and books published annually. In among the multitude of articles, presentations and chapters is a small but select number of items that relate to papermaking, environmental and waste processing, packaging, moulded pulp and wood panel manufacture. The edited abstracts contained in this report show the most recent items likely to prove of interest to our readership, arranged as follows:

Page 2	*Biomass / Biorefinery* *Energy*
Page 3	*Engineering* *Nano-Science* *Novel Products*
Page 5	*Packaging Technology*
Page 6	*Papermaking*
Page 7	*Pigments*
Page 8	*Pulping*
Page 9	*Recycling* *Waste & Environment*
Page 10	*Wood Panel*

Those marked OPEN ACCESS can be downloaded from the internet in their entirety, free of charge.

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BIOMASS / BIOREFINERY

Field trial results of straw yield with different harvesting methods, and modelled effects on soil organic carbon. A case study from Southern Finland, Kaija Hakala *et al*, *Biomass and Bioenergy*, Vol.95. We estimated the effects of different cutting heights and harvesting strategies on the amounts of harvestable residue biomasses and allocation of residue biomasses in the soil. A case study on regional straw biomass resources was performed with the different crops cultivated in Varsinais-Suomi (Southern Finland) at present (averages of 2003–2012) and in the predicted future warmer climate (scenario RCP 4.5, year 2055). We also estimated, with the help of the Yasso07 model, the effects of different residue incorporation intensities on soil organic carbon (SOC) at present and in the future warmer climate.

Elemental analysis of various biomass solid fractions in biorefineries by X-ray fluorescence spectrometry, Duy Michael Le *et al*, *Biomass and Bioenergy*, Vol.97. Elemental analysis by X-ray fluorescence spectrometry (XRF) of solid samples from a biorefinery process was performed to study the behaviour of mineral elements in a process involving hydrothermal pretreatment of biomass (wheat straw, corn stover, sugarcane bagasse, palm oil empty fruit bunches, poplar) followed by enzymatic hydrolysis and fermentation.

Rheometry of coarse biomass at high temperature and pressure, Daniel J. Klingenberg *et al*, *Biomass and Bioenergy*, Vol.99. We designed, constructed, and tested a new device that can measure the rheological properties of lignocellulosic biomass slurries with high solids concentrations (>25%) containing large particles (>10 mm), and that can operate at high temperatures (>230 °C), high pressures (>2.8 MPa), and low pH (<1.0). Rheological properties measured with this Lignocellulosic Biomass Rheometer (LCBR) are consistent with those measured with another instrument.

Technological innovation systems for biorefineries: a review of the literature, Fredric Bauer *et al*, *Biofuels, Bioproducts and Biorefining* (online). The concept of a bioeconomy can be understood as an economy where the basic building blocks for materials, chemicals, and energy are derived from renewable biological resources. Biorefineries are considered an integral part of the development toward a future sustainable bioeconomy. The purpose of this literature review is to synthesise current knowledge about how biorefinery technologies are being developed, deployed, and diffused, and to identify actors, networks, and institutions relevant for these processes.

ENERGY

Energy conservation potential of an energy audit within the pulp and paper industry in Morocco, Ali Boharb *et al*, *Journal of Cleaner Production*, Vol.149. An energy audit is a primary step toward improving energy efficiency at the facility level and ensuring ‘clean’ production. The pulp and paper sector is one of the most energy-intensive industries in Morocco. This article aimed at identifying energy conservation opportunities at a Small and Medium-sized paper mill. The audit results together with their financial viability are presented regarding the analysis of energy consumption and electrical quality issues. The paper introduces an action plan for a more efficient energy use of some specific applications such as furnaces and compressed-air installations as well.

ENGINEERING

Effect of anvil position on cutting force and energy measurements of a disc chipper, Stéphane Labbé *et al*, *Biomass and Bioenergy*, Vol.99. Using renewable energy as wood chip or improving wood chip heating process are different usual ways to reduce carbon dioxide emission. The more uncharted path to reduce it is to limit energy consumed to produce wood-based fuel as wood chips or pellets. Wood chipping is the first step of each wood fuel production process. Chipping wood knowledge is also important for improving wood chipper efficiency. This paper compares two methods for determining cutting energy of a disc chipper and evaluates influence of anvil position on chipper efficiency.

NANO-SCIENCE

Preparation, properties and applications of nanocellulosic materials, Subrata Mondal, *Carbohydrate Polymers*, Vol.163. Recently, nano materials derived from natural renewable resources have drawn much attention in the nanotechnology research thrust. Lignocelluloses are composed of cellulosic nano-fibrils which can be disintegrated by chemical, mechanical and enzymatic methods in order to obtain nanocellulose. Further, nanocellulose can also be synthesised by bacterial method in a suitable culture. In this paper, the author reviewed research on recent advances in nanocellulosic materials. Various methods of nanocellulose preparation and their properties, surface modifications of nanocellulose, and applications of nanocellulose in the diverse fields are discussed in the paper.

Integrated production of lignin containing cellulose nanocrystals (LCNC) and nanofibrils (LCNF) using an easily recyclable di-carboxylic acid, Huiyang Bian *et al*, *Carbohydrate Polymers*, Vol.167. Here we demonstrate di-carboxylic acid hydrolysis for the integrated production of lignin containing cellulose nanocrystals and nanofibrils using two unbleached mixed hardwood chemical pulps of different lignin contents.

NOVEL PRODUCTS

A facile method for preparation superhydrophobic paper with enhanced physical strength and moisture-proofing property, Hui Li *et al*, *Carbohydrate Polymers*, Vol.160. We proposed a green and facile method to fabricate superhydrophobic paper in this study, which is layer-by-layer deposition of TiO2 nanoparticles/sodium alginate multilayers on paper surface followed by an adsorption treatment of colloidal carnauba wax.

Facile and green fabrication of cellulosed based aerogels for lampblack filtration from waste newspaper, Peidong Fan *et al*, *Carbohydrate Polymers*, Vol.162. In this study, the lightweight, hydrophobic and porous cellulose-based aerogels (CAGs) were synthesized through a freeze–drying process using waste newspaper as the only raw material. After crosslinking with glutaraldehyde and treatment with trimethylchlorosilane using a simple thermal chemical vapour deposition process, the resulting CAGs became hydrophobic and oleophilic. Furthermore, the as-prepared CAGs exhibited a low density (17.4–28.7mg/cm^3) and mesoporous inner-structure. All these properties attributed the novel aerogel not only with a good adsorption capability of oils and organic solvents, including kerosene, nitrobenzene, and chloroform, but also an excellent filtration capacity of lampblack.

Environmentally friendly procedure for in-situ coating of regenerated cellulose fibres with silver nanoparticles, Tanja Pivec *et al*, *Carbohydrate Polymers*, Vol.163. This study introduces a novel green in-situ procedure for introduction of silver nanoparticles on and into cellulose fibres in a three-stage process. Efficiency of the method towards incorporation of silver particles into the fibres' internal structure was characterised; the coatings' morphology and determination of spatial presence of Ag particles were imagining by the scanning electron microscopy and accompanying energy dispersive x-ray spectroscopy analysis; prepared fibres have superior durability of particles' coating against washing and excellent antimicrobial activity even after 20 washing cycles. Additionally, the water retention of silver treated fibres was improved, while the mechanical properties were not significantly impaired.

Multi-layer nanopaper based composites, Andreas Mautner *et al*, *Cellulose* (online). Native cellulose nanofibrils (CNF) were prepared from bleached birch pulp without any chemical or enzymatic pretreatment. These CNF were modified by adsorption of a small amount of water-soluble polysaccharides and used to prepare nanopapers, which were processed into composites by lamination with an epoxy resin and subsequently cured. The results were compared to the properties of composites prepared using bacterial cellulose nanopapers, since bacterial cellulose constitutes highly pure and crystalline cellulose. It was found that both types of nanopapers significantly improved both the thermal stability and mechanical properties of the epoxy resin. The mechanical properties of the composites thus reflected the improvement of the nanopaper properties by the polysaccharides.

Ultra-lightweight cellulose foam material: preparation and properties, Ran Li *et al*, *Cellulose* (online). Ultra-lightweight cellulose foams were prepared by regeneration of sodium dodecyl sulphate (SDS)/cellulose/NaOH/urea blend solution via mechanical agitation and then freeze-drying. The morphology and properties of the blend solutions and foams were investigated via optical microscope, rheometer, BET and SEM. As a result, it was found that the inclusion complex structure between cellulose macromolecules and the solvent molecules was not destroyed. In this work, cellulose foams with ultra-lightweight and good mechanical properties were obtained, which exhibited great potentials for further development and comprehensive utilisation of cellulose.

(Bio)Chemical Sensors Based on Paper, Nipapan Ruecha *et al*, chapter in *Materials for Chemical Sensing* (Springer). The authors discuss the use of paper as a material in (bio)chemical sensing approaches. After providing a short historical overview, a general introduction into paper properties and the motivation for using paper in (bio)chemical sensors, specific examples of the application of paper as a material are discussed in more detail for systems relying on optical and electrochemical signal transduction. The chapter closes with a short outlook on future perspectives.

Cellulose-Based Functional and Smart Materials, Haisong Qi, chapter in *Novel Functional Materials Based on Cellulose* (Springer). To convert the traditional cellulose material into functional and smart materials, a series of procedures involved modification or functionalisation of cellulose have been developed. By integrating nanoparticles or other functional materials, the cellulose-based materials can achieve tailored properties such as electrical conductivity, magnetic properties, photosensitivity, catalytic activity, sensing ability, and other special properties. The fabrication processes, properties, and applications of the recently reported cellulose-based functional materials are summarised in this chapter.

PACKAGING TECHNOLOGY

Synthesis of hybrid paper sheets with enhanced air barrier and antimicrobial properties for food packaging, Magda A. El-Samahy *et al*, *Carbohydrate Polymers*, Vol.168. Paper sheets made from bagasse pulp have been modified using nanocellulose (NC) obtained from the same raw material. Modification of paper sheets have been carried out either through loading of paper with different concentrations of NC and antibacterial agent, Chitosan (Ch), during making sheets, or by surface coating of the paper. The results showed that presence of NC did not negatively affect the obtained modified paper sheets, while air permeability decreased with adding 8% NC to paper matrix. On the other hand, surface coverage of paper sheets with NC greatly reduced air permeability. Antimicrobial investigations carried out by optical density method indicated that presence of Ch in the paper sheets as an additive or in a coating formulation enhanced paper resistance to different microorganisms especially those causing food poisoning. The current study confirms that the modified paper can have potential application in food packaging.

Outlook and Challenges of Nanotechnologies for Food Packaging, Yves Wyser *et al*, *Packaging Technology and Science*, Vol.29 (OPEN ACCESS). Nanotechnology has been considered to have high potential for food packaging applications very early on. The ability to provide additional consumer benefits through the improvement of key properties of packaging materials and the creation of new functionalities means that the increased use of nanomaterials and nanotechnologies is highly likely. It has however up to now failed to reach the widespread use that was initially expected, mainly because of remaining uncertainties on the safety of these materials during the various stages of their life-cycle, which limit legal and consumer acceptance. This paper aims at presenting the latest developments in the field of nanotechnologies for food packaging applications.

Moulded Pulp Manufacturing: Overview and Prospects for the Process Technology, Mattia Didone *et al*, *Packaging Technology and Science*, (online). Eco-friendly packaging such as moulded pulp products have gained commercial importance in recent years. However, it remains a greatly under-researched area, and there is an arising need to consolidate the best practices from research and industry in order to increase its implementation. The goal of this paper is to give an overview of the main aspects involved in the manufacture of moulded pulp products. This includes a classification of moulded pulp products, historical and current applications, production processes, materials, mechanical properties and environmental sustainability. Moreover, an innovative drying technique that utilises concepts derived from impulse drying is presented, and the implementation of this process technology is discussed.

Stiffness Heterogeneity of Multiply Paperboard Examined with VFM, Anton Hagman *et al*, *Residual Stress, Thermomechanics & Infrared Imaging, Hybrid Techniques and Inverse Problems*, Vol.9. Mechanical heterogeneity of a multiply paperboard was characterised in uniaxial tension using DIC and VFM. The specimen was divided into three subregions based on axial strain magnitude. VFM analysis showed that the subregions had stiffnesses and Poisson's ratios that varied in a monotonically decreasing fashion, but with the stiffness differences between subregions increasing with applied tensile stress. An Equilibrium Gap analysis showed improved local equilibrium when comparing a homogeneous analysis with the subregion analysis. Although only a single specimen was examined, results suggest that high stiffness regions provide only marginal improvement of mechanical behaviour. The analysis also showed that even though the subregions themselves were non-contiguous, their mechanical behaviour was similar.

Odors in Paper and Cardboard Packaging, Michael Czerny, chapter in *Springer Handbook of Odor*. Packaging materials based on paper are often used for packing foods, for example, flour, spices, rice, noodles and frozen products. Like all materials used for packing, cardboards and papers have to fulfil legal requirements in order to avoid the transfer of undesirable and harmful packaging constituents to foods. These legislations also cover the deterioration in the organoleptic properties of the packed food. Thus, methods and standards have been established in order to evaluate the sensory impact of packaging on foods. This chapter reviews several human-sensory tests that are often applied for the evaluation of the organoleptic – in particular olfactory – quality of cardboards and papers.

Static and Dynamic Strength of Paperboard Containers Subjected to Variations in Climatic Conditions, M.J. Lamb and V. Rouillard, *Packaging Technology and Science*, Vol.30 (3). The variability in climatic conditions during product distribution, especially across large distances, can be significant and is well known to affect the mechanical properties of many packaging materials. In the case of paperboard boxes, this is dealt with by accounting for the loss of static (compression) strength with increasing relative humidity. However, no method exists to address the dynamic loads induced by vehicle shocks and vibrations especially for configurations that involve stacked boxes and where the vibration intensity within the stack is influenced by the dynamic characteristic of the boxes themselves. This paper describes the evaluation of the fatigue resistance of paperboard boxes subjected to random excitation and compares the results with those obtained from quasi-static compression tests under various environmental conditions.

Taped Barrier Test for Internal Bags Used in Boxes of Recycled Paperboard: Update of the Method, Sandra Biedermann-Brem *et al*, *Packaging Technology and Science*, Vol.30 (3). Internal bags with an integrated functional barrier are a promising solution to avoid food contamination from recycled board packaging. The efficiency of the barrier should be measurable by a simple test that appropriately reflects reality. A previously described test, involving four surrogate substances on a donor paper and silicone paper as a receptor in a taped format (Packag Technol Sci. 2014; 27:713–726), was amended to take into account findings on absorption in the internal bag and the board. The combined effects on migration are now calculated as the percentage of the surrogate substances detected in the receptor compared to the amount in the donor.

PAPERMAKING

Effect of cellulose microfibril (CMF) addition on strength properties of middle ply of board, J. Lehmonen *et al*, *Cellulose*, Vol.24 (2). Cellulose microfibrils (CMF) are a promising biobased material with unique nanospecific properties, giving them potential for use in numerous applications. Based on this, cost-effective and novel high-consistency enzymatic fibrillation (HefCel) technology was used to produce CMF, which was further used to reinforce middle ply of board structure and the results compared with those obtained without CMF addition and with addition of CMF produced by traditional Masuko grinding (VTT Native grade).

Substrate role in coating of microfibrillated cellulose suspensions, Vinay Kumar *et al*, Cellulose, Vol.24 (3). Interest in nanocellulose-based coatings for packaging applications has been growing due to their excellent oil and gas barrier properties combined with their sustainable, recyclable, biodegradable, and non-toxic nature. Coating of nanocellulose materials such as microfibrillated cellulose (MFC) on paper/paperboard is

challenging compared to traditional paper coating materials due to excessively high viscosity and yield stress of MFC suspensions at rather low solids content, typically below 5%. A custom-built slot geometry is used herein to enable coating of highly viscous MFC suspensions on different paper-based substrates in a roll-to-roll process. The impact of substrate properties, such as surface chemistry and surface energy, surface roughness and surface porosity, and water absorption capacity on MFC coatability and coating quality is reported.

Further understanding on the mechanism of alkyl ketene dimer sizing on the causticized calcium carbonate filled paper and its improvements, Jian Wang *et al*, *Environmental Science and Pollution Research*, Vol.35 (5). Causticized calcium carbonate (CCC), a solid waste derived from kraft black recovery process, can be used as an alternative for the conventional precipitated calcium carbonate (PCC). However, the application of the CCC has been limited due to its low sizing efficiency in filled paper. In this study, the characteristics of the CCC were studied aiming to improve the alkyl ketene dimer sizing performance of the CCC filled papers, and the results were compared with those from PCC filled papers.

Study on the Antistatic Coating Technology and Coated Paperboard Performance, Qinghua Gao *et al*, *Advanced Graphic Communications and Media* (PPMT 2016 conference proceedings). In order to study various properties of the coated antistatic corrugated board, the effect of coating weight on the antistatic property of paper board was understood by pre-test, thus the optimal coating weight was selected. The three layers (S5S) and five layers (S545S) ordinary corrugated board, printed and coated antistatic corrugated board were produced by coated machine and corrugated board production line, and the edgewise crush resistance, flat crush resistance, compressive strength and antistatic property in the optimal coating weight were tested and analysed.

Improving strength properties of recycled and virgin pulp mixtures with dry strength agents, Sezgin Koray Gulsoy and Saduman Erenturk, *Starch – Stärke*, Vol.69 (3-4). In the paper industry, the increasing use of recycled fibres as a substitute for virgin fibres has resulted in decreased strength properties. In this study, old corrugated container fibres were added in different ratios to virgin kraft fibres, and the effects on paper properties were investigated. Furthermore, 0.75% cationic starch and 0.75% Luredur® with respect to oven-dry fibres were added separately to old corrugated container fibre-containing/fibre-free suspensions, and the effects on handsheet strength properties were determined.

PIGMENTS

Preparation of Zinc Oxide-Starch Nanocomposite and Its Application on Coating, Jinxia Ma *et al*, *Nanoscale Research Letters*, Vol.11, (OPEN ACCESS). A new production method of zinc oxide (ZnO)-starch nanocomposite was invented in this study. Starch was dissolved in zinc chloride ($ZnCl_2$) solution (65 wt%) at 80°C. Then, ZnO-starch nanocomposite was achieved when the pH of the solution was adjusted to 8.4 by NaOH solution (15 wt%). ZnO nanoparticles were also obtained when the generated ZnO-starch nanocomposite was calcined at 575°C. The ZnO-starch nanocomposite was used to directly coat the surface of plain paper with a laboratory paper coater. The surface strength and smoothness of paper were improved by the coating of ZnO-starch nanocomposite. The antibacterial property was also identified from the coated paper.

Preparation and application of Tunisian phosphogypsum as fillers in papermaking made from *Prunus amygdalus* and *Tamarisk sp.*, N Mechi *et al*, *Powder Technology*, Vol.312. Large mineral fillers have long been used in papermaking for many reasons. During this study, *Tamarisk sp.* and *Prunus amygdalus* pulp-filled papers with raw phosphogypsum (PG) and calcined PG (CPG) at different percentages were studied. The added amounts of PG and CPG fillers were included from 0% to 15% based on the pulp. The effects of incorporation as well as the quality fillers into physical and optical properties were assessed. It can be deduced that the incorporation of CPG at 800 °C improved filler retention by as high as 92%, and the optical properties of the filled paper was strikingly enhanced, while the strength properties were practically negatively influenced. It was clear that calcination steps reduce the fibre–filler–fibre bond.

Synthesis of precipitated calcium carbonate: a review, Onimisi A. Jimoh *et al*, *Carbonates and Evaporites*, (online). The current high global demand for high-quality paper, paint, adhesive/sealant, and plastic, filler industries cannot survive without unique and high-quality precipitated calcium carbonate (PCC). This article reports the effect of various organic and inorganic additives used in the synthesis of the different polymorph of calcium carbonate. PCC can best be synthesized using solid–liquid route or the gas–solid–liquid carbonation route, which consists of bubbling gaseous CO_2 through a concentrated calcium hydroxide ($Ca(OH)_2$) and/or calcium magnesium hydroxide ($Ca{\cdot}Mg(OH)_2$) slurry with suitable organic additives. The use of several organic and synthetic additives in conjunction with different reaction parameters for the synthesis of the various polymorph of precipitated calcium carbonate is reported.

Calcium Carbonate Fillers, Roger Rothon and Chris Paynter, *Fillers for Polymer Applications*, (*Polymers and Polymeric Composites*: A Reference Series - Springer). Calcium carbonate fillers have ideal properties for many polymer applications and the world consumption is over ten million tonnes annually. Both natural (ground (natural) calcium carbonates, GCC) and synthetic forms are in use and can be derived from abundant and widely occurring natural deposits. While GCC fillers are long established, they continue to evolve. Developments in grinding are likely to result in even finer forms and increased opportunities. Examples of recent developments include an innovative mineral additive for fibres and nonwovens from Imerys known as FiberLink®. FiberLink increases softness, reduces lustre, improves opacity, and improves tensile strength of the fabric/web.

PULPING

Understanding the role of water in the interaction of ionic liquids with wood polymers, A. Roselli *et al*, *Carbohydrate Polymers*, Vol.168. Hemicellulose lean pulps are a raw material source for numerous high value products. We have previously presented the IONCELL-P(ulp) process, a hemicellulose extraction method, based on a binary mixture of ionic liquid and water. The IONCELL-P process does not suffer from yield losses or polymer degradation and retains the Cellulose I crystalline form. In this paper, a selection of cellulose dissolving ionic liquids is tested, in order to compare their applicability in the process. The results show that all the tested ionic liquid-water mixtures were able to dissolve hemicelluloses, but there were differences in their efficiency, selectivity and the ability to process high pulp consistencies.

RECYCLING

Evaluation of Enzymatic Deinking of Non-impact Ink Laser-Printed Paper Using Crude Enzyme from *Penicillium rolfsii* c3-2(1) IBRL, Kok Chang Lee *et al*, *Applied Biochemistry and Biotechnology*, Vol.181 (1). Application of microbial enzymes for paper deinking is getting tremendous attention due to the rapidly increasing use of waste paper every year. This study reports the deinking efficiency of laser-printed paper by the lignocellulolytic enzyme from *Penicillium rolfsii* c3-2(1) IBRL strain compared to other enzyme sources as well as commercial available enzymes. High enzymatic deinking efficiency of approximately 82% on laser-printed paper was obtained by pulp treatment with crude enzyme from P. rolfsii c3-2(1) IBRL. However, this crude enzyme was found to reduce the paper strength properties of the pulp based on the results of tensile, tear and burst indices, most probably due to cellulose degradation. Extensive research should be conducted to understand the nature and mechanism of enzymatic deinking process by the crude enzyme from P. rolfsii c3-2(1) IBRL in order to improve paper strength properties.

***Paper Industry Material Recycling: Revealing and Rectifying the Chaos in Terminology*, Ilpo Ervasti, Aalto University publication series Doctoral Dissertation 273/2016 (OPEN ACCESS).** The objective of this doctoral dissertation was to create guidelines for a comprehensive, uniform terminological system for paper recycling. The uniform system should be such that it can be used globally, cross all geographical regions, and it should meet the needs of all stakeholders in the field.

The objective was divided into four sub-objectives. Firstly, to provide a comprehensive analysis of existing terminological systems for paper recycling. Secondly, to provide a comprehensive analysis of existing frameworks for describing the material streams and stages in the paper recycling industry. Thirdly, to create a comprehensive, uniform framework for describing the material streams and stages in the material chain of the paper recycling industry. And, fourthly, to present a method to quantify the material streams and stages in the material chain of the paper industry.

It became obvious that a state of chaos exists with respect to how terminology is used in the paper recycling industry. A comprehensive analysis of existing frameworks dealing with material streams and stages related to paper recycling was done. After this, a comprehensive uniform framework for material streams and stages in the paper recycling industry was developed. This framework was named the Detailed Wheel of Fibre. A method for quantifying the different material streams and stages in the paper industry was developed. In this quantification a common denominator, the roundwood equivalent (RWE) was used.

WASTE & ENVIRONMENT

Effects of papermaking sludge-based polymer on coagulation behavior in the disperse and reactive dyes wastewater treatment, R Li *et al*, *Bioresource Technology*, (online). In this study, papermaking sludge was used as the raw biomass material to produce the lignin-based flocculant (LBF) by grafting quaternary ammonium groups and acrylamide. LBF was used as a coagulant aid with polyaluminum chloride (PAC) to treat reactive and disperse dyes wastewater. Effects of dosing method, pH, hardness and stirring speed on the coagulation behaviour and floc properties were studied.

Application of cellulose nanofibers to remove water-based flexographic inks from wastewaters, Ana Balea *et al*, *Environmental Science and Pollution Research*, Vol.24 (5). Water-based or flexographic inks in paper and plastic industries are more environmentally favourable than organic solvent-based inks. However, their use also creates new challenges because they remain dissolved in water and alter the recycling process. Conventional deinking technologies such as flotation processes do not effectively remove them. Adsorption, coagulation/flocculation, biological and membrane processes are either expensive or have negative health impacts, making the development of alternative methods necessary. Cellulose nanofibers (CNF) are biodegradable, and their structural and mechanical properties are useful for wastewater treatment. TEMPO-oxidised CNF have been evaluated for the decolourisation of wastewaters that contained copper phthalocyanine blue, carbon black and diarlyide yellow pigments. Flocculation studies carried out show the decolourisation mechanism during the dual-component treatment of wastewaters containing water-based inks.

***Anaerobic Technology in Pulp and Paper Industry*, Pratima Bajpai, (Springer).** This book presents a state-of-the-art report on the treatment of pulp and paper industry effluents using anaerobic technology. It covers a comprehensive range of topics, including the basic reasons for anaerobic treatment, comparison between anaerobic and aerobic treatment, effluent types suitable for anaerobic treatment, design considerations for anaerobic treatment, anaerobic reactor configurations applied for treatment of pulp and paper industry effluents, present status of anaerobic treatment in pulp and paper industry, economic aspects, examples of full scale installations and future trends.

Statistical Optimization to Model Ammonia Removal During Co-Composting of Pulp/Paper Mill Sludge and Corn Wastes, Nurdan Aycan and Nurdan Gamze Turan, *CLEAN – Soil, Air, Water*, Vol.44 (11). This work presents an effective way to remove ammonium from compost using corn wastes. The study examined the role of experimental factors on the removal of ammonium using a full factor experimental design. The experimental factors and their related levels selected were as follows: Material type (corn cob and corn husk), ratio (10 and 25%), moisture (50 and 70%), and finally duration (30 and 60 days). The results were evaluated with an ANOVA test. The proposed procedure is simple to implement and cost-effective.

Evaluation of the Pozzolanic Activity of Residue From the Paper Industry, A. R. G. Azevedo *et al*, Part of the series *The Minerals, Metals & Materials* Series 2017, (Springer). The paper and cellulose industry is responsible for generating large amounts of solid waste, which are produced during various stages of the production process. Currently this material goes to places like landfills and other generating costs for the company. Furthermore, cement, mortar and concrete represent a significant economic and environmental cost. This study aims to determine the pozzolanic activity index in the residue studied to verify its viability in the incorporation of the same in cement. It will be used Luxan method for this determination. The data found show that the material has the possibility of being incorporated in the mortar due to its pozzolanic activity index.

WOOD PANEL

Isolation of cellulose nanocrystals from medium density fiberboards, Jin Gu *et al*, *Carbohydrate Polymers*, Vol.167. Cellulose fibres have been successfully isolated from medium density fibreboards (MDFs) by sodium chlorite oxidation-potassium hydroxide (NaClO2-KOH) leaching process, at 37.6% yield, comparable to the 39.3% and 37.3% cellulose fibres from eucalyptus and eucalyptus with 12% cured urea-formaldehyde (UF)

resin, respectively. Therefore, CNCs derived from MDF are comparable to CNC from wood and promising for expanded applications.

At-line validation of a process analytical technology approach for quality control of melamine-urea-formaldehyde resin in composite wood-panel production using near infrared spectroscopy, Roger Meder *et al*, *Analytical and Bioanalytical Chemistry*, Vol.409 (3). The reactivity of melamine-urea-formaldehyde resins is of key importance in the manufacture of engineered wood products such as medium density fibreboard (MDF). Often the MDF manufacturing plant has little information on the resin reactivity other than details of the resin specification at the time of batch manufacture. Often too, fresh resin on delivery at the MDF plant is mixed with variable volume of aged resin in storage tanks, thereby rendering any specification of the fresh resin batch obsolete. It is therefore highly desirable to develop a real-time, at-line or on-line, process analytical technology to monitor the quality of the resin prior to MDF panel manufacture. This article describes Near infrared (NIR) spectroscopy applied to the problem.

Development and Characterization of Wood and Non-wood Particle Based Green Composites, Abdul Halip Juliana *et al*, Chapter "Green Biocomposites", Part of the series *Green Energy and Technology* (Springer). Production of green composites involve a manufacturing process combining both renewable plant-based particles and green polymers. Characteristics of wood and non-wood particles are one of the main factors that influence the properties of green composite, particularly particle based composite i.e., particleboard and wood plastic composite (WPC). The present work reviewed some characterisation studies of particles including the size (length, width, and thickness, aspect ratio, and slenderness ratio) and geometry, and highlights their effects on the mechanical and physical properties of particleboard and WPC.

Manufacturing of Natural Fiber/Agrowaste Based Polymer Composites, Debora Puglia et al, Chapter Green Biocomposites Part of the series Green Energy and Technology (Springer). Most recently, there has been an increasing interest for the production of laminates for semi-structural applications using sustainable materials. In this field, a possible option is the use of composites including ligno-cellulosic fibres, which are normally obtained as by-products from the textile industry, therefore mainly in the form of fabric or mats. This chapter discusses first the opportunities offered and challenges encountered in the production of natural fibre composites, then concentrating on the possibilities to obtain a polymer matrix alternative to petrol-based ones, especially in the particular case of manufacturing biopolymers by using agrowaste as received or with limited structural transformations rather than simply as a monomer (e.g., dextrose) source for polymer synthesis.

Effect of Polyethylene on the Physical and Mechanical Properties of Particleboard, Salwanee Waelaeh *et al*, *Macromolecular Symposia*, Vol.371 (1). Particleboard is a common material used in furniture manufacturing. In the present study, it is made from natural rubber wood in the form of coarse and fine particles which is glued with urea formaldehyde adhesive. The objective of the present study was to increase the water resistance of the particleboard by adding polyethylene (PE). Four grades of PE were selected and mixed with the rubber wood particles before forming as a three-layer particleboard. Water absorption and thickness swelling were determined. In addition, the mechanical properties of the particleboard were evaluated including modulus of rupture (MOR), modulus of elasticity (MOE), internal bond strength (IB) and screw holding force.

PAPERmaking!
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Events

Reviews of some old events, and details of selected forthcoming world events along with the latest copy of the PITA Calendar of World Events.

In this edition:

- CPA&G International Symposium (Serbia) 13-16 June
- CPI 'Bringing Industry Together' (UK) 21-22 June
- Technologie Kring (Netherlands) 21-22 June
- PTS Coating Symposium (Germany) 5-6 Sept.
- PAPEREX (India) 1-4 Nov.
- APPITA Fibre Value Chain (Australia) 14-16 Nov.
- DITP Annual Symposium (Slovenia) 22-23 Nov.
- Calendar of World Events

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PROGRAM

22. MEĐUNARODNI SIMPOZIJUM IZ OBLASTI CELULOZE, PAPIRA, AMBALAŽE I GRAFIKE
13-16. JUN 2017, Čigota, Zlatibor, Srbija

22nd INTERNATIONAL SYMPOSIUM IN THE FIELDS OF PULP, PAPER, PACKAGING AND GRAPHICS
June 13th-16th, 2017, Čigota, Zlatibor, Serbia

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TUESDAY, June 13th – UTORAK, 13.06.2017.

19:00-21:00 Notification of participants and distribution of materials (Hotel Cigota reception)
Prijava učesnika i podela materijala (Recepcija hotela Čigota)

WEDNESDAY, June 14th – SREDA, 14.06.2017.

08:00-09:00 Notification of participants and distribution of materials (Hotel Cigota reception)
Prijava učesnika i podela materijala (Recepcija hotela Čigota)

09:00-09:15 OPENING OF THE XXII SYMPOSIUM – OTVARANJE XXII SIMPOZIJUMA

09:15-12:00 Chairman – Predsedavaju: S. Jovanovic, V. Valent, B. Jeftenić

09:15-09:45 Lecture 1 - Predavanje 1

STANJE INDUSTRIJE CELULOZE I PAPIRA U POSTKRIZNOM PRIVREDNOM AMBIJENTU SRBIJE

THE STATE OF CELLULOSE AND PAPER INDUSTRY IN THE POST-CRISIS ECONOMIC ENVIRONMENT IN SERBIA

Nataša Bogavac-Cvetković, Tamara Cvetković, Milanka Bogavac

Faculty of Business and Law, "Union - Nikola Tesla" University, Belgrade, SERBIA

09:45-10:15 Lecture 2 - Predavanje 2

CELULOZA: OD PRIRODE DO MATERIJALA VISOKIH PERFORMANSI

CELLULOSE: FROM NATURE TO HIGH PERFORMANCE MATERIALS

Mira Kostić, Matea Korica

Faculty of Technology and Metallurgy, University of Belgrade, Serbia

10:15-10:35 Lecture 3 - Predavanje 3

BUDUĆA TEHNOLOŠKA UNAPREĐENJA U PROIZVODNJI U FABRICI KARTONA UMKA

FUTURE TEHNOLOGICAL IMPROVEMENTS IN PRODUCTION IN CARDBOARD MILL UMKA

Saša Dobrić, Rade Krsmanović, Staniša Lukić

UMKA Cardboard Mill, Umka, SERBIA

10:35-10:55 **Lecture 4 – Predavanje 4**

ESTIMATION OF ENERGY SAVING POTENTIAL OF UKRAINIAN PULP AND PAPER INDUSTRY

PROCENA MOGUĆNOSTI UŠTEDE ENERGIJE U UKRAJINSKOJ INDUSTRIJI CELULOZE I PAPIRA

Boldyryev S.[1], Ulyev L.[2], Samoylenko M.[2], Duic N.[3]

[1]Centre for Sustainable Development of Energy, Water and Environment Systems, Faculty of Mechanical Engineering and Naval Architecture University of Zagreb, CROATIA; [2]National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine; [3]Department of Energy, Power Engineering and Environment, Faculty of Mechanical Engineering and Naval Architecture University of Zagreb, CROATIA

10:55-11:15 **Lecture 5 – Predavanje 5**

SLUDGE FROM WASTE WATER TREATMENT AS ADDITIVE IN PRODUCTION OF RECYCLED PAPER FOR CORRUGATED PACKAGING SOLUTIONS

MULJ DOBIJEN TRETMANOM OTPADNIH VODA KAO ADITIV U PROIZVODNJI RECIKLIRANOG PAPIRA ZA REŠENJA AMBALAŽE OD TALAS KARTONA

Denislava Elenkova[1], Spas Ladzhov[2], Ivo Valchev[1]

[1]University of Chemical Technology and Metallurgy, Sofia; [2]DS Smith Bulgaria, Padardzhik, Bulgaria

11:15-11:35 **Lecture 6 - Predavanje 6**

WASTEWATER TREATMENT IN PULP & PAPER INDUSTRY, NEW DEVELOPMENTS

TRETMAN OTPADNIH VODA U INDUSTRIJI CELULOZE I PAPIRA, NOVI RAZVOJ

Alfred Helble[1], Dr. Andreas Rüdiger[2]

[1]AH CONSULT DIPL.-ING. ALFRED HELBLE, Stuttgart, Germany; [2]AQUABIOTEC ENGINEERING, Paris, France

11:35-12:00 **DISKUSIJA I PAUZA ZA KAFU – DISCUSSION AND COFFEE BREAK**

12:00-14:40 **Chairman – Predsedavaju: S. Ibrahimefendic, P. Živkovic, G. Jankes**

12:00-12:20 **Lecture 7 – Predavanje 7**

ZAVISNOST BOJE PROIZVEDENOG CLUPAK PAPIRA OD STEPENA IZBJELJIVANJA CELULOZNOG VLAKNA

DEPENDANCE OF CLUPAK PAPER COLOR ON BLEACHING DEGREE OF THE CELLULOSE FIBER

Husejin Duraković, Edina Husić, Almir Muftić

NATRON-HAYAT d.o.o.Maglaj, BOSNA i HERCEGOVINA

12:20-12:40 **Lecture 8 – Predavanje 8**

KLJUČNI POKAZATELJI USPEŠNOSTI PROIZVODNJE SITA ZA INDUSTRIJU PAPIRA I CELULOZE

KEY PERFORMANCE INDICATORS FOR PRODUCTION OF THE SCREENS FOR PAPER AND PULP INDUSTRY

Nada Bojić[1], Ninoslav Stojanović[2]

[1]Woven Wire Cloth and Bearings Factory - Fasil a.d, Arilje; [2]StandCert, Belgrade, SERBIA

12:40-13:00 **Lecture 9 – Predavanje 9**

IMPROVING THE PAPER STRENGTH WITH MODIFIED UREA-FORMALDEHYDE OLIGOMERS

POVEĆANJE JAČINE PAPIRA MODIFIKOVANIM UREA-FORMALDEHIDNIM OLIGOMERIMA

Natalia Zholnerovich, Natalia Chernaya, Irina Nikolaichik

Belarusian State Technological University, Minsk, Belarus

13:00-13:20 **Lecture 10 – Predavanje 10**

STUDIES ON BIOPOLYMERIC ADDITIVES FOR PAPERPAKING

PROUČAVANJE BIOPOLIMERNIH ADITIVA ZA PAPRINU AMBALAŽU

Sedat Ondaral

Dep. of Pulp and Paper Technology, Forest Product Engineering, Faculty of Forestry, Karadeniz (Black Sea) Technical University, Turkey

13:20-13:40 **Lecture 11 – Predavanje 11**

UTICAJ PAKOVANJA U MODIFIKOVANOJ ATMOSFERI I VAKUUMU NA ODRŽIVOST ZLATIBORSKE PRŠUTE

INFLUENCE OF PACKAGING MATERIAL ON DRY-CURED SHEEP HAM SUSTAINABILITY

Stanisavljević D[1], Žugić-Petrović T., Veličković D., Miljojković V., Šošević D., Ilić P.

College of Agriculture and Food Technology, Prokuplje, SERBIA

13:40-14:00 **Lecture 12 - Predavanje 12**

PREZENTACIJA FIRME SUPERLAB, BEOGRAD, SRBIJA

PRESENTATION OF THE SUPERLAB COMPANY, BELGRADE, SERBIA

Jelena Vučićević

SUPERLAB, Novi Beograd, Srbija

14:00-14:20 **Lecture 13 - Predavanje 13**

EFFECT OF PAPER SAMPLE-FORMING CONDITIONS ON DEFORMATIONAL BEHAVIOR OF PAPER

UTICAJ USLOVA FORMIRANJA UZORAKA PAPIRA NA DEFORMACIONO PONAŠANJE PAPIRA

Yakov Kazakov, Anastasiya Romanova

Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk, Russia

14:20-14:40 **DISKUSIJA – DISCUSSION**

THURSDAY, JUNE 15th – ČETVRTAK, 15.06.2017.

08:30-11:30 **Chairman – Predsedavaju: M. Krgovic, S. Jovanovic, S. Nikolic**

08:30-09:00 **Lecture 14 – Predavanje 14**

STRATEŠKO REPOZICIONIRANJE INDUSTRIJE CELULOZE I PAPIRA U SRBIJI - KA ODRŽIVOSTI

STRATEGIC REPOSITIONING PULP AND PAPER INDUSTRY IN SERBIA - TOWARDS SUSTAINABILITY

Petar Đukić

Faculty of Technology and Metallurgy, University of Belgrade, Serbia

09:00-09:20 **Lecture 15 - Predavanje 15**

PERSPEKTIVE GLAVNIH TEHNIKA ŠTAMPE U ŠTAMPI AMBALAŽE

PERSPECTIVES OF MAIN PRINTING TECHNIQUES IN PACKAGING PRINTING

Predrag Živković

Faculty of Techniology and Metallurgy, University of Belgrade, Serbia

09:20-09:40 **Lecture 16 – Predavanje 16**

HYDROGEN PEROXIDE AND PERACETIC ACID – APPLICABLE SCIENCE IN OUR LIFE (OXIDATION, DISINFECTION AND CLEANING)

VODONIK-PEROKSID I PERSIRĆETNA KISELINA – PRIMENJENA NAUKA U NAŠEM ŽIVOTU (OKSIDACIJA, DEZINFEKCIJA I ČIŠĆENJE)

Ivan Grčar

Belinka Perkemija, d.o.o., SLOVENIA

09:40-10:00 **Lecture 17 - Predavanje 17**

PRESENTATION OF THE SCHÄFERROLLS D.O.O., KRANJ, SLOVENIA

PREZENTACIJA FIRME SCHÄFERROLLS D.O.O, KRANJ, SLOVENIJA

Gregor Ažman, Marjan Urh

SCHÄFERROLLS, d.o.o., Kranj, Slovenia

10:00-10:20 **Lecture 18 – Predavanje 18**

A NOVEL TEST METHOD FOR PREDICTING CRUSHING ELASTICITY IN MEDIUM FLUTING WITH HIGHER RELEVANCE THAN THE CURRENTLY USED METHODS LIKE CMT

NOVI METOD PREDVIĐANJA ELASTIČNOSTI LOMA U SREDNJIM FLUTINZIMA SA VEĆIM ZNAČAJEM OD UOBIČAJENIH METODA KAO ŠTO JE CTM

Thomas Fürst

ABB AB, LORENTZEN & WETTRE PRODUCTS, Kista, Sweden

10:20-10:40 **Lecture 19 – Predavanje 19**

PRIMJENA MINERALA IZ BOSNE I HERCEGOVINE KAO PUNILA U PROIZVODNJI PAPIRA

APPLICATION OF MINERALS FROM BOSNIA AND HERZEGOVINA AS FILLERS IN PAPER PRODUCTION

Salim Ibrahimefendić, Amra Tuzović, Marija Garić, Aldin Obućina

Faculty of Technical Studies, University of Travnik, BiH

10:40-11:00 **Lecture 20 - Predavanje 20**

OPTIMIZING PRINTED SURFACE

OPTIMIZACIJA POVRŠINE KOJA SE ŠTAMPA

Helena Peuranen

KEMIRA OYJ, Espoo, Finland

11:00-11:30 **DISKUSIJA I PAUZA ZA KAFU – DISCUSSION AND COFFEE BREAK**

12:00-14:00 **ROUND TABLE – OKRUGLI STO**

Moderators: M. Krgovic, S. Jovanovic, V. Valent, S. Nikolic

- KRATKO PREDSTAVLJANJE SVIH UČESNIKA
  BRIEF INTRODUCTION OF ALL PARTICIPANTS
- STANJE U CELULOZNO – PAPIRNOJ, AMBALAŽNOJ I GRAFIČKOJ INDUSTRIJI
  SITUATION IN PULP, PAPER, PACKAGING AND GRAPHIC INDUSTRY

14:00-14:15 **CLOSING OF SYMPOSIUM – ZATVARANJE SIMPOZIJUMA**

14:30-18:30 **EXCURSION – ACCORDING TO THE CHOICE OF PARTICIPANTS OF THE SYMPOSIUM:**
Andric grad, Mokra Gora (Sargan, Mecavnik) or Sirogojno – Ethno village.

IZLET – PO IZBORU UČESNIKA SIMPOZIJUMA:
Andrićgrad, Mokra Gora (Šargan, Mećavnik) ili Sirogojno – Etno selo.

20:30-... **CEREMONIAL DINNER – SVEČANA VEČERA**

SCIENTIFIC BOARD OF SYMPOSIUM – NAUČNI ODBOR SIMPOZIJUMA

- Prof. Slobodan Jovanovic, Ph. D., Faculty of Technology and Metallurgy, (TMF) Belgrade, Serbia, chairman
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- Prof. Lothar Göttsching, Ph. D., University of Technology, Darmstadt, Germany
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- Prof. Valentin I. Popa, Ph. D., Faculty of Chemical Industry, Iassi, Romania
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- Mateja Mesl, Mr. Sci., ICP - Pulp and Paper Institute, Ljubljana, Slovenia
- Prof. Diana Gregor Svetec, Ph. D., Faculty of Natural Sciences and Engineering, Ljubljana, Slovenia
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- Prof. Rade Knezevic, Ph. D., Lepenka, Novi Knezevac, Serbia
- Prof. Salim Ibrahimefendic, Ph. D., Faculty of Biotechnology, Bihac, Bosnia & Herzegovina
- Prof. Milorad Krgovic, Ph. D., TMF, Belgrade, Serbia

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- Predrag Zivkovic, TMF, Belgrade
- Slobodan Jovanovic, TMF, Belgrade



ADDITIONAL INFORMATIONS

Place: *ČIGOTA Hotel, Zlatibor (http://www.cigota.rs)*

Location: *ČIGOTA hotel on Zlatibor is situated at an altitude of 1,000 m, near Zlatibor Lake and King's Square.*

Hotel's offer: *Snack bar, cafe and confectionery, billiards hall, indoor pool 25mx12,5m, fitness hall, gym and outdoor sport stadiums, hydro and manual massage parlours, finnish sauna, steam bath with aroma therapy, hydro baths and solarium, beauty parlour and hairdresser, hotel boutiques and shops, congress hall, internet caffe, wireless internet, library, tv studio, club and gallery.*
http://www.cigota.rs, tel: +381-31- 597 - 237, +381 31-597-597
e-mail: *recepcija@cigota.rs, hotelcigota@gmail.com*

Service: *Half-board (breakfast and dinner - organized as breakfast buffet)*

Price of accommodation (122din = 1 €):

- *single rooms (1/1) in A BLOCK - 4.600,00 din;*
- *rooms with double bed (1/1F) in A and B BLOCK - 4.700,00 din.;*
- *two-bed rooms 1/2 in A BLOCK - 3.600,00 din.;*
- *three-bed apartment (1/3 AB) - 3.600,00 din.;*

If apartment AB is used by one person, price is 50% higher, and if two persons use apartment price is 25% higher;

DODATNE INFORMACIJE

Mesto održavanja: *Hotel ČIGOTA, Zlatibor (http://www.cigota.rs)*

Lokacija: *Hotel ČIGOTA na Zlatiboru nalazi se na nadmorskoj visini od 1.000 m, nadomak zlatiborskog jezera i Kraljevog trga.*

Hotelska ponuda: *aperitiv bar, poslastičarnica, kafe bilijar, zatvoreni bazen 25m x 12,5m, fitnes sala, teretana i otvoreni sportski tereni za male sportove, saloni za hidro i manuelnu masažu, finske saune, parno kupatilo sa aroma terapijom, hidro kade i solarijum, frizerski i kozmetički salon, hotelski butici i prodavnice, internet caffe, wireless internet, kongresna sala, biblioteka, TV studio, klub i galerija.*
http://www.cigota.rs, tel: +381-31-597-597, +381-31-597-237.
e-mail: *recepcija@cigota.rs, hotelcigota@gmail.com*

Cene smeštaja:

Cene smeštaja na bazi polupansiona (švedski sto doručak i večera) u dinarima (122 din = 1 €) iznose:

- *Smeštaj u 1/1 sobama A bloka je 4.600,00 dinara;*
- *Smeštaj u 1/1F sobama A i B bloka je 4.700,00 dinara;*
- *Smeštaj u 1/2 sobama A bloka je 3.600,00 dinara;*
- *Smeštaj u 1/3 AB apartmanima je 3.600,00 dinara;*

Ukoliko dve osobe koriste apartman, cena se uvećava za 25%, a ako ga koristi jedna, za 50%;






Hungary
Romania
Croatia
E75
E70
BEOGRAD
E760
E75
230km
Bosnia
and
Herzegovina
Serbia
Zlatibor
E75
E80
Montenegro
Albania
Macedonia
Beograd
Hotel
Olimp
Z l a t i b o r
Jezero
Lake
Hotel
Zelenkada
Hotel
Lovćen
Čigota
Podgorica

‘Bringing Industry Together’
2017 CPI Biennial Health and Safety Conference

Bookings are now being taken for this year’s conference and spaces for the seminars and sessions are beginning to fill.

Tuesday 20 June 2017
As a new addition to the conference, this half day seminar focusses on key issues across the Paper Industry, including:

- Future opportunities and challenges for paper packaging
- Brexit and its impact on secondary materials markets
- Water resilience
- Energy use options and the impact on investment
- Reducing fire risks

Wednesday 21 June 2017
With a wide-ranging choice of topics and sessions to choose from, Day Two of the conference will be dedicated to Health and Safety. Delegates will once again be able to tailor the event to suit their interests. The sessions will include a variety of topics including:

- process safety
- sharing good practices
- health and wellbeing and regulatory issues, including the sentencing guidelines.

Join us on the evening of 20 June for a BBQ and the chance to socialise with colleagues in an informal and relaxed atmosphere.

Further information on booking options, and booking forms can be found on the conference website at www.paper.org.uk/biennial/biennial.html

Please note that places for Options 1 and 3 are limited so book early to avoid disappointment.

We look forward to seeing you at this most important event in the CPI calendar.

For further information contact Andrew Braund:
Tel: 07974 980842 or email: abraund@paper.org.uk

VAPA Millvision seminar
21th en 22th of June 2017

Registrationform

Name:		Invoice adress (in case different)	
e- mail:			
Company:		Company:	
Adress:		Adress:	
PC&City:		PC&City:	
Tel.nr.		Tel.nr.	

☐ **I register for the seminar of the 21th and 22th of June 2017 and pay € 490,-**

☐ **I will attend the dinner on day 1 (inclusive)**

☐ **I register for the takeaway lunch on day 2 (inclusive)**

☐ **Please make a hotelreservation for me (exclusive)**

Dinner 21th of June and lunch 22th of June are included, excl. VAT.
Overnight stay hotel NOT included. Cancelling costs: hotelroom charges, if booked.

Signature:

E-mail to: kirstenschuster@vapa.nl or send to: VAPA, Anklaarseweg 95, 7317 AS Apeldoorn.

PTS Coating Symposium 2017

“Coated – Upgraded – Smart” is the motto of the PTS Coating Symposium that is will be held on 5th-6th September 2017 at Leonardo Royal Hotel in Munich. With some 350 participants, this event is the largest and most prominent international meeting place for the surface finishing of paper and board. We aim to provide fresh impetus for innovation and initiate interdisciplinary and cross-sector co-operations between the partners of the added value chain.

Coating technology has undergone a sea change in the past few years to become a flexible coating process for innovative surface functions. Today, barriers and multifunctional surfaces can meet complex requirements for a wide range of applications in an endless variety of sectors. We are also observing new technological solutions for upgrading smart products as another emerging trend.

The attendees will benefit from a profound overview about current scientific trends and industrial developments in coating technology for printing and packaging solutions or for special-purpose applications.

Programme and registration: www.coating-symposium.com

LECTURE PROGRAMME
Tuesday, 5 September 2017
Markets and strategies in change
KEYNOTE: Future of paper and board converting and impact on coated paper and boards, Leif Frilund, Walki Group

Folding boxboard – packaging material of the future, Roland Rex, Weig Karton

Markets in Transition: Big Picture Market Contexts in Coated Papers and Coated Packaging and the Role of Industry 4.0, Alexander Wirth, StepChange Consulting

Coating and upgrading technology
Impact of pre-wetting on the subsequent absorption of water and its applicability to drying of multi coloured flexo prints, Janet Preston, Imerys Minerals

Paper quality and print parameter influences on the dimensional stability in web offset printing, Rainer Klein, PTS

Limits of overprinting. Which print methods can be used to overprint areas of different height?, Edgar Dörsam, TU Darmstadt

Impact of base substrate on perceived and measured surface properties, Peter Rättö, RISE

Components & concepts for coating colour formulation
Influence of the processing conditions of PVOH coatings to achieve high oxygen barrier on paper, Shu-Hsien Li, Kuraray

Oxygen permeability and economic-environmental impact studies of some polyvinyl alcohol dispersion barrier coatings for packaging applications, Magnus Lestelius, Karlstad University

Development of new fluorocarbon-free oil and grease resistant barrier coatings for paper and paperboard, Bryan McCulloch, DOW

MOTIVATIONAL SPEECH an SHOW Ligthening juggling and video art, Christoph Rummel

Wednesday, 6 September 2017
Novel polysaccharide additives for inkjet printing of paper and board, Samit Chevil, DuPont

Quality enhancements, CO2 reductions and total system cost reductions with bio based latex solutions in high quality graphic packaging, Gavin Hatherell, EcoSynthetix

Microfibrillated cellulose as coating binder, Per Svending, FiberLean Technologies

Process technology
Pinholes reduction in water based barrier coatings, Per Emilsson, UMV Coating Systems

Coating colour preparation - disperging combined with vacuum expansion, Hans-Joachim Jacob, Ystral

Quality assurance of coated liner with DOMAS surface measurements (Covering) in the spremberg mill of Hamburger, Peter Leinert, Papierfabrik Hamburger Spremberg

DF Coat - Further development of the curtain coater combining best coverage with an easy and safe operation, Christoph Henninger, Voith Paper

Innovative process technology enables manufacturing of new products, Christian Elsner, Repulping Technology

Innovative Products
Use of chromatogeny for the development of barrier and release papers, Philippe Martinez, CTP

Aqueous coating formulations for cupstock to make recyclable hot drink cups, Dirk Stanssens, Topchim

Towards an improved surface sizing - A study of the interaction between recycled linerboard base paper and surface sizing agent, Kai Dahlskog, Chemec

High Barrier cellulose-based packaging for Li_ion pouch cell, Laura Crowther-Alwyn, CTP

Lectures will be given in German or English, each will be simultaneously translated into the other language.

PAPEREX 2017 – Call for Papers

Theme: Pulp and Paper Industry: Strategies for sustainable growth
Technical Conference: 1-3 November; Exhibition: 1-4 November.
Venue: Pragati Maidan, New Delhi.

Technical papers encompassing the strategies and technologies for sustainable growth for pulp and paper industry are invited. The scope of the Conference covers the strategies, emerging and innovative technologies in pulp, paper, packaging and printing including:

- Raw materials (Wood, Recycled paper and Agro-residues)
- Fibreline
- Paper and Board making
- Energy & Environment
- Power generation & Utilities
- Printing & Packaging
- Coating
- Converting and Packaging
- Mineral fillers and pigments
- Chemicals
- Machinery manufacturing
- Micro and Nano technology
- Materials for Construction and in Machinery (Ceramics/Iron/Steel/Plastics/Rubber)
- Automation
- Instruments, Pumps, Valves, Gears etc
- Warehouse & Logistics

Papers on Application of New and Renewable Energy to Pulp and Paper Industry; Technologies for Enhancing the Environmental Norms (Water and Air) and for efficient us of Solid Wastes (e.g. Sludge & Plastic) and Green Technologies are especially invited.

Cross-cutting Technologies including Nanotechnology and Biorefinery; Forecasting on the Future of Pulp & Paper industries and Enhancing Recycled Fibre Collection & Processing etc. are other topics on which papers are welcomed.

If you are interested in making presentation(s) in the Technical Conference, you may send us an extended abstract (1-2 pages) of the paper along with the title of paper, name(s) of the author(s) and organisation(s) at the earliest, latest by 30th May 2017.

Acceptance of the paper will be judged based on the novelty and level of application of technology/ process/ product in the industry. Papers already presented or sent for publication, will not be accepted. The abstract and paper should contain adequate facts and figures but not superfluous or advertisement type of descriptions. Papers are selected on first-cum-first and therefore, prospective authors should submit their papers in time.

The authors will have to submit the full paper in text form and PowerPoint presentation in time. The paper should be of international quality and the authors will have to cooperate for editing/correction.

Dr M. Patel, Coordinator, PAPEREX-2017
Mobile: 91(0)9871787870 Email: industrypaper@yahoo.co.uk

APPITA 2017 Fibre Value Chain Conference & Expo

The 2017 Fibre Value Chain Conference – "The rise of business ecosystems" will be held at the Melbourne Convention and Events Centre from 14–16 November 2017. The 2017 event marks Appita's 70th year and will bring together association members and industry leaders from across the sector to celebrate this important milestone.

This year's event explores the concept of "business ecosystems" and the opportunities for creating value and new markets through collaboration. It will explore how complimentary companies are collaborating to produce a variety of new high value add biobased products, such as biomaterials, biofuels and bio chemicals.

The event will also feature a variety of breakout sessions, symposia, forums and workshops on pulp, paper, packaging and related industries including:

- 3rd Bio-manufacturing Symposium
- Health & Safety Symposium
- Packaging & Food Contact Material Forum
- Maintenance Forum
- Mill Managers Forum
- Technical Steams
- Poster presentations Mill presentation

The highlight will be the Gala Dinner on the Thursday 16 November, in Melbourne.

Don't miss the opportunity to be part of this important event!

DITP 44th International Meeting of Slovene Paper Industry

"COLLABORATING. NETWORKING. SHAPING TOGETHER … OUR FUTURE"
22 – 23 November 2017 I Golf Hotel, Bled, Slovenia

Representatives from the industry, institutes and universities are invited to participate with
• a paper or
• a poster

To present your paper/poster you need to send a short abstract in English (25 typed lines max) to ditp@icp-lj.si, by 16 June 2017 at the latest. Suggested topics:

- modern preparation and cleaning of recycled fibres,
- technological novelties on paper and paperboard machines,
- new coating concepts,
- trends in printing and finishing technics,
- possibilities of reducing the energy consumption at papermaking processes,
- usability of sludges and ashes,
- education for the future,
- ways to new knowledges,
- commercial views on the global paper market,
- financing in paper industry.

The official languages are Slovene and English with simultaneous translation.

Instructions: each presentation will consist of three parts:

a) An abstract of the poster content presentation in the Book of Abstracts
The Book of Abstracts will include abstracts of poster content presentations, each consisting of 1,100 characters with spaces, in Slovenian and English languages. The abstract is to be prepared in a Microsoft Word document, using the Times New Roman font, size 11 pt.

b) A presentation in the lecture hall to the participants of the DITP Symposium
The aim of the presentation is to animate the symposium participants and encourage them to look for you in the poster exhibition room, where they will be able to give detailed information about your work. To prepare your presentation for the symposium, use the PowerPoint template provided below. The presentation is to be a maximum of two pages long and limited to two minutes.

c) A presentation of the posters
The posters will be displayed for the duration of both events, namely on 22 and 23 November. During the break held on 23 November the participants will have the opportunity to meet you and talk to you next to the exhibited poster. The required poster format is A0 (84 cm x 119 cm), portrait orientation.

You are kindly asked to submit the following:

- an abstract of the poster content presentation consisting of 1,100 characters with spaces in Slovenian and English languages – to be sent to the email address: ditp@icp-lj.si by October 1st 2017,

- the presentation – to be sent to the email address: ditp@icp-lj.si by November 11th 2017 in PowerPoint and a PDF file,

- the poster – to be mailed to the postal address DITP, Bogišićeva ulica 8, SI - 1000 Ljubljana by 11th November 2017.

If you require any further information, feel free to contact us via the email address ditp@icp-lj.si

Metka Ševerkar

Transparency Template:

PITA Calendar of World Events

June 2017		
5 - 8	Int. Conference on Nanotechnology for Renewable Resources @ Montreal, Canada	www.tappi.org
13 - 16	CPA&G International Symposium @ Zlatibor, Serbia	m.krsikapa@gmail.com
14 - 16	Papír a Celulóza 2017 @ Velké Losiny, Czech Republic	www.sppc.cz
20 - 21	CPI 'Bringing Industry Together' / H&S Conference @ Chesford Grange Hotel, UK	www.paper.org.uk
21 - 22	Technologie Kring @ Apeldoorn, The Netherlands	www.technologiekring.nl
26 - 28	Security Document World 2017 @ QEII Centre, London, UK	www.sdwexpo.com
27 - 28	PITA Paper Appreciation Course @ PITA HQ, Bury, UK	info@pita.co.uk
July 2017		
4 - 6	Zellcheming 2017 @ Frankfurt am Main, Germany	www.mesago.de/en/ZEX/home.htm
6 - 7	Digital Print for Packaging 2017 @ Atlanta, GA, USA	www.smitherspira.com
September 2017		
3 - 8	FRC Symposium @ Oxford, UK	www.ppfrs.org
5 - 6	PTS Coating Symposium @ Munich, Germany	www.ptspaper.com
6 - 7	Paper & Related Industries Marketing Assn. (PRIMA) Conference @ Berlin, Germany	www.prima-paper.com
12 - 14	RWM, Energy, Renewables and Water Events @ NEC, UK	www.rwmexhibition.com
13 - 14	Packaging Innovations @ London, UK	www.easyfairs.com
18 - 20	19th International Papermaking Conf. & Ex. PROGRESS'17 @ Lodz, Poland	www.progress.spp.pl
19 - 21	Specialty Papers 2017 @ Milwaukee, WI, USA	www.smitherspira.com
22 - 24	BAPH Annual Conference @ Gloucester, UK	www.baph.org.uk
27	Forum PAP-FOR 2017 @ Moscow, Russia	www.papfor.com
October 2017		
3 - 6	Tissue 2017 Conference and Expo @ Miami, USA	www.tappi.org
5	PITA Wet End Workshop @ tbc, UK	info@pita.co.uk
11 - 13	MIAC @ Lucca, Italy	www.edipap.com
11 - 13	Paper & Plastics Recycling Conference @ Chicago, IL, USA	http://paperplasticsna.recyclingtodayevents.com
16 - 18	RISI 32nd North American Conference @ Boston, USA	http://mb.risiinfo.com
22 - 24	Paper Middle East @ Cairo, Egypt	http://papermideast.com
30 - 1 Nov	Fundamentals of Papermaking @ SKF, Luton, UK	info@pita.co.uk
31 - 3 Nov	IPEX @ NEC, Birmingham, UK	www.ipex.org
November 2017		
1 - 4	PAPEREX-2017 @ New Delhi, India	www.paperex.in
5 - 9	Printing for Fabrication 2017 @ Denver, Colorado, USA	www.imaging.org
6 - 10	London Pulp Week @ London, UK	www.bwpa.org.uk
9	Hawkins Wright Symposium @ London, UK	www.hawkinswright.com
14 - 16	APPITA Fibre Value Chain 2017 Conference @ Melbourne, Australia	www.appita.com
22 - 23	DITP @ Bled, Slovenia	www.danpapirnistva.si
22 - 23	Technologie Kring @ tbc, The Netherlands	www.technologiekring.nl
December 2017		
5 - 7	Digital Print for Packaging Europe 2017 @ Berlin, Germany	www.smitherspira.com
11 - 13	Paper One Show @ Sharjah, UAE	www.paperoneshow.net
12 - 14	Paper Arabia 2017 @ Dubai, UAE	www.paperarabia.com
February 2018		
28 - 1 Mar	Packaging Innovations @ NEC, Birmingham, UK	www.easyfairs.com
June 2018		
25 - 29	It's Tissue 2018 @ Lucca, Italy	www.edipap.com
September 2018		
19 - 23	International Paper Historians Biennial Congress @ Gent, Belgium	www.paperhistory.org
November 2018		
14 - 15	PAP-FOR Business Forum 2018 @ St. Petersburg, Russia	www.papfor.com