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KemRevive: Recovering starch from recycled fiber

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KemRevive: Recovering starch from recycled fiber

Overview

- The Opportunity
- Current Practice
- KemRevive Concept Overview
- Case Studies
Sustainability Through Reuse of Recycled Fiber Starch

For a mill producing 400,000 tons per year, 16,000 metric tons of starch from recycled fibre is lost.

- 700 Truckloads or 2 per day of raw starch
- Value of the lost starch is about 6 M€
- Represents area of corn field of around 3000 ha (7,500 acres)
- Number of times one can drive a car around the earth (CO2) 3,500

The Financial Opportunity

Recycled fiber contains high amounts of starch

- unprotected, this starch can become COD loading for the wastewater
- It can become food for microbiological growth which produce detrimental by-products
- Added starch costs are increasing. Allowing this “free” starch to be consumed is a financial burden.
- The ability to reuse starch provides a significant value potential
Process issues due to starch degradation

- High COD loading
- Increase in VFA’s (Volatile Fatty Acids)
- pH depression
- Increased dissolved calcium concentrations

- Calcium scaling in waste water treatment
- Runability problems due to reduced chemical efficiency
- Increased use of biocides to combat high amounts of microbiological contamination
Starch Degradation in the Mill Environment

Worst Case Scenario
Anaerobic bacteria are prevalent and able to grow
Acid production, pH drop, Calcium dissolution, H2S production

Traditional Strategy
Amylase enzymes in process water degrade starch into sugars
Starch from RCF is lost: COD and loss of yield
Potential for system variability
Higher than normal biocide consumption needed

KemRevive
Possible to reuse starch from recycled fiber
Stable wet-end pH and redox
Lower COD
Increased yield
Lower VFA
Further benefits

Traditional Strategies to Reduce Starch Degradation

• Eliminate majority of the amylase-producing bacteria in the process
  – Requires much higher biocide dosage than is necessary for the purpose of machine cleanliness
• Reduce water closure (use more fresh water)
• Retain starch coming in with the recycled fiber (reduce starch cycle up)
• Use non-contaminated recycled furnish
The cycle of starch degradation in paperboard process

- Starch comes in with the raw material and/or is added to reach strength requirements
- Amylase enzyme breaks down the starch molecules into smaller sugar components
The cycle of starch degradation in paperboard process

Starch

\(\alpha\)-amylase

Sugars

Microorganisms

Food

Sugars are good energy source for bacteria

High microbe activity supported by high nutrient level in process waters

pH drop, Ca\(^{2+}\) solubilisation, Fermentation, VFA-Smell, Slime etc...
The cycle of starch degradation in paperboard process

- **Starch**
- **Sugars**
- **Food**
- **Microorganisms**

α-amylase

High amount of amylase enzyme produced by bacteria to further break down the starch

1 ton starch = 1.2 ton COD
Keys to breaking the cycle of starch degradation

- Add enough inhibition chemistry such that we prevent amylase from degrading the starch
- If bacteria populations are not controlled to normal extent, the FennoSpec 1200 dosage would be cost prohibitive
- If starch is not retained in final sheet, benefits are greatly reduced

Therefore a successful KemRevive program consists of targeted inhibition, good MB control, and a retention program with the muscle to retain it.
Kemira KemRevive: The Basics

Patent pending Technology

**Biocides**

- Prevention of enzymatic degradation of starch polymers

**Enzymatic Inhibition**

Normal biocide dosage for MB Control

**Starch Retention**

Secondary starch retention improved with Kemira’s Retention systems

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Reclaiming Starch with KemRevive is a Two Step Process

**STEP ONE – Protect**

Amylase enzyme inhibitor (FennoSpec 1200)

Normal biocide use rate

**STEP TWO – Retain**

KemForm retention program

retain starch while maintaining/improving drainage
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How does FennoSpec 1200 prevent starch degradation?

**Current Situation**
Starch → Amylase Enzyme → degradation

**With FennoSpec 1200**
Starch → Amylase Enzyme → inhibited

Alpha Amylase molecule – Calcium Ion
Amylase enzyme inhibitor provides an effect beyond biocides

RESIDUAL STARCH IN PROCESS WATER

<table>
<thead>
<tr>
<th>Sample</th>
<th>Starch concentration, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>200</td>
</tr>
<tr>
<td>DBNPA 40 ppm</td>
<td>250</td>
</tr>
<tr>
<td>FennoSpec 1200 40 ppm</td>
<td>300</td>
</tr>
<tr>
<td>FennoSpec 1200 80 ppm</td>
<td>350</td>
</tr>
<tr>
<td>FS 1200 40 ppm + DBNPA 20 ppm</td>
<td>400</td>
</tr>
</tbody>
</table>

Biocides alone do not prevent amylase activity

Typical dosage points

- After pulper
- Before storage towers
- Into broke system.

Typical FennoSpec 1200 dosage depending on situation:
- 0.5 to 1.5 kg/tonne as received on fibre
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Kemira’s KemForm Retention Concepts

Process
Conditions:
Furnish: 100 % OCC
Retention/dewatering system
PAC + FennoSil + FennoPol

Graph showing Starch Reduction in DDA Filtrate (%) vs. FennoPol Dosage [Kg/T]
The Opportunities and Benefits

Significant benefits realised:
- Lower COD in waste water
- Lower disposal costs
- Improved yield
- Reduced odour
- In final product and atmospheric
- Increased pH
- Reduction in conductivity
- Improved functional chemical efficiency
- Improved productivity

The effect of COD reduction on board machine yield

As an example consider:
- A 400,000 tpy board machine with a waste water amount of 4 m3 per produced ton of board.
- KemRevive reduces the COD by 2 kg/m³ of waste water
- With 1,600,000 m³ of waste water annually this means 3200 tons less COD into waste water
- This COD = the protected starch that ends up in the dry board as a yield increase
Case Studies

Program KPI
Customer requirements:
- Maintain fibre ratio waste/OCC ratio
- To at least 50/50.
- COD reduction

Parameters measured:
- Process water Redox, pH, conductivity
- Waste water COD
- Strength parameters of final board

VAT machine
- Speed: 120 to 200 m/min
- Production: 55 000 to 60 000 tonne/year
- Grades: Chipboard at 320 to 900 gsm
- Furnish: 100% RCF
- Retention system: FennoLite UK @ 3.5 kg/t and FennoPol 4240T @ 660 g/t, PEI 1 kg/t
- Biocide: Competitor Biocide program Glutaraldehyde and quat
- Amylase enzyme inhibitor FennoSpec 1200 @ 1.0 to 1.2 kg/t

Case study

24/10/2018 KEMREVIVE 28
Benefits to customer

KemRevive provided starch protection in the wet end enabling the mill to successfully alter the raw material ratio (waste/OCC) for the first time from 20/80 to 75/25

Potential gross savings for the mill 0,9 M€/year based on fibre costs

Other benefits observed:
- Starch degradation was reduced
- Waste water COD reduced
  - 11 000 mg/l down to 2750 mg/l
  - Average reduction 75%
- Process water quality improved
  - Cationic demand down 15%
  - Increase in average redox potential from -153 to -60 mV
  - Maintained pH with no NaOH addition
  - No more odour across mill site
- Reduction of retention aid polymer 18%
- Reduced fixative dosage 2%
- Good situation allowed the mill to close the water loop more than ever before
  - Decrease in conductivity 5000 µs to 2600 µs
  - Good runnability

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Summary

A new, sustainable and innovative way to reuse starch

Two-step concept:
- Amylase enzyme inhibitor decreases starch degradation
- Optimized retention system captures starch

Patented technology

BiR, FDA, and GB9685 compliant
Thank you