Starch for surface sizing
Topics

Enzyme conversion for surface sizing application

• Batch process
• Continuous process
• Critical control points
• Important starch parameters
• Stability in storage
• Troubleshooting
• Paper properties
Starch in Papermaking

Cellulose Fillers Starch Additives

- Wet End
- Spray Starch
- Surface Starch
- Coating

Process
- Paper Formation
- Retention
- Dry Strength

Starch
- Cationic
- Amphoteric
- Unmodified Starch
- Polymers

Typical Uptake
- 0.3 – 2%
- 1-4%
- 2-6%
- 0.5 – 2.0%

- Improve Surface Strength
- Improve Ply Bond
- Improve Internal Bond
- Fill voids
- Oxidized
- Enzyme Converted
- Other Modified
- Specialty
- Starch and Latex Mixtures with Fillers

- Improve Printing
- Improve Optical, Printing and Functional Properties
Surface sizing starch

- Paper makers use native starch which is converted in-situ for the surface sizing application using alpha amylase enzymes.
- The viscosity develops during the cooking and the enzymes assist in reducing the final cooked starch viscosity.
Batch Enzyme Conversion

- Fill Reactor with 1st Water
- Add 0.05% Calcium Carbonate on Starch
- Add Starch
- Add 2nd Water to Wash Dome and sides
- Heat to 55°C
- Add Enzyme
- Heat to 80°C and hold for 15 minutes
- Heat to 110°C and hold 10 minutes
Continuous Enzyme Conversion

1. **Starch Silo**
   - Mass Flow Meter
   - Water
   - Enzyme

2. **1st Jet Cooker**
   - 80-82°C
   - Steam
   - 3 Minutes Retention

3. **Enzyme Reactor 80°C**
   - ~20 Minutes Retention

4. **2nd Jet**
   - 130-135°C
   - To Storage Tank

5. **Slurry Make-up**
Critical Control points

• Make – up: affects starch solids
• Enzyme dosage: affects the final viscosity
• Mass flow meters: Controls retention time in the convertor
• Jet 1 temperature: affects the enzyme activity – starch gelling
• Jet 2 temperature: denatures the enzymes – stop breakdown of viscosity in the storage tank
• Variables are interdependent to produce quality starch

\[ Y = f(x_1, x_2, x_3, \ldots, x_k) \]

The input parameters
Starch important parameters

Viscosity

• Starch solids (make down and dilution)
• Enzyme dosage
• Cooking (temperatures)
• Temperature (storage and measurement)
• Shear rate – pump speeds and mixing
• Setback
Factors Affecting Storage Stability

- pH – 7 – 7.5 to prevent RAPS
- Temperature (avoid 65°C to 90°C for long time)
- Gentle agitation required
- Cleanliness of storage tank – any existing crystals will grow bigger and contaminate new starch
Factors Affecting Day Tank Viscosity

- Temperature
- Solids content
- Fibre – return from paper
- Sludge formation
- Setback
Troubleshooting the size press

Variable hold out
• Wet-end sizing efficiency*
• Retention of size on the paper
• Variation in filler and fines surface area
• Surfactants

High hold out
• Low cobb
• Low sheet density
• Low starch solids
• Low starch viscosity
• High paper moisture into size press

*Tests for sizing efficiency and fines and filler content:
• Percent active sizing agent
• Test pre-size press cobb
• White water consistency
• Headbox or machine chest furnish ash
• Headbox or machine chest furnish fines
## Starch Solids/Viscosity Paper Property Relationship

<table>
<thead>
<tr>
<th>Property</th>
<th>Low Viscosity High Solids (more penetration)</th>
<th>High Viscosity Low Solids (stays on surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Strength</td>
<td>Good</td>
<td>Better</td>
</tr>
<tr>
<td>Internal Strength</td>
<td>Better</td>
<td>Good</td>
</tr>
<tr>
<td>Porosity</td>
<td>Decrease</td>
<td>Decrease</td>
</tr>
<tr>
<td>Ink Hold Out</td>
<td>Good</td>
<td>Better</td>
</tr>
<tr>
<td>Opacity</td>
<td>Slight loss</td>
<td>Least Loss</td>
</tr>
<tr>
<td>Stiffness</td>
<td>Increase</td>
<td>Most Increase</td>
</tr>
</tbody>
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