Stock preparation & approach system

Process detail

2.1  Slushing / pulper station with auxiliaries
2.2  Screening and cleaning
2.3  Fractionation
2.4  Flotation
2.5  Dispersion
2.6  Refining
2.7  Stock mixing
2.8  Approach system
Coarse screen

- Virgin fiber
- Recycle fiber
Stock line coarse screening

Tasks

• To remove coarse impurities

• Separates coarse particles such as grit, sand and wires

• Increases the lifetime of refining fillings
Stock line coarse screening

Requirements

• To remove impurities with minimized fiber loss
• High-consistency range up to 5 %
• Low installation cost
  – Compact machine size due to feed consistency up to 5 %
• Low operation cost
  – Low energy consumption
  – Low basket cost as the rotating basket is protected from heavy particles by centrifugal force
  – Low fiber loss due to low and controllable reject rate
Stock line process

coarse screen as option to HC Cleaner
Coarse screen

- Virgin fiber
- Recycle fiber
Coarse screen
Applications

• Coarse screening must handle a variable load of sand, glass, staples and other wearing impurities

• The best solution for coarse screening is rotating basket technology with continuous reject removal.

• When heavy loads of wearing impurities are expected, the inclusion of a medium-consistency cleaner system is recommended in order to protect the tailing coarse screen from wear.
Coarse screen

Requirements

• Mild screening
  – Avoid impurity disintegration
  – If the screening conditions on the surface of screen basket are harsh, the soft stickies may be forced through the slot

• High runnability
  – Wide operation range
  – Protect subsequent process stages

• Low operating costs
  – Energy efficient and low maintenance requirements
  – High system operation consistency

• Low installation costs
Coarse screening system

Diagram showing the flow of material through a coarse screening system, including primary screens, secondary screens, tertiary screen, and reject tanks.
Coarse screening

Overview
Coarse screening
Rotating screen basket

Feed

Accept

Reject Junk
Coarse screening
Light reject removal
Coarse screening

Intermediate centrifugal cleaning

HC Cleaner

1 = Feed
2 = Accept
3 = Reject
4 = Flushing water
   - upper; stops rotation
   - lower; fills trap and lifts suspension limit to glass tube
5 = Exhaust

2010 04 20K
Fine screen
Particle size and contaminant removal efficiency

Distribution of contaminants in pulper

Efficiency of contaminant removal

Number of particles

Particle size (Microns)

Washing
Flotation
Cleaning
Screening

Visible limit

Optical microscopic limit

Hydrophilic nature
Specific gravity
Hydrophobic nature
Stiffness size

0.1 1 10 100 1,000 10,000

0.1 1 10 100 1,000 (1 mm) 10,000 (1 cm)
Screen operational philosophy

- Cleanliness
- Capacity
Consistency limits for screening of pulp

![Graph showing consistency limits for pulp screening]

- **Pulp Consistency %**
- **Passing Speed m/s**
- **Fluidization energy kW/l**

The graph illustrates the relationship between pulp consistency and passing speed, as well as fluidization energy, providing a visual representation of the limits for pulp screening.
Conventional screen

Feed

Accept

Reject
Ideal screen
The factors influence production capacity and cleanliness efficiency

• Screen area:
  Higher total system screen area: higher production capacity or higher cleanliness efficiency

• Screen opening area:
  Dependence on type & size of opening; higher screen opening area: higher production capacity

• Rotor linear speed:
  Higher linear speed: higher production capacity, higher energy consumption, higher reject thickening effect, too low linear speed might caused screen basket plugging problem

• Pulse frequency:
  Effect on screen cleanliness efficiency

• Screen profile
Screen basket profile angle
Controlled boundary layer fluidization
Flow pattern in screen bars
Effect of profile angle and slot width on cleanliness efficiency

- Same profile angle $\alpha_1$, 0.1mm slot cleanliness efficiency > 0.15mm slot
- While $\alpha_1 > \alpha_2$, 0.15mm slot cleanliness efficiency > 0.1mm slot
- This is due to boundary layer fluidization
Effect of screen basket slot width on cleanliness efficiency for sticky removal

![Bar chart showing the effect of different screen basket slot widths on sticky reduction efficiency. The chart displays the following data:

- 0.25 mm slot width: 80% reduction
- 0.20 mm slot width: 82% reduction
- 0.15 mm slot width: 88% reduction
- 0.10 mm slot width: 93% reduction]
Different cleanliness efficiencies of hard and soft stickies depending on specific flow through screen
Effect of mean screen through velocity on removal of stickies
Effect of slot width on reject thickening factor
At same through velocity

![Graph showing the relationship between thickening factor and slot width.](image)
Effect of mean screen through velocity on reject thickening factor

![Graph showing the relationship between calculated mean slot velocity and thickening factor.](image-url)
Cleanliness efficiency vs thickening factor with different slot width in same screen

![Graph showing the relationship between cleanliness efficiency and thickening factor with different slot widths.](image)
Change of size spectrum of stickies influenced by screening stages
Effect of screen basket slot width on reject thickening factor of different stages

![Graph showing the effect of screen basket slot width on reject thickening factor for different stages. The x-axis represents the stage number (1, 2, 3) and the y-axis represents the thickening factor. The slot width values for each stage are indicated.]
Screen mechanism

- Improve specific loading capacity
- Improve cleanliness
- Avoid thickening
- Reduce specific energy consumption
Screen capacity

- Screen area
- Screen opening area
  - Slot / Hole size
  - Bar / Pitch width
  - Conventional slotted screen basket
    (slot opening length / blank length)
- Rotor linear speed
- Pulse frequency
Screen capacity

- Gap between leading edge of rotor foil and basket
  - Narrow gap higher pulse?
  - Narrow gap higher capacity?
- Shape of bar surface
- Stock consistency
- Power input
Screen efficiency
Cleanliness of screened pulp

- Reject ratio
- Infeed pulp cleanliness
  - Dirt size, dimension, amount, distribution
- Slot size, hole diameter
- Through put speed
- Pulp consistency – acceptance
- Differential pressure
- Risk of dirt dispersion
  - Gap, power input, consistency
Screen efficiency

Efficiency vs reject ratio
Screen efficiency
Efficiency vs through put speed
Screen operational philosophy

• Slot size

  vs

• Cleanliness
Relative sizes

- Fiber cross sections
- Smallest visible particle
- Smallest particle according to TAPPI T213 dirt count

Hole 1.0 mm
Slot 0.10
Slot 0.30
News 0.075
LWC 0.053
Fractionation vs barrier separation
Probability of rejecting particles whose dimensions is one, two or all three dimensions are smaller than screen perforations vs screen contact frequency
Mass balance and definitions in a separation system

Total solid mass flow (by weight)

\[ M_i = M_a + M_r \]

Reject rate by total solid mass

\[ R = \frac{M_r}{M_i} \]

Thickening factor

\[ C_E = \frac{C_r}{C_i} \]
Definition in a separation system

Debris separation ratio
\[ T = \frac{m_i - m_a}{m_i} \]
where \( m \) is the debris mass flow by weight.

Debris concentration
\[ c = \frac{m}{M} \]

Debris enrichment factor
\[ c_E = \frac{c_r}{c_i} \]

Debris removal efficiency
\[ \eta = \frac{c_i - c_a}{c_i} \]
Screen efficiency parameters

**Operation related**

- Speed through slots
- Reject ratio
- Pulp consistency
- Differential pressure
- Infeed pulp cleanliness

**Machine related**

- Rotor design
- Gap between foil and screen basket
- Power input
- Screen basket surface pattern
- Slot size, hole diameter
Key points dimensioning screen

- Screen area
  - Specific loading capacity
- Screen opening area
- Slot / hole dimension
- Through put speed
- Reject ratio
- Consistency - acceptance
Fine screening system
Multistage low-consistency fine-screening system
Cleaning plant
Stock preparation & approach system

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Separation diagram
Separation diagram for debris, long fibers and short fibers
The differences between screening and fractionation goals
Fractionation Requirement

- One or two-stage fractionation
- Narrow slots and high reject rate give clean accept (short and medium fiber fractions)
- High fractionation degree, \( \Delta \text{CSF SF/LF} > 250 \text{ ml} \)
- Modified for fractionation (high reject flow)
Fractionation
What should happen in successful fractionation

• Difference in cleanliness
• Difference in fiber properties
• Difference in consistency
Fractionation
Fractionation efficiency

SF sticky removal

SF dirt removal

Fractionation consistency %

0,5 1,0 1,5 2,0 2,5 3,0
Fractionation
Fractionation efficiency

Slot size increase
Basket profile increase
Foil speed increase
Fractionation
How many fractionation stages

Two stage
- Improved pulp quality
- Higher reject rate screening stage
- Wide operating window
- Higher investment cost

Single stage
- Standard pulp quality
- Lower mass reject rate
- Needs more control
- Lower investment cost
Fractionation
2-stage
Fractionation

Coarse screening → DW-pump → Fractionator 1 → Short fiber storing → Fractionator 2 → Long fiber screening → CsW pump
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Flotation
Tasks and requirements

Tasks:
• To remove ink
• To remove stickies and other hydrofobic particles, e.g. fillers, coating components

Requirements:
• Minimum fiber losses
• Minimum specific energy consumption
• Easy operation and maintenance of the system
• Optimization tools
Flotation cell

Flotation cell is based on basic physical phenomenon

- The difference in pulp density between the aeration and separation sectors of the flotation cell
Flotation cell

The performance of flotation cell (with given raw material and specific chemistry)

- depends on the optimization of pulp aeration
  air removal and reject removal
Flotation System

Pressurized air

Primary stage

Secondary stage

Previous stage

Next stage

DW-pump
Flotation

Key parameters

• Control of key parameters of flotation:
  – Air-to-pulp ratio
  – Average bubble size
  – Reject properties
Stock preparation & approach system

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Dispersion

Target of dispersion result

- 75 - 85 % Reduction in visible ink specks
- 90 - 100 % Reduction in macro hotmelts
- 10 - 20 % Improvement in pulp strength
Dispersion plant form 1949
<table>
<thead>
<tr>
<th>Low fiber loss, High washing efficiency</th>
<th>Equal treatment of all pulp</th>
<th>Large processing area of disperser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable consistency</td>
<td>CLEAN, STRONG AND HOMOGENEOUS PULP</td>
<td>Unique fillings design</td>
</tr>
<tr>
<td>Controlled preheating</td>
<td>Systems and operational variability</td>
<td>Optional / adjustable Refining impact</td>
</tr>
</tbody>
</table>
Target of dispersion

1. Reduction in speck size
2. Freeing of inks from fibers
3. Dispersion of hotmelts and stickies
4. Homogenous pulp
5. Development of pulp properties
Dispersion Plant

Overview
## Dispersion Temperature

<table>
<thead>
<tr>
<th>Impurity</th>
<th>Softening temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>100 - 110° C</td>
</tr>
<tr>
<td>Waxes</td>
<td>85 - 110° C</td>
</tr>
<tr>
<td>Hotmelts</td>
<td>85 - 100° C</td>
</tr>
<tr>
<td>Inks</td>
<td>85 - 120° C</td>
</tr>
<tr>
<td>Newsprint ink</td>
<td>85 - 90° C</td>
</tr>
<tr>
<td>UV-Varnishes</td>
<td>85 - 120° C</td>
</tr>
</tbody>
</table>
Dispersion
Dispersion at atmospheric / pressurized

30%

80-120°C
0-100kPa

Steam

4-8%

Dilution water
( in pressurized mode not necessary )

1-5%