OptiCycle your pulp and paper process

Seminar: Developing future water technologies - Membranes

8.6.2011

Pasi Nurminen
Metso Paper, Inc.
OptiCycle your pulp and paper process

- Metso and Metso Paper - General
- Pulp and paper vs. water in globe
- Closing the system - result
- Water management and OptiCycle idea
- Technological solutions
- Visions
  - Zero effluent paper making line
    - ‘OptiCycle Z’
  - Vision of chemical pulp line
- Diamond-water paradox
Metso and Paper and Fiber Technology
General overview
Metso is a global supplier of sustainable technology and services

- Our customers operate in the following industries:
  - Mining
  - Construction
  - Power generation
  - Oil and gas
  - Recycling
  - Pulp and paper
- About 28,500 employees in more than 50 countries.
- 2010 net sales EUR 5.6 billion.
- Our shares are listed on NASDAQ OMX Helsinki Ltd.
Balanced portfolio

Net sales in 2010 EUR 5.6 billion

Net sales by customer industry:
- Mining: 30%
- Construction: 27%
- Power: 8%
- Oil and gas: 7%
- Recycling: 13%
- Pulp: 4%
- Paper: 11%

Net sales by type:
- Service business: 45%
- Project business: 35%
- Product business: 20%

Net sales by market area:
- Finland: 28%
- Other Nordic countries: 14%
- Other European countries: 17%
- North America: 24%
- South and Central America: 7%
- Asia-Pacific: 5%
- Africa and Middle East: 5%
Strong global presence

Personnel by area
About 28,500 employees

- Finland: 31%
- Other Nordic countries: 16%
- Other European countries: 15%
- North America: 12%
- South and Central America: 11%
- Asia-Pacific: 10%
- Africa and Middle East: 5%
Metso Paper and Fiber Technology

• Most extensive range of technologies for the pulp and paper industry

• Leading supplier in power generation and chemical recovery sector

• Globally local

• Life cycle customer care
Pulp & paper and water in the globe
Pulp and paper
Global trends

- **Installed base market**
- **Emerging market**
- **New investments**
  - **Focus pulp**
  - **Focus paper and pulp**

- **Recycled fiber**
  - increased share in furnishes
  - increasing quality (brightness)

- **Papermaking**
  - large production lines for bulk grades
  - smaller lines for emerging markets
  - lower energy consumption
  - less effluent

- **Chemical pulp**
  - plantation hardwood
  - large single lines, 5,000 – 6,000 ton/d

- **Mechanical pulp**
  - possibility to replace kraft pulp content in some grades
  - hardwood as raw material
Today’s Water challenges
Water Utilization Change, E2025

Water scarcity is a result of a mismatch between the demand and supply of water for human applications.

Projections by 2025

Population faces water scarcity when annual water supplies drop below 1 000 m³ per capita and water stress when annual water supplies drop below 1 700 m³ per capita.

Today’s Water challenges

Water Pollutant

- Highest environmental stress in the industrial and high-growth regions experiencing scarcity of water as raw material
- Increasing pressure on intensified ground water utilization

Low fresh water consumption

Driving forces

• Environmental aspects:
  - Environmental load will be lower
  - Limitations at effluent emissions and water amounts

• Water costs
  - Fresh water and effluent water

• Energy cost
  - Water transport energy and heat out from the process

• Water treatment capacity too low
  - Internal water recirculation give reserves to fresh water treatment and effluent treatment

• Good water management improves runnability and quality
• Green image
Closing the water system – risks and consequences
Reduction of fresh water consumption

Benefits and risks

Benefits

• Decreased operational costs
• Increased white water temperature and drainage
• Reduced energy, because less fresh water heating is needed
• Environment

Risks *without water treatment concepts*

• Higher trash concentrations
• Runnability and product quality problems caused by water chemistry and increased microbiological activity

- All paper mill filtrates carry highly concentrated dissolved and colloidal material as well as bacteria, if not further purified
Consequences of low water consumption
Precipitations; deposits; filtrates are recirculated

• Dissolved and colloidal substances from raw materials will concentrate to process waters:
  - Carbohydrates (cellulose, hemicelluloses)
  - Lignin
  - Extractives (pitch, resin and fatty acids)
  - Salts (Cl⁻, SO₄²⁻, SiO₂⁻…)
  - Metal‑ions (Na⁺, Ca²⁺, Fe³⁺…)
  - Latex
  - Starch
  - Stickies
  - And many more…

• Process chemistry and microbiology balance will change
Paper mill wire section
The effect of microbiological growth and precipitation

RISKS AND CONSEQUENCES
Paper mill showers
The effect of microbiological growth

Slime formation before showers

RISKS AND CONSEQUENCES
Paper mill showers
The effect of Super clear filtrate

Wire section High Pressure showers;
4 of 6 were blocked

RISKS AND CONSEQUENCES
Filtration of biologically treated effluent
The effect of tight ultrafiltration

Scandinavian mill - clear results

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Basic OCC liner/fluting concept
No water treatment concepts

- Without internal water purification
- Without recirculation of biofiltrate

**RISKS AND CONSEQUENCES**
## OCC liner paper

### The effect of water treatment

<table>
<thead>
<tr>
<th></th>
<th>Without</th>
<th>With</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD mg/l</td>
<td>35 000</td>
<td>7 500</td>
</tr>
<tr>
<td>Ca mg/l</td>
<td>3 700</td>
<td>535</td>
</tr>
<tr>
<td>Chloride mg/l</td>
<td>550</td>
<td>450</td>
</tr>
<tr>
<td>pH</td>
<td>6.25</td>
<td>7.25</td>
</tr>
<tr>
<td>Conductivity mS/cm</td>
<td>9.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Sulphate mg/l</td>
<td>1 500</td>
<td>500</td>
</tr>
<tr>
<td>Acetic acid mg/l</td>
<td>5 000</td>
<td>1 000</td>
</tr>
<tr>
<td>Propionic acid mg/l</td>
<td>700</td>
<td>250</td>
</tr>
<tr>
<td>Butyric acid mg/l</td>
<td>400</td>
<td>20</td>
</tr>
<tr>
<td>Lactate mg/l</td>
<td>5 800</td>
<td>800</td>
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</table>

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Closing the water system – water management and OptiCycle idea
Water management systems

- Fresh Water Treatment
- White Water Treatment for PM
- White Water Treatment for Pulp Mill
- Effluent Treatment
Water management

Challenges

• Environmental legislation
  - Reducing toxic pollution to the water system
  - Reducing air pollution; carbon dioxide
  - Reducing energy consumption
  - Reducing fresh water consumption and waste water
  - Reducing solid waste

• Cost efficiency and high runnability
  - Reduction of fresh water treatment costs
  - Reduction of waste water treatment costs
  - Reduction of total water treatment costs
  - Reduction of carbon dioxide emission costs
  - High process cleanliness
Another philosophy is to use independent kidneys in both mills and have one reject and sludge treatment connected with efficient biological treatment.
Steps to controlled water management

Fresh water consumption m³/ton of paper

Recommended Actions

- All fresh water to paper machine
- Counter-current principle for all process water
- All make up water from clean to dirty
- Waste water out from pulp mill
- Separate water loops for different departments
- Recycling and cleaning of save all clear filtrates
- Efficient pulp washing before paper machine
- Minimizing the long loop water volume
- Minimizing the salts at chemicals and process
- Water buffer volume bigger than stock volume

Water Management Technologies

- Effluent treatment and microflotation
- Removal of stickies and ash/microflotation
- White water treatment /microflotation
- White water treatment with OptiCycle W
- Extractives removal with OptiCycle R
- Biokidneys for pulp mill
- Salt removal with OptiFilter NF

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## Water concepts for paper making lines

### Paper process

<table>
<thead>
<tr>
<th>Fresh water consumption m³/t paper</th>
<th>Low fresh water consumption</th>
<th>Minor fresh water consumption</th>
<th>Special cases</th>
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<tbody>
<tr>
<td>BOARD BROWN OCC</td>
<td>5 – 7 Microflotation</td>
<td>3 – 5 Microflotation OptiCycle W</td>
<td>&lt; 3 OptiCycle W+ NF Microflotation</td>
</tr>
<tr>
<td>FINE KRAFT</td>
<td>6 – 7</td>
<td>4 – 6 OptiCycle W</td>
<td>&lt; 4 OptiCycle W+ NF</td>
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### Pulp process

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<tr>
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<td>4 – 6</td>
<td>&lt; 4</td>
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Technological solutions
OptiCycle Membrane Technology
Ultrafiltration membrane technology
OptiCycle

OptiCycle processes are based on OptiFilter CR® ultrafiltration technology:

OptiCycle W  White water treatment for paper mill’s white water
OptiCycle C  Coating color recovery and recycling
OptiCycle R  Resin removal at mechanical pulping process

Products:
• Continuous production of colloidal and bacteria free ultrapure water for recycling
• Raw material recovery for recycling
White water treatment for paper machine
OptiCycle W

- Production of colloidal and bacteria free ultrapure water
- Reduction of fresh water consumption
- Improvement of PM runnability and efficiency

- Based on membrane technology with OptiFilter CR ultrafiltration
OptiCycle W
Based on OptiFilter CR ultrafiltration

- Plate & frame module
- Polymeric flat sheet membranes
- Cross flow created by rotors
- High cross flow velocity (> 10 m/s)
  - High turbulence
  - High and stable capacity
  - Low clogging of membrane
- Low pressure difference (< 1 bar)
  - No clogging of membrane
  - High membrane life time
- Patented technique

OptiFilter CR-1010

Rotor
Membrane
Drainage support
Filter cassette
Support ring
Concentrate
Feed
Permeate
OptiFilter CR
Model

OptiFilter CR 1010/100

• membrane area 140 m²
• membrane diameter 1000 mm
• filter cassettes 100 pcs
• motor 110 kW
• weight, ca 9700 kg
• size, ca 4,3 x 1,4 x 2,4 m
  (height - width - length)
• membrane pore size 0,02 µm
Propapier PM2, Germany
OptiCycle W ultrafiltration process

• OptiCycle W process was chosen to reduce fresh water consumption
• Propapier PM2
  - 650 000 t/a testliner and fluting from 100% recycled fibre
• OptiCycle W
  - 4 x OptiFilter CR1010/100
  - membrane area: 560 m²
  - feed water: PM clear filtrate
  - capacity
    • Dimensioning 1200 - 1500 m³/d
    • Realized 1500 - 2000 m³/d
  - permeate is used at wire section high pressure showers

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Experience in paper and boardmaking

40% of the world’s paper is produced with machines by Metso, or associated origin.

- 850 paper machines
- 650 board machines
- 150 tissue machines
- 200 mechanical pulping lines
Water Concepts
“OptiCycle Z” – future solution – zero effluent???
Pulp Mill
Pulp Mill
From log to bale
Effluent from Pulp Mill – State of the art process

- Modern mills total effluent 15 – 30 m³/adt from the whole mill
  - 10 – 20 m³/adt effluent from the fiberline
    • Alkaline effluent
    • Acidic effluent
  - 5 – 10 m³/adt effluent from
    • Wood handling, Pulp Drying, Evaporation, Causticizing and Cooling water circulation

- BAT 30 – 50 m³/adt, COD 8 – 23 kg/adt
Modern Pulp Mill
15 – 30 m³/adt
Vision Pulp Mill
5 – 15 m³/adt

Evaporation

Bleaching

Oxygen

Pulp Drying

Waste water treatment

HOT WATER

CONDENSATE

HOT WATER

WHITE WATER

EFFLUENT

HOT WATER
“Diamond-water paradox”
Diamond-water paradox

Water treatment price should not exceed price of water!