Energy-saving solutions for the paper machine

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Board production costs, by main grades

Global average cost, FOB mill site

Energy cost varies between 15 – 30%

Energy consumption
Modern newsprint machine

**Electricity**
- Press section: 31%
- Forming section: 19%
- Dryer section: 17%
- Calender: 15%
- Short circulation: 12%
- Headbox: 0%
- Winder: 2%
- Reel: 4%

**Steam**
- Dryer section: 69%
- Press section: 13%
- Short circulation: 11%
- Headbox: 1%
- Ventilation (hall): 6%
Electricity usage, forming and press sections
Drives, vacuum and hydraulics, modern newsprint machine

Forming section:
- Sectional drives: 42%
- Vacuum system: 35%
- Shower water system: 11%
- Hydraulic system: 1%
- Pressurized air system: 1%
- Ventilation: 4%
- Broke collection: 6%

Press section:
- Sectional drives: 60%
- Vacuum system: 20%
- Shower water system: 2%
- Hydraulic system: 15%
- Pressurized air system: 1%
- Broke collection: 3%
Modern machines are more efficient

- Film size press
- Efficient drying and heat recovery
- Fast tail threading and break recovery
- High dryness after press with shoe pressing
- High time efficiency
Run with less energy – Levels of improvement

1. Best operational parameters with the present equipment
2. Maintenance and preventive service
3. Repairs
4. Rebuilds
5. New technologies

Extent of investment
Stock preparation - refining
One OptiFiner Pro can replace two traditional refiners
and even deliver 20% electrical energy savings
Energy efficiency and vacuum system analyses
Energy efficiency analysis

Results example: short-term actions

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Savings [k€/yr]</th>
<th>Payback Time [yrs]</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted press section dewatering approach</td>
<td>11</td>
<td>Very short</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Reduced vacuum pump capacity</td>
<td>63</td>
<td>&lt; 1 year</td>
<td>Small investment</td>
</tr>
<tr>
<td>Increased steambox flow</td>
<td>15</td>
<td>Very short</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Increased final base paper moisture</td>
<td>52</td>
<td>Very short</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Reduced basic line power</td>
<td>21</td>
<td>Very short</td>
<td>Further study</td>
</tr>
<tr>
<td>Reduced heating of process water</td>
<td>110</td>
<td>Very short</td>
<td>Study+ investment</td>
</tr>
<tr>
<td>Increased return of condensate</td>
<td>72</td>
<td>Short</td>
<td>Study+ investment</td>
</tr>
<tr>
<td>Improved heat recovery</td>
<td></td>
<td>Short</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Optimized hood air balance</td>
<td>50</td>
<td>Very short</td>
<td>Adjustment/system</td>
</tr>
<tr>
<td>Reduced equipment air temperature</td>
<td>12</td>
<td>Very short</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Improved compressed air system</td>
<td>50</td>
<td>&lt; 1 year</td>
<td>Control system</td>
</tr>
<tr>
<td>Optimized cylinder drying</td>
<td></td>
<td>Very short</td>
<td>Control system</td>
</tr>
<tr>
<td>Reduced (10%) number of breaks</td>
<td>103</td>
<td></td>
<td>Further study</td>
</tr>
</tbody>
</table>

Total: 559 k€/yr

Grade: Fluting
Grammage: 100-200 g/m²
Reel width: 6,680 mm
Machine speed: 700 m/min
Vacuum system upgrades
Press section

• Vacuum system design
  - Typically all systems are designed at “low cost energy time” and based on very traditional engineering.
  - System efficiency loss is high

• Felt types and operation conditions
  - Many fast running paper machines are today targeting dewatering at the nip instead of at the Uhle box.
  - Vacuum levels of Uhle boxes are often also lower than earlier.
Vacuum system rebuild - energy saving 770 kW
European mill, LWC, project start-up Sept 2010

- Preceded by a vacuum system study
  - total theoretical electric energy saving potential over 1 MW
  - About 70 % of savings with relatively small investment

- Rebuild results
  - Rebuild in a two day shut-down in September
  - Two vacuum pumps were stopped and total energy consumption decreased by 770 kW

- Metso scope:
  - Process engineering, automation field equipment, DCS system software modifications, pick-up logic update

- Customer scope:
  - Piping materials and installation
Forming section
Optimization of dewatering in the forming section

It's all about maximizing the dewatering and minimizing the rewetting!
New perforated suction box cover

Inclined drilling and new cover material for lower flow resistance

Traditional cover
New perforated suction box cover gives high consistency with low vacuum

![Graph showing dry content change over suction box versus suction box vacuum for perforated and slotted covers.](image-url)
Press section
Solutions to reduce energy usage

Press section

From Uhlebox dewatering to nip dewatering

Runnability improvements and cost savings with shoe pressing and belt doctoring (BeltDoc)

Perforated uhlebox cover
Energy savings due to shift from Uhle box to nip dewatering

Estimated normal running loads (kW)

<table>
<thead>
<tr>
<th>Load (kW)</th>
<th>Press section drive NRL, kW</th>
<th>Blower/Pump NRL, kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open felt 55 kPa Uhle vacuum</td>
<td>800</td>
<td>500</td>
</tr>
<tr>
<td>Open felt 45 kPa Uhle vacuum</td>
<td>600</td>
<td>400</td>
</tr>
<tr>
<td>Dense felt 45 kPa Uhle vacuum</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Dense felt 25 kPa Uhle vacuum</td>
<td>150</td>
<td>240</td>
</tr>
</tbody>
</table>

Assuming, that blowers/pumps are selected to operate at optimum conditions (no bleed air, no throttling of valves).
Perforated Uhle box cover, shoe pressing & BeltDoc doctoring
Perforated Uhle box cover

Longer felt lifetime – lower energy load

• Dewatering capacity is based on a large open area of the perforation
  - Long dwell time in the suction area
• Increases felt dewatering at a lower energy load and vacuum level than a conventional slotted cover
• Decreases friction between the cover and the felt
  - No slots for the felt to "dive" into anymore
  - Gives a longer felt lifetime
• Felt well supported over the entire suction area
• Quick and easy assembly to existing Uhle boxes

Perforated Uhle box cover *):
• 25 kPa lower vacuum level
• 13 kW lower friction effect
• 65 % lower air flow
Felt behaviour in the suction area

Liner / fluting production machine
Conventional slotted cover
### SymBelt shoe press rebuild

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear load (kN/m)</td>
<td>120-130</td>
<td>200 kN/m</td>
<td>350 kN/m</td>
<td>Up to 600 kN/m</td>
<td>600-1500</td>
</tr>
<tr>
<td>Dry content increase</td>
<td>Ref.</td>
<td>Approx. 1 – 1.5 %</td>
<td>Approx 2 %</td>
<td>Approx. 2 – 3 %</td>
<td>Approx. 3 - 6 %</td>
</tr>
<tr>
<td>Production increase or steam consumption decrease</td>
<td></td>
<td>4 – 6 %</td>
<td>6 – 8 %</td>
<td>8 – 12 %</td>
<td>12 – 24 %</td>
</tr>
<tr>
<td>Press / Shoe press roll diameter</td>
<td>700-900</td>
<td>1095</td>
<td>1095</td>
<td>1095</td>
<td>1250-1595</td>
</tr>
<tr>
<td>Counter roll</td>
<td>Solid roll</td>
<td>Existing (new drive)</td>
<td>Existing (new bearing housing, new drive)</td>
<td>New SolidL roll</td>
<td>New SymZLC roll package</td>
</tr>
</tbody>
</table>

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BeltDoc improves dryness and moisture profile

- Minimizes misting around the shoe press
- Increases dryness and improves moisture profile after press
- Close to 100 references
Higher web dry content and speed

BeltDoc doctoring solution – WFU line, 80 gsm copy

• Target
  - Increase web dry content & improve runnability after the SymPress B press section

• Actions
  - Installation of BeltDoc with saveall
  - Saveall close to felt → possible to increase linear linear load from 700 kN/m to 850 kN/m

<table>
<thead>
<tr>
<th>Action</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher linear load</td>
<td>1.5 % web dry content increase after press</td>
</tr>
<tr>
<td>BeltDoc &amp; saveall</td>
<td>0.5 % web dry content increase after press</td>
</tr>
<tr>
<td>Machine speed</td>
<td>From 1,450 m/min to 1,505 m/min</td>
</tr>
<tr>
<td>Dry content</td>
<td>From 48.5 ..49.5 to 51 – 52 %</td>
</tr>
<tr>
<td>Bulk</td>
<td>No difference</td>
</tr>
</tbody>
</table>
Other energy saving solutions
Energy savings through optimized doctoring at the dryer section

Relative power consumption of doctor blade materials

Based on laboratory tests in simulated paper machine environment
Energy savings through optimized doctoring at the dryer section

- Results: Energy savings, a cleaner cylinder will improve cylinder drying capacity and runnability, reduced total doctoring costs.

**Example calculation**
7 m wide paper machine running at 900 m/min, using either glass fiber or carbon doctor blade on cast iron cylinders (dryer can)

**Assumptions**
- Width: 7 m
- Machine speed: 900 m/min
- Load: 300 N/m
- Dryer cylinder radius: 0.915 m
- Glass fiber friction coefficient: 0.5
- Carbon fiber friction coefficient: 0.2
- Number of blades: 50
- Running days/year: 300

**Results**
- Power consumption to overcome friction generated by a single blade on a dryer can
  - Glass fiber blade: 15.75 kW
  - Carbon blade: 6.3 kW
  - Difference per blade: 9.45 kW
  - x 50 blades: 472.5 kW
- Annual difference in energy consumption: 3402 MWh
- Energy price: €0.04 /kWh

**Potential annual savings**: €136,080
High intensity air dryer to replace IR dryers

PowerDry Plus

- High drying rate with effective nozzle technology
- Significant energy savings (50%) compared with infrared drying
- Environmentally friendly, 50% less fuel burned and CO2 formed
- Low moisture and heat loads to machine room
- Low maintenance costs
Summary

- Energy costs are the second biggest cost
- Improving efficiency reduces specific energy cost
- Metso offers many services, new innovations and technologies that directly reduce energy and production costs
- Most of these small investments have short payback times and can be installed as retrofits