Industrial experience of producing high quality woodfree deinked pulp from a furnish containing HP Indigo LEP printed material

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Agenda

1. Deinking collaboration between AW and HP
2. The importance of Digital Printing
3. Status and mechanism of Digital Deinkability
4. Objectives of the AW-HP Indigo LEP deinking trial.
5. Introduction to the Greenfield process
6. Lab and pilot results
7. Protocol of Industrial trial
8. Summary of results
9. Next steps
Deinking collaboration between AW and HP

• “Arjowiggins Graphic and HP have announced an ongoing partnership to look into de-inking Indigo liquid toner and inkjet prints at its advanced wood-free Greenfield mill in France

• « The two companies have agreed to test new techniques for deinking and test on an industrial scale ». 

• « The Greenfield mill is one of the most advanced environmentally friendly de-inking sites in Europe. This relationship will contribute to establishing Greenfield as an industry centre of excellence for de-inking solutions of digitally printed materials. »

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The importance of Digital Printing

- Digital printing shows strong year on year growth despite the global economic downturn and reduction in offset print volumes.

- Key drivers are the trend towards personalisation, short more flexible runs and minimisation of print shop waste.

- Digital print quality is constantly improving.

*Include Offset, Gravure and Flexo
Source: The future of Printing, PIRA, EIU Economist

Indigo Pages 5.9x by the EoY 2010

Digital printing 4.1x since 2003
WW GDP 1.3x
Total print industry is showing marginal growth
Conventional Printing* forecasted to decline 10% by 2013

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Status of deinking of digital prints

- Most dry toner prints are judged to be deinkable.
- Inkjet dye printed papers can give low luminosity after deinking (without bleaching) due to the presence of soluble dyes in the water phase.
- Indigo Liquid toner printed papers can give problems of high dirt count.
  - The polymer film shows resistance to breakdown under typical pulping conditions.
  - The resulting large ink fragments are then difficult to remove by flotation, unless further reduced in particle size.
In theory the solution to enhancing the deinking of Indigo printed papers therefore requires optimisation of:

- Ink particle size after release.
- Bubble size and chemistry during flotation.
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Objectives of the AW-HP Indigo LEP deinking trial

- To obtain industrial experience of LEP deinking in a state of the art multi-loop mill producing high grade graphics arts pulp.

- To assess the risk of inclusion of such material at the maximum level that could normally be encountered.

- To assess the relative importance of energy input (mechanical reduction of ink particle size) versus flotation.
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Introduction to the Greenfield process

- One DIP processing line with three loops for optimal efficiency.
Pulping and prescreening

**Pulping**
- Breaks paper down into individual fibers
- Separates ink particles from fibers
- Reduces contaminant size

**Prescreening**
- Removes big size contaminants,
- Removes staples, sand & glass
CONTRACT WITH NATURE

1st & 2nd Loops

Flotation
Removes ink particles

Screening
Removes small contaminants

Bleaching

1st loop bleaching
By oxidation with hydrogen peroxide
(Blue & yellow tints)

2nd loop bleaching
Reductive bleaching with sodium hydrosulfite
(red tints)

Washing & thickening
Removes fillers
Extracts process water which is clarified and recirculated

Dispersing
Reduces ink particles’ size
3rd loop & formation of final product

Flotation
Removes remaining ink particles

Thickening
Removes fillers
Extracts process water
which is clarified and recirculated

Formation & pressing
Pulp sheet formation

Drying, 87% dryness

Cutting & packaging
Greenfield process schematic

- Storage & Selection
  - Pulping
    - HD cleaners
      - Pre-screening
- Loop 1
  - Flotation 1
    - Cleaning
      - Fine screening
    - Washing
      - Thickening
    - Bleaching
      - Dispersing 1
- Loop 2
  - Flotation 2
    - Cleaning
    - Washing
      - Thickening
    - Bleaching
      - Dispersing 2
- Loop 3
  - Flotation 3
    - Thickening
    - Wet Lap
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WMU pilot lab studies - results
WMU pilot lab studies - results
AW/HP predictive 2 loop test

- A 2 loop test has been developed to simulate Greenfield industrial practice.

Furnish

18% consistency  
55°C, 15min

1% consistency  
45°C, 5min, 8L/min

30% consistency  
25°C

20% consistency  
72°C, 20min, 40rpm

1.2% consistency  
45°C, 6min, 8L/min

Pulping

Pulping chemicals

1st Flotation

Recovered process water

Kneading chemicals

Dewatering

Kneading

2nd Flotation
AW/HP 2 loop test procedure

- Initial results using AW furnish and chemistry demonstrated good correlation to industrial practice with 3 loops.

<table>
<thead>
<tr>
<th>Ink Removal Rate (%)</th>
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</thead>
<tbody>
<tr>
<td>$A_{100}$</td>
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<tr>
<td>$A_{250}$</td>
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<tr>
<td>TAPPI 563</td>
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</tbody>
</table>
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Trial protocol – industrial trial

- Control run without LEP prints
- 10 hours of LEP deinking trial (standard recipe including 5% Indigo printed material)
- Time from initial pulping to final product = 8 hours.
- 2 sets of measurements during trial at various points in the process.
- 11 pulp batches each of 16T containing LEP
- Production of about 175 tons market pulp with LEP prints (at 5% level)
Trial protocol – LEP prints

- Indigo prints were collected from HP Israel R&D centre.
  - Full page coverage (heavy solid color), Photobook and 4 colour, customer jobs.
  - 70% coated 30% uncoated.
Trial protocol – industrial trial

• Process variables - online:
  – Tappi dirt (>200 microns)
    (measured at very end after wet laps)
  – Total dirt (>50 microns)
    (measured at very end after wet laps)
    – Brightness
  – Flotation parameters (rejects)
    – Pulping energy
    – Disperger energy
    – Foam height

• Measurements on finished pulp
  – Pulp concentration and ash
    (yield calculation)
  – Pulp dewatering (input to paper makers)
  – Total >50µm and Tappi >200µm dirt count
    (handsheet *)
  – Brightness (Handsheets *).
### Trial protocol – industrial trial

#### Products range

<table>
<thead>
<tr>
<th>Brightness</th>
<th>%</th>
<th>Elrepho Datacolor 3000</th>
<th>Printing &amp; writing</th>
<th>Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

- **Brightness**
  - 98% +/-2
  - 94% +/-2
  - 90% +/-2
  - 86% +/-2
  - 82% +/-2

- **Dirt Tappi (>200μm)**: mm²/m², Dot counter 3,0, maxi
  - 3
  - 11
  - 1,5
  - 4

- **Dirt Total (>50μm)**: mm²/m², Dot counter 3,0, maxi
  - 3
  - 20
  - 1,5
  - 4

- **Stickies**: mm²/100g Pulmac (0,15 mm), maxi
  - 10

- **Ash content**: % Tappi 211, maxi
  - 4

#### Control product

- Product made with 5% LEP

#### Same dirt area spec with and without LEP

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Photos from the trial - process
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Greenfield mill LEP trial – process and sampling points

- Samples for handsheets taken at points A-I
- Two sample sets taken for LEP trial
Greenfield mill LEP trial – results - handsheets

Washing, cleaning, screening

Flotation 1

Disperger 1

Flotation 2, cleaning, washing

Sampling Point

Tappi Dirt (ppm)

Total Dirt (ppm)

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000

A B C D E F G H I

Control (Tappi)
LEP1 (Tappi)
LEP2 (Tappi)
Control (Total)
LEP1 (Total)
LEP2 (Total)
Surface area of dirt in flotation 1 rejects

Surface mm²/m² exit flot1 as a function of the size of the ink particles

Essai LEP
Observations after 1st loop

- The ink particles are difficult to be removed by flotation after the initial pulping.

- Large ink particles are found in the flotation 1 rejects.

- A significant reduction in both Tappi and total dirt count is seen after screening and washing (presence of small particles as well as large).

- A further large reduction in dirt count is also seen after the 1st dispersion.

- This suggests that:
  - LEP ink particles require high energy to be broken down.
  - Flotation conditions may need to be optimised for increased removal efficiency of LEP particles.
Closer look at the 2\textsuperscript{nd} loop.

Possible sample contamination for handsheet preparation?

2nd Flotation

Before 3rd Flotation
Observations after 2nd loop

- Presence of LEP increases the dirt count at the beginning of the 2nd loop.
- 2nd flotation efficiently reduces the dirt count.
- 2nd dispersion has little impact.
- Dirt count after 2nd flotation is near to target.
Finished pulp - Dirt count

- After 3rd loop flotation results are in pulp specification (PW94).
Finished pulp - Brightness +UV

- No unexpected impact of LEP on final pulp brightness
Photos from the trial - samples

After pulping with 5% LEP

Final pulp with 5% LEP
Trial conclusions

- The pulp quality with and without 5% addition of LEP was the same at the end of the 3 loop process.
- No process modifications were made during the trial.
- Confirmation that LEP prints give large plates of ink after repulping.
  - The standard pulping conditions do not introduce enough energy to overcome the viscoelasticity response of the ink polymer film.
- The 1st dispersion step in conjunction with the 2nd flotation has most significant influence on dirt count.
- The 3rd flotation step is required in order to guarantee market specifications for dirt count.
Next steps

- Continuation of the active AW-HP collaboration.

- Predictive use of the AW/HP 2 loop protocol to explore LEP deinking mechanisms and deinking enhancement through alternative chemistries and process variables.

- Further industrial trials at 5-10% LEP addition to investigate the influence of higher pulper consistency and increased energy during the 2nd dispersion stage.