Deinking of HP Indigo Prints: Laboratory Assessment Methods for 2-Loop Tests, and Influence of Paper Composition

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Outline

Acknowledgement

HP Indigo ElectroInk (LEP) technology overview

2-loop laboratory test
  • Background and motivation
  • PMV studies
  • WMU pilot work

Effect of paper

Overall summary
Acknowledgement

Dr. Hans Putz, PMV, Darmstadt: for many helpful discussions around 2-loop lab processes and proposed dirt area targets
HP Indigo 7X00 Digital Press
Technology fundamentals make HP Indigo presses the leading solution for production of high value pages

- Thin images
- Efficient material use
- High speed with superior image quality
- Saturation
- Gloss uniformity
- Sharpness
- Transparency

- “Offset” look & feel
- Any substrate
- No fusing
- No drying
- Supports sheet-fed and web-fed presses

Unmatched digital quality, versatility, and substrate flexibility
HP Indigo printing process – How does it work?

1. Charging the PIP
2. Exposing the PIP
3. Transfer ink to PIP
4. Transfer image to blanket
5. Transfer image to substrate
Papers used by Indigo’s customers

More than 3000 papers have been certified worldwide for Indigo’s commercial digital presses

The vast majority of these papers are wood-free high brightness papers

Our customers sometimes ask if these HP Indigo ElectroInk prints can be recycled back into similar high-quality papers

Thus our focus on deinking processes in wood-free deinking mills, and the development of a lab test to simulate these processes
**2-loop lab deinking test**

Most Graphic Arts quality deinking mills use multi-loop process with kneading/disperging step(s)

Given range of inks and toners on market, cannot assume response to kneading/disperging will be similar; therefore helpful to include kneading/disperging step in 2-loop lab-scale testing

As correlations of 2-loop lab-scale tests to mill performance improve, should be possible to develop assessment criteria

Two main issues

- Development of the 2-loop process itself
- Development of pass/fail criteria

We will review several 2-loop methods, and propose a 2-loop target for dirt area
PMV 2-loop test process flow

Feed*
100% ElectroInk prints INGEDE test pattern

Aging*
60 C, 72 hr

Pulping*
Hobart, 15%, 45 C, 20 min
NaOH, Na₂SiO₃, H₂O₂, Oleic Acid

Flotation 1*
Voith Delta 25
0.8%, 45 C, 12 min

Flotation 2
PTS cell, 0.8%, 45 C, 10 min

Kneading
Beken Kneader, 20%, 92 C, 10 min
NaOH, Na₂SiO₃, H₂O₂, Oleic Acid

Dewatering

*Adapted from INGEDE Method 11p
# PMV 2-loop test – papers studied

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Popular, representative papers used by Indigo customers  
All papers with brightness > 75
PMV 2-loop test – overall results

Deinkability Score*, Points

-10 -20 -30

P1/1 P1/2 P2/1 P2/2 P3/1 P3/2 P4 P5

*ERPC scoring shown even though it is not directly applicable for 2-loop process

Photo prints – not discussed in this presentation

P1-5: different papers
Px/1: high ink coverage, duplex
Px/2: INGEDE test pattern, simplex
PMV test – yield vs. process step

Yield, normalized to organic content, similarly good for all papers
PMV test – total dirt area reduction vs. process step

200 ppm proposed $A_{50}$ dirt area target:
- Single paper
- Simplified lab process
PMV test – dirt area reduction of large particles (>250 microns) vs. process step

Dirt area of large particles (ppm)

process step

UP
DP1
KNP
DP2

P1
P2
P3
P4
P5

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PMV test – total average speck diameter vs. process step

Floatable range with standard chemistries
PMV test – large speck diameter (>250 microns) vs. process step
PMV 2-loop test – key takeaways

2-loop lab test results in yields representative of mill process

Kneading and 2\textsuperscript{nd} flotation significantly reduce total dirt area, by a factor of 10 or more

• Effect on large particles is even more dramatic

Several papers can meet 200 ppm \( A_{50} \) dirt area target

• Solution to enhanced deinkability should involve paper design

Kneading reduces average particle diameter to range that can be successfully removed by standard flotation chemistry

These initial studies were done with standard alkaline chemistry and limited paper set – need to expand to study effects of:

• Deinking chemistry
• Deinking process
• Paper
WMU 2-loop Pilot run process flow

**Feed**
100% SOP, 100% ElectroInk, 5% ElectroInk/95% SOP
Various images

**Aging**
None

**Pulping**
Kadant Black Clawson Hydrapulper, 18%
NewPage proprietary chemistry

**Flotation 2**
Voith-Morden, 1.3%

**Kneading**
Shinhama Kneader, 29%, 82 C, 200 sec
NaOH, Na₂SiO₃, H₂O₂, Oleic Acid

**Flotation 1**
Voith-Morden
1.3%, 45 C, 12 min

SOP = Sorted Office Pack, similar to MOW (mixed office waste)
WMU test – Total dirt area (ppm) vs. process step

Process is simulation of NewPage Duluth mill
WMU test – Particle size after pulping vs. after kneading, for different LEP contents

Control

1.0

10.0

100.0

1000.0

0

500

1000

1500

Particle count

Particle size (microns)

Hydrapulper

After kneading

100% ElectroInk

0

500

1000

1500

2000

Particle count

Particle size (microns)

Hydrapulper

After kneading

5% ElectroInk

0

500

1000

1500

2000

Particle count

Particle size (microns)

Hydrapulper

After kneading
WMU test – Particle size vs. ElectroInk content, after pulping and after kneading

After pulping, particle size distribution similar for control, 5% ElectroInk and 100% ElectroInk
WMU 2-loop test – key takeaways

Pilot trial demonstrated that 5% ElectroInk/95% SOP could be deinked to same quality as control batch – quality comparable to mill deinking requirements

Kneading critical for reducing dirt area to achieve target

Kneading reduces average particle diameter to range that can be successfully removed by flotation – after kneading, all test materials (control, 5% ElectroInk, 100% ElectroInk) have similar particle diameters and counts
Effect of paper on HP Indigo ElectroInk deinking

Various studies, for both ElectroInk and other technologies, have shown that the paper plays a strong influence on the deinking results.

The adhesion of the ElectroInk to the paper does not seem to affect deinkability.

Several factors have been found to be important:

- Availability of foam during flotation – e.g. P5 had a noticeable lack of foam during flotation and deinkability was poor.
- “Cleanliness” of detached ink particles after pulping:
  - Papers that have better ink/coating or ink/fiber separation will have better deinking.
  - Fibers and/or coatings attached to ink may inhibit floatability and hydrophobicity of ink particles.
- Fragmentation of the ink in the pulping stage – in general lower the dirt area after pulping the lower the dirt area after the final stage.

Ongoing work to correlate paper properties and compositions with these findings.
Overall summary

Multi-loop deinking (multiple flotation + kneading/disperging) is common in industry, particularly for higher grade recycled papers.

There is a need for a generally accepted 2-loop lab protocol with failure criteria to enable assessment and improvement of deinkability of high grade wood-free prints.

Results have been presented from 2-loop lab tests and a pilot study demonstrating that kneading is critical for:

- Reducing dirt area
- Reducing particle size to a range suitable for flotation

A50 dirt area target of 200 ppm is proposed.

HP Indigo ElectroInk prints can be successfully deinked in a 2-loop lab test, based on the 200 ppm target – confirmed by full-scale Arjowiggins mill trial.

Paper greatly influences fragmentation and flotation deinkability – focus of ongoing research.

Our proposals could be basis for further discussions within the industry to develop an agreed-upon test and success criteria.
Thank you
Effect of paper on electroink deinking: “Cleanliness”

Good deinkability:
Small amounts of paper coating and fibers attached to ink

Poor deinkability:
Paper coating attached to ink