

# Can Papers Imaged with UV-Cured Inks and Toners be Deinked and Recycled?

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International Association of the Deinking Industry  
(INGEDE)

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## Outline

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- Who is INGEDE?
- How does paper recycling work?
- What is digital printing?
- What is the problem about it?
- What has been done?
- What can be done in the future?



## Who is INGEDE?

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- International Association of the Deinking Industry, founded in 1989
- An association of paper mills utilizing recovered paper
- All major European paper mills producing newsprint
- Some major European paper mills producing hygiene papers



## What is deinking? Generally:

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- Removal of printing ink during the paper recycling process
- Cost effective and sustainable source of fibers for graphic papers (and hygiene papers)



## Who is INGEDE? The members

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**Cartiere Burgo S.p.A.**, Italy, Belgium

**Dalum Papir A/S**, Denmark

**Hakle-Kimberly**, Germany

**Holmen Paper AB**

Braviken Mill, Sweden

Fuenlabrada Mill, Spain

**Leipa Georg Leinfelder**, Germany

**MD Lang Group**

Gebrüder Lang GmbH, Germany

MD Papier, Plattling, Germany

Papierfabrik Utzenstorf, Switzerl.

Rhein Papier GmbH, Germany

**Norske Skog Group**

Bruck GmbH, Austria

Golbey S.A., France

Parenco B.V., Netherlands

Skogn Mill, Norway

Steti Mill, Czech Republic

**Palm KG**, Germany

**Perlen Papier AG**, Switzerland

**SCA Hygiene Products Consumer**

**SCA Hygiene Products Away from**

Home, Germany

**Steinbeis Temming**, Germany

**Stora Enso Group**

Hylte AB, Sweden

Langerbrugge N.V., Belgium

Maxau-Wolfsheck Mills, Germany

Sachsen Mill, Germany

**Keräyskuitu OY**, Finland

**UPM-Kymmene Group, Helsinki**

Augsburg Mill, Germany

Chapelle Darblay, France

Kaipola Mill, Finland

Schongau Mill, Germany

Schwedt Mill, Germany

Shotton Mill, Germany

Steyrerstuhl AG, Austria



## Objectives of INGEDE

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In order to improve the necessary **supply** of recovered graphic paper for the paper industry and to **avoid** an increasing role of **legislation** it is important that

- the **paper industry** defines, supports and coordinates the necessary research activities in the field of deinking and
- to seek the **cooperation** with all other members of the paper chain.



## What does INGEDE do?

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**Collect money** from members

**Spend the money** for research and communication

**Unique:** Based on amount of recovered paper used for production

**Advantage:** Very high budget for research, exceeding that of a single member



## What does INGEDE do?

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**Research projects** (examples):

- Utilization of deinking residues
- Removal of stickies by flotation
- Recyclability of water based rotogravure inks
- Recyclability of silicone coated papers
- Deinkability of flexo newsprint
- **Deinkability of digital color prints**



## How does INGEDE communicate?

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- Annual meeting
- Seminars with printers, publishers, ... and their representatives
- Press releases
- [www.ingede.com](http://www.ingede.com)
- Presentations at conferences



## What is deinking? Background

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- More and more paper is recovered
- Even more has to be recovered
- Separation of white and brown grades is necessary
- Newsprint made of 100 percent recovered fibers already
- Resource "urban forest" also for higher qualities



## What is deinking? Chemistry & Physics

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- Recovered paper is pulped
- Chemicals support the ink detachment:  $\text{NaOH}$ ,  $\text{H}_2\text{O}_2$ ,  $\text{Na}_4\text{SiO}_4$ , soap
- Removal of contaminants based on
  - Size (screens)
  - Density (cyclones)
  - Surface properties (flotation)



## What is deinking?

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What is deinking?



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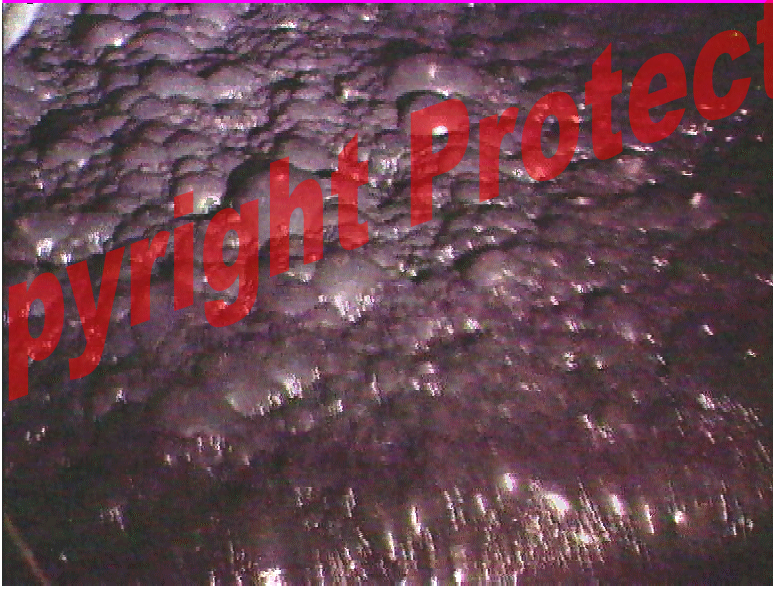
What is deinking?



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## What is deinking?

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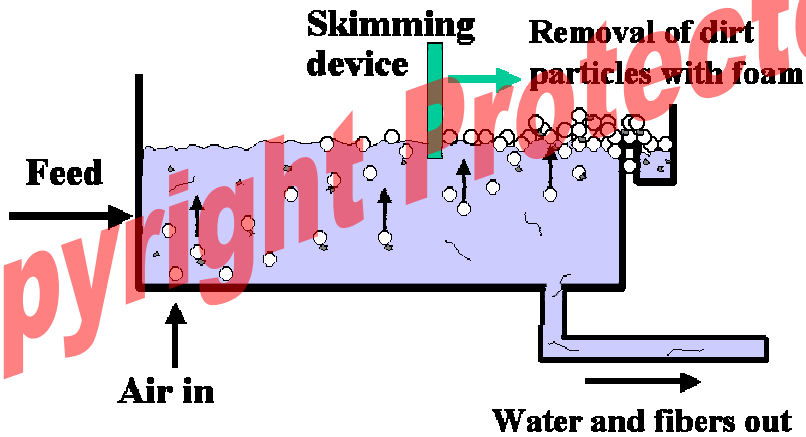
## What is flotation?

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- Flotation is the key process for the removal of printing ink in Europe
- Washing is more and more replaced by flotation also in the U.S.  
(due to disadvantage: low yield)

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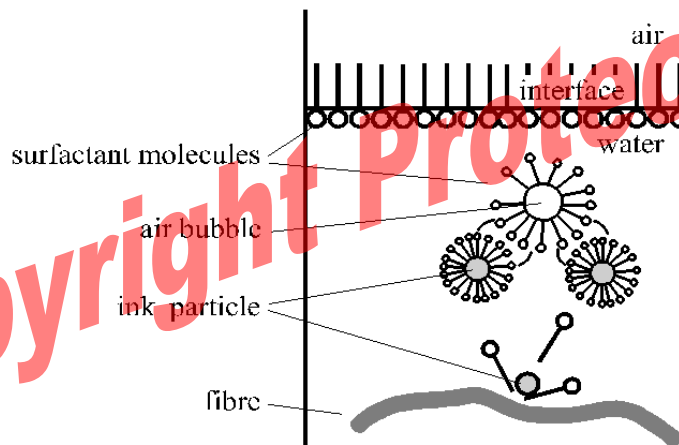
## What is flotation?



(Source: Wood and Paper Science, NC State University)

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## What is flotation?



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## Consequence for printing ink

### **Ink has to be**

- hydrophobic
- particle  $> 150 \mu\text{m}$  = screenable (stiff!)
- $30 \mu\text{m} < \text{particle} < 300 \mu\text{m}$  = cleanable
- $10 \mu\text{m} < \text{particle} < 100 \mu\text{m}$  = flatable
- particle  $< 10 \mu\text{m}$  = problem

### **Problems with water based inks!**



## What is digital printing?

- Faster turnaround
- Economical short-run jobs
- No obsolete or wasted literature
- No warehousing issues
- Easy updates and reprints of materials

**But: A nightmare for paper recycling?**



## Digital printing: A nightmare?

### Xerographic and laser toner systems

- Dry toner
  - 😊 no problem if fusing is low (Océ)
  - 😊 no problems if particles not too big
- Liquid toner
  - ☹ hydrophilic toner films not removable (Indigo)

### Ink jet

- Water based
  - ☹ w/ pigment not deinkable
  - 😊 w/ dye ± bleachable
- Oil based inks
  - 😊 ? (few tests)
- UV inks
  - 😊 ? (few tests)

### Other water based hydrophilic systems

- Elcorsy
  - ☹ electro coagulation hydrophilic ink not deinkable
- Water based roto
  - ☹ hydrophilic ink not deinkable

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## Negative example: Indigo

- Ink film cannot be removed by screening, cleaning, flotation or dispersing



- And: Heated particles are **tacky** → deposit in the paper machine's drying section (problem!)

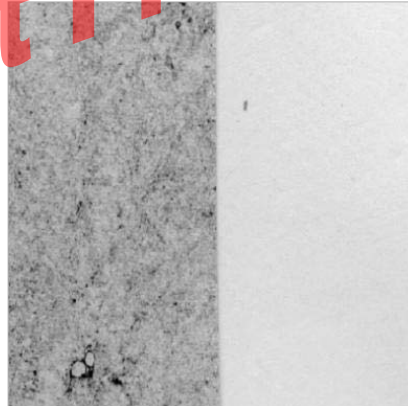
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## Positive example: Océ

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- Toner particles are easily detached from the paper, they are hydrophobic and have the ideal size distribution for flotation

- before and after flotation:



  
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## Deinkability of ink jet inks

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- **Pigment based** black ink jet prints are **neither deinkable nor bleachable**.
- **Dye based** black ink prints are more or less efficiently colour stripped, depending on the dye formula.
- **10 % black ink jet printed papers** in a wood-free or wood-containing furnish result in **inacceptable brightness loss**.

  
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## Deinkability of ink jet inks

- **Coloured ink jet prints are mostly not deinkable**
- Sometimes efficient colour stripping with chemicals like hydrosulfite or ozone for magenta, cyan
- Yellow shade persists – even ozone



## Influence of paper

- **Influence of coated vs. uncoated paper has been tested**
- Poor results for uncoated paper – no matter what type of ink
- Sometimes coating changes behaviour: for pigment oil based inks
  - more specks (less fragmentation)
  - less shade



## Influence of paper

### Coated paper

- Sometimes difficult to disintegrate
- Needs more time, stronger pulping conditions
- Better results (higher brightness)
- Advantage?

## UV curable inks

- How do they behave?
- Inks for ink jet – will UV curing improve deinkability (bigger particles) or create new problems?

## What happens with UV ink?

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Generally, ink polymerizes and

- forms large particles
- attaches to fibers
- is not removed by flotation
- can leave specks in the paper
- can ruin the production

## Example: specks

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Requirements for rotogravure:

- $Y$
- $In$
- $a^*$  -2,5 and +1,0
- $\Delta Y$
- Speck area. not defined yet

## Specks – limits (mm<sup>2</sup>/m<sup>2</sup>)

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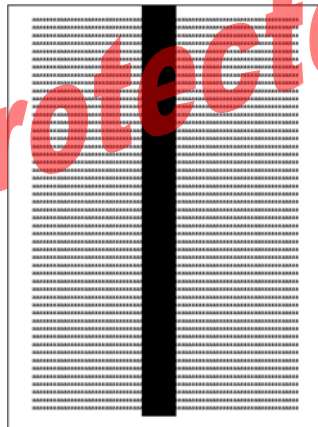
- rotogravure catalogue, coated: < 16
- rotogravure magazines, uncoated: < 21
- rotogravure newspapers, coated: < 34
- offset newspapers, uncoated: < 180
- offset supplements, coated: < 195
- offset magazines, coated: < 318
- offset magazines, uncoated: < 334
- offset supplements, uncoated: < 500



## UV curable inks: toner

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- Systematic study with different toners and conditions
- High speed 4c copier
- Standard test form
- e.g.: IR fused 135 °C, UV cured

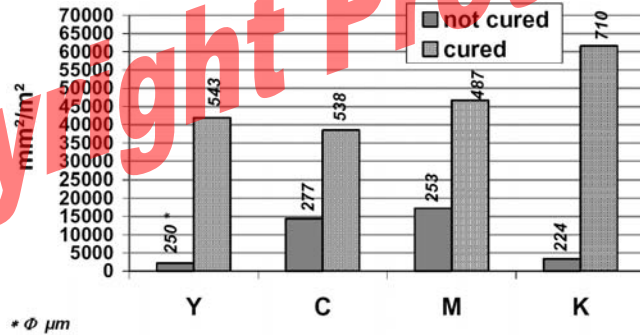


Source: CTP



## UV curable inks: toner

- Results after pulping

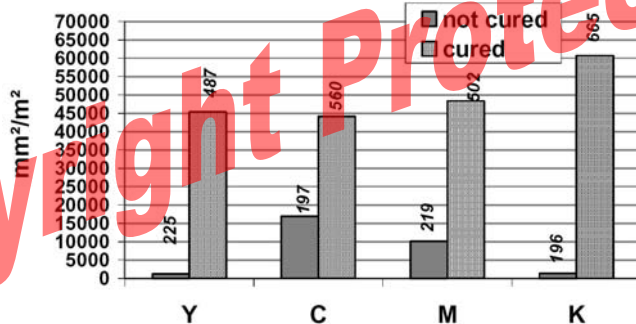


Source: CTP



## UV curable inks: toner

- Results after flotation



Source: CTP



## UV curable inks: toner

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- Conclusion:

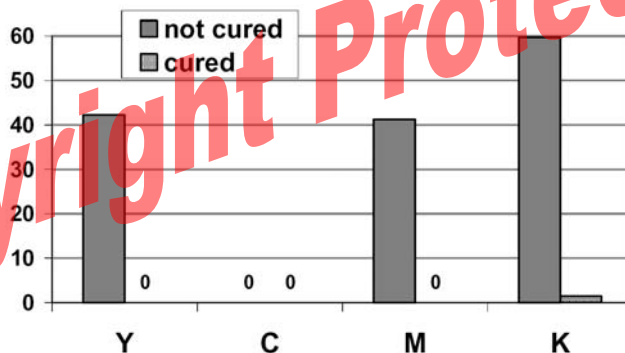
very big specks occur after curing

due to polymerisation of the ink,  
crosslinking with fibers, cannot be  
detached, form hard ink-fiber particles

## UV curable inks: toner

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- Specks removal efficiency by deinking



## UV curable inks: coating film

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- UV curable film applied on conventional toner
- Only preliminary results, only on coated paper (ink adhesion to fibers ↓)
- 96 % speck elimination, but high yield loss  
filler? UV? (to be examined)



## UV curable inks: ink jet inks

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- Acceptable results with coated offset papers
- With uncoated papers not acceptable (specks attached to fibres, not removed during flotation)

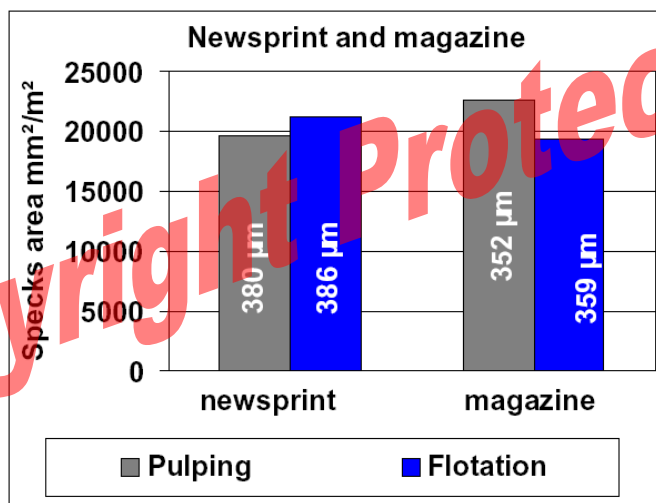


## UV curable ink jet inks

- Completely unacceptable results with newsprint and magazine papers
  - residual ink content too high
  - brightness too low
  - high speck contamination
  - big specks



## UV curable ink jet inks – specks



## What has been done, can be done?

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### INGEDE Project Recyclability of Digital Prints

- Cooperation with digital industry to improve recyclability of problematic systems
- Cooperation already with Océ, Xeikon, Agfa, Canon, NexPress, Xerox
- Recyclability is now accepted as an important product characteristic (partners in the paper chain)
  - Contact to ink suppliers?
- Research results show:

**Ink jet inks seem to be a big problem**



## What has been done, can be done?

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Cooperation with partners in the paper chain:

### **Guide to an Optimum Recyclability of Printed Graphic Paper (Addendum)**


- "Ink jet inks, commonly used on paper and found in office waste are usually water based dye types. The inks contain little or no resin component and the dye is completely water-soluble. In the flotation cell the dye redissolves and cannot be separated and subsequently moves onto the paper fibres as described (...) The recommendation is therefore the same, that recovered paper should contain as few components as possible that may cause discolouration."



## Test methods

INGEDE Method 11 2001-04	Assessing the Recyclability of Print Products – Deinkability Test –
<p><b>1 Purpose and scope</b></p> <p>This INGEDE Method describes a procedure to evaluate the deinkability of print products subsequent to deinking, the individual treatment stages of a mill process for the flotation deinking of printed recovered papers – including a preceding accelerated ageing stage of the sample material – are carried out under defined conditions in the laboratory (Fig. 1), a procedure typical of technological testing methods.</p> <p><b>2 Definitions</b></p> <p><b>Deinked Pulp (DP):</b> Pulp consisting of print products deinked according to this method.</p> <p><b>Undeinked Pulp (UP):</b> Pulp consisting of print products disintegrated by means of deinking chemicals, prior to flotation.</p> <p><b>3 Equipment and auxiliaries</b></p>	<p>rer, or commercial-grade hot-water heater</p> <ul style="list-style-type: none"><li>• Rapid-Köthen sheet former according to ISO 5269/2 or DIN 54 358, fitted with white water recirculation</li><li>• Distribution container holding 10 l</li><li>• PIS flotation cell holding 1.5 l, compressed air connection 1 bar, 60 l/h laboratory stirrer, 1,200 min<sup>-1</sup>, with special disk (alternatively: other type of laboratory flotation cell)</li><li>• Plastic scraper</li><li>• Beakers</li><li>• Büchner filter (160 mm Ø), fitted with suction bottle and water jet pump or vacuum pump</li><li>• Filter paper, 150 mm Ø, medium pore size, for example Selecta round filter no. 595 or Ederol no. 12</li><li>• Covering papers and carrier boards according to DIN 54 358</li><li>• Vacuum filtration device, 50 mm Ø, fitted with water jet pump or vacuum pump</li></ul>

www.ingede.com



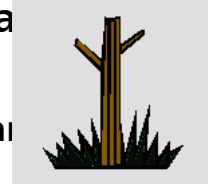
## What happens today?

- **UV printed magazine covers:**
  - have to be collected separately at the printer
  - can spoil paper recycling
  - no refund from waste paper dealer
  - disposal?
  - other applications?
  - amounts?

## Conclusions

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- Some digital prints are deinkable
- Some might be improved
- UV inks seem to be not deinkable
  - can spoil paper recycling
  - basic changes might be necessary
  - legal actions might follow



**Discussions & cooperation  
necessary and welcome! (Ink mfr!)**

  
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## Acknowledgements

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- Johann Weigert, NexPress, Germany

Thank you for your attention.

  
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