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# WATER-BASED FLEXOGRAPHIC LAMINATION INKS DISSERTATION

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# Introduction 1/2

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- Environmental issues  
(directives-legislations)
- Water-based inks as an eco-efficient printing solution  
(according to BASF calculation tables)
- Lamination inks application areas

# Introduction 2/2

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- Physical properties of liquid inks  
(specifications - quality control )
- Description and analysis of laboratory tests
- Conclusions

# Environmental issues

## directives-legislations

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- “The Solvent Emissions Directive“ (SED)
  - invest in incineration equipment
  - substitute approximately 75 % of its solvent-based inks with solvent-free or low-solvent alternatives
  
- ATEX
  - draw up an explosion protection document
  - take adequate protection measures and
  - provide adequately safe equipment
  
- “Integrated Pollution Prevention and Control Directive“ (IPPC)
  - have a comprehensive environmental permit
  - apply “Best Available Techniques“ (BAT).

# Water-based inks as an alternative solution for solvent-based inks 1/2

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- Applying 75 to 80 % water-based inks and other solvent-free products is sufficient to benefit from this advantage in most EU member states.
- Water-based inks might be an alternative solution for solvent-based inks when it comes to legislations

# Water-based inks as an alternative solution for solvent-based inks 2/2

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## Total ink-related costs

|                                | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|--------------------------------|----------------------------|--------------------------|
| ink                            | 437.4                      | 480.3                    |
| solvent                        | 80.0                       | 6.4                      |
| <b>total ink-related costs</b> | <b>517.4</b>               | <b>486.7</b>             |

Table 1: "Total ink-related costs"

## Total environmental costs

|                                    | Solvent-based inks [k€/yr] | Water-based inks [k€/yr] |
|------------------------------------|----------------------------|--------------------------|
| incinerator; capital               | 128.0                      | 0.0                      |
| incinerator; operational           | 40.2                       | 0.0                      |
| ink waste disposal (k€)            | 1.7                        | 4.8                      |
| waste water treatment; capital     | 1.6                        | 6.4                      |
| waste water treatment; operational | 1.3                        | 5.2                      |
| <b>total environmental costs</b>   | <b>172.9</b>               | <b>16.4</b>              |

Table 2: "Total environmental costs"

\*"BASF has developed a digital cost calculation model summarizing printing-related expenses for flexible packaging converters in cooperation with Paul Verspoor of Sitmae Consultancy". [web\\_EDC\\_1010\\_e\\_BR\\_FLX\\_Line.pdf./P:10](#)

# Lamination inks application areas

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- Reverse Print OPP Low-duty lamination



- Reverse Print OPP, PET Medium-duty lamination



- Reverse Print Nylon, PET Heavy-duty lamination



# The aim of the study

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To develop water-based flexographic lamination inks (CMYK), with properties such as:

- Adhesion to PP substrate (ASTM D3359)
- Drying rate (sec) (internal standard)
- Performance of printed inks (on a substrate leneta 3NT-33)
- Blocking set / off resistance (internal method)
- Lamination bond strength (DIN 53357)



# Specifications - Quality control 1/3

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- Laboratory tests are clearly stated in Regulations and directives
- The mechanical equipment used are calibrated and all of the test procedure were carried out strictly according to specifications and provisions

# Specifications - Quality control 2/3

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The most active standardization organizations in the paint sector are:

- ▣ ASTM  
(International standards organization)
- ▣ BSI  
(British Standards Institution)
- ▣ DIN  
(German institute for standardization)
- ▣ AFNOR  
(French national organization for standardization)

# Specifications - Quality control 3/3

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basic physical properties  
of liquid inks

- Viscosity (ASTM D4212)
- pH (ASTM E70)
- Solids (ASTM D4713)
- Drying rate (Internal method)

basic properties of  
printed inks

- Adhesion (ASTM D3359)
- Block/Set-off Resistance (Internal method)

critical performance  
printed inks for packaging  
applications testing

- Lamination bond strength (DIN 53357)

# Description and analysis of laboratory research. Necessary equipment

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- Zahn Cup No2 (dip type cup)
- K Control Coater , K Bar No 1 (wet film deposit 6 $\mu$ m)
- Heat seal testing machine (Brugger HSG-C)
- Tensile strength tester (Instron 5543)
- Balance precision 0.01 gr

# Description and analysis of laboratory research. Consumables

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- OPP
- White polyethylene
- 300ml plastic containers with lids
- Tongue depressors
- Petri dishes
- Pipettes
- Scotch 3M

# Description and analysis of laboratory research. Raw materials

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- Pigment concentrate
- Self-cross linking acrylic emulsion
- Self-cross linking acrylic copolymer solution
- Polyurethane dispersion for lamination ink formulation
- Defoamer emulsion
- Surfactant
- Water
- Two component solvent-free adhesive

# Description and analysis of laboratory research. Underwork

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- Development of a water-based lamination ink system (summarized in four laboratory tests)
- Printing of a four-color (CMYK) water-based lamination ink system
- Lamination of printed samples (internal method)
- Recording the results of laboratory tests

# Description and analysis of laboratory research. Presentation of the test results (table 1)

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|  |   |   |  |
|--|---|---|--|
| pigment concentrate<br>self-cross linking acrylic emulsion<br>water<br>defoamer emulsion<br>surfactant | pigment concentrate<br>polyurethane dispersion for lamination ink formulation<br>water<br>defoamer emulsion<br>surfactant | pigment concentrate<br>polyurethane dispersion for lamination ink formulation<br>self-cross linking acrylic emulsion<br>defoamer emulsion | pigment concentrate<br>self-cross linking acrylic copolymer solution<br>self-cross linking acrylic emulsion<br>defoamer emulsion |
|--|---|---|--|

| <b>Measurements</b>                        | <b>1<sup>st</sup> test</b> | <b>2<sup>nd</sup> test</b> | <b>3<sup>rd</sup> test</b> | <b>4<sup>th</sup> test</b> |
|--|----------------------------|----------------------------|----------------------------|----------------------------|
| <b>Viscosity Zahn Cup No2 (ASTM D4212)</b> | 23"                        | 29"                        | 33"                        | 35"                        |
| <b>pH (ASTM E70)</b>                       | 8.25                       | 8.5                        | 9                          | 8                          |
| <b>Adhesion (ASTM D3359)</b>               | 80%                        | 10%                        | 10-90%                     | 90%                        |
| <b>Lamination bond strength (DIN53357)</b> | 0.6                        | 1.5                        | 0.7                        | 2.5                        |

Lamination bond strength in N/15mm.  
OPP//OPP

Table 3: "Condensed four test measurements"



# Description and analysis of laboratory research. Presentation of the test results (table 2)

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Internal methods descriptions:

1. Dilution:  
flexographic inks  
25sec  
(Zahn Cup No2)

2. Drying rate  
conditions: Printing on  
white polyethylene/K  
Bar 2.

3. Block/Set-off  
conditions:  
60°C/780N/30min.

| <b>Measurements</b> | <b>Viscosity<br/>Zahn<br/>Cup No2<br/>(ASTM<br/>D4212)</b> | <b>pH<br/>(ASTM<br/>E70)</b> | <b>Dilution<br/><sub>1</sub>(water)</b> | <b>Solids<br/>(ASTM<br/>D4713)</b> | <b>Adhesion<br/>(ASTM<br/>D3359)</b> | <b>Drying<br/>rate<br/><sub>2</sub>(Internal<br/>method)</b> | <b>Block/Set-off<br/>Resistance<br/><sub>3</sub>(Internal<br/>method)</b> |
|---------------------|--|------------------------------|---|------------------------------------|--------------------------------------|--|---|
| <b>Cyan</b>         | 35"  | 8.5-9.1                      | 6%                                      | 40%                                | 90%                                  | 90"-115"   | OK  |
| <b>Magenta</b>      | 30"  | 8.8-9.5                      | 5%                                      | 23%                                | 90%                                  | 90"-115"   | OK  |
| <b>Yellow</b>       | 28"  | 8.5-9.1                      | 3%                                      | 30%                                | 90%                                  | 90"-115"   | OK  |
| <b>Black</b>        | 33"  | 8.5-9.1                      | 6%                                      | 24%                                | 90%                                  | 90"-115"   | OK  |
| <b>White</b>        | 33"  | 8.5-9.1                      | 5%                                      | 37%                                | 90%                                  | 90"-115"   | OK  |

Table 4: "Final test's measurements"

# Description and analysis of laboratory research. Presentation of the test results (table 3)

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Lamination bond strength in N/15mm. OPP//OPP

Adhesive: solvent free, 2.2 gsm dry

## Water – based lamination ink system

| <i>Measurements</i> | <i>Lamination bond strength (DIN53357)</i> | <i>Lamination bond strength + white (DIN53357)</i> |
|---------------------|--|--|
| <b>Cyan</b>         | 2.15                                       | 1.9  |
| <b>Magenta</b>      | 2.5  | 2  |
| <b>Yellow</b>       | 2  | 1.9  |
| <b>Black</b>        | 2.1  | 1.5  |
| <b>White</b>        | 2.5  | -  |

Table 5: " Lamination bond strength (CMYK+W) for W.B "

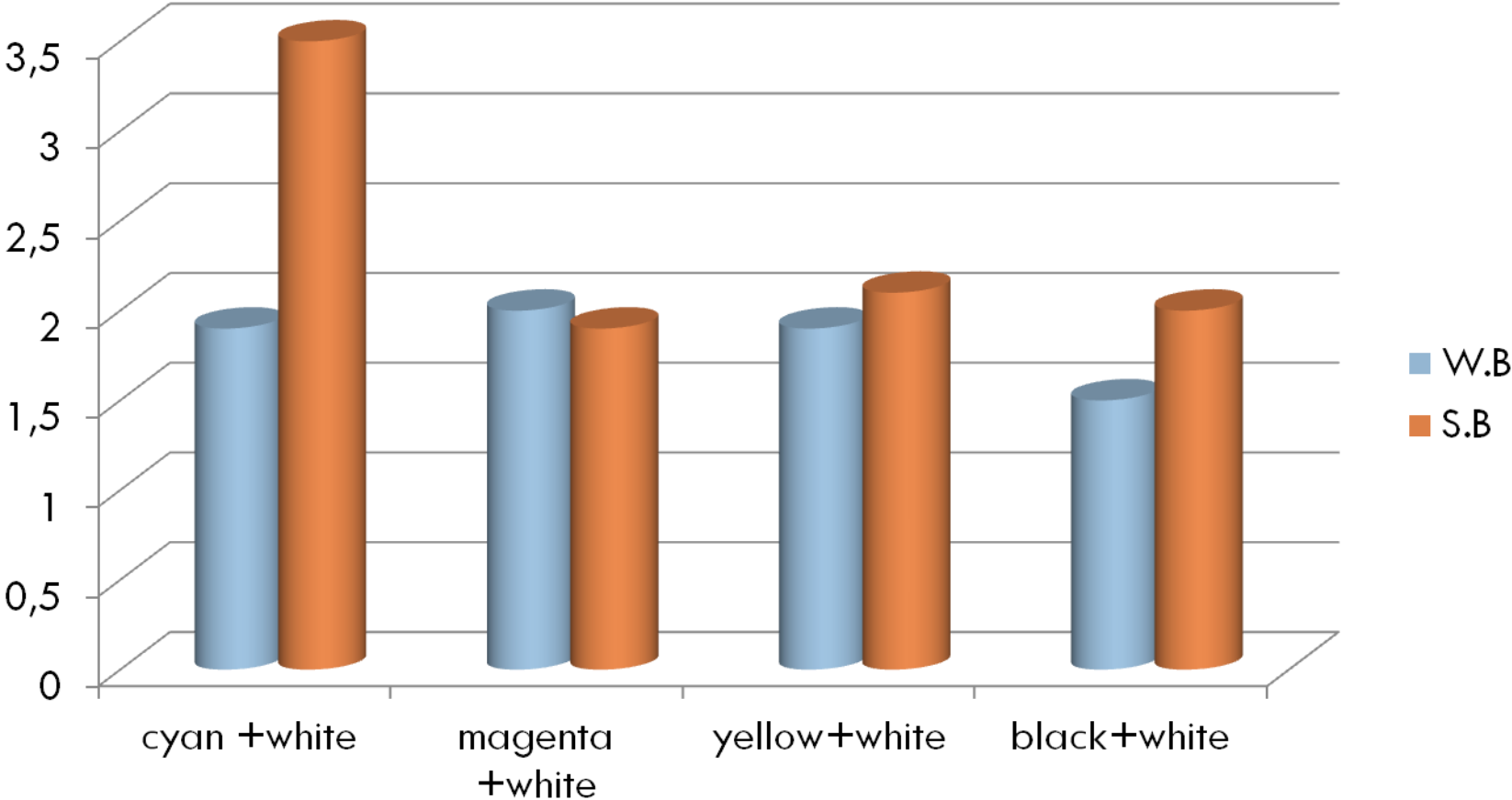
## Solvent – based ink

Flexoprop FX( reverse printing lamination)

| <i>Measurements</i> | <i>Lamination bond strength (DIN53357)</i> | <i>Lamination bond strength + white (DIN53357)</i> |
|---------------------|--|--|
| <b>Cyan</b>         | 3.4  | 3.5  |
| <b>Magenta</b>      | 3.1  | 1.9  |
| <b>Yellow</b>       | 2  | 2.1  |
| <b>Black</b>        | 3.4  | 2  |
| <b>White</b>        | 3.5  | -  |

Table 6: " Lamination bond strength (CMYK+W) for S.B "

# Description and analysis of laboratory research. Presentation of the test results (graph)

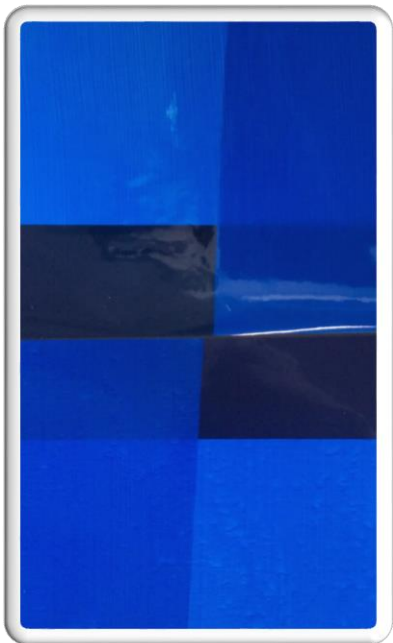


Graph: "Lamination bond strength (CMYK+W) for water and solvent based inks"

# Print

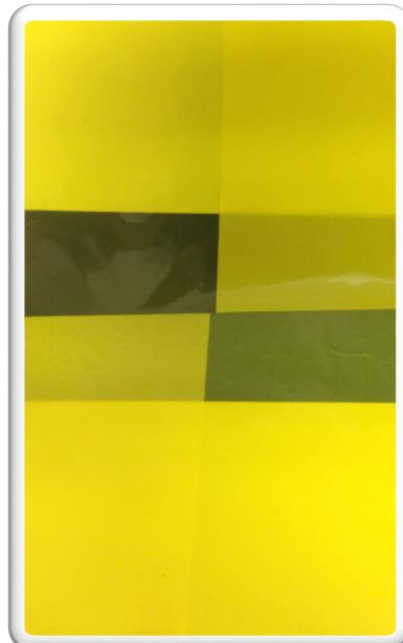
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Solvent based



Water based

Solvent based



Water based

Solvent based



Water based

Solvent based



Water based

# Conclusions

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- The results indicate that in general lines the examined water-based inks gave good results regarding print quality
- Water-based inks showed a good adhesion to the substrate, so they withstand the mechanical stresses during the printing process.

# Conclusions

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- Weak points were observed that need further investigation and improvement in order to match performance requirements and market demands
- Slow drying rate that in turns requires a lot of energy that affects speed of print production and costs
- Finally, printing under usual processing conditions is required in order to get a full knowledge of the strengths and weaknesses of the examined water-based inks, evaluating the printing effect and correcting any technical issues



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*"WATER BASED INKS FOR FLEXOGRAPHIC PRINTING " / By Fred Shapiro/ PNEAC*

*"Good prospects from every perspective" / Joncryl® FLX Line – water-based technology for medium duty film printing*

THANK YOU FOR  
YOUR ATTENTION

QUESTIONS?

