Ink-water balance during emulsification and its relation to substrate transfer and optical properties of prints

The International Association of Research Organizations for the Information, Media and Graphic Arts Industries - Helsinki 2015

7.9.2015, Mikael Tåg

Presentation outline

- Background
  - Paper moisture variation in offset printing
  - Image area vs. Non-image area moisture content
  - Fountain solution / ink – fount emulsion uptake
- Materials and methods
- Results
- Conclusions
- Summary and next steps

Process

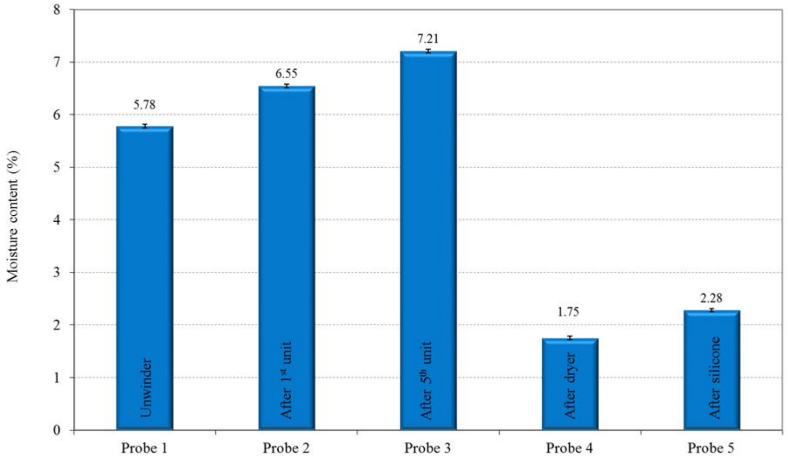
Process fluids

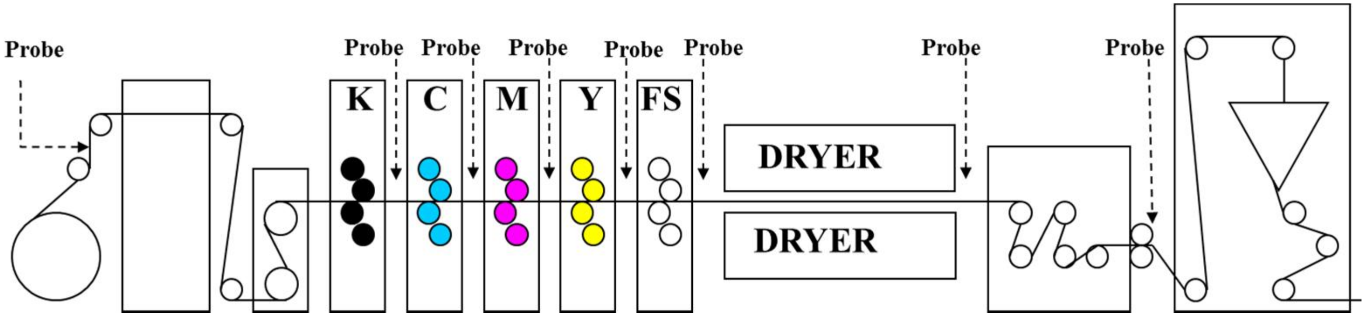
Substrate

Background

Moisture content measured by dynamic near infrared spectroscopy

- The offset printing process is transferring a fount water ink emulsion to paper from a number of printing units.
- The addition of emulsion causes changes in paper moisture content and affects paper print quality



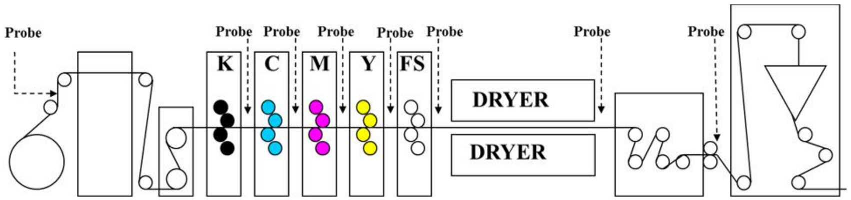


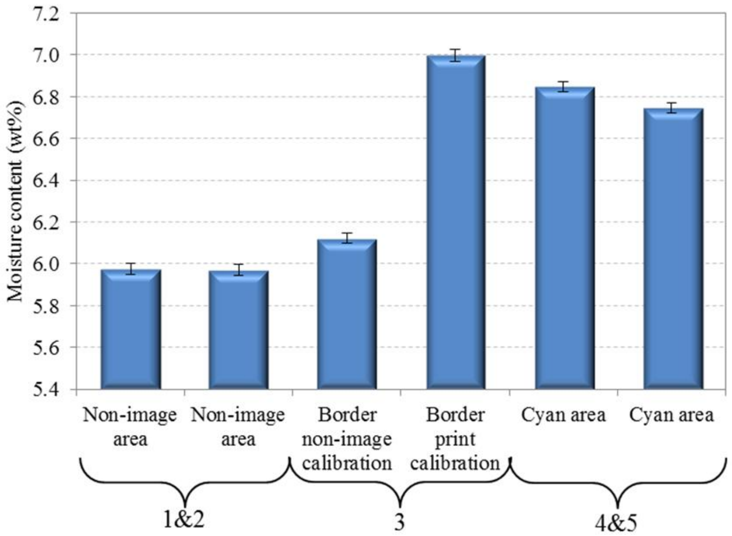
Source: Tåg, C.-M., Toiviainen, M., Juuti, M., Gane, P.A.C., Dynamic analysis of temporal moisture profiles in heatset printing studied with near-infrared spectroscopy, Meas. Sci. Technol. 21 105602 (11pp), 2010.

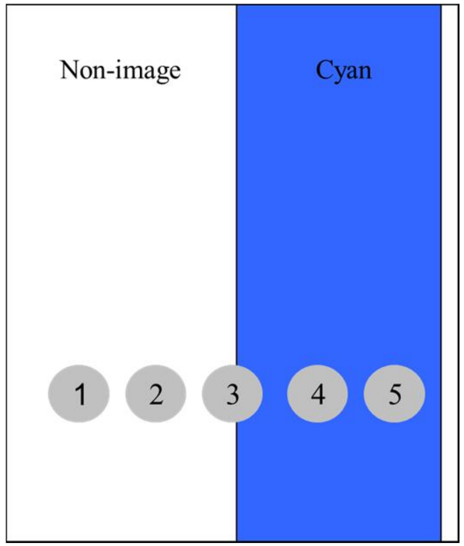
Background

Moisture content measured by dynamic near infrared spectroscopy

- Analyzing moisture content in an image versus non-image area, including also the boarder line, clear differences are observed.
- The pressure created in the nip, may squeeze fount towards print edge especially at high fount loading.





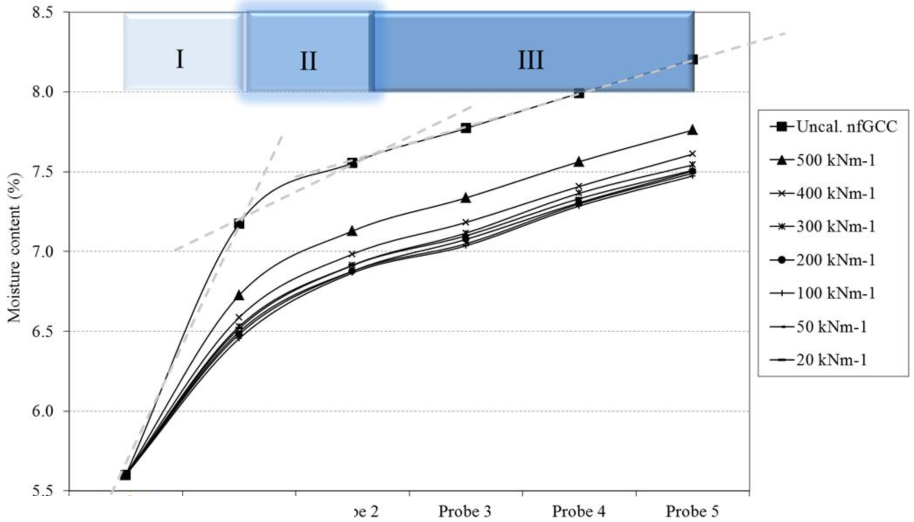


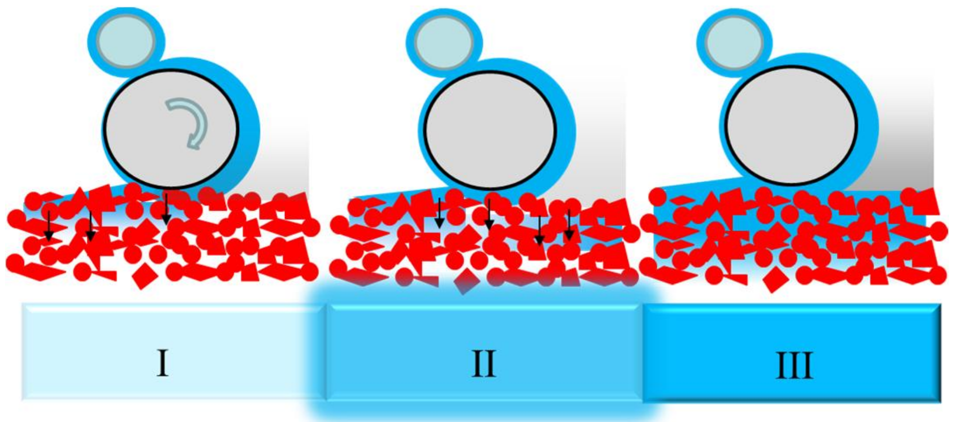
Source: Tåg, C.-M., Toiviainen, M., Juuti, M., Gane, P.A.C., Online Detection of Moisture in Heatset Printing: liquid transfer to printed and non-image areas, Nordic Pulp and Paper Research Journal, 27, 1, 112-121, 2012.

Background

Liquid uptake by paper

Mechanism of liquid transfer in subsequent units is controlled by splitting of the liquid film and the amount of permeation that is able to occur as a function of permeability.



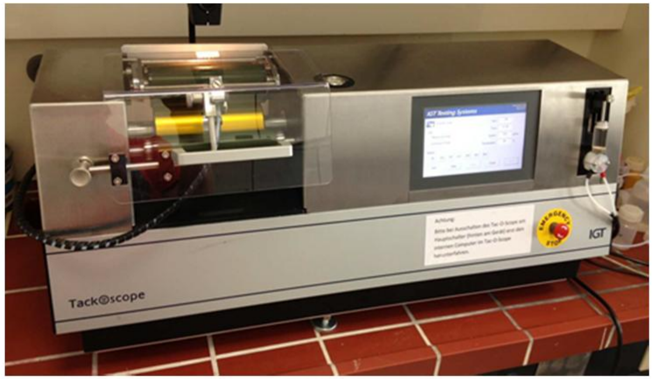


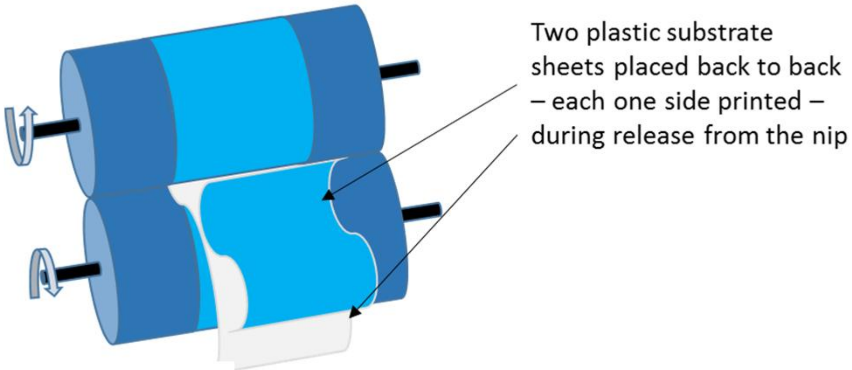
Source: Tåg, C.-M., Toiviainen, M., Juuti, M., Ridgway, C., Gane, P.A.C., Online Detection of Moisture in Heatset Printing: the role of substrate structure during liquid transfer, Ind. Eng. Chem. Res. 50, 8, 4446–4457, 2011.

Materials and methods

- The emulsion is prepared with rotating rollers by controlled adding of fountain solution.
- The desired amount is defined by spraying time
- As the amount is reached, the plastic film is fed through the nip
- The printed film was analyzed
  - Roughness (CLSM)
  - Gloss (DOG)
  - Lightness
  - Print density

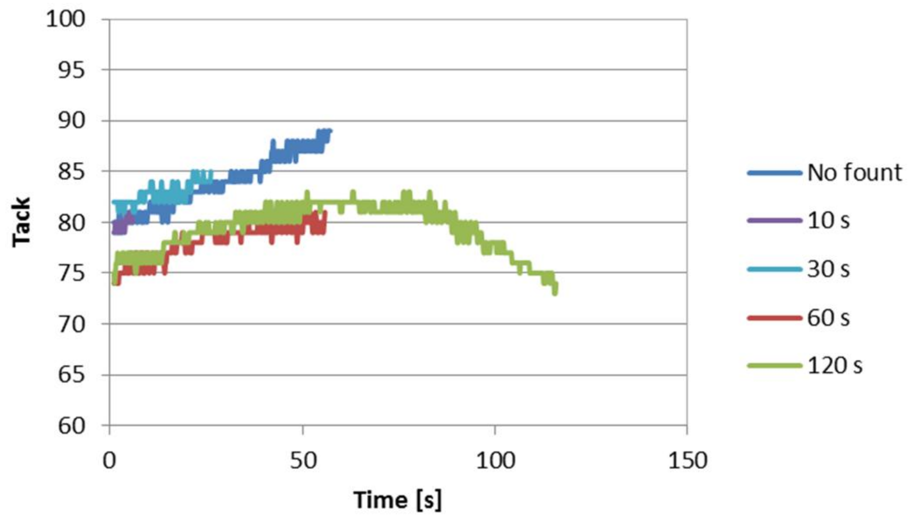
  As a function of dosing time





Results
Ink and ink emulsion tack as a function of time

- The tack of the ink was monitored as a function of time and fountain solution dosage
- The tack is increased with time
- The fountain solution causes a collapse of the ink at high dosage



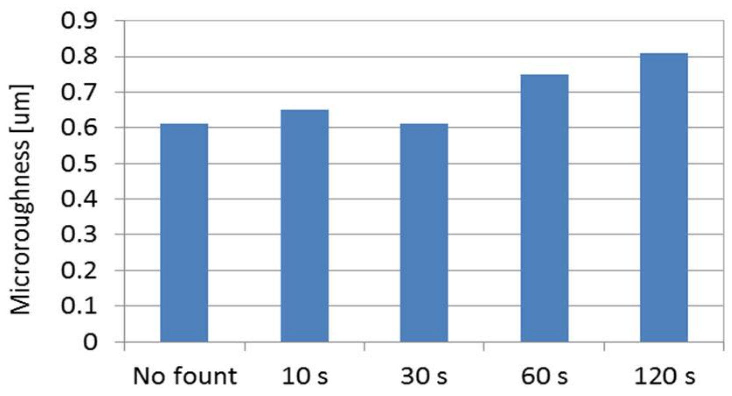
Results

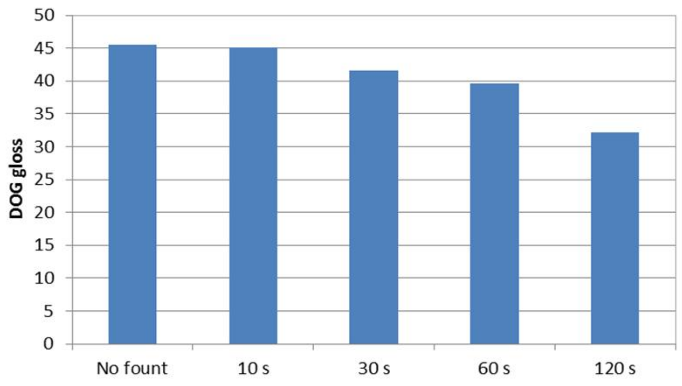
Surface roughness and gloss of printed substrate

- A slight increase in surface roughness is observed at higher fountain solution dosage

- A drop in gloss is seen as the amount of fountain solution is higher in the ink.

- Gloss is inversely proportional against roughness

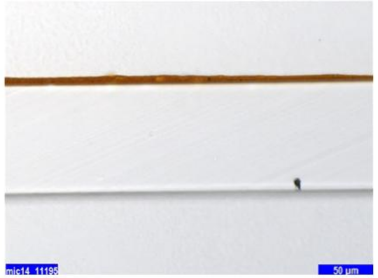


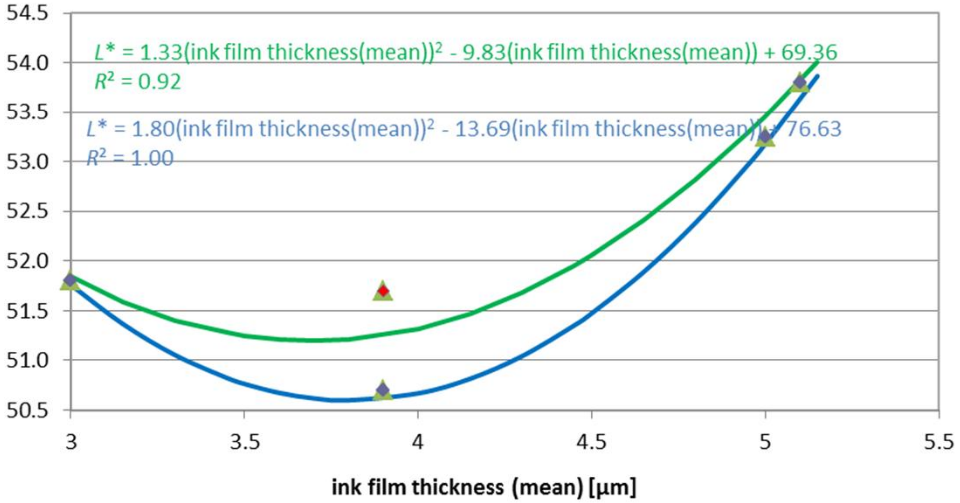


Results

Lightness vs. Ink film thickness

- The ink film thickness for the different prints was determined with scanning electron microscopy
- The correlation between lightness and mean ink film thickness using the fitting equation.
- Colour functions are a logarithmic fit * of how much "colour" one has in a print.

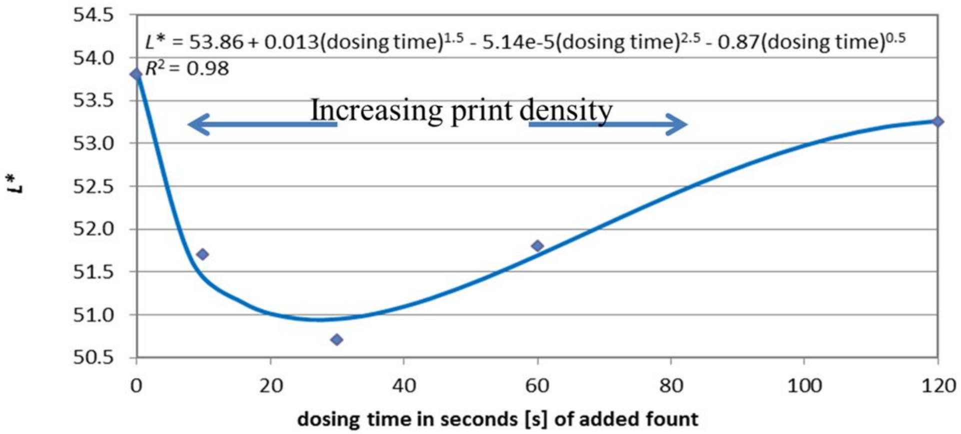




Results

Print density as a function of fountain solution dosing time

- The more intense the image on a given substrate, the greater is the effective print density.
- The transferred ink amount varies depending on the emulsification degree/composition
- The initial print density is higher and faces a drop as fountain solution is added.
- At high (over) loading the print density again approaches the initial value.

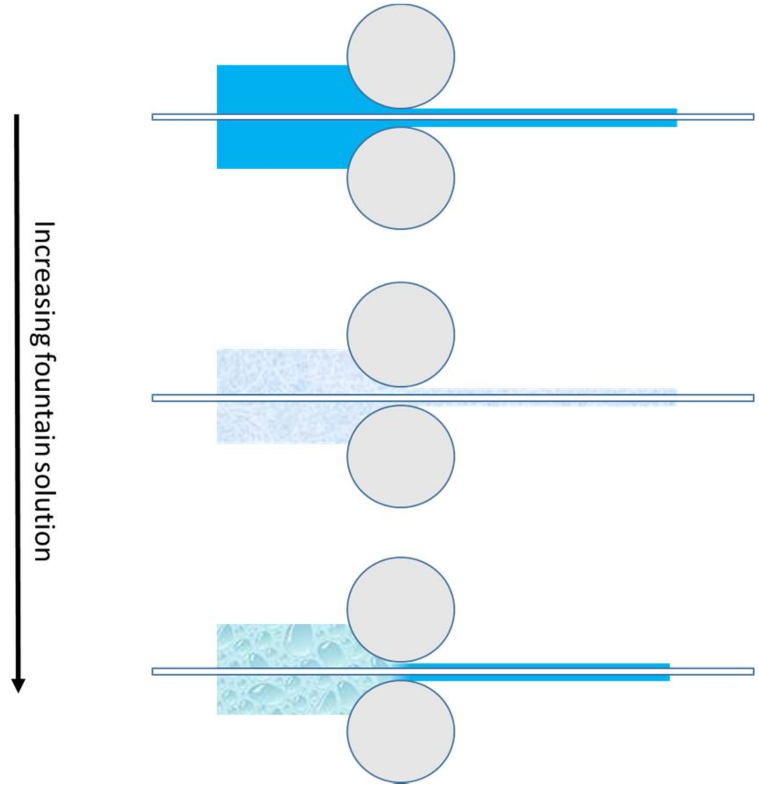


Conclusions

- Since the total volume in the nip under lubrication conditions remains constant, a replacement of ink volume by fountain solution is the cause for the lower amount of ink being transferred.

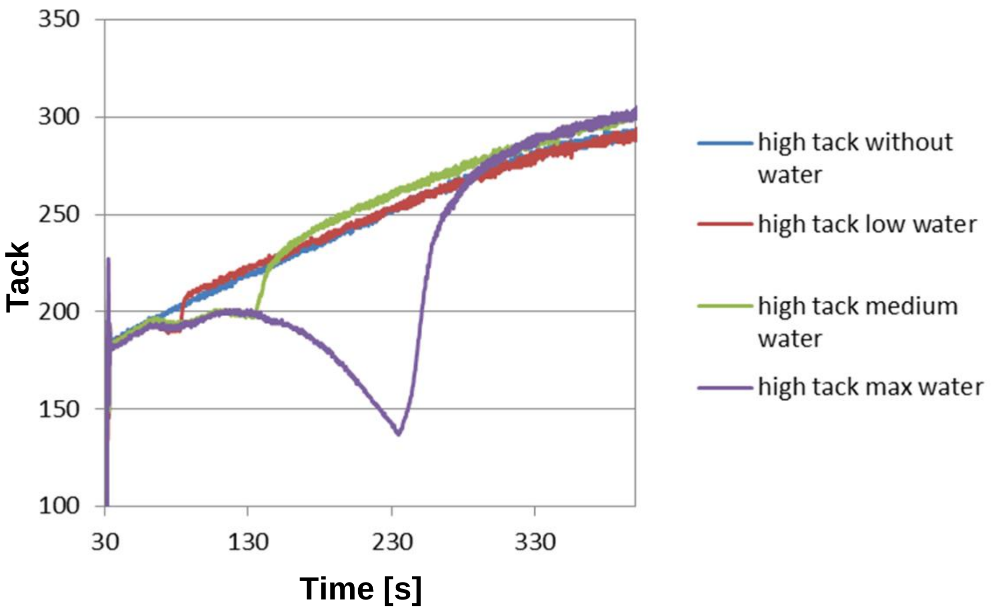
- When overdosed with fountain solution, the emulsion inverts, and the ink and aqueous phase under the extensional flow entering the nip can separate.

- Point of emulsion inversion.



Summary

- A dynamic contact procedure was developed to monitor ink-fount emulsification
- The substrate is passed through the same nip as is used for the emulsion production.
- Monitor dynamics at different press stations.
- The next step is to include a correction factor for evaporation to describe the relationships between dosage time, roughness and gloss.



THANK YOU FOR YOUR ATTENTION