Critical evaluations of liquid absorption testing methods for package printing

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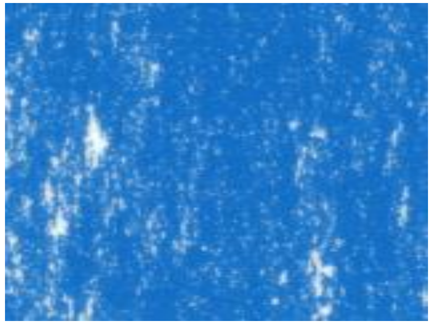
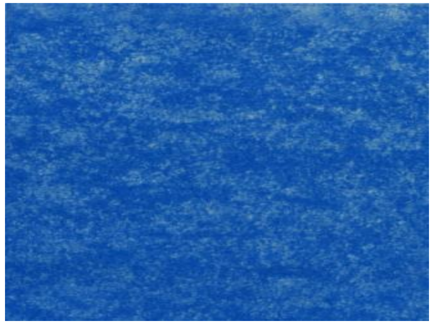
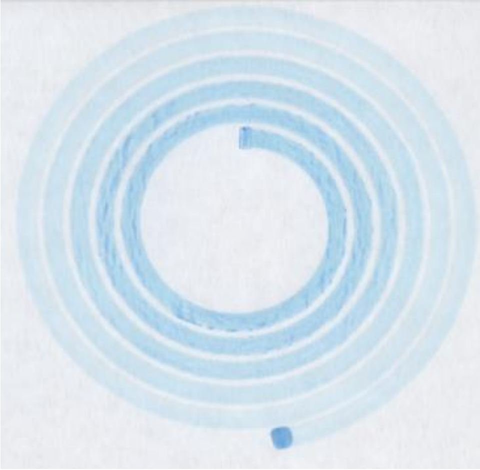
Background

- Topography + absorption ➔ print quality
- Appropriate and robust measurements ➔ predictable print quality
- How to measure the absorption properties ?
  - Total absorption
    - Cobb60 ?
    - Bristow wheel ?
    - IGT penetration tester ?
    - …
  - Absorption non-uniformity
    - Stain technique



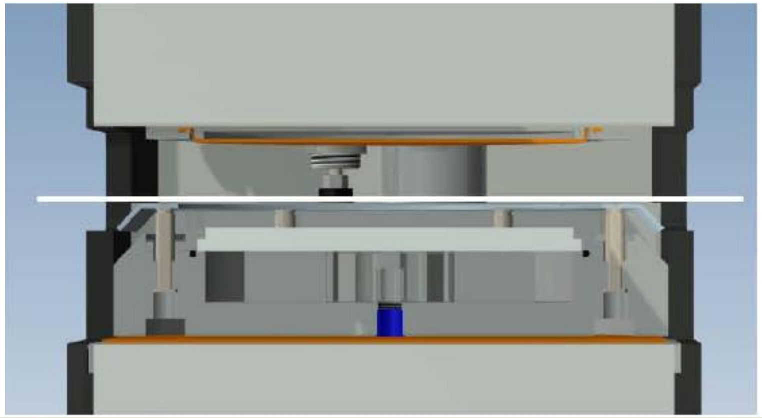


Measurement methods



- Two relatively new methods have been evaluated
  - ASA – Automatic Scanning Absorptometer
  - ACT – Automatic Cobb Tester
- Both methods provide time-resolved absorbency measurements
  - To examine short or long time absorption characteristics
  - Capillary-driven absorption (no external pressure applied)

$$V(t) = V_0 + k\sqrt{t}$$



Paper boards

- Six pilot coated paper boards
  - Different top-coatings on the same pre-coated base
  - Similar surface roughness
  - But broad absorbency range

- Latex
  - Latex A: vinyl acetate acrylate (VAA)
  - Latex B: styrene butyl acrylate (SBA)
- Pigments
  - HC90=Hydrocarb® 90
  - SCHG=Setacarb® HG
  - Clay=Capim NP delaminated clay
  - CCN75 = Covercarb® 75, narrow PSD

No.	Board notation	Coating compositions	Roughness, std. dev , height [µm]	Contact angle, H_2O
1	12.5 Latex A	12.5 pph VAA Latex A, 60 pph HC90 + 40 pph SCHG.	0.86	71.2
2	15 Latex A	15 pph VAA Latex A, Pigments as 1.	0.88	75.2
3	20 Latex A	20 pph VAA Latex A, Pigments as 1.	0.76	80.8
4	15 Latex B	15 pph SBA latex B, Pigments as 1.	0.89	84.4
5	40 Clay	15 pph VAA latex. Pigments; 60 pph HC90 + 40 clay	0.83	70.3
6	N75 GCC	15 pph VAA latex. 100 pph CCN75	0.87	73.4
-	Pre-coating	100 pph Hydrocarb® 60 and 13 pph of the VAA latex.		

Measurements

Testing liquids

- ASA
  - 12% (volume) of the condensed blue liquid, methylene blue, diluted in deionized water.
  - 8.6 wt-% n-propanol in order to reduce the surface tension similar to flexographic inks. (38 mj/m2)
- ACT
  - water

Surface roughness

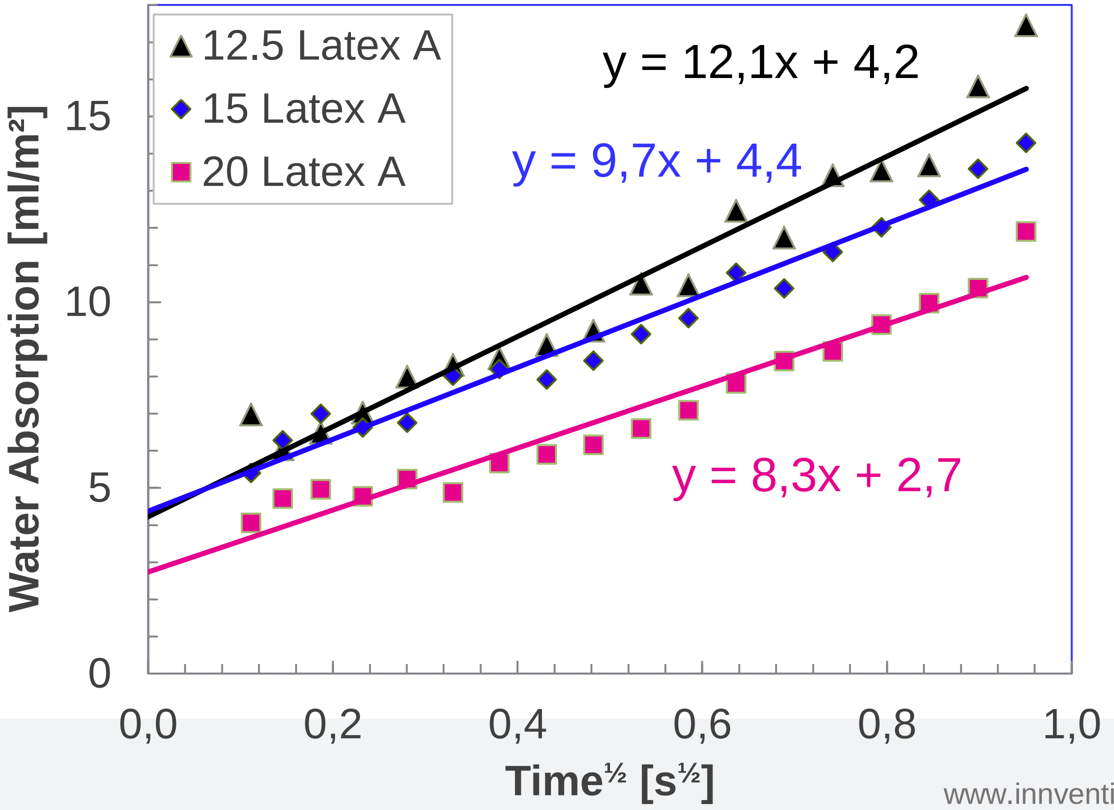
- OptiTopo
  - height standard deviation
  - wavelength interval 0.06-1 mm
- PPS
- Bendtsen

Print trial

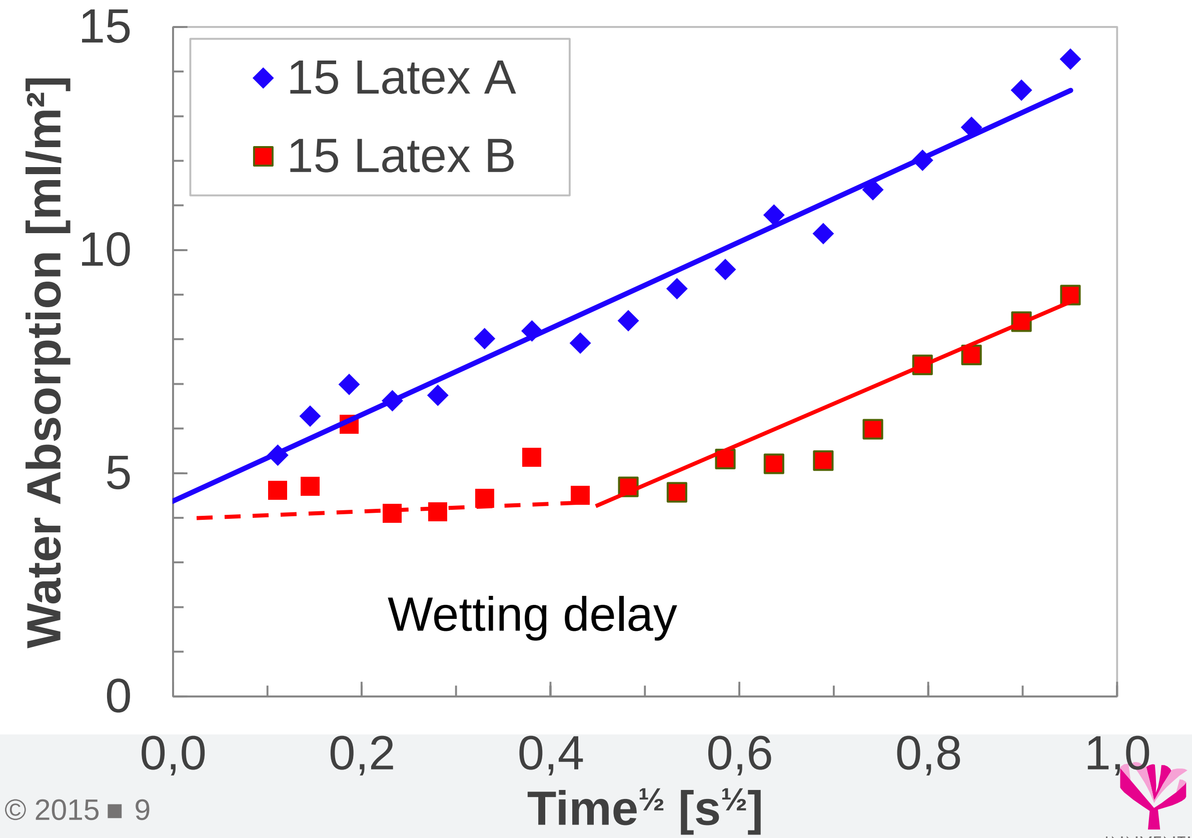
- Full-scale printing with an in-line flexographic press at Tetra Pak, Lund, Sweden.
- Print density of a solid cyan area was measured on five consecutive signatures.
  - Spectro-densitometer, SpectroDens (TECHKON GmbH, Königstein, Germany),
    - calibrated against the board white and with the following settings: D50 illumination, 2º observer, polarization filter and density filter ISO E.

Results -- ASA

- Boards of the same pigments but different amounts of latex A
  - Absorption rate decreases with increasing latex

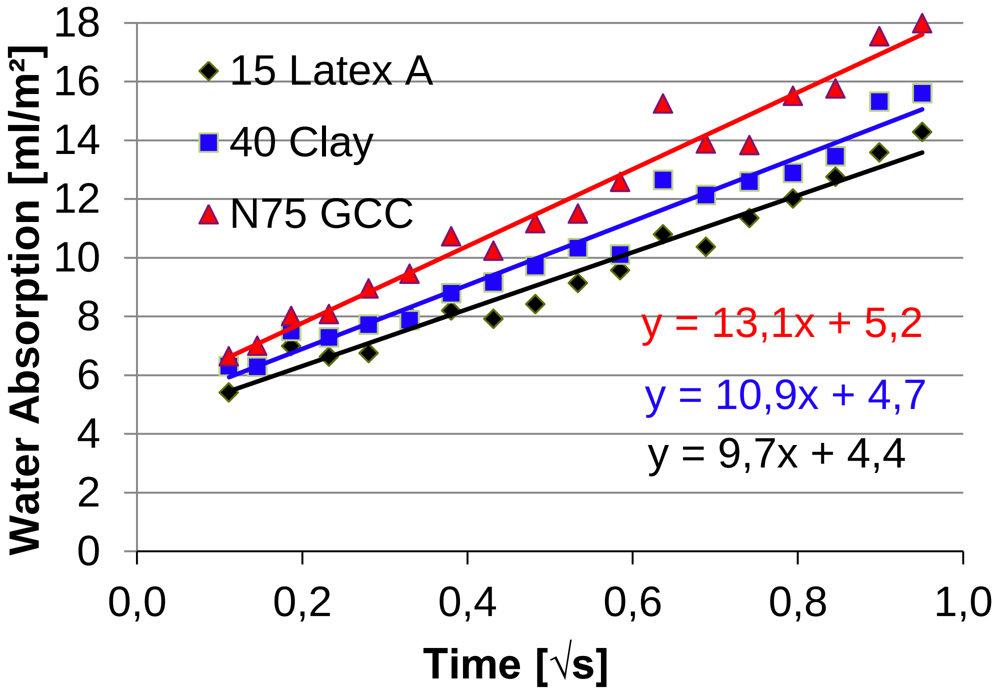


- Different types of latexes A *vs.* B leads to different liquid absorption
  - Type B shows a wetting delay



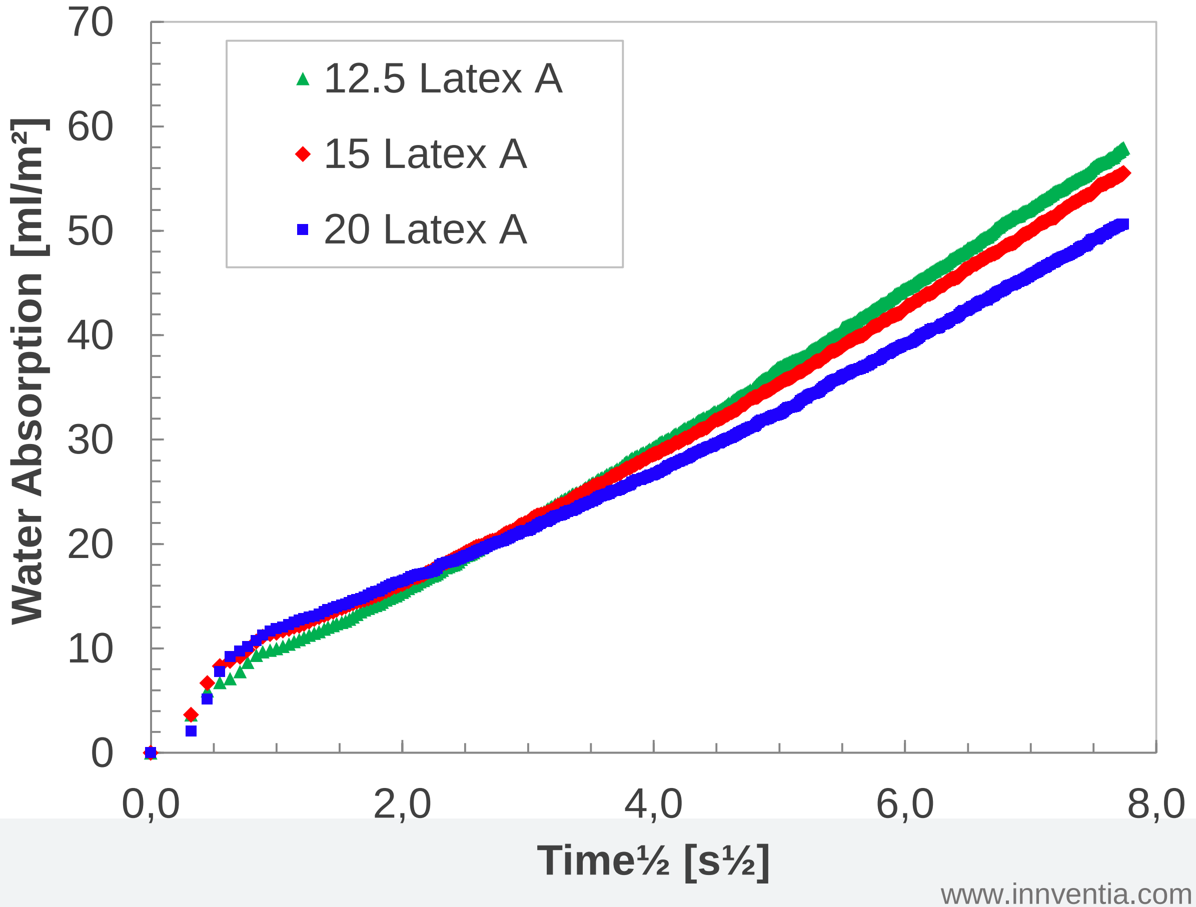
Results -- ASA

- The porosity of the coatings affect the liquid absorption
  - Board (N75) having the most porous surface (GCC of narrow PSD)
  - Board with 40% clay is less porous
  - Board having GCC of broad PSD has the lowest porosity.
  - The boards have similar contact angle

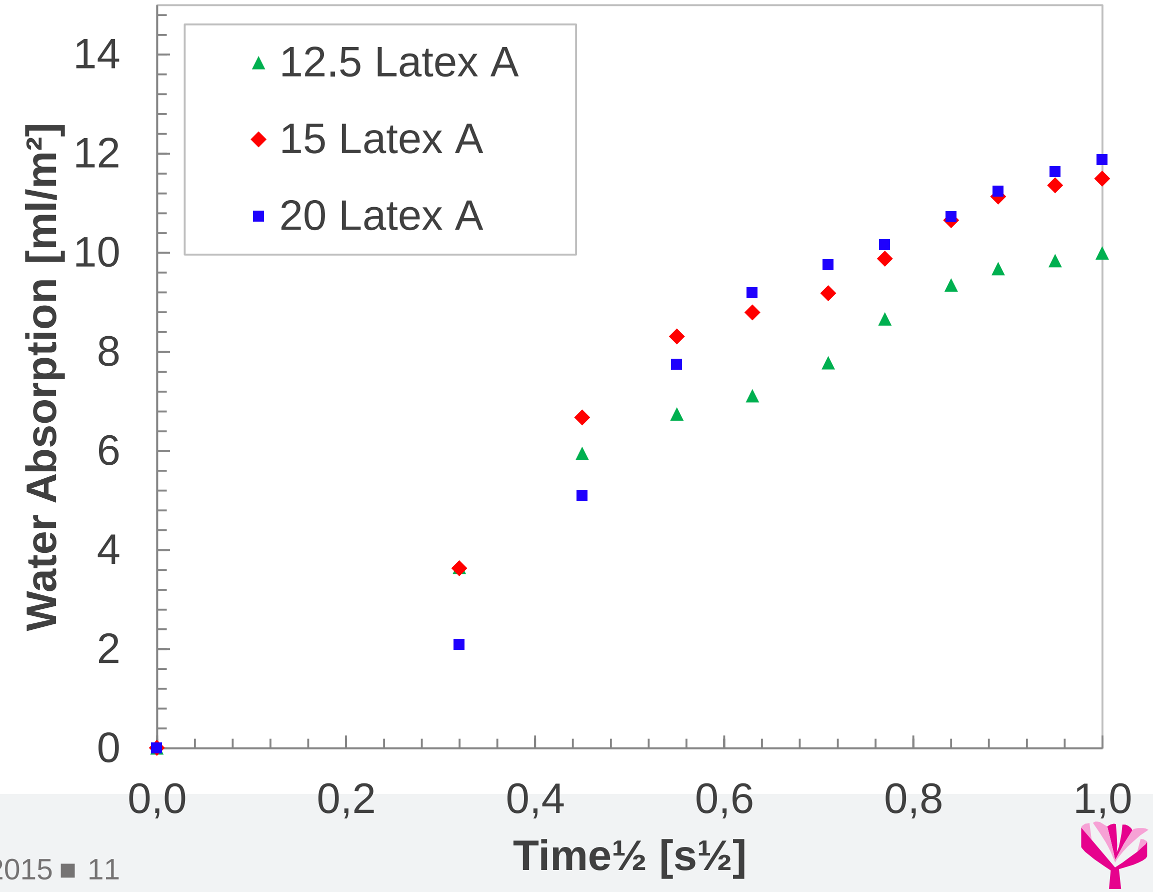


Results -- ACT

- The measurements show similar long-term trends as those from ASA



- Less reliable in short-term behaviour
  - More latex, higher absorption
  - Incorrect measurement at t→0
  - In contradictory to the ASA observations



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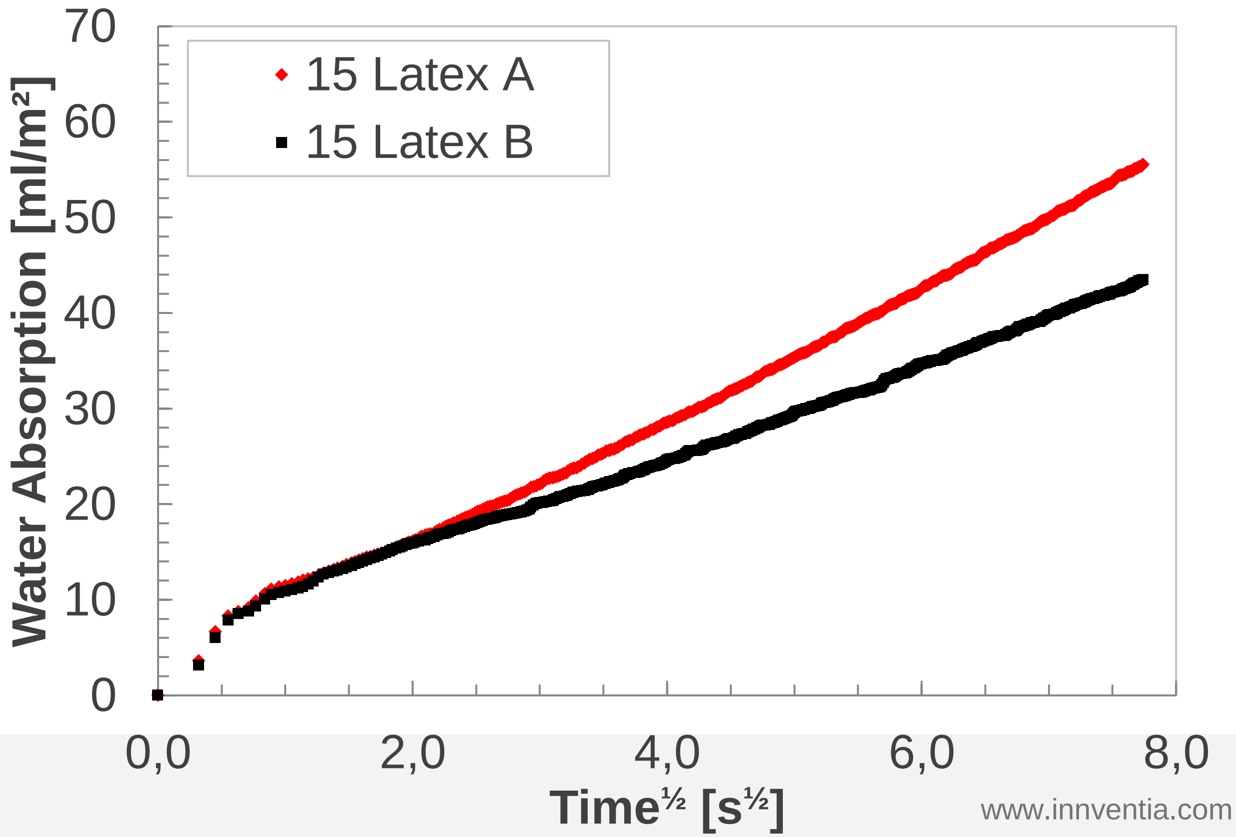
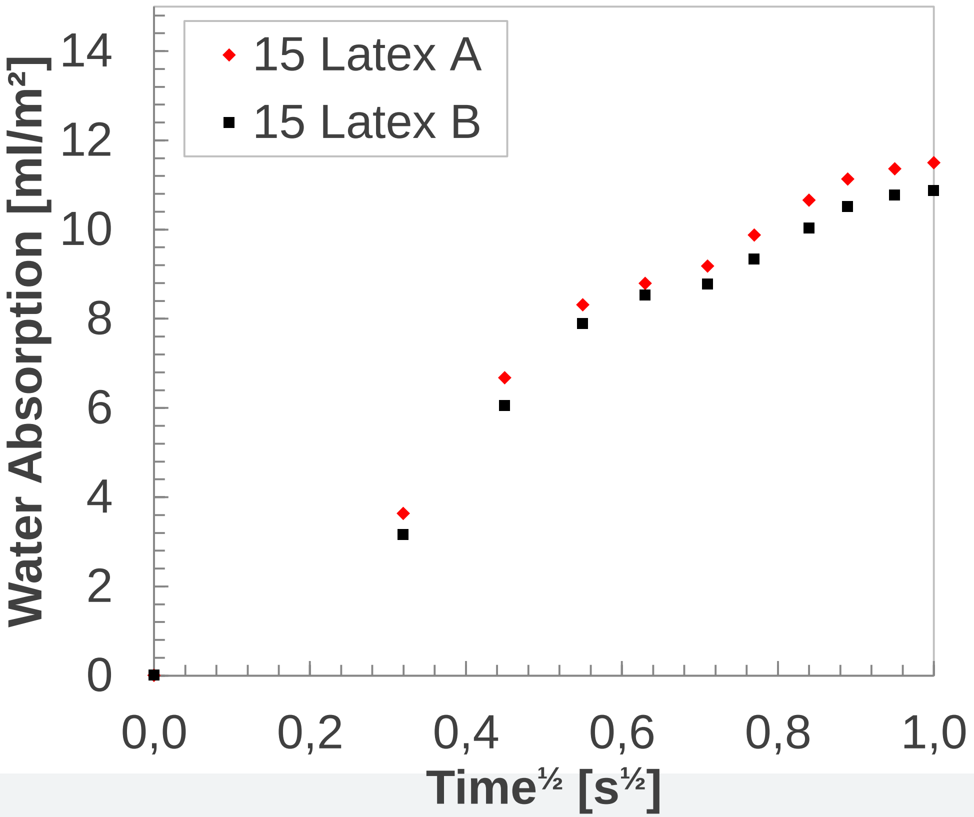
Results -- ACT

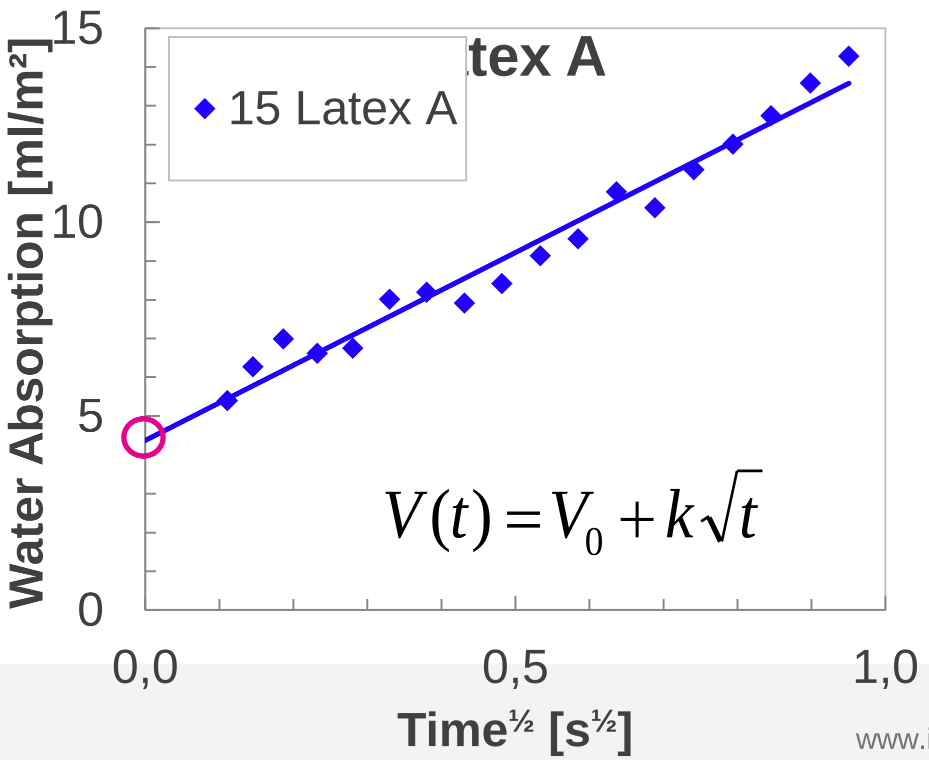
- The measurements show similar long-term trends as those from ASA
  - For short term, it is less obvious with less information
- No wetting delay observed

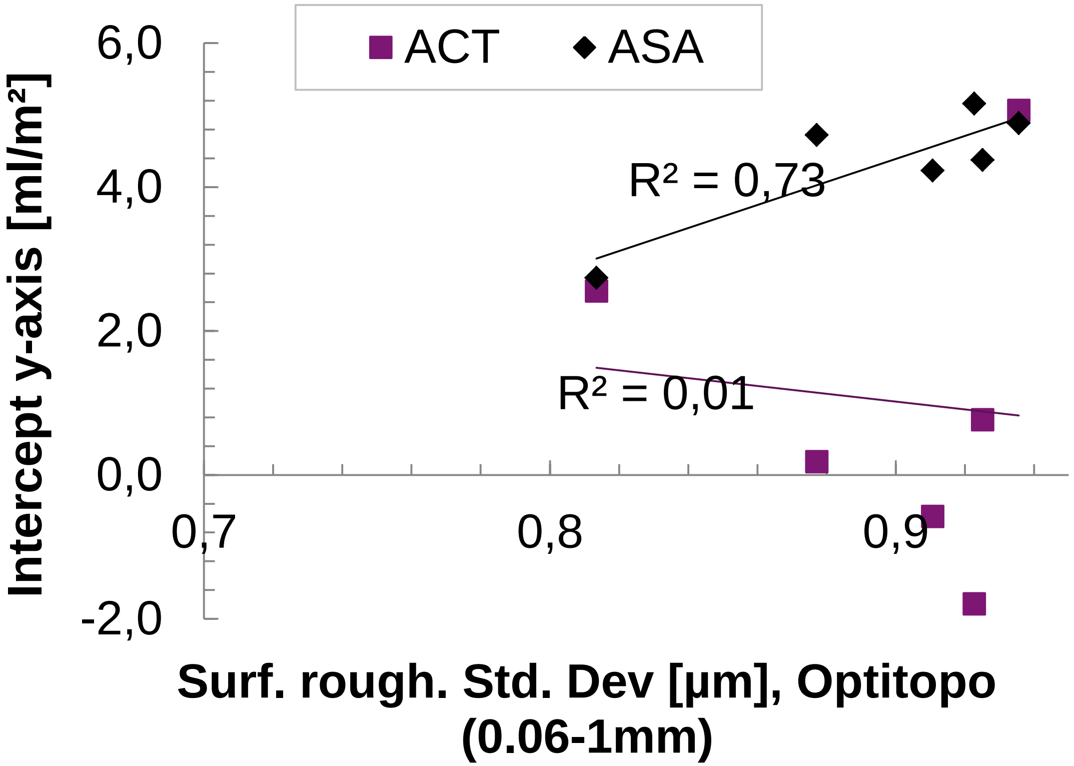




Surface roughness vs. absorption at t→0

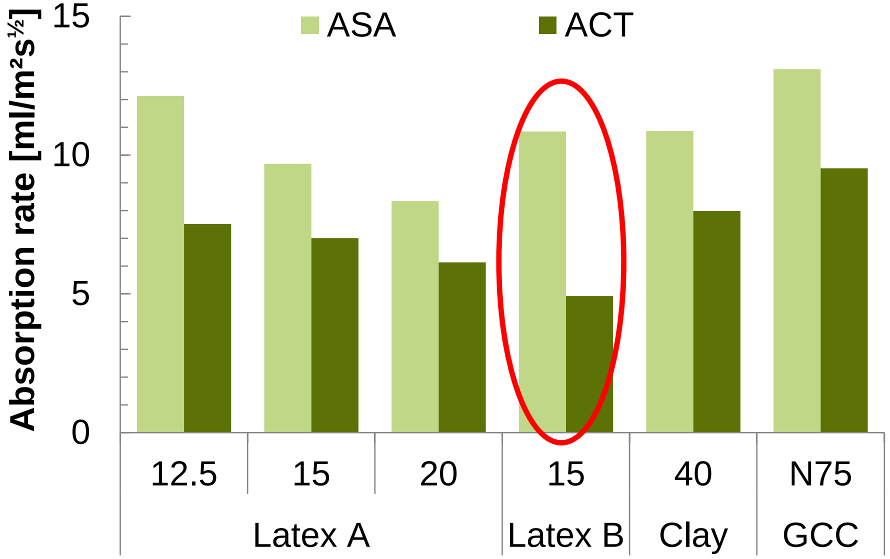
- At t=0, the liquid only fills the surface roughness.
- The intercept with the y-axis (t=0) is proportional to surface roughness

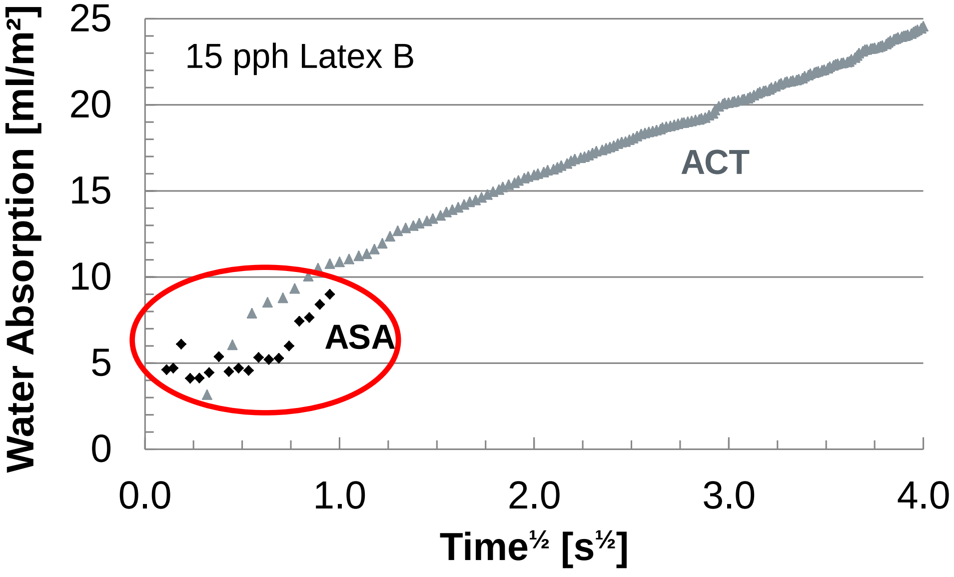




Comparison between ASA and ACT measurements

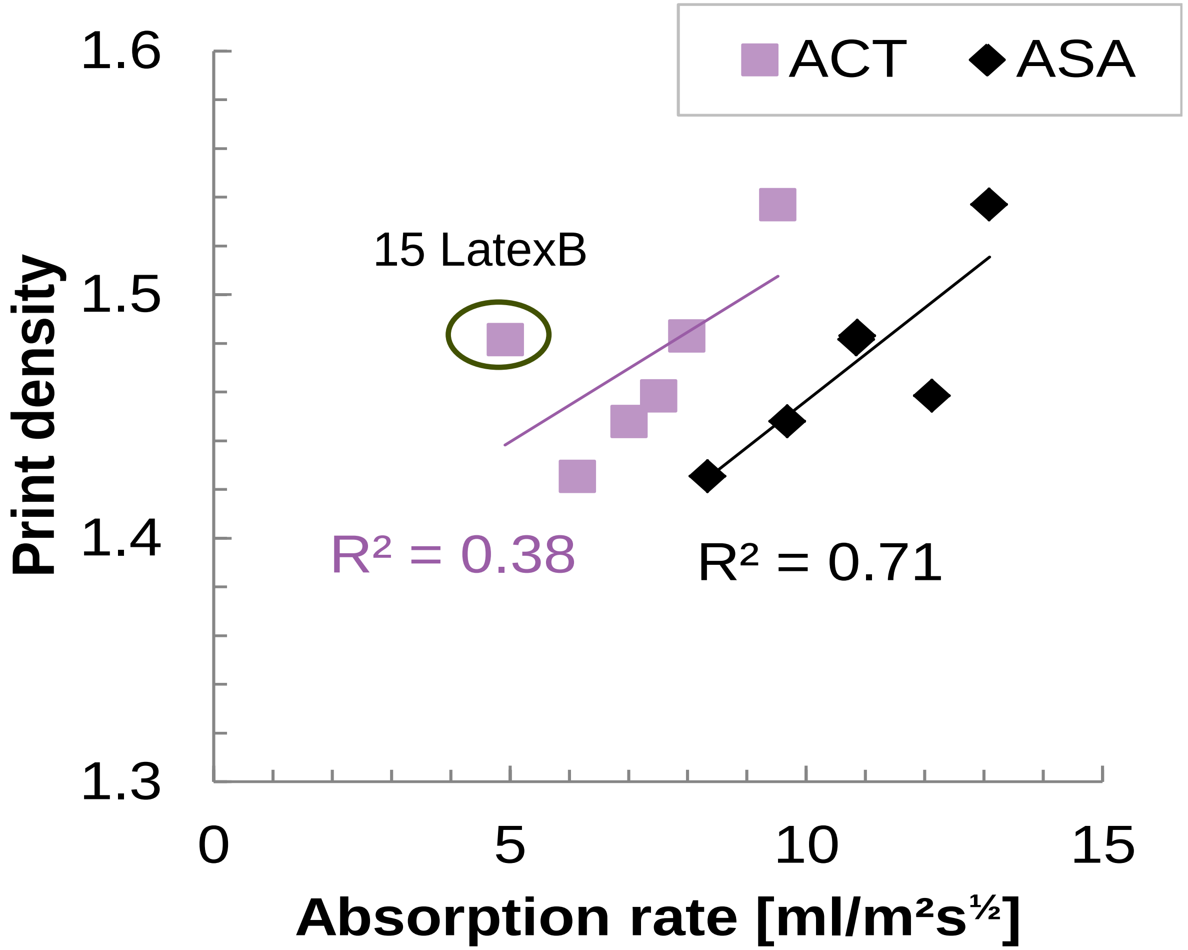
- Absorption rates
  - Both methods reveal similar long-term trends
    - The absorption rates of ASA measurements are generally proportional to those of ACT
  - the board 15 Latex B is an exception
- Their short-term observations differs significantly
  - t< 1.0 s
  - ASA's measurements is probably more reliable
    - makes more sense as it reveal surface topography





Print density *vs.* absorption rates

- There are a clear correlation between the absorption rates of the boards and the respective print densities.



Industrial applications

- Being capable of predicting print quality from unprinted surfaces (paper/board) will help the producers to
  - supply substrates with properties demanded by converters and end-users.
  - develop products of preferred printing surfaces.
  - increase production efficiency and effectiveness by reliable in-house quality control.

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