Aqueous primer wicking into paper strips – an experiment

I. What is a primer and its role in printing industry

Primers play a crucial role in the printing industry by enhancing the adhesion of ink on various materials and improving print quality. They are essential for printing on smooth surfaces (plastics, metals, glass, etc.), where ink struggles properly to stick, but also on porous paper (plain and coated) in order to help in droplet pinning. Practically, using primers new materials possibilities as substrate are unlocked. More than that, primers enhance the hue color and clarity, resulting in more visually appealing products.

The inkjet printing in today's digital print technology has created new challenges for primers, they being technology and substrate dependent. A variety of primers are available to enable proper adhesion between a substrate and ink. Most of them are complex aqueous solutions with multivalent cationic salts, which might contains glycols to define the viscosity and surfactants to establish the surface energy.

The ink contains, as solid component, pigments and polymeric colloidal particles. When negatively charged pigments get in touch with the positively charged salt layer, they immediately "coagulate" to the surface. In this way, there is a movement restriction for the pigment particles onto the substrate, preventing the mixing of adjacent droplets and therefore the colors from mixing (bleeding) and the formation of larger, irregular ink spots (puddling).

A typical primer formulation for digital inkjet printing may contain[1]:

- 15% to 70% cationic salt by weight of dry components.
- 10% to 30% polyvinyl alcohol.
- 5% to 25% aminated polymer (e.g., PEI).
- 1% to 20% organic solvents
- Water.

Primers are applied prior to printing either inline or offline. Most of the main players in the printing industry prefers the inline application, jetting or spraying the primer solution. It is important to understand the substrate surface properties when the ink droplet will interact with it. In other words, the primer liquid absorption into porous paper prior the ink landing is vital for the role of the primer and the print quality.

II. Experiment to measure the wicking in porous paper

In this work we present a simple method to investigate the liquid absorption into paper. A high speed camera is used to monitor in time the liquid up-taken. For a better visualization of the liquid into paper, a small amount of tartrazine (highly stable and water soluble) was added to the liquids to be investigated. Strips of paper are fixed vertically with one edge into the liquid bath as it is seen in Figure 1. The high speed camera is fixed so that the liquid advancing front is well visualized. For comparison the experiments have been made on three types of paper: coated paper, plain paper (commercial RedLabel paper) and a plastic paper, where the solid skeleton is preserved. As liquids, the aqueous primer and UHQ water have been compared. The recorded movie of the liquid front in time is analyzed via a

[1] WO2017039586A1 - Primer compositions - Google Patents

homemade MatLab program and the curves h(t) are obtained. Such kind of plots are shown in Figure 2.

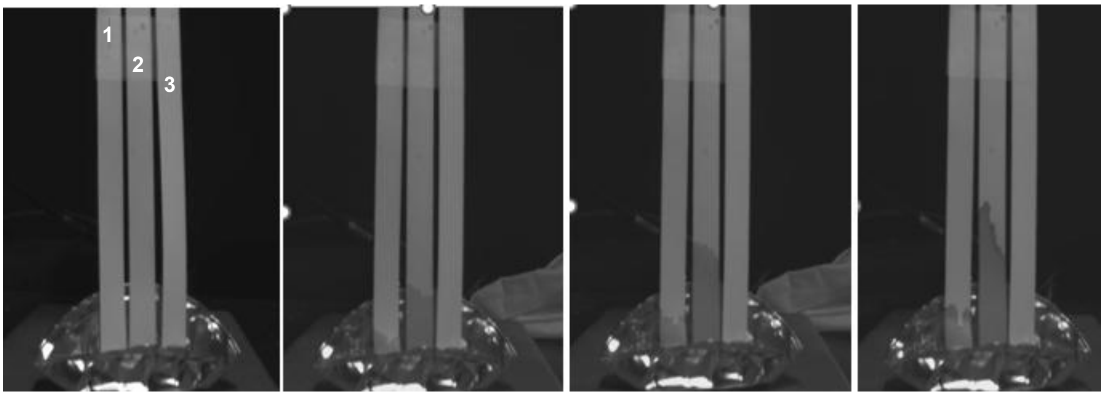
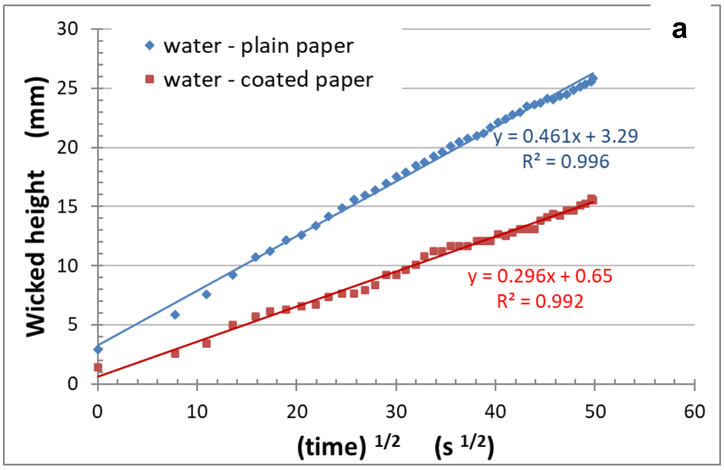


Figure 1. Wicking experiment of primer into: 1) coated paper, 2) plain paper (RedLabel) and 3) plastic paper (Teslin) for different moments in time.



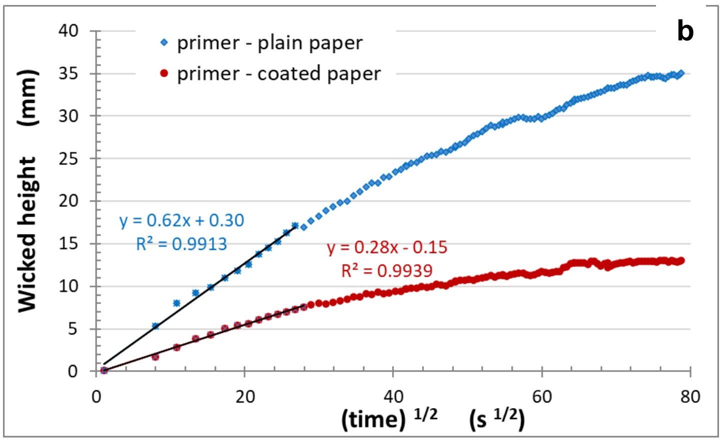


Figure 2. The measurements results converted into wicked height versus square root of time for water (plot a) and for primer (plot b), into plain paper (blue curves) and coated paper (red curves).

III. Results and discussions

From Figure 1, it is clear that the liquid (either water or primer) does not penetrates into the plastic paper (Teslin). This is due to the physical properties of the paper – hydrophobicity.

In Figure 2 few observations are clear:

a) Both investigated liquids wicked much more into the plain paper than into the coated paper in the same time: at t=100s water had h=3.5mm in coated paper and respectively 7.4 mm in plain paper; while primer had 2.8mm and respectively 7.1mm;
b) Water in plain paper is wicking with a speed of 17um/s while primer seems to be a bit faster 18.2 um/s. This can be seen from the slope of the plots in Figure 2 where $h=f(t^{1/2})$ is represented: it is 0.46 for water and 0.62 for primer. Of course this can be explained via viscosity (the primer has a larger effective viscosity than water) and via surface tension, contact angle.
c) There is another physical process that must be considered: the water evaporation along the wet surface of the strip. This is not the subject of this work.
d) The coating from the paper seems to act diminishing the wicking speed. It has much smaller pores in diameter comparing to the fibrous inner part (the latter, much similar to the plain paper).

IV. In steed of conclusions

The primer is an important candidate which makes the difference in the printing industry from a print quality point of view and by extending the applicability of the printing process. Primering is applied by many printing competitors, but a lot of knowledge about it is based on trial-and-error experimental work. The work presented here, shows a method to investigate the primer wicking into porous paper (plain and coated paper) and, in our vision it is the beginning of a scientific research journey.