Practical Case Studies with ASA Sizing

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ABSTRACT

Coated paper quality depends on coating color characteristics, coating method and base paper properties. In this case with hydrophobic ASA sizing we could influence on gloss and coated roughness even though the film transfer press application is less sensitive on internal sizing and final roughness should depend on base paper roughness.

Keywords with ASA sizing for coated papers are on-machine curing and the adjustable degree of sizing. On-machine curing makes it possible to have a positive impact on coating coverage and with an adjustable and stable degree of sizing it is possible to reach the desired quality targets.

INTRODUCTION

The addition of hydrophobic chemicals to papermaking furnish in order to reduce the rate of penetration of a liquid, usually water, into the paper structure is known as internal sizing. Water resistance is generated by introducing hydrophobic groups onto fiber with either a mechanical or chemical mechanism.

The Prime objective of sizing is to impart liquid resistance to give paper sheet a desirable end-use characteristic. With internal sizing one can control the level of pickup and penetration in a coating or size press operation. Grades of paper designed for writing and printing applications benefit from the use of sizing agents with improved printability qualities. The functionality of packaging grades for milk, juice or other fluids is dependent on high levels of internal sizing as well.

The Penetration of liquids through capillaries of a sheet is defined by a relationship known as the Lucas-Washburn theory. This equation has been found by experiment to be very useful in explaining liquid penetration in paper /1/. The Lucas-Washburn theory reveals that both sheet structure via capillary pore radius and fiber surface chemistry have an effect on determining liquid penetration behavior.

The major effect of internal sizing is on the contact angle of liquid with the paper surface. Cellulose is a very hydrophilic substance, and unsized paper has a contact angle with water near zero. As a result, penetration of water into unsized paper is extremely quick. When sizing agents are added to furnish, their hydrophobic nature increases the contact angle and the rate of penetration of water is reduced.

When the contact angle is greater than 90°, in theory, no penetration is possible without external pressure to force liquid into the pores of the paper. Varying degrees of contact angle and levels of sizing imparted are represented in Figure 1. The addition of surfactants to aqueous penetrants or internal sizing agents increases the rate of penetration by lowering the contact angle of the penetrant and sized sheet. In some instances, surfactants are required to emulsify hydrophobic materials used for sizing. At any contact angle, pore radius, is an important factor. As the sheet becomes less porous, liquid penetration is reduced.

SIZE PRESS TECHNOLOGY

In a conventional flooded nip size press paper absorbs part of the sizing solution and overflow is recirculated back. Flooding nip size press can be used for both starch surface sizing and pigmented coating, but it has speed limitations because of turbulence and splashing at nip pond. It also can have poor runnability on lightweight sheets. Another problem with a conventional size press is film splitting at exit of the nip causing an uneven orange peel surface.

Pickup is depending on internal sizing level. Factors influencing conventional size press pickup /2/:

Sheetcharacteristics:
- Paper substrate (basis weight, density, smoothness, capillary structure, void size, etc.)
- Level of internal sizing
- Moisture content

Sizing solution:
- Solids content
- Temperature
- Viscosity
- Composition (type of starch, use of additives)

Design
- Machine speed
- Pond depth
- Nip pressure
- Nip width

The limitations of conventional size presses led to the development of the film transfer size press. Size or coating film is formed between the roll and the applicator element and transferred to the paper in the roll nip. This system provides a contour-type coating where final roughness depends on base paper roughness/3/.

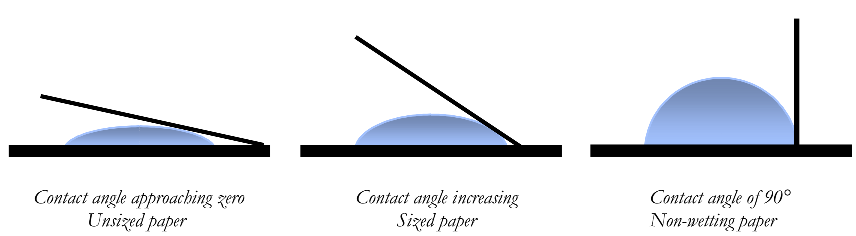

Figure 1: Representation of contact angle and levels of sizing

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Figure 2: Example of a modern film transfer press

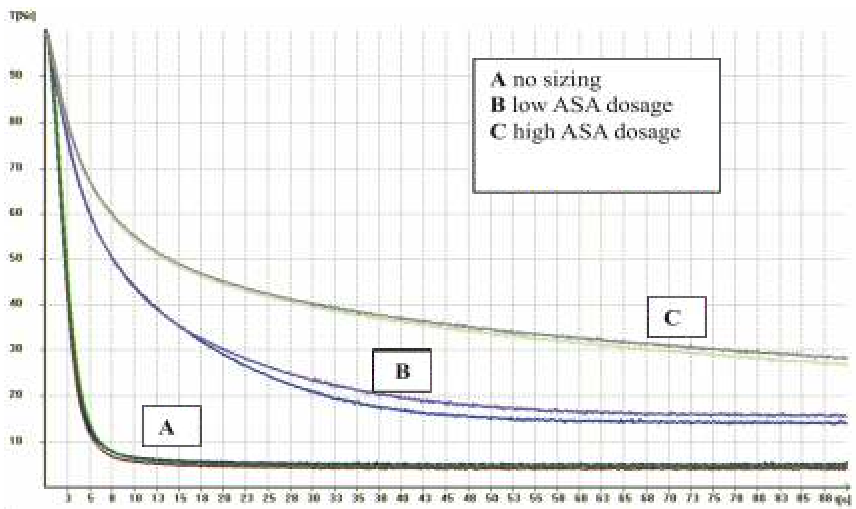


Figure 3: Dynamic penetration measurements

Film split pattern limited pigmented coat weight with conventional size press to 5 g/m², but with the film transfer press it is possible up to 10 g/m². Film transfer press can also be applied to new grades such as de-inked papers. Film transfer press application is also less dependent on internal sizing /2/. Example of a modern film transfer press in figure 2.

COATING TECHNOLOGY

The driving force in coating technology development is to raise capacity of coater lines by increasing speed and reducing the amount of breaks. At the same time coated papers are produced of lighter and weaker sheets.

Blade coaters with short dwell applicators or applicator rolls were the most common technology on the market up to the beginning of the 1990's /4/. The problem of short dwell streaks in the web at speeds above 1200 m/min was solved with a sealing blade. Applicator roll problems, like uncoated areas at high speeds, were solved by replacing roll type application with jet type application.

Coating color dewatering in the blade coating process was studied at reference /5/. The proposed model states that dewatering is depending on dewatering force, time, viscosity and coating color characteristics. Dewatering in the application stage is more extensive for the roll applicator than for the short dwell system, because of higher pressure. On the other hand dewatering under the blade is greater for the short dwell system.

Between the application and drying of coating color, paper is also a source for dewatering force. The increase in the absorption potential of paper decreases the influence of pressure pulses on the final dewatering amount. The absorption potential is especially dependent on hydrophobicity of base paper /5/.

At reference /6/ are presented results of a study analyzing the effect of hydrophobic sizing and porosity on paper absorbency. Sizing was done with AKD and the coating application was a short dwell blade coater. Hydrophobic sizing had a slight effect on coated gloss, but no effect on coated roughness. Base sheet surface structure, density and roughness were found to govern coating holdout and uniformity.

An experimental study of a free jet application in pigment coating was made at reference /7/. Coating color solids increase with both coating systems during the coating run, but solids increase with flooded nip appears to be about 25 % higher than with free jet. The surface of free jet coated samples was slightly worse in surface roughness and optical properties.

The water absorption potential of base paper was measured with ultrasonic technique and was found to be higher at the wire side. Also coating color solids increase was higher at the wire side with both coating technologies.

ASA SIZING AND COATED PAPERS

Coated papers are produced primarily for printing. The most important property of coated paper is the capability to reproduce the printed image. Different printing processes have different requirements, but all of them need a surface that is strong, clean and uniform.

For coated sheet the main measure of uniformity is gloss. Large scale uniformity, formation and smoothness, are influenced by the base paper, but gloss is mainly influenced by coating.

From an operational point of view, coater runnability is the most important factor. The most challenging situation is on-machine coating since there is no opportunity to remove sheet defects before coaters and defects like holes usually cause a sheet break at the coater blade.

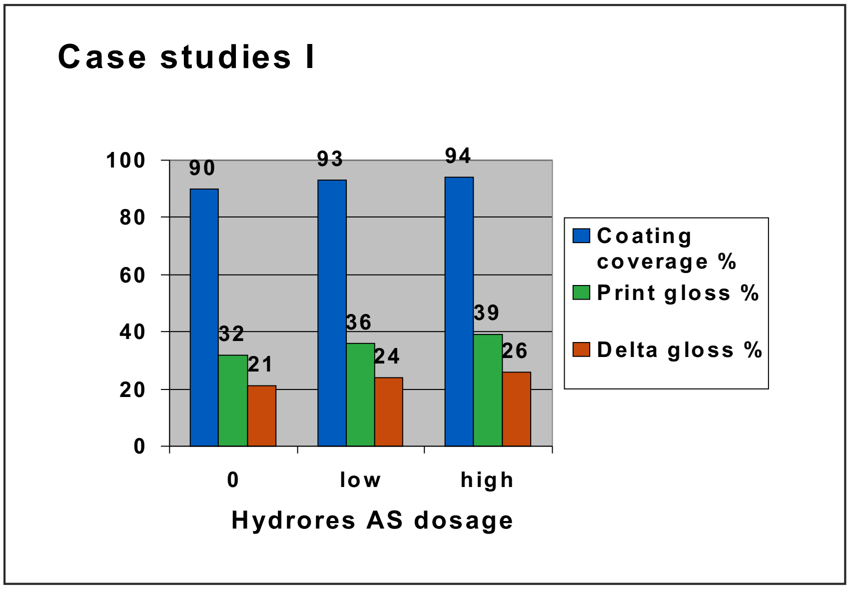
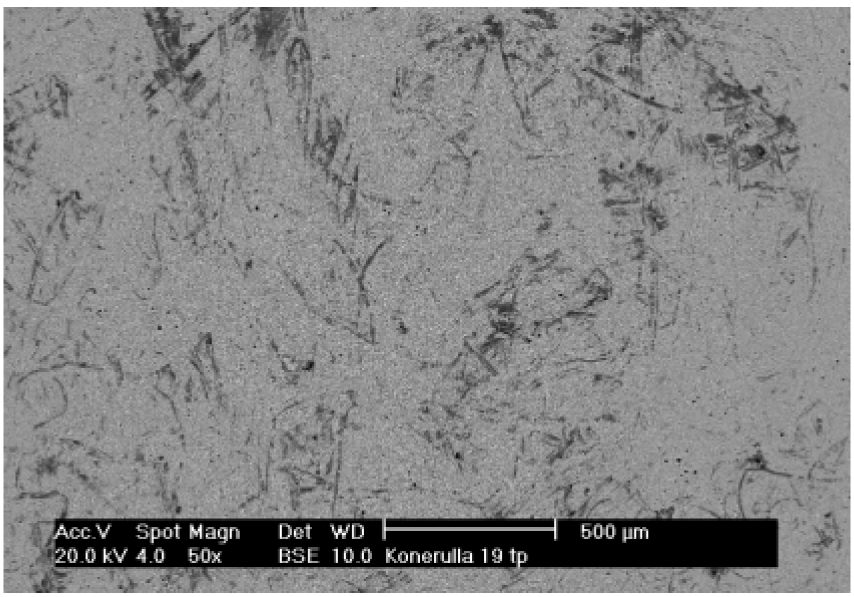
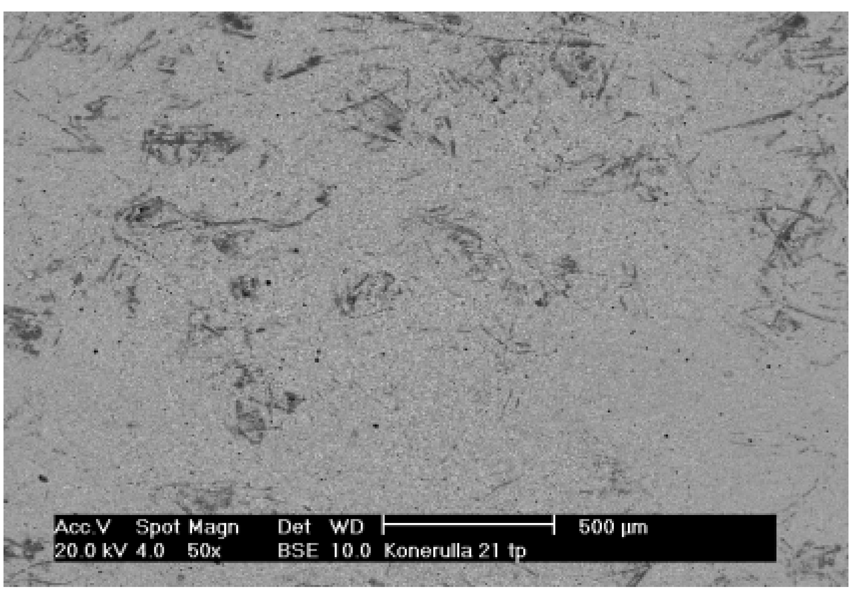


Figure 4: Coating coverage and gloss as a function of ASA dosage



A



B

If we think of ASA opportunities and coated papers, there are two key words: controllability and curing. With cured sizing before the coater or size press it is possible to improve runnability with lightweight and other low wet tensile strength sheets, especially in the case of the conventional pond type press. Because of the high reactivity of ASA it is possible to adjust sizing in required level to optimize runnability and paper quality.

CASE I

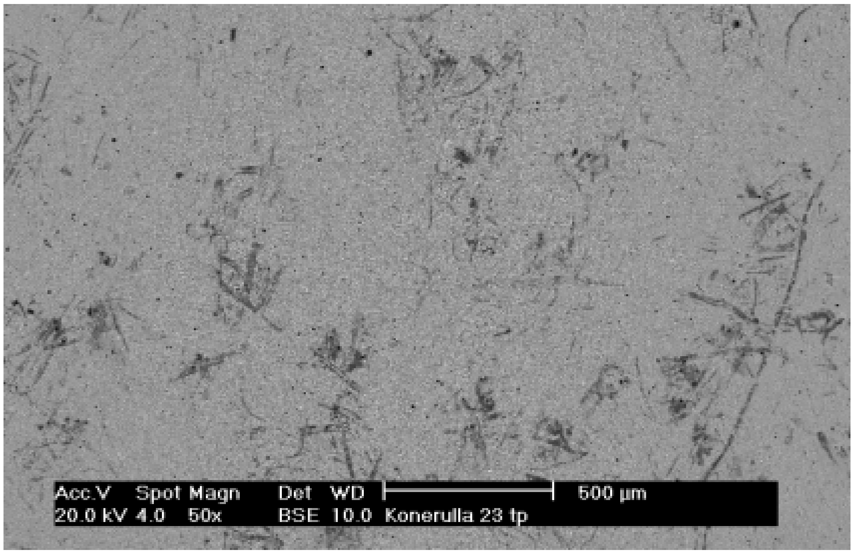
The purpose of this trial was to test, if with ASA sizing it would be possible to improve the quality of on-machine coated paper. Paper is produced from de-inked furnish and coated with film transfer press. Base paper is 50 g/m², coating 10 g/m² on both sides and the speed of the machine is less than 1000 m/min.

In figure 3 are presented penetration measurements done with EMCO DPM apparatus. The penetration of a liquid is monitored by the measurement of transmission of ultrasound through sample. Low hydrophobicity is characterized by the following factors:

- dampening of transmittance (wetting of sample) starts almost immediately
- fast dampening of transmission level (steep decline in penetration curve) indicating fast penetration
- final level of transmittance is reached early

In figure 3 the curve A (no sizing) is very steep, penetration of water is rapid indicating a high absorption potential of the paper. Curves B and C show that with hydrophobic ASA sizing it is possible to control the absorption potential of this paper.

The coating coverage on the paper was studied with a scanning electron microscope (SEM) using a back scattered electron detector. In these images fibers are shown as dark areas (light elements, less back scattered electrons) and pigments as bright areas (heavier elements, more back scattered electrons). An analyser measures the ratio between them and it is reported as coating coverage percentage. An example of these images is shown at appendix:



C

-picture A with no sizing, coating coverage 90 %
- picture B with low ASA dosage, coating coverage 93%
- picture C with high ASA dosage, coating coverage 94 %

At figure 4 is presented coating coverage and gloss values as a function of ASA dosage.

Both coating coverage and gloss results improve as ASA dosage is increased.

According to these results it is possible with hydrophobic ASA sizing to decrease the absorption potential of base paper and provide more uniform coated paper surface for printing. Also surface roughness measurements were improving from 4.1 to 3.6 µm as ASA dosage was increased

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