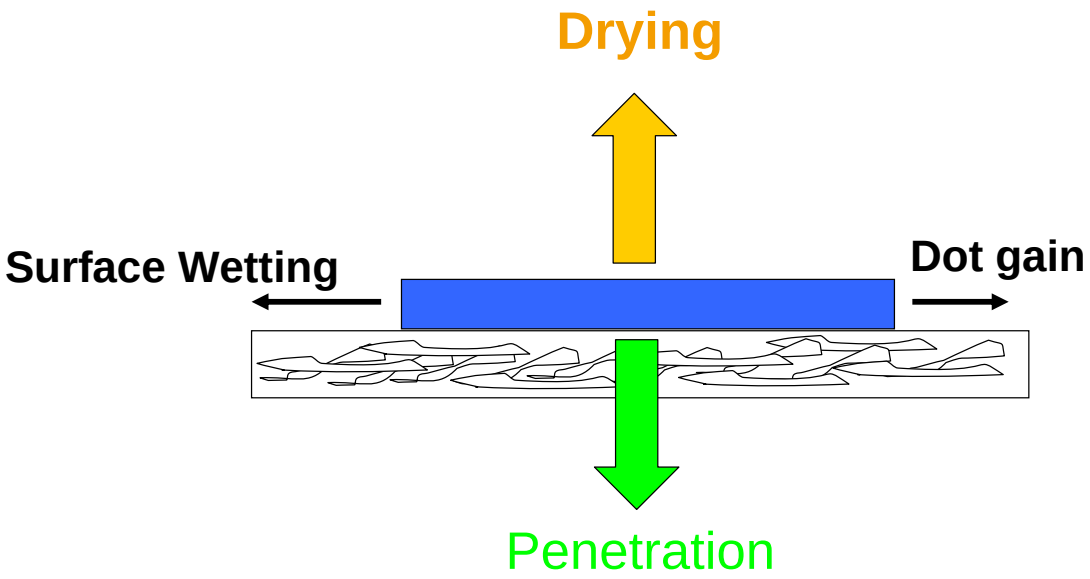
Title: The interfacial Chemistry of Paper and Paper Coatings
Author: John Du
BYK USA Inc., 524 South Cherry St. Wallingford, CT 06492

The coating of paper surfaces to improve its print characteristics is a complex system of interactions between the fibers of the paper, the physical and chemical properties of the paper surface and the interactions and response to the coatings applied on the paper surface. This presentation will examine individually, the parameters of surface wetting and penetration speed, and their dependence on paper surface characteristics

Paper surface properties greatly impact the wetting and penetration of liquids. In all conversion processes starting from surface sizing, coating, printing or impregnation, these various processes can all be classified as a liquid being applied on the paper surface.



Regardless of method of applications, the final quality criteria is visual uniformity; therefore the non-uniform nature of the substrate paper must be completely covered.

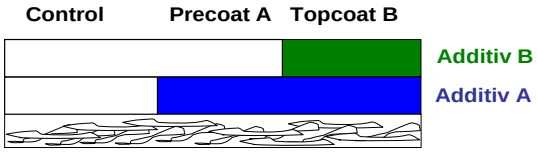
To meet this requirement, various application technologies are available, each able to provide high levels of quality but due to the market conditions and price sensitivity, the best technology is not always commercially feasible.

The measurement of paper characteristics for predicting penetration speed and wetting is available but due to method limitations, these mostly single point measurements are not enough to provide adequate characterization of the paper surface. First of all, wetting and penetration are not easy to address separately because any applied liquid will not remain at the surface, nor can it penetrate without wetting the surface first. Secondly, most measurements used are indirect measurements, as a model of an ideal situation, which paper is not.

BYK has just completed a joint a study with a paper university institute to model these relationships to study the impact different additives can have, and which measuring technique/device is best for correlation with actual results.

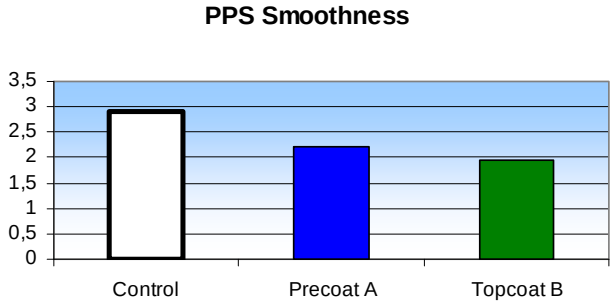
The influence of additives was modeled using two different additives on a pilot coater running at 1000 m/min. The application was bar/blade setup to replicate a standard double layer coating process.

Additive A was added to the precoat to lower its rate of penetration, Additive B is a typical leveling additive added to the topcoat.

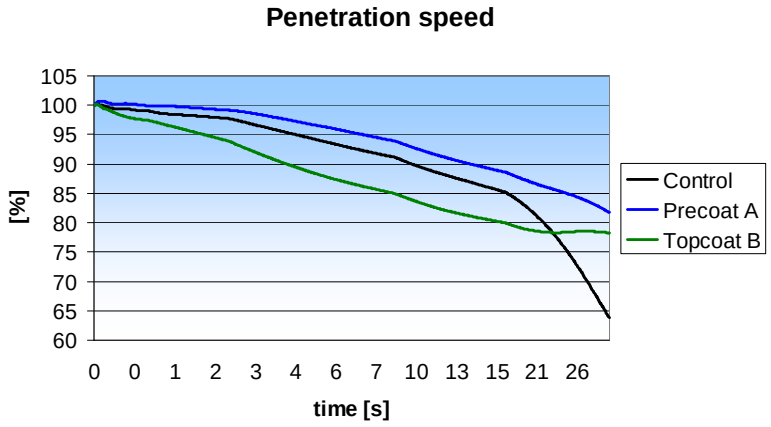


The three possible combinations of coating color were measured using different measurement systems to show the influence of additives in a standard graphic coating color.

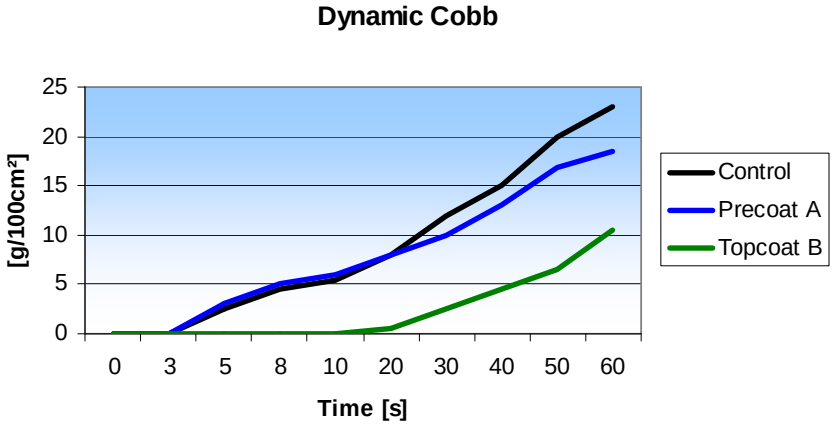
The improvement in smoothness can be seen in the Parker print surf values



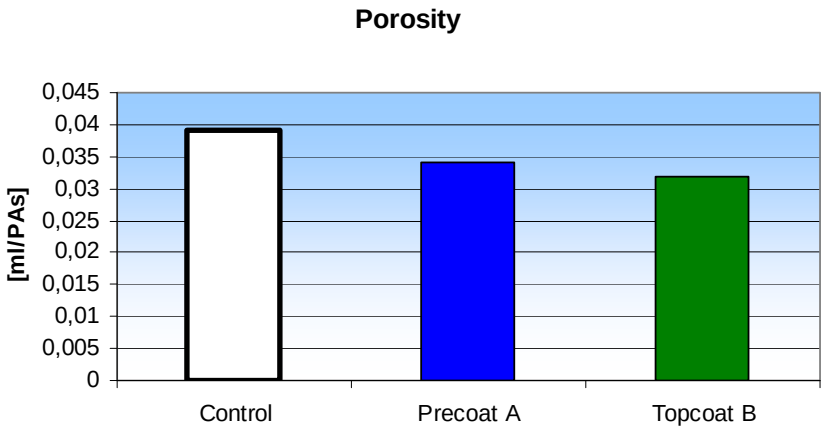
The objective is to maximize uniformity of the coated paper for better print hold out. Dynamic Penetration shows clear differences amongst the three samples; the reduction in penetration speed correlating well with the chemical structure and function of the additives.



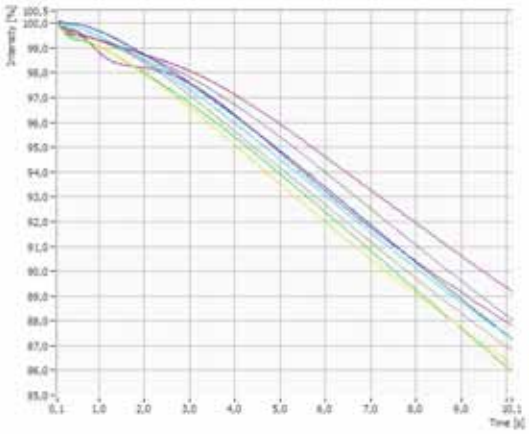
The reduction in penetration speed of the precoat follows a clear reduction in penetration of the sample. Adding an interfacial additive to the topcoat increases the penetration speed again.



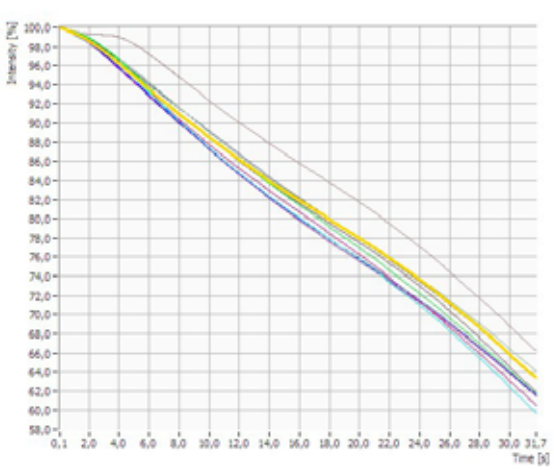
Dynamic Cobb measurements reveal a different story; Cobb values obtained clearly differ from penetration speed values. Therefore there must be another as yet neglected parameter as to why these measurements do not agree and in fact are opposite in their values.



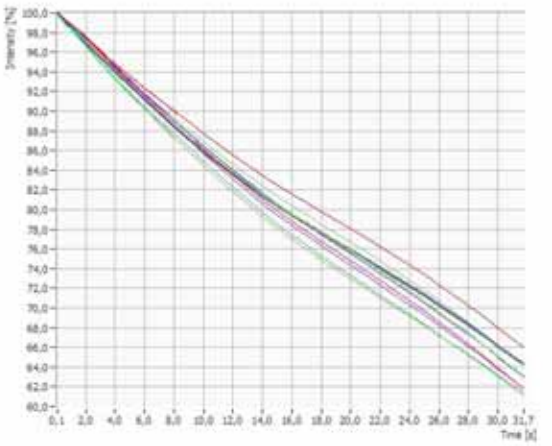
In measuring the porosity of the samples, we see that coating porosity is lowered by the interfacial surface additive. The coating color is denser so the ultrasonic signal dampening will be less. What the ultrasonic signal shows is a clear increase in uniformity due to the addition of additives.



Picture 3
Control

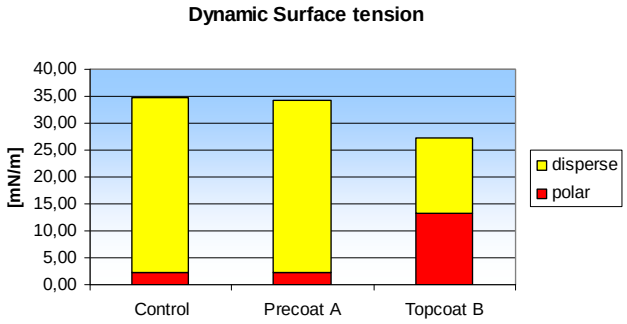


Precoat A

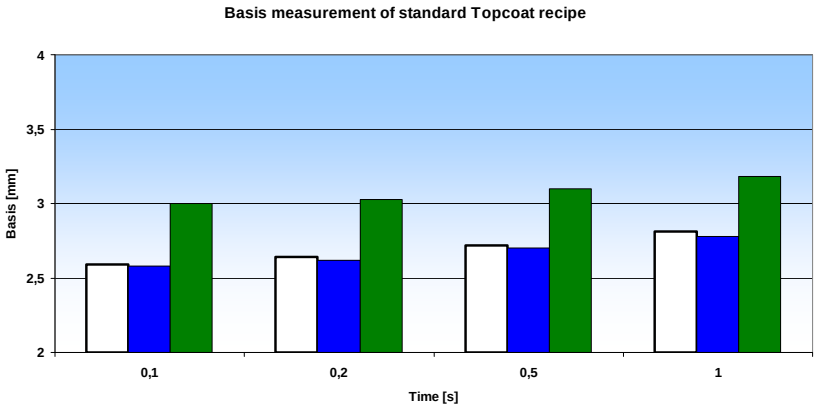


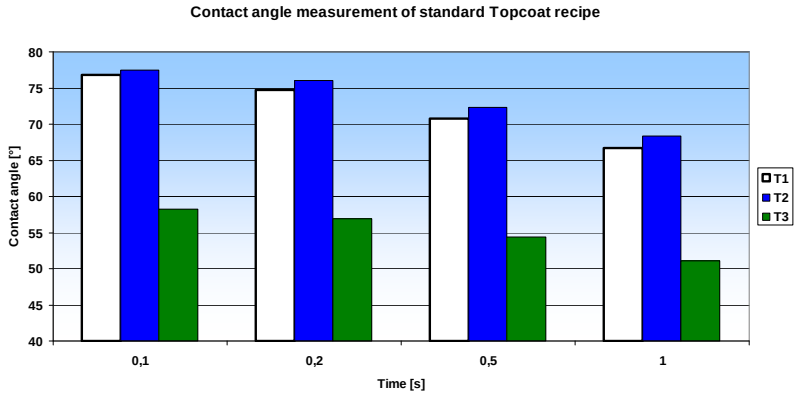
Topcoat B

Especially in the early stages of surface wetting, in the control diagram, non-uniformity is clearly visible. Due to the reduction of penetration speed in figure A there is a reduction in variety of the curves. In the last picture the variety increases due to the surface wetting additive, but at a much later stage. Additive B shows a totally different wetting behavior and increases the polar component of surface tension.



Increasing the polar component of surface tension will change the surface's water wetting rate; waterborne systems typically have a very high wetting value and low penetration values. Dynamic wetting measurement with water confirms this fact.





Contact angle and the water drop spreading show totally different behaviors. With additive A the base decreases while contact angle increases slightly, because the influence of the precoat is much less with the control topcoat. With the leveling Additive the wetting of water is greatly improved. For various converting applications, proper control of paper characteristics and interfacial chemistry can improve the final product.

In a gravure printing of effect ink we see clear differences in printability. This paper pilot trial raises the determination of printability to a new level.

Grey Image – big uncovered details

Image becomes silver – better coverage

Top coverage and silver image

Summary.

This Study shows that combination of new dynamic measurement techniques can provide a totally different view of paper surface properties. Additives in precoat or topcoat can greatly influence these paper characteristics. Due to the variety of coating color recipes and coating application methods, understanding the influence additives can have on interfacial interactions will bring science to the art of predicting printability and subsequent converting steps. The end result is a better understanding of the various multiple interfacial interactions. . Dynamic measurement taken within one second of material contact can capture in real time, concurrent interfacial interactions.

This interfacial know how derived from the paint industry can be used to form better models for developing a better understanding of paper surface improving processes and techniques. This improved understanding will lead to the development and application of new additive to better control of application and final product quality.