Lessons Learned: Viscosity Control for Converters

Technical Presentation for the CMM Exhibition

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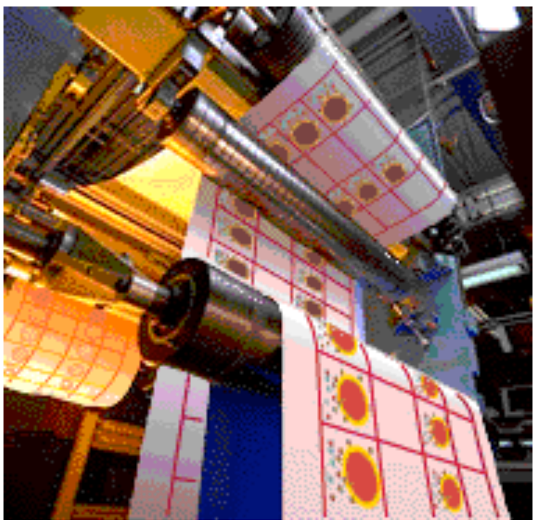
Pressroom environments are challenging. These challenges all too often translate to errors, and errors mean unhappy accountants and unhappy customers.

Equipment advances solve some problems, but all too often raise other issues and focus attention on new problems elsewhere. In ink and coating control, such advances include improvements in doctor blades, chambers and automatic wash-up systems to name a few. These changes plus pressroom pressures to increase productivity have now converged to require real improvements in viscosity control.



All press equipment, including viscometers and viscosity control systems need to be much more reliable, require significantly less maintenance, enable shorter make-ready times, and be able to operate in a world where pressman skills are decreasing.

Complexity and its impact on pressroom operations is evident in this chart which was put together by Windmoeller & Hoelscher. This shows the typical pressroom runs only slightly more than 54% of the time, with a whole series of activities taking up the rest. Two of the 'non-productive' categories are make-ready, which uses 20% of the total press time and color match which makes up 8%. The viscosity control system influences the amount of time required by both of these. This system needs to help converters reduce this non-productive time and improve run quality and productivity, to be part of the solution instead of the problem.

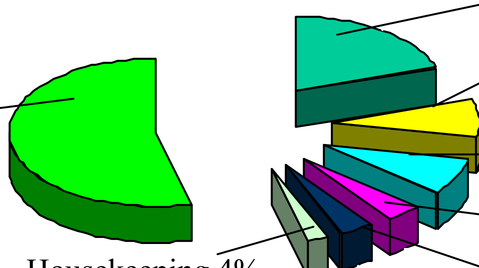


Exhibit 1: Converter Press Room Time Usage

Factors Influencing Viscosity Control Improvements

A number of factors influence viscosity control; several are particularly important to consider. These include film consistency, temperature, and color consistency.

Film Consistency

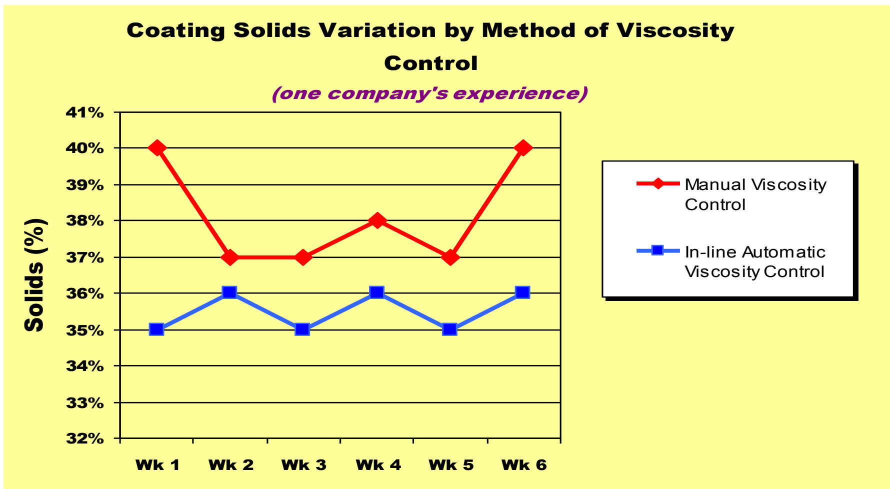


Exhibit 2: Film Consistency and Viscosity

First, let's discuss the relation between viscosity and film consistency. Viscosity relates directly to the amount of solids in the ink or coating and ties directly to the converter's costs and perceived quality. This can be clearly seen in this chart provided by Darrell Krause, a converting industry consultant, which shows the results of a 12 week test by one converter. It involved two sequential periods in which the converter controlled viscosity differently but kept everything else constant in the process, and recorded the results of coat weight tests. In the first 6 weeks the traditional manual method of viscosity control was used, while during the second 6 weeks an in-line automated viscosity control from Cambridge Viscosity, Inc. was employed.

When controlling manually, the press operator gave himself a margin for error, as shown by consistently running the viscosity higher than necessary. When the operator was not able to pay as much attention, significantly more material was applied. This extra margin translated directly into excess coating being applied and needless money being wasted. This converter saved $80,000 in coating costs per year plus improved his quality and consistency by changing to Cambridge's automatic viscosity control, according to Krause.

Ron Young of Georgia Pacific in Ft. Smith, AR concurs with Krause, stating "we have used the Cambridge system to control coatings with exceptional results across the board."

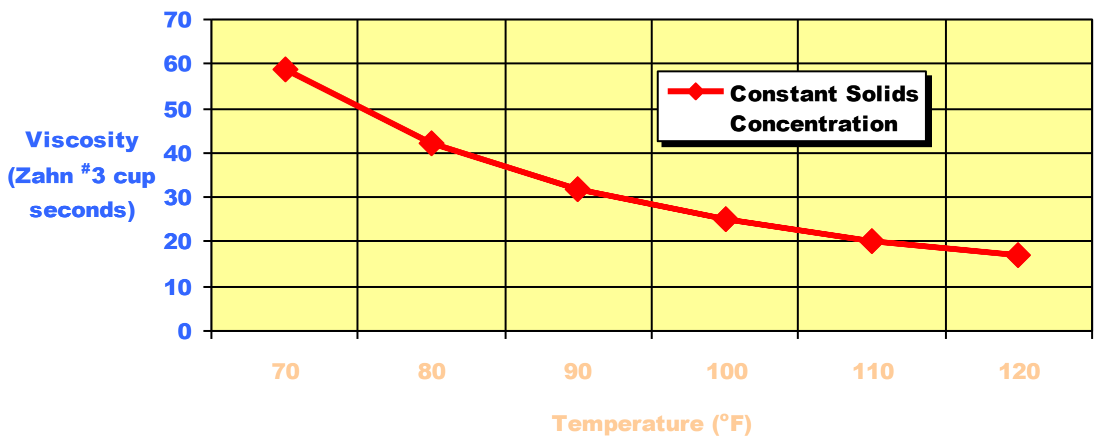


Exhibit 3: Viscosity, Temperature and Solids Concentration

Temperature

Temperature is also a key factor. It has a marked impact on the relation between viscosity and the solids concentration in the ink or coating. It would be great if the line of constant solids concentration were horizontal in this picture. This would mean viscosity could be controlled without worrying about temperature! Unfortunately, it is not. It has the characteristic curve shape shown. Whenever the ink or coating temperature varies due to changes in the press room temperature, the viscosity must be changed appropriately to maintain constant percent solids. If you are above the line, excess ink or coating material is being applied and money wasted; if below, inadequate coat weights result.

The color lab might be at 75F, for instance. Based on that, they might tell the pressman to maintain a viscosity of 50 cup seconds on a #3 Zahn cup to maintain the targeted coat weight or color concentration. In the pressroom the press might also be at 75F at start-up as well, or 50 seconds is fine. After 10 minutes of operation, however, the press might heat-up to 80F, and after ½ hour might be 85 or 90F. At these raised temperatures, the viscosity to keep the correct solids concentration drops to 37 or 32 cup seconds. If the viscosity set-point is not temperature-corrected, you are giving away money! This can be managed a couple of ways: managing absolute temperature throughout the press equipment, process fluids and pressroom; or incorporate temperature-compensation into the viscosity measurement. With today's electronics and software, temperature compensation is easily accomplished. Al Baracani of Cork Industries commented that "we have had years of trouble-free operation with the CVI (Cambridge Viscosity, Inc.) in-line viscometers. I recommend this viscosity controller in any process where viscosity and temperature are key process variables."

Color Consistency

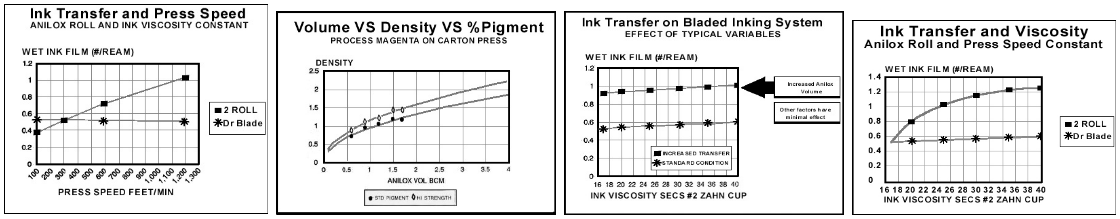
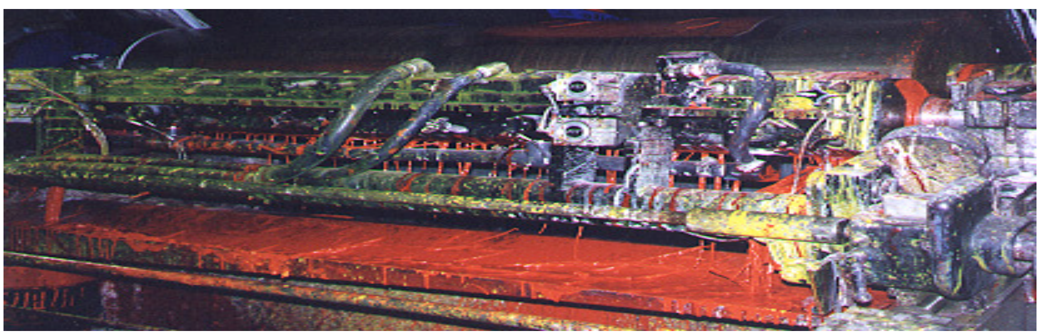


Exhibit 4: Examples of Studies Relating to Color Concentration and Viscosity

Color consistency and viscosity are also related. Color consistency is influenced by a number of factors including color density, anilox volume, ink transfer, web substrate characteristics, doctor blade use and characteristics, as well as ink viscosity. Representative results from various studies on these relations are shown here. In summary, viscosity control is important to color consistency.



Lessons Learned

We've talked about challenges and influencing factors. Now let's turn to key lessons learned for improved viscosity control.

Lesson 1: Simple closed-loop control works well. A typical closed-loop control system for converters is shown. Let's start at the mix tank. As you can see degraded material is returned from the process, new base material enters from one tank, as well as new solvent or water to re-make the degraded material. The function of the mix tank is to mix: to allow the material to be blended so that the coating or ink going to the applicator is perfect. Measuring viscosity in the mix tank gives different values depending on where it is measured, and that is fine. Viscosity should be monitored and controlled in-line on the way to the applicator: that is where the ink or coating must be right. In this chart, you can see the in-line viscometer sending its signal to a controller which controls solvent addition by opening and closing a solenoid valve.

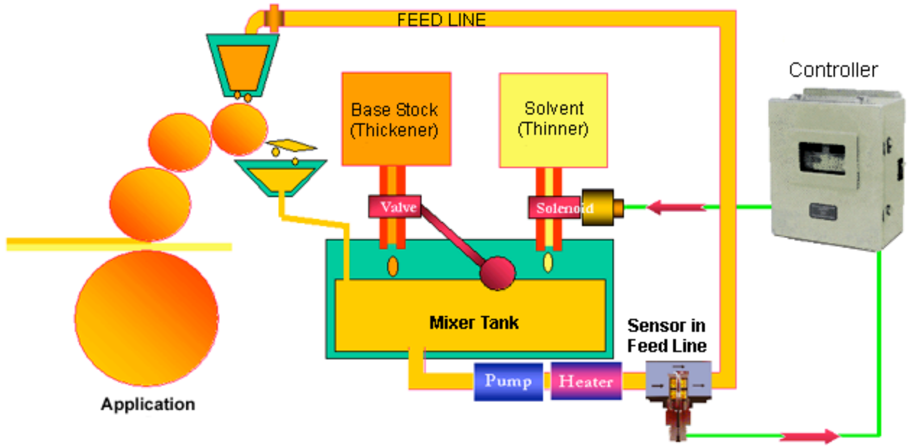


Exhibit 5: Closed Loop Control for Converters

Lesson 2: Mount the viscosity sensor in-line to minimize maintenance, the need for frequent re-calibrations, and excess spare parts. In-line mounting allows the sensor's environment to be controlled so that the requirement for press operators to maintain the viscosity sensor is minimized, which frees up the press operator time for his other responsibilities, and reduces the need to carry the expense of spare sensors and parts. This chart also indicates the flexibility of in-line mounting. It gets viscosity sensing away from high activity and high clutter areas around the mix tank.

Exhibit 6: In-Line Viscosity Mounting Flexibility

Lesson 3: Simple, inherently low maintenance in-line sensors are now available. The one shown, a sensor by Cambridge Viscosity, Inc. has no linkages and no seals in the measurement chamber to cause maintenance problems. Further, it uses the piston's motion to measure and scrub the sensing chamber clean automatically during and between ink/coating operations. In fact, the company has additional patents applied for this critical function of self-cleaning.

Paper Converting Machine Company ran tests comparing how well different viscometers survive in press room environments. When asked about the results, Craig Compton, VP of

PCMC, stated "Cambridge won the PCMC tests hands down." This sentiment has been echoed by Rich Czarnecki, Director of Polymer Chemistry for Sun Chemical, who stated "we have been using the Cambridge sensor for over two years without any downtime."

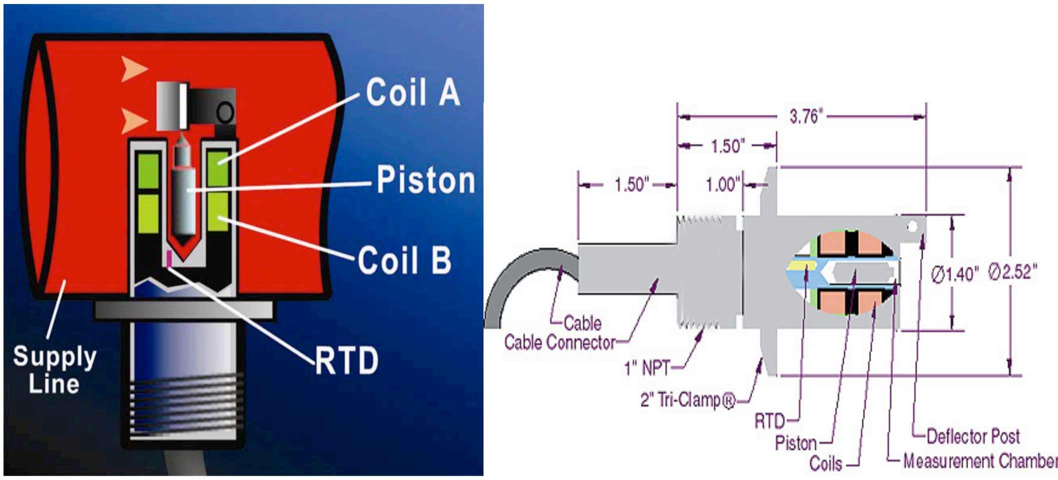


Exhibit 7: Cutaway Views of Cambridge's In-Line Sensor

Lesson 4: Adjusting for the effects of temperature on viscosity is easily accomplished. Cambridge viscometers, for instance incorporate a temperature detector in the heart of the sensor so both temperature and viscosity is recorded for each and every measurement. Cambridge's electronics integrates these to calculate temperature-compensated viscosity so that it can tell whether the concentration measured is on target or not, and then take appropriate action.

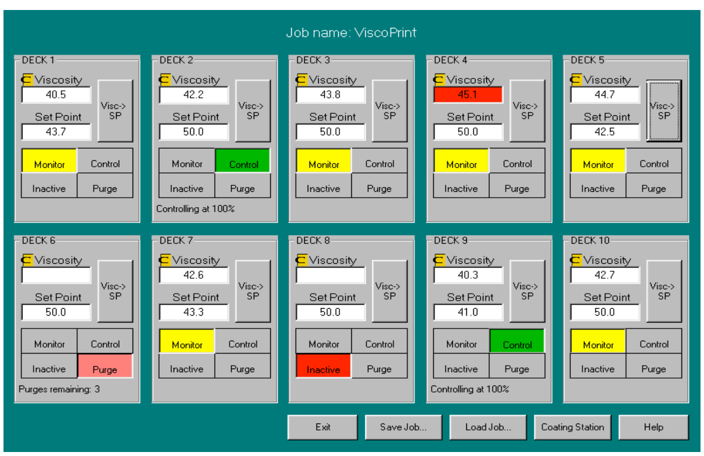


Exhibit 8: Simplified Operator Interface

Lesson 5: Keep the operator interface simple and intuitive. While today's sensors can provide tremendously sophisticated information necessary for the complexities of today's converting processes, operator controls should be obvious for the press operators.

More information about effective viscosity control for today's converting environment is available from Cambridge Viscosity, Inc. at www.cambridgeviscosity.com.