OPTIMIZING THE FLEXO PRINT STATION

HEATING, COOLING, CONDITIONING CONTROL SYSTEMS ENSURE QUALITY

By Carsten O. Schultze

Modern flexo presses—with their high speeds, integrated automatic controls, drives and functions—bring out temperature problems for inks and coatings. These problems are exacerbated by the tendency to design housings for the machines in such a closed way that it is hard to see inside the central cylinder machine.

A heating, cooling and conditioning system controls temperature and prevents problems with changing viscosities and foaming. About a dozen times, these systems have been used on modern flexo presses in Europe, and the advantages are effectively seen.

To understand how a heating, cooling and conditioning system can optimize print quality in a flexo pressroom, it is important to understand the basic print quality requirements. The parameters that are important for printability are viscosity, temperature and the pH value of the liquids.

Viscosity. The correct viscosity is the most important factor. Only with the right consistency is the printing unit able to bring the coatings and inks to the substrate on their way through the doctor blade chamber system and anilox roll. The anilox roll is the part that must be fed with media at an exact viscosity range.

Viscosity is often measured manually with test cups during printing.

For water- and solvent-based materials, the correct viscosity is also a must to get the desired color and print appearance. The intensity of the color is dependent on the ratio between the water/solvent and the coating/ink particles. The viscosity measurement and permanent control ensures this ratio by adding the smallest amounts of water/solvent as soon as the viscosity increases beyond the desired value.

Different inks and coatings are indicated for water- and solvent-based materials and for UV inks and coatings. Inks and coatings can be handled with the same technologies and systems for measuring and control. Water-based and solvent-based inks react the same; when more ink is added, viscosity decreases. UV coatings are a bit different, for the viscosity adjustment is done with temperature only. In practice, however, the same conditioning systems are used when interchanging between aqueous coatings and UV coatings.

Temperature. The correct temperature is responsible for the starting viscosity for the above-mentioned controls (but normally not for the viscosity control itself). A heated liquid has a lower viscosity than a cool one. This is especially true for UV and aqueous coatings.

Higher temperatures can affect the problem of foaming in the coating circulation. Water-based coatings might have a stronger tendency to foam around stirrers, and additional small air bubbles can be created in the anilox roller. Macro-foam is made up of large surface bubbles; micro-foam consists of smaller air particles within the liquid.

If the printing unit transfers coatings with micro-foam, for example (and especially when gloss or gold effects are the targeted outcome), the printing and coating result will fail to meet customer demands. The reason is that micro-foam has opened up holes, and the surface looks like moon craters. No shine or gloss has any chance.

Coating suppliers have developed some highly concentrated water-dispersion agents, and they continue to develop better chemicals. The target is gloss as high as it is normally achieved only with UV coatings. In order to work with those high-viscosity dispersion agents, the starting temperature must be even higher than with UV media. But keep an eye on it—too high a value will quickly increase viscosity. Therefore, minimum and maximum temperatures must be set.

pH Value. Water-based media contain additional liquids; for example, liquids to stabilize the pH value. This is important for correct transfer, and to layer the substrate with a good "gliding" of the coating where it should be.

Temperature Control

Depending on the specific coating control system, there are different ways to adjust the relevant parameters during coating and printing. The most common way to ensure the best coating result is constant temperature adjustment and stabilization with optionally integrated automatic viscosity controls. The coating control systems are set to a certain temperature value for the media. Cooling and heating elements act each time it is necessary to bring the value back into tolerance range. In this way, energy consumption is minimized.

The individual application determines if both heating and cooling are necessary, or if only one is enough for the control work. If, for example, at one machine the user is working with only metallic coatings (gold inks), then it can be handled with a cooling system only. A setpoint for the temperature of 18 degrees C. is good for most cases; ranges between 15 and 20 degrees C. are seen in practice.

The sample on the other range of the scale is found in the usage of UV coatings, supplied to the user often in a higher viscosity range. The UV coatings are best at a temperature range of 40 - 45 degrees C.

Standard aqueous coatings are usable at room temperature. If the coating heats up, the viscosity decreases, resulting in a loss of printing quality. After a longer time of higher temperatures, the water content is lost in greater amounts, and the viscosity increases again, causing variations in the coating. In addition, the coatings tend to foam when temperatures are too high.

More and more, we see new developments in high-viscosity and water-based coatings for high substrate protection and gloss. Viscosities of up to about 120 seconds (DIN 4 mm) are seen. Basic temperatures for the best usage of these coatings are in a range of 50 - 55 degrees C. An automatic viscosity control with dosing valves that add water or a water mixture at this temperature level are a must.

Viscosity Control

The best viscosity control is a direct viscosity sensor. This is comparable to manual measurements with test cups, which the printer should do from time to time. The electronic sensors ensure a constant and exact measurement each minute from the beginning to the end of the print job.

Stand-alone pH and temperature control units.

Today, rotating dip sensors are used most often. A high accuracy rate and easy handling and maintenance are the main reasons. Falling-ball or piston sensors are sometimes used as an alternative. For both rotating dip and falling-ball sensor types, a control unit transfers the measuring result in understandable values, such as seconds of specific test cups or mPas as neutral units.

A setpoint for viscosity with defined tolerances is adjusted, and the controls open dosing valves for adding water (or a water mixture) as soon as the viscosity increases above the upper tolerances by just one-tenth of a second. Viscosity ranges are between 20 and 60 seconds (DIN 4 mm), depending on the desired kind of coating and adjustments made in the anilox and flexo units. Please note that for different cups such as Zahn, ISO or Ford, the value range is different—but the viscosities are the same!

With modern doctor-blade chamber systems, viscosity ranges must be quite accurate; even with water-based materials, in which the viscosity changes relatively slowly. These changes will cause problems during coating and a loss in printing quality. A permanent, accurate viscosity measurement and control system is indispensable for many applications.

pH Value Stabilization

As with measuring and controlling viscosity, one could use a pH sensor to measure the pH value and use a control with a valve to add a liquid to adjust the pH value. But this is not the most practical method of measuring and controlling pH, and it is not necessary for all cases. It even can be more detrimental than helpful. Imagine the viscosity value (the more important parameter for coating) is good, but the pH control decides to correct its value by adding some liquid. This could throw off the viscosity, depending on what is added. Also, pH probes are expensive and need constant maintenance and cleaning.

By knowing the pH value is changing very slowly and with a kind of fixed relation to the change of viscosity, however, one can obtain pH stabilization. If the dosing valve for the viscosity control is not adding pure water only, but a mix of water and liquid for pH correction (i.e., an ammonia solution), then the print quality will be maintained for a long period of time when the starting pH is in a good range. For example, for many coatings, a workable pH range between 8 and 9 (sometimes even wider) can be held for the whole day without problems.

Separated Coating Circulation

Aqueous and UV coatings are often used in large amounts. Without a heating, cooling and conditioning system, the pump lines are simply connected directly to the big tanks containing 500 or 1,000 liters of that coating. The circulation with the coating unit at the press is done with the entire volume. Regarding any kind of control—and that means any wish for constant production quality and result—this must be seen as a worst-case scenario.

Heating, cooling and conditioning systems separate the circulation into two parts. One circulation is between the coating stations, the pumps and the production tank, containing about 10 to 50 liters. Such a small volume can be quickly adjusted for temperature and viscosity. The energy level required to keep it at the desired levels is low and efficient.

For long print jobs needing large amounts of coating, the heating, cooling and conditioning systems activate a second coating circulation between the production tank and the store tank (those 1,000-liter containers). A level control unit (mostly based on ultrasonic) measures the content in the production tank. As soon as a small, adjusted volume (used for coating) is gone, a refill pump is activated and brings in fresh media.

A viscosity controller (left) and integrated temperature and pH channels.

This is done in small amounts, and that is an important fact. A small amount of this fresh media (which is surely not correct in its temperature and viscosity) can be mixed under the correct coating in the production cycle and controlled to the desired range again in the shortest time. The quality and stability of the coating is again optimized.

The second "circulation" is in the refill pumps' reverse function. The production tank can be emptied by this reverse function, too, which helps the printer to get quicker coating changes.

Indirect Heat Transfer

The design of older conditioning systems sometimes negatively affects their ability to control the temperature of the coatings. These in-line systems attempted to use the high surface temperature to heat the coating within the shortest time possible on its way through the heating chamber to a coating unit. But high surface temperatures can cause defects to the coating pigments. In addition, the temperature control in these in-line systems was often inaccurate.

With heating, cooling and conditioning system production tanks, temperature control is achieved in a different way. The whole tank—in which the coating stays most of the time—is designed to be the heating chamber, with the whole surface in contact with the coating. The tanks are double-walled with a forced guide inside for the cooling or heating media. A permanent, well-dosed heat exchange to the coating is achieved through the stainless steel walls.

Mix it right. A special stirrer in the production tanks works to maintain a uniform temperature and viscosity and to keep the coating particles from settling in the tank and "unmixing" (which is especially important with metallic coatings). The speed is adjustable, but the stirrer always runs slow to protect the coating pigments. An enlarged special impeller guarantees a good movement in the coating, even at slow speeds. This ensures consistent printing quality.

Measure it right. The temperature control is done with a real temperature measurement in the coating itself. This is done on the only good place for it: the preflow connection to the supply pump for the coating station. The temperature is controlled for the exact volume that will be used in the coating station. Energy is thereby used with the best effect for the coating result.

About the Author…
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