2022 AIMCAL Executive Leadership Conference ▪ April 4-5 ▪ Charlotte, NC

CONVERTING QUARTERLY

Web Processing & Finishing Technologies

Vacuum-coated roll to product: What's coming?

2022 Quarter 1:

- Special Market Report on Flexible Packaging
- Basic configurations for drying & curing
- How to R2R-convert an electronic writing tablet

AIMCAL®

Official Publication of the Association of International Metallizers, Coaters and Laminators

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Web Processing & Finishing Technologies

2022 Quarter 1
Vol. 12, No. 1

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SPECIAL MARKET REPORT: FLEXIBLE PACKAGING

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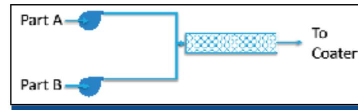
ON THE COVER: An E+R Genesis L coater engineered for the PECVD process runs film, foil and nonwoven substrates up to 1,200 mm wide at speeds to 500 mpm. (Courtesy of Emerson & Renwick [*www.eandr.com*]).



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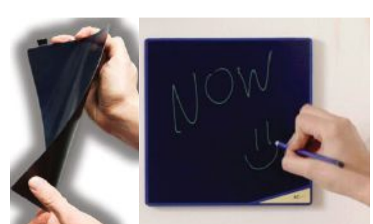

84 Roll-to-roll manufacturing of electronic writing tablets

Ink-viscosity optimization and automation systems for gravure printing and coating: Part 1

By Joe Goodbread, Ph.D., chief technology officer; Sunil Kumar, Ph.D., chief executive officer; and Manpreet Dash, markets development and applications engineering, Rheonics

While the latest printing presses are equipped with sophisticated quality control and automation systems, one of the most important variables in printing – ink viscosity – typically still is measured with inexact and cumbersome methods, such as efflux cups and falling-ball viscometers. Sensors that measure up to the accuracy operators expect from their color control and press adjustment systems enable on-line, automatic, dynamic control of viscosity within previously unattainable narrow limits, affording start-to-finish maintenance of print quality in even the longest print runs. Using accurate, repeatable viscometers with a responsive control system improves color quality and efficiency and reduces waste and emissions.

Introduction

Ink viscosity is one of the most important factors for achieving high and consistent color quality in gravure printing. Despite the sophisticated measurement and control systems built into today's printing presses, ink viscosity still is frequently measured with inefficient and inaccurate methods, such as efflux cups and falling ball viscometers.

The variability of these measurements makes consistent color quality difficult to maintain. It underscores the need for a viscosity measurement and control system that can help operators obtain the very best color quality over the very long print runs that are characteristic of gravure.

Viscosity plays an important role in the final quality of printed matter. Ink layer thickness and flow behavior deviate from the optimal values when the viscosity is incorrect, resulting in substandard print quality. Poorly adjusted ink viscosity also can lead to excessive ink consumption and unnecessary costs. Accurate viscosity measurement and control substantially can improve print quality, while reducing waste and boosting efficiency.

Even though methods now are available for continuous in-line measurement of ink viscosity, many are sensitive to contamination, installation variables and baseline shifts, which can impair operator confidence and cast doubt as to their long-term reliability. We will show the value of stable, easily cleanable and repeatable viscosity sensors in printing processes. We will support our conclusions with experience and data from printers that have been using our sensors and automation systems over a period of several years.

A further benefit of high-accuracy viscosity measurement and control is on-line, automatic, dynamic control of color accuracy within previously unattainable narrow limits, thus ensuring high and consistent print quality over even the longest runs.

Technical challenges of on-line ink viscosity measurement and control

Goals of viscosity control: Print and color quality are paramount. With very tight profit margins in a highly competitive industry, each job rejected for poor print quality can damage the gravure printer's reputation while resulting in tons of waste. Automated on-line viscosity control can maintain print quality from start to finish, regardless of how long or complex the job might be.

A further benefit of ink viscosity control is improved operating efficiency. We will show how tight viscosity control reduces setup times and reduces scrap, making gravure more agile and competitive with flexography and

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FIGURE 1. *In-line viscometer, based on balanced torsional resonator principle*

digital printing. Fast setup time translates to rapid job turnover, keeping the presses printing instead of idling.

Achieving these goals requires a *system*: On the one hand, an accurate and repeatable sensor is needed that can provide the viscosity resolution necessary for printing accurate and consistent color. It is equally critical to have an automatic control system that constantly adjusts ink viscosity, regardless of temperature variation and solvent evaporation.

Accuracy of ink-viscosity measurement: Traditionally, ink viscosity is measured with a viscosity measuring cup. Cup measurements never have been totally standardized and are only "reliable" over a relatively narrow measuring range with a typical margin of error of 5 to 10%. Some of these errors are caused by dirty, worn or damaged cups, while others are a function of operator skill. Cup measurements are not sufficiently repeatable. Temperature, which has a strong influence on viscosity, is difficult to control when using a cup. Contamination of the cup and different densities of inks influence the run-out speed. All of these add up to poor repeatability and inaccuracy of viscosity cup measurements.

One early adopter of the high-accuracy measurement and control system described in this article previously had used a great variety of viscosity sensors in its printing plant, including a variety of resonant sensors whose vibrations are damped by the ink's viscosity. Electronics units connected to these sensors evaluate the damping of the vibrations and translate it into a viscosity measurement.

One particularly compact, robust and accurate sensor is based on a so-called "symmetric torsional resonator" [i]. Hereafter referred to as the symmetric resonator viscometer (SRV), it offers high accuracy – better than 5% of the actual reading, and reproducibility better than 1% of its reading, making it particularly suitable for high-accuracy, reproducible job-to-job color matching (see Figure 1).

FIGURE 2. *Installation of a symmetric resonator viscometer (SRV) using a flow adapter in an ink-delivery system (note the yellow oval)*

Because its resonator is completely balanced, its accuracy is immune to its mechanical environment.

Its accuracy was tested on site by adding 20 gm (0.7 oz) of solvent to 25 kg (55 lb) of ink – a very small dilution. The sensor (installed in the press ink line) registered a viscosity change of 0.1 mPa.s, which is the equivalent of a cup-measurement difference of 0.02 secs. This is a previously unknown accuracy of measurement of viscosity in this industry, and because the viscometer incorporates an accurate temperature measurement into the sensing element, it is possible to compensate the measured viscosity for the effects of temperature.

One user of the SRV technology found that its viscosity measurement with a cup was not only outdated but counterproductive. It stopped converting to cup-seconds altogether, elevating its viscosity measurement to the same technological level as the rest of its printing and laminating systems.

Installation on the printing press: Two options are available for installing the in-line SRV system. On machines with fixed inking systems, the sensor is mounted in a fitting with an inlet and outlet opening and installed in the supply line between the ink pump and the doctor chamber. The sensor can be mounted next to the diaphragm pump with no effect from flow pulsations or machine vibration (see Figures 2-3). In this kind of installation, the sensor is cleaned by the normal washup procedure, being bathed in a continuous solvent stream along with the pump, doctor chamber and piping.

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FIGURE 3. *A symmetric resonator viscometer (SRV) installed on a press using a tee adapter*

The sensor is maintenance-free; each cleaning cycle of the lines and gravure doctor-blade chamber ensures that the sensor is clean again because it is automatically washed in solvent. As shown in Figure 4, only a very thin haze of color may remain on the sensor, which has no influence on its accuracy or repeatability. Because of the sensor's robust construction, any necessary cleaning, such as after a long shutdown with inadequate washing of ink lines, can be done with a solvent-soaked rag, with no danger of damaging the sensor or changing its calibration. ■

Part 2 of this technical paper will cover challenges specific to gravure printing and coating, predictive tracking control and achieving sustainability goals with complete viscosity-automation solutions.

Footnote and References

[i] US Patents 10,502,670 and 9,267,872

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FIGURE 4. *The SRV sensor after measurement in cyan ink*

Joe Goodbread, chief technology officer at Rheonics (Winterthur, Switzerland), holds a B.S. in Aerospace and Mechanical Engineering Science from Princeton University, an M.S. in Biomechanics from Stanford University and a Ph.D. of Technical Science in Biomechanics from ETH Zurich. He is a founding member of the team that developed the firm's core technologies over the past 30 years. Joe established and directed the Experimental Mechanics Laboratory at the Institute for Mechanics, ETH Zurich. He has developed substantial IP in the field of fluid-properties sensors with 11 granted patents and several more pending. Joe can be reached at +41-78-735-1273, email: joe.goodbread@rheonics.com, https://rheonics.com.

Sunil Kumar, chief executive officer at Rheonics, holds a Bachelor's in Aerospace from the Indian Institute of Technology, Kharagpur, a Master's in Mechanical Engineering from the University of California, Irvine, and a Ph.D in Electrical Engineering from Imperial College, London, where he developed the Seis-SP seismometer that is part of the main payload for the NASA Insight mission to Mars. He has extensive experience in the sensors and energy sector, having worked in a variety of roles in engineering and research in his early career. Most recently, Sunil worked at Baker Hughes, where he led global engineering for drilling services. He can be reached at +41-52-511-3203, email: sunil.kumar@rheonics.com.

Manpreet Dash leads the markets development and applications engineering team at Rheonics. He holds a Bachelor's in Mechanical Engineering and a Master's in Industrial and Systems Engineering (Dual Degree) from the Indian Institute of Technology, Kharagpur. During his studies, he worked on developing fluid-characterization models in thermal spray-process applications. Manpreet co-founded the IIT Kharagpur Young Innovators Program and is a recipient of the Institute Silver Medal. He can be reached at +91-99339-40602, email: m.dash@rheonics.com.