Circuit Board

Reprint 144

Better Viscosity Yields Better Circuit Boards

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Automatic viscosity controllers are helping Westinghouse Electric Corporation meet customer requirements for high quality laminated circuit boards. Built for the company's Specialty Materials and Copper Laminates Divisions, the controllers replace time-consuming and imprecise, manual control techniques on seven fiberglass cloth treating lines at plants in Hampton and Pendleton, South Carolina. The newest controller, a microprocessor-based system, was recently installed at Hampton, bringing the total number at that plant to five.

Like its predecessors, the new controller supplied by the Norcross Corp. (Newton, MA) continuously measures the viscosity of epoxy. The controller automatically adds solvent as required to maintain the epoxy at a viscosity that will ensure uniform coating of the fiberglass and absorption at a constant rate. In addition, the new controller responds quickly to correct a wide variety of viscosity deviations, which are characteristic of the process. It provides digital displays of the viscosity in familiar centipoises. The result is a significant decrease in rejects and an increased capability for producing boards of precise thicknesses. The system provides an accurate status of the epoxy during production and calls attention to certain process irregularities. This provides the opportunity to interrupt cloth treatment and correct the problem before quality is compromised. It also speeds up the process and simplifies quality control procedures. It does the latter by eliminating the need for manual additions of solvent and frequent sample checking by the lab whenever raw epoxy is added to the mix tank during a production run.

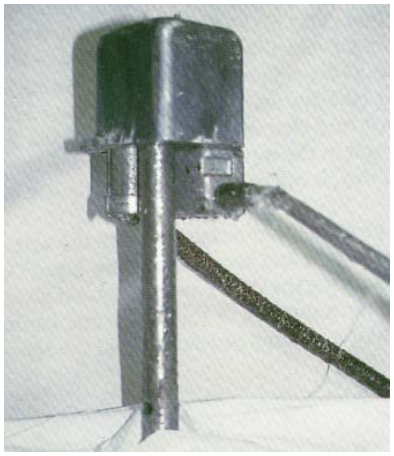

Fig. 1 — The stainless steel measuring element is submerged in the epoxy mix tank.

A System that Handles Volatile Solvents

The new viscosity control system consists of a measuring element mounted at the top of the resin mix tank, a stainless steel measuring tube submerged in the epoxy (Fig. 1), and a remotely mounted digital controller (Fig. 2). Because of the volatile nature of the solvents, all electrical components of the measuring element are UL listed for operation in hazardous environments. The controller is contained in a NEMA JIC enclosure. An Omega temperature indicator is included to display the epoxy temperature as measured by a thermocouple in the tank.

The piston in the measuring element (Fig. 3) is cycled about twice per minute. It draws epoxy into the measuring tube (Fig. 4) when raised by air pressure, and expels epoxy through the path it entered when allowed to fall by gravity. The interval between the top of the piston stroke and the bottom is electronically timed by the controller. The piston time-of-fall — which is a measure of the epoxy shear strength and proportional to the viscosity — is displayed digitally to either the nearest 0.1 s or 0.1 centipoise. During startup, the system is operated manually with solvent additions triggered by a pushbutton on the controller.

Getting Started

When the operator believes that the viscosity is satisfactory, a sample is sent to the plant laboratory for analysis. Based on the finding, the lab establishes a setpoint in centipoise for

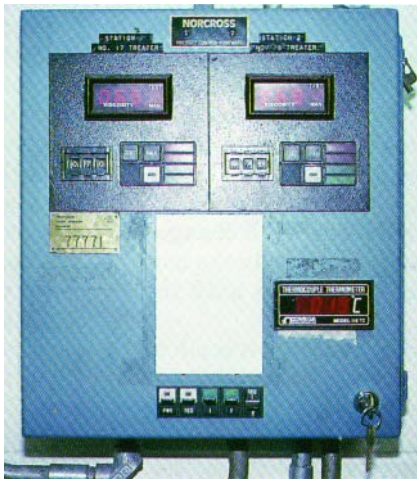

Fig. 2 —Remote digital controller is housed in a NEMA JIC enclosure and mounted on the wall of the treater room.

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the production run. The operator then dials the setpoint into the controller and equates the piston time-of-fall to the setpoint value in centipoise. If the viscosity exceeds the setpoint by a predetermined amount, the controller adjusts the viscosity by making solvent additions until the setpoint is reached. Similarly, if the setpoint is changed at any time, the controller adjusts the viscosity to the new setting by either adding or withholding solvent until the setpoint is reached.

When the epoxy reaches the proper viscosity, it is circulated between the mix tank and a treater. The treater impregnates the epoxy into the wide fiberglass web. During this time the controller constantly measures the viscosity and quickly corrects deviations by means of a dual stage solvent addition feature. If the viscosity varies between 2 and 10 centipoise above the setpoint, the controller energizes the smaller of two solvent addition valves for a predetermined time period. Thus, the viscosity is maintained through small incremental additions of solvent. If the viscosity variation is greater than 10 centipoise above setpoint, the controller energizes the larger valve for a predetermined length of time.

The larger valve is also the one energized by the operator via the controller while the system is in the manual operating mode.

Whenever the viscosity either exceeds or lags the setpoint by 10 centipoise, high and low alarm lights on the controller signal the operator. There is also a "loss of solvent alarm" consisting of a 110V ac signal. This signal is generated whenever the controller has tried to make six consecutive solvent additions. The alarm condition could result from:

A loss of solvent supply pressure -—solvent is not being added to the mix tank as called for by the controller;
The system taking an excessively long time to restore the viscosity after a large batch of raw epoxy was added to the mix tank.

In either case, the operator has to check the epoxy and, if necessary, turn off the treater until the proper viscosity has been restored.

Maintenance and Data Tracking

Concerning maintenance, the flushing action caused by the piston cycling in the tube provides self-cleaning for the measuring element. However, to eliminate cleaning whenever the resin tank is shut down or emptied, the operator removes the wetted parts of the measuring element and inserts them into a solvent-filled tube welded to the side of the tank. Remarks Oliver Barnes, senior facilities engineer at Hampton, "It [the system] works great as long as they remove the measuring element from the resin tank when not in use and put it in the solvent tube fastened to the side of the tank. This way, it can soak and be ready for use when required."

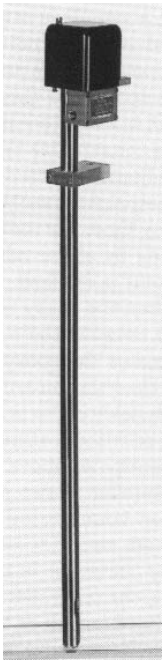

Fig. 3 — The measuring element has a piston that is cycled twice per minute.

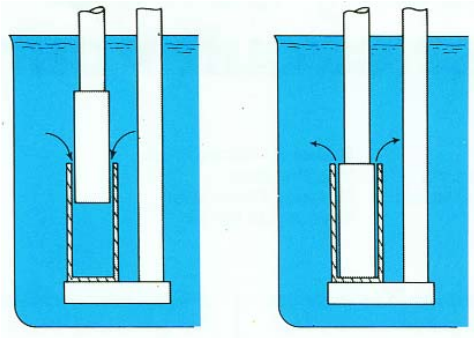

Fig. 4 — Schematic shows the operation of the measuring element.

Operators are given another advantage with the new system: The displayed data and temperature are logged routinely for each job during the run. This log makes it possible to relate problems encountered in the curing and laminating process to the viscosity and temperature of the epoxy.

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