CASE STUDY

Progressive Cavity Pumps Cut PC-Board Coating Costs

Printed circuit boards are used in nearly everything today from computers and kitchen appliances to automobiles and heavy industrial equipment. And although many of the applications are quite rugged, they belie the delicate accuracy of printed circuits whose quality is often measured in terms of mils and microns.

Thus, the precision, reliability, and repeatability of printed circuit board manufacturing processes are crucial to PC-board performance in critical end-user applications. Nowhere is this better understood than at the Photopolymer Systems Division of W. R. Grace & Co., which manufactures a fully-integrated package of application equipment called the Accumask Electrostatic Solder Mask System. Designed to coat and dry both sides of a printed circuit board in one step, the unit is sold to manufacturers that provide finished circuit boards for use in industrial and consumer applications.

PUMP PROBLEMS

Field reports indicated that the Accumask automated coating system that applies specialty resins to PC-boards had been experiencing costly maintenance-related problems. The source of the problems seemed to be the feed pumps used in transferring the solution to the unit's spray nozzles. The pumps were unable to maintain consistent flow rates over sustained operating periods due to leakage and/or inability to accommodate changes in pressure.

By switching to a new progressive cavity pump, however, the W. R. Grace Photopolymer Systems Division saved itself and its customers time and money by eliminating non-scheduled pump downtime for maintenance and repairs.

COATING PROCESS IS CRITICAL

In the Accumask process, an operator first loads clean, uncoated circuit boards into the unit's conveyor system which sequences them automatically at one-inch intervals. The panels are then conveyed into an enclosed spray booth at a rate of about 130 boards per hour. During this process, the first of two atomizers electrostatically applies a photo-definable dielectric coating, or solder mask, to one side of the panel. The panel is then flipped or rotated 180 degrees and the second atomizer sprays the other side.

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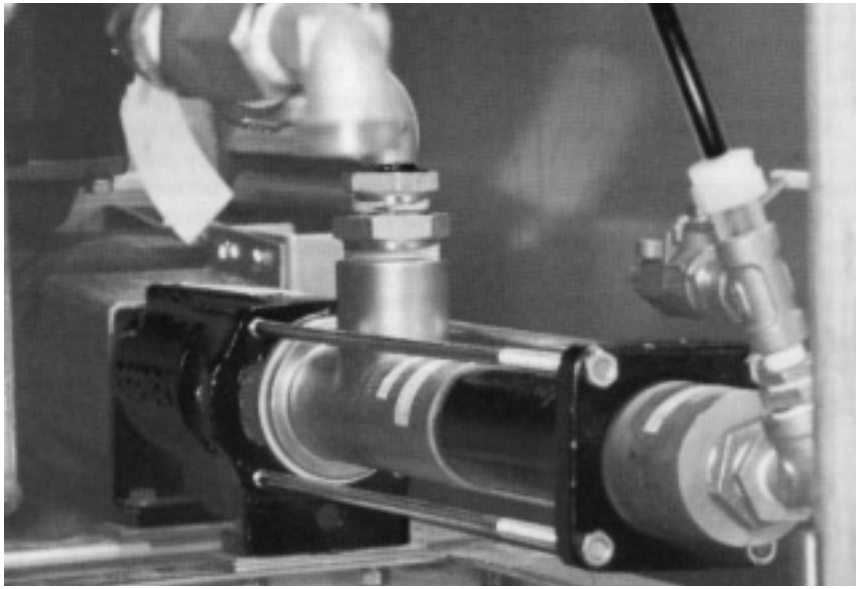
As the panels pass through the spray cycle, the atomized solder mask builds up a uniform, defect free coating without skips, voids, or sag. The solder mask provides both insulation and protection for the circuit boards. After coating, the panels are conveyed to the unit's convection over for drying. From there, the boards are racked and prepared for further processing. The Accumask system runs automatically and continuously, although it can be operated intermittently as well.

PROBLEMS DEVELOP

During a coating sequence, the solder mask must be pumped from Accumask's utility room to the unit's two reciprocating atomizers. The chemical composition of the epoxy-based coating, however, was causing persistent pumping problems. The shear-sensitive, partly abrasive, partly corrosive, viscous solution consists of about 50% solvents and 50% dielectric material. The pumping distance of about six ft also compounded the problem.

The pumping operation begins when an operator mixes the various components of the solder mask in a paint shaker and then empties it into a stainless steel gravity-feed vessel. The vessel is mounted on a three-legged stand with an electronic load cell supporting one of



the legs. The load cell weighs the vessel's contents and relays that information to the Accumask's control panel so the operator can see when to add more coating.

The vessel feeds the solder mask, as required, to the suction side of each of two identical pumps installed beneath it. The pumps, which are regulated by the unit's control system, transfer the coating at 70 to 90 grams/min via polypropylene tubing through a 20-micron stainless steel filter to the twin atomizers.

An inconsistent flow of solder mask solution represents a potential quality control problem for Grace's customers by causing slight variations in the thickness of the coating applied to the circuit boards. While not necessarily sufficient in itself to cause a reject, these variations do not optimize the insulative and protective properties of the dielectric material.

To resolve this problem, Grace had tried using several different types of both progressive cavity and gear pumps. In each case, however, the pump was unable to maintain a consistent flow rate over an extended operating period. This meant that Grace customers and the equipment operators in particular had to monitor flow consistency very closely and make frequent corrections or adjustments.

STATOR DESIGN/ CONSTRUCTION IS KEY

Grace turned to seepex, Inc., Dayton, OH, for a solution to its pumping problem. Extensive research and design studies were conducted by seepex before suggesting a Type NS progressive cavity pump. Although designed to handle liquids of all viscosities as well as products with high solids content, the major difference in this pump is that its construction features a stainless steel housing, a Duktil-chromium rotor, and a molded-to-size EPDM stator.

From Grace's point of view, the customized seepex stator was the critical difference for several reasons. First, the NS's stator is molded to size rather than molded in long tubes and then cut to a desired length as is common practice. Thus, the pump's seal collar can be molded at both ends as an integral part of the stator. Corrosion of the tube is rarely a problem because the pumpage does not come into direct contact with either the bonding adhesive holding the elastomer to the metal stator tube, or the tube itself.

Second, most standard and cut-to-size stators have cylindrical cores that are uniform throughout their entire length. During the vulcanization process, however, the stator elastomer shrinks more on the ends, creating different compression ratios at different points along the rotor/stator interface. This, in turn, causes fluctuations in the fluid flow. The seepex core

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design compensates for this phenomenon, ensuring an identical compression ratio along the entire stator length.

Grace also conducted its own independent evaluation of the pump. In 1992 company engineers put the Type NS through a series of five basic tests. The first two test determined the consistency of the solder mask's flow over time with respect to: 1) changes in the coating's viscosity, and 2) changes in pressure head.

The third test was to determine the pump's compatibility with various Grace coatings exhibiting different rheological profiles. The fourth test was for leakage, and the fifth was to determine visible wear on the pump's internal structure.

After running the pump continuously for 285 hours, the engineers came to two main conclusions. First, the pump was still performing consistently with "no visible signs of wear." And, second, they noted that the main difference between the seepex Type NS progressive cavity pump and a competitive pump of the same type also with an EPDM stator was that there was no solvent leakage through the Type NS. The other pump, however, failed after 100 hours. From that time on seepex progressive cavity pumps were installed on all new Accumask units from W. R. Grace.

MAINTENANCE DOWNTIME REDUCED

By adopting seepex pumps for use in its Accumask system, Grace reduced the cost of maintaining the pumps. It also eliminated the extra time customers were required to spend monitoring the consistency of the solder mask flow rates. Because seepex uses a dedicated stator mold and injection molding machines for each of its elastomers, Grace is assured of installing a pump that is free from any possible elastomeric contamination—a potential source of flow problems.

According to Lance R. Smith, Grace technical service manager for board fabrication, "Pump downtime is now zero, compared to an unacceptable rate of 1-2% before we installed the seepex pumps." He also says that the company has been able to alter the pump section of its recommended preventive maintenance (PM) schedule provided with the Accumask system.

Previously, the schedule called for a daily pump PM program. Now, with the established track record of the new units in the field, Smith says that the company recommends only a monthly PM program. This saves customers considerable time and money. And he adds "We may soon recommend just a quarterly maintenance check." ■

seepex, Inc., Enon, OH

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