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EFI POLYMERS

FORMULATED SOLUTIONS WORLDWIDE

EFI Polymers Best Practice Guidelines for Epoxy Potting Process

Processes: Epoxy Potting Material Storage, Handling, and Processing Guidelines

System:
General Epoxy Systems

The Technical Data Sheet for each system gives data characterizing each component and the properties of the cured system.

Health and Safety Guidelines

Epoxy products are chemical components and workers should always practice personal protection guidelines specified by the SDS for each material. Please refer to the SDS documents from these components prior to working with these materials.

Receiving

Inspect all incoming materials for damage, verify part numbers and labels against the purchase order, and review certificates of analysis. Segregate unapproved materials until inspection is complete. Record lot numbers in the ERP system for traceability, and release only approved materials into active inventory.

Warehouse Storage of Inventory

Store materials in a temperature-controlled warehouse maintained at 25°C ±5°C and 50% RH ±25%, ensuring protection from direct water contact. Continuously monitor and record temperature and humidity levels. Use FIFO practices by assigning relative age through lot numbers and implement lot control to manage physical inventory and maintain traceability throughout the internal supply chain.

Quarantine Procedures

Establish an area or method of quarantine available to hold questionable or unapproved material and prevent it from accidental use in production.

Inspection of Material

Material and mixing equipment should be periodically inspected. Look for abnormalities.

Dispensing Process

Notes: The following guidelines focus on quality control procedures that ensure proper mixing and dispensing of EFI potting systems. The steps required to accomplish the sampling and verification recommended here will depend on equipment design. Please refer to your supporting documentation and recommendations from your equipment supplier to define the steps required to complete the testing and verification recommend below.

Pre Dispensing Check List for Equipment

1) Station a spill containment kits at the location of product transfer for quick response to spills.
2) Clearly label supply tanks for each component such that accidental cross contamination of Potting System Parts A and B cannot occur!
3) Verify supply tanks are filled to proper levels, product is degassed and nitrogen blanket or desiccant dryers are in place and properly maintained.
4) Verify all supply pumps and metering cylinder parts are properly lubricated to prevent iso reaction on critical parts.
5) Verify air supply pressure setting and dryer function for all pneumatic inputs.

Material Verification Dispensing Check List

Note: These test procedures ensure that the meter mix dispense equipment is properly metering the potting system to the specified ratio, that the materials are flowing simultaneously (In phase) and that the flow rate through the static mixer is providing sufficient mixing to allow proper cure of the material. The following testing should be completed in the sequence outlined below.

1) Follow start up guidelines for the equipment.
2) Ratio Check (quantitative data test, perform prior to each the start of each production shift)
    a. Ratio Check Schedule: Perform ratio checks to verify proper metering by the equipment at the start of each production shift. Additional ratio checks should be performed if the static mixer is changed, the equipment is turned off and restarted, a supply tank runs dry, air is introduced into the equipment due to maintenance or if the operator or

supervisor suspects the material is not curing properly (Triggers to perform additional ratio checks: tacky surface, lack of hardness development, variations in shot size, constant drips from the manifold or static mixer when the equipment is not dispensing)

b. Ratio Check Guidelines:
    i. Follow the equipment supplier's step by step guidelines for ratio check sampling.
    ii. Equipment and materials needed to perform ratio check
        1. A shot splitter is typically provided by the equipment manufacturer to allow dispensing into separate disposable cups.
        2. Disposal paper or plastic cups.
        3. A gram scale accurate to a tenth of a gram.
        4. QC log to record data and calculate ratio.
    iii. Pre-weigh 10 cups to ensure equal weight.
    iv. Visually check the manifold to ensure the device is clean and attach the shot splitter provided by the equipment manufacturer.
    v. Take a test shot to ensure the flow of parts A and B are separated cleanly and the splitter ifs functioning properly
    vi. Take 5 samples using cups to capture separate samples of Parts A and B and keep each set paired together for weight measurement.
    (Note The 5 sample shots should be a minimum of 100 grams of the largest volume part and should be taken as a continuous stream. Do not repeatedly start and stop or pulse the flow into the cups)
    vii. Place an empty cup on the scale at tare to zero grams.
    viii. Weigh each pair and record weights into QC log.
    ix. Calculate the ratio (wt. of Polyol / wt. of Isocyanate)
    x. Dividing the weights of each paired sample recorded in the QC log will produce the samples data. All calculated ratios should be within 5% (+ or -) of the specification.
    xi. All 5 samples should fall within this acceptable range. If one or more calculated ratios do not conform. Follow the equipment manufactures guidelines for trouble shooting ratio failure until the ratio sampling conforms to the guidelines.
    xii. Indications of ratio failure:
        1. Parts do not cure even when heated overnight at 50 C.
        2. Parts are sticky after full cure
        3. Parts have a low durometer hardness after full cure
        4. Parts have a significant variation in color (too dark or too light)

5. Cured material softens and flows when heated above 50 C.

3) Test for Phasing (Qualitative or video visual test to be performed prior to the start of each production shift)
   Note: Phasing occurs when the two liquid components parts A and B do not flow simultaneously during the dispense shot. This phenomena can be observed visually or recorded by the video feature of a smart phone.
   a. Visually check the manifold to ensure the device is clean. No shot splitter is required.
   b. Place a cup under the manifold and dispense a series shots.
   c. Observe or record the flow of material from start to stop.
   d. Parts A and B should begin and end together. This is especially easy to see using the slow motion feature on a smart phone camera but can also be easily observed visually.
   e. Record the result of phasing as pass (flows together and ends together) or Fail (one part begins and ends before the flow of the other part)
   f. If phasing is detected follow the equipment manufactures guidelines for trouble shooting phasing failure to resolve the issue.
   g. Indications of phasing
      i. Parts have a small tacky spot that does not cure completely. Typically, these occur on the top or the bottom of the part.
      ii. Parts do not cure evenly even when cured when heated overnight at 50 C.
      iii. Parts have a swirl in color or clarity.
      iv. Parts have a low durometer hardness after full cure

4) Sample Cure and Hardness Testing (can be done to characterize how machine is working).
   a. Place a static mixer on the manifold and dispense two 50 grams shots to wet the mixer completely.
   b. Take two samples by placing a disposable cup below the static mixer and dispense about 150 grams into each cup.
   c. Allow material to cure according to recommended cure schedule. Allow sample to cool completely to room temperature (if sample is hot, results may not be accurate) and test and record hardness.

Potting Conditions and The Effects of Temperatures and Humidity

Temperature and humidity have a significant impact on the potting process. The following principals apply to all potting processes:

Heat & Temperature:

1) Stable temperatures and controlled humidity provide the best conditions to control the potting process.
2) Process temperature affects viscosity, air release, shrinkage, exotherm and stress. As the temperature of the potting material increases; viscosity decreases and the potting material become thinner and flows better throughout the part releasing air faster. Typically elevated temperatures result in better potting conditions.
3) Potting compounds cure through chemical reaction. As temperatures increase the potting components react faster and generate higher exotherms. In some cases, the reaction rate becomes too rapid and potting quickly builds viscosity hampering air release. Additionally, faster reaction rates increase the exotherm (heat generated by the thermoplastic reaction). The result is typically an uneven distribution of heat within the part. Areas where larger bodies of potting are concentrated become too hot causing stress and shrinkage of the potting during cure.
4) Controlling the temperature of the process requires control of 3 variables:
    a. Material temperature (heated hoses and supply tanks are commonly employed)
    b. Part temperature (most important when parts have a significant heat sink)
        i. Pre-heat parts to a standard temperature
        ii. Control the temperature of stored parts
    c. Environmental / work place temperature (best if controlled at 75 F +/- 5 degrees) or curing in a controlled oven at a given set point.
    d. When conditions allow for control of a single temperature variable the process will be inconsistent and adjustments will need to be made to improve consistency. (For example, if the potting material is heated but is dispensed into a cold part with a big heat sink the material will quickly cool to the temperature of the part and the reaction rate will slow down and the viscosity will increase reducing air release.)
    e. The steps and set points for optimizing material temperatures, part temperatures and curing conditions will vary with each process location. The process will be most difficult to control when temperatures and conditions of the parts and the curing area are allowed to vary more than 10 degrees F with changes in season. Best practice for these variable conditions is to adjust the material temperature to compensate for colder parts and curing temperatures.

Humidity:

1) Humidity above 50% can affect the potting process for both epoxy and urethane compounds.
2) Effects of humidity on epoxy potting
    a. Moisture contamination of epoxy system components is less pronounced than urethanes. Typically, epoxy resins (Part A) are quite tolerant of exposure to moisture. The amine hardeners (Part B), can react with moisture in the air and form a salt on the

surface of the liquid. This presents as a white to yellow crust on the surface of the amine or on the sides of a tank or container. This material should not be used preventing these solids from fouling the meter mix equipment.

b. Humidity levels above 75% can also affect the surface of parts potted with epoxy systems as they cure. In these conditions, the amine in the uncured, mixed potting material reacts with moisture in the air resulting in a white or hazy film that is often sticky on the surface on the part. This film of poorly cured material is typically very thin (1-2 mm) and does not affect the integrity of the potting below the surface.

Curing Conditions and The Effects of Temperatures and Humidity Cure cycle:

1) The effects of temperature and humidity are the same for curing as they are for potting.
2) Elevated temperature or oven curing accelerates the curing process and reduces time available for humidity to adversely affect the surface.
3) As discussed above, stress and shrinkage are indications that the curing temperature is too high.
4) Finally, controlling the temperature and humidity of the curing process will ensure a consistent process.
5) Many customers rely on curing at ambient conditions. This work well when the environment is climate controlled for temperature and humidity. For those companies curing in an uncontrolled factory environment, the speed of cure and the effects of high humidity are constant issues that lower productivity and result in higher process failures.