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ToolKit

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Using Solvent Resistance to Measure the Cure of a Coating System

Introduction

Solvents, specifically Methyl Ethyl Ketone (MEK), are often used to measure the level of cure of coating systems. While this method of measuring cure has a certain appeal due to the short time and relative ease with which the test can be performed, the method's test results can be misleading, making it difficult to quantify cure response.

Cure

In the prepaint industry the dominant coating technologies are "thermoset" or "thermosetting" systems. In such systems, a resin, often a polyester, reacts with a crosslinker, such as a melamine or isocyanate, during the baking (curing) process. Developing an appropriate degree of crosslinking is critical to achieving the desired physical, moisture resistance and exterior durability properties of the coating. As the coating is transformed from a liquid state to a solid coating, it is necessary to measure the degree of crosslinking to ensure the coating system has been cured.

Discussion of Ambiguities

There are several ways to measure the degree of crosslinking in a laboratory setting, by either analyzing the chemical bonds associated with crosslinking or by measuring the temperature of a critical polymer transition known as the glass transition, or Tg. These laboratory methods, including Fourier Transform Infrared Analysis (FTIR) and Thermomechanical Analysis (TMA), are not practical in a production environment. The only method to date that is suitable under production conditions is measurement of solvent resistance.

The basis for the solvent resistance test method is the fact that as a coating crosslinks it becomes more insoluble. The most commonly used test method is ASTM D 5402-06, "Standard Practice for Assessing the Solvent Resistance of Organic Coatings *Using Solvent Rubs*", Method B (Coil Coater's Method). The highlights of Method B can be summarized as follows:

- Use moderate to severe pressure (2000 – 3000 grams of force)
- Mark an 8" x 1" area on the coated surface to test
- Fold cheesecloth, of the proper type and grade specified in the standard, into a double thickness and saturate it to a dripping wet condition with specified solvent
- Place index finger into center of cheesecloth and rub the test area at a 45° angle
- One forward and back motion is one double rub. Typically, the coating manufacturer will specify the number of double rubs to be performed (often 50 or 100 minimum).

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- Reposition finger on an unused portion of cheesecloth and resaturate cheesecloth every 25 double rubs
- Repeat until the predetermined number of double rubs have been performed or until the substrate becomes visible (disregarding the ends)

There are some ambiguities associated with this test method which can lead to a subjective interpretation of the test results. Different types of coating systems have different test results using the solvent resistance test method. Listed below are some of the variables associated with solvent resistance testing::

1. If the coating has weak adhesion to the layer immediately below, it is possible that the solvent resistance test will yield a "false negative". In other words, the number of double rubs may be unexpectedly low, but the failure is actually the result of poor adhesion, not lack of crosslinking
2. When running the solvent resistance test, the failure point is not always completely evident. Two operators can disagree considerably about the actual failure point and how significant the break is at the heel and toe (the ends).
3. The test can yield varying results as the stroke rate and downward pressure can vary among different individuals or with the same individual at different times.
4. The level of solvent resistance alone does not determine whether a coating is fully cured. Some coatings may become resistant to solvents before they have attained proper cure.
5. Rubs on metallic coatings may vary with metallic content and particle size.

Automated Methods of Measuring Solvent Resistance

Mechanical methods of measuring solvent resistance have been developed, using automated test devices, that reduce variability in pressure, angle, stroke rate, etc. Although mechanical devices are now widely used by many coil coaters, even with these automated test devices, some variability remains. For example, sometimes mechanical testers will break through to bare metal, but they will smear the dissolved coating back and forth making it difficult to determine when the initial break through occurred. Standardized methods of using these automated devices are currently being developed within consensus standards developing organizations.

Summary

The solvent resistance test is a practical, reasonably accurate, and fast method of measuring the cure response of a coating; however, interested parties should be aware of the limitations of this test method to determine whether a coating system has been fully cured. When combined with other common coil coating tests used in the production environment (pencil hardness, t-bends, impact resistance, etc.), the quality and performance of prepainted metal can be maintained at a very consistent level.

Other Solvent Resistance Methods in Use

1. NCCA Technical Bulletin 4.2.11 "*Test Method for Evaluation of Solvent Resistance by Solvent Rub*"

2. ECCA – T11 "*M.E.K./Solvent Rubbing Test*"