Testing Raw Materials, Part II: Solvents

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Solvents are used in coatings for a variety of reasons. Their main job is as carrier for resins, pigments, and other components. Other functions include controlling viscosity by providing fluidity to formulations, plasticization of waterborne resins to aid in film formation, and wetting of pigments and substrates to help with dispersion and adhesion.

It turns out that many solvent properties, such as volatility (evaporation rate), solvency (solvency parameters), density (wt/gal), viscosity, toxicity, and tendency to contribute to pollution problems, rarely change from one batch to another. In addition, solvent shipments from a regular supplier normally are accompanied by certificates of analysis. Data on other properties also may be included. It might seem that testing of incoming solvents is not particularly important and is less of a concern than deciding which ones to put in formulations in the first place. However, properties such as flammability, electrical resistance (for electrostatic spray), water content, color, and odor can be affected by contamination—which may occur at the supplier, during shipping, or in storage at the paint plant. Therefore, these properties often are evaluated.

Newly available solvents and solvents from new suppliers always should be tested against supplier and paint company specifications before contracts are signed or batches are accepted. For any solvent, a simple test to tell whether it is as-advertised is to measure the index of refraction, since that number is unique for a given substance. Years ago, our chief analyst did just that for each shipment of solvent on arrival and occasionally sent one back because it was not the correct material.

Let us look at tests for some of the properties that can change. Flammability of paints and solvents is determined by flash point measurements, usually a closed cup test. The material being tested is placed in an enclosed cup and a flame is introduced via a small port in the lid (ASTM methods D93, D3278). As the temperature of the specimen is raised, the volatiles over the liquid eventually ignite. The temperature at which this occurs is the flash point. Flammability can be increased (flash point reduced) considerably by contamination by a small amount of a highly volatile flammable solvent such as acetone. This is less apt to happen in paint from a bad batch of solvent than from formulation or manufacturing mistakes. I recall dealing with a waterborne product that had to be designated “red label” because it had a flash point below 73°F. The formulator had not realized that a little acetone goes a long way in reducing flash point.

The solvents in paint affect the electrical resistance, which, in turn, governs the effectiveness of electrostatic spraying. If the paint resistance is too low (conductivity is too high), there will be overcharging, resulting in shorting out and wrap-back. If the resistance is too low, the transfer efficiency will be low. Resistance depends on polarity. Highly polar solvents such as alcohols and glycol ethers have low resistances, and nonpolar solvents such as hydrocarbons have very high resistances. Not surprisingly, water content has a strong effect on resistance. Most solvents can pick up significant amounts of water, causing them to have lower resistance than expected.

Literature on solvent resistances should only be used as guidelines and estimates. ASTM D5682, which employs a concentric cylinder electrode and a conductivity meter, can be used to measure resistance. This method does not have good precision, but it and related techniques have been useful for testing solvents and paints for many years. Polar solvents can be used as additives to lower resistance, but addition of nonpolar solvents usually is not effective in raising resistance. Besides affecting electrical resistance, high water content in a solvent may affect other properties such as paint stability and may contribute to defects such as blushing and popping. The standard water content test method is D1364, based on Karl Fischer reagent titration.

Solvents normally are colorless (specifications used to refer to “water-white”), but pick-up of colored material during handling, storage, or shipping can lead to light yellow, brown, or other coloration. Whether this is a problem depends on which paints use the solvent and how tight their color specifications are. Colored solvent can give a noticeable and unacceptable color tinge to whites, pastels, and automotive light metallics. Solvent color often is estimated by eye, but it is better to use ASTM D1209, the standard test for measuring the color of clear liquids.

Odor is an important property of a solvent in a negative sense. It is only noticed if it is strong or objectionable. Contamination can make the odor of a normally acceptable solvent objectionable because it changes the odor or makes it stronger. Even if an odor change does not seem likely to cause a problem, it probably is an indicator of contamination, and the batch in question should be tested by gas chromatography and compared to a control. There is an ASTM guide to odor of paints and solvents (D6165) and a test method for odor (D1296).