Tips for Reducing Coatings Failures with Solvents

Photo courtesy of Eastman Chemical.

by **Ranae Anderson**
Eastman Chemical Company*

For OEMs and other coatings end-users, reducing costs, increasing production efficiencies, and driving product sales are critical to staying competitive. Choosing the right coating can help them achieve these goals. That, however, puts tremendous pressure on coatings formulators: with the increased selection of raw materials available for coatings and the complex environmental regulations governing the industry, formulating coatings seems ever more intricate and complicated. Given the tight competition dominating the coatings marketplace, coatings failures are simply unacceptable.

The right solvent selection can reduce premature coatings failures caused by formulation problems. In addition, coatings formulated with the right solvents offer end-users important performance benefits: reduced surface cracking and flaking, stronger adhesion, faster dry time, and durable, eye-catching finishes. After all, delivering a coating that offers good performance, a durable, protective finish, and the proper aesthetic will go a long way towards building customer loyalty. This article discusses the formulation problems that can cause coatings failures, and offers formulators practical tips on how to minimize these failures through proper solvent selection.

IDENTIFYING THE SOURCES OF PREMATURE COATINGS FAILURES

Many premature coatings failures are the result of stresses induced in the coating film during drying, exposure, and use. Identifying the source of stress is critical to solving premature coatings failures. We examine five sources of failures related to coatings stress. They are listed here from the easiest to the most difficult to control:

*P.O. Box 431, Kingsport, TN 37662-5371, www.performancesolvents.com.

- *Cure-related stress*, typically caused by shrinkage during drying or crosslinking, which can result in cracking and flaking;
- *Interfacial (multiple-surface) stress*, resulting in cracking and flaking caused by poor adhesion between coating and substrate, or between coatings (inter-coat adhesion);
- *Mechanical stress*, resulting in film failure, rupturing, or cracking once the coating has been subjected to physical manipulation;
- *Pigment-induced stress*, typically localized points of stress concentration caused when pigment particles bubble or agglomerated pigments form within a coating system, which can lower the tear strength of a coating system;
- *Environmental stress*, induced in a coating film when a coated surface is exposed to moisture, cold, extreme heat, or corrosive conditions (salt).

Formulating with the following five techniques can help prevent these stresses and improve coating reliability:

(1) **Consider surface-active solvents**. Once a liquid coating has been applied to a substrate, it is cured in one of two ways: through a chemical reaction during the drying stage, or through the evaporation of solvents. Stress is introduced from the dimensional changes occurring within the coating as it shrinks during evaporation and crosslinking, which can result in cracking or flaking. Surface-active solvents such as alcohols and glycol-ethers readily migrate to the coating's surface, reduce tension, and promote improved substrate wetting and film cohesion.

(2) **Reformulate with a longer cure window**. To improve the durability and barrier performance of coatings, a formulator will often increase the amount of crosslinking agent in a coating to promote a tighter film network. Although such coatings may show improved hardness, there is a trade-off: a more tightly crosslinked film can show a reduction in the flexibility of the film itself, leading to stress-induced cracks and adhesion loss. Such failures offer a pathway for corrosion over time—one of the very problems that increasing barrier performance was trying to resolve!

Reformulating the solvent system to promote a longer cure window can help ensure that the resin and crosslinker are given adequate time to complete the curing process, resulting in good flow and leveling properties and a stronger coating bond.

(3) Control the evaporation rate. Excessive buildup of film during the early stages of drying can result in solvent popping, occurring when residual solvents force their way through a film which has already begun to harden. Imperfections in the film resulting from the release of these solvent vapors provide a pathway for premature coating failure to occur. Slower drying solvents such as methyl amyl ketone (MAK) can minimize solvent popping in high-build baked films, resulting in a uniform film free from surface defects.

(4) **Take a layered approach**. Maximize the adhesion and cohesive strength within coatings systems. Ensure that each coating has at least the tensile strength and rigidity of the layer above it. As a rule of thumb, the surface energy of the substrate should be higher than the surface tension of the liquid coating that is being applied in order to achieve good adhesion. Good inter-coat adhesion occurs when the surface tension of each coating layer decreases with each layer applied. Ketone solvents like methyl n-propyl ketone (MPK) can be used to manage multi-surface stress because they exhibit low surface tension, improving substrate wetting and promoting adhesion.

(5) **Promote proper pigment wetting**. Proper pigment wetting affects the gloss, gloss retention, corrosion resistance, leveling, and overall film integrity of the paint. Without it, vacuoles, air bubbles, and pigment agglomeration can occur, weakening the pigmented film. Using ester solvents can help prevent these problems, because they are effective at lowering the surface tension and viscosity of the binder, thereby promoting pigment wetting. They have a low odor, offer good solvency, and are available in a range of boiling points for varying needs. In addition, ester solvents provide coatings systems with a number of important performance and aesthetic benefits: high yellowing resistance, high gloss, good drying and mechanical properties, high corrosion protection, and excellent weather resistance—all benefits that maintain film integrity.

CONCLUSIONS

Formulating coatings is a complex process, involving many variables that can be challenging to sort through. But do not let formulating with solvents "stress" you out, remember to ask your solvent supplier for help. Good solvent suppliers work closely with their customers to identify the best solvent for each coating application. They are also well versed in current coatings technologies, actively work on formulating innovations, and offer customers technical assistance to balance performance and regulatory requirements—all of which can help their customers build their own customer loyalty and maybe even enter new markets. CT