Introduction To Plural-Component Spray

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Editor's Note: This Applicator Training Bulletin is adapted from the document, plural-component Materials and Proportioning, developed by Graco Inc., Minneapolis, MN.

This Applicator Training Bulletin describes plural-component materials. The article explains the function of plural-component chemicals as well as mix ratio and its measurement. Various plural-component chemicals are identified, along with their applications. The article concludes by reviewing the advantages and limitations of plural-component materials.

What Are plural-component Materials?

Paints come in two kinds of packages: single-package, which are most familiar to many of us, and multi-package, which are the subject of this ATB.

Single-package coatings, as their name says, are stored in one container. The container holds the resin, pigment, and solvent—the three main ingredients of any coating. The coatings cure by a chemical reaction called crosslinking; but the reaction doesn't occur until the coatings are out of the can and (ideally) applied to the substrate to be coated.

Multi-package coatings, or, as we will call them throughout this article, plural-component coatings, also cure by crosslinking, but the coating ingredients must be stored separately in two or more containers. The components must be mixed in the right proportions at the work site right before they are applied. The chemical reaction begins once they are mixed. After mixing, the material is applied by spraying, dispensing, or extruding (Fig. 1).

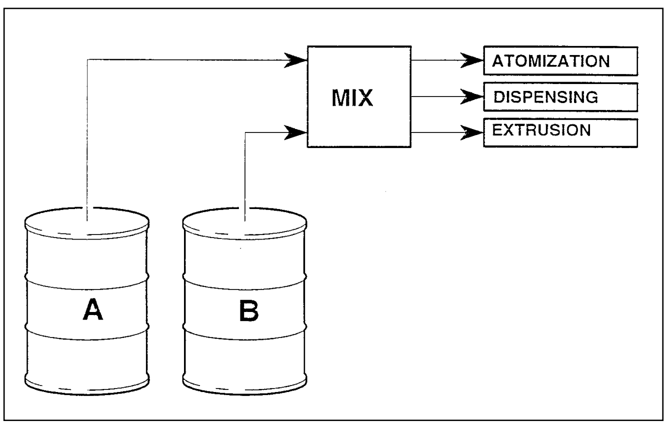

Fig. 1: The basic sequence in the use of plural component coatings Illustrations courtesy of Graco, Inc.

The Functions of Component Chemicals

In a two-component material, component chemicals are referred to as "Component A" and "Component B" (Fig. 2).

Component A is the base material. It may also be referred to as resin, prepolymer, polyol, or lacquer. This component gives the material its desired properties. For example, Component A can give the color in a plural-component paint.

Component B is the catalyst. It may also be called isocyanate, accelerator, promotor, activator, or hardener. It starts the reaction; controls the rate of the reaction; and promotes curing, crosslinking, or polymerization. Figure 3 shows some common names for components A and B.

Some plural-component materials use three chemicals (referred to as 3k): a base, a catalyst, and an accelerator.

Mixing the Component Chemicals

A chemical reaction begins spontaneously as soon as the component chemicals are mixed. The chemicals are trans-

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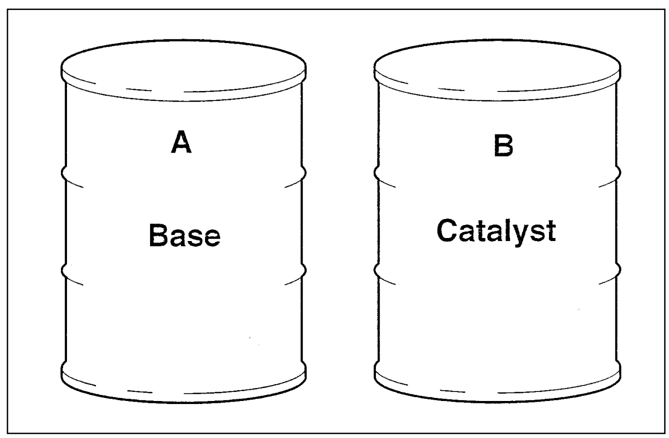

Fig. 2: The base and catalyst of a plural component coating are commonly referred to as Component A and Component B.

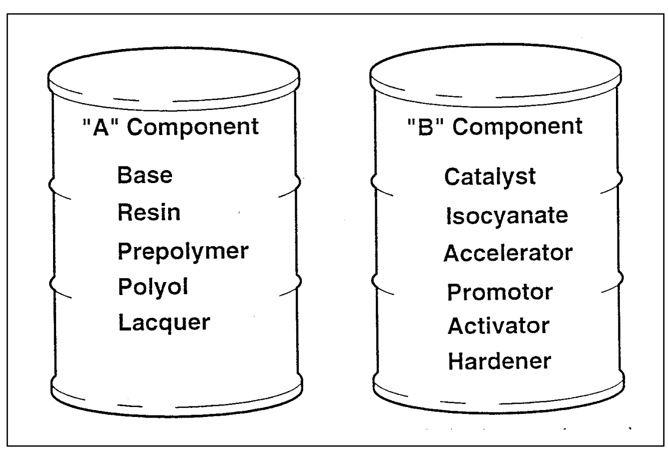

Fig. 3: Other terms used to describe Component A and Component B

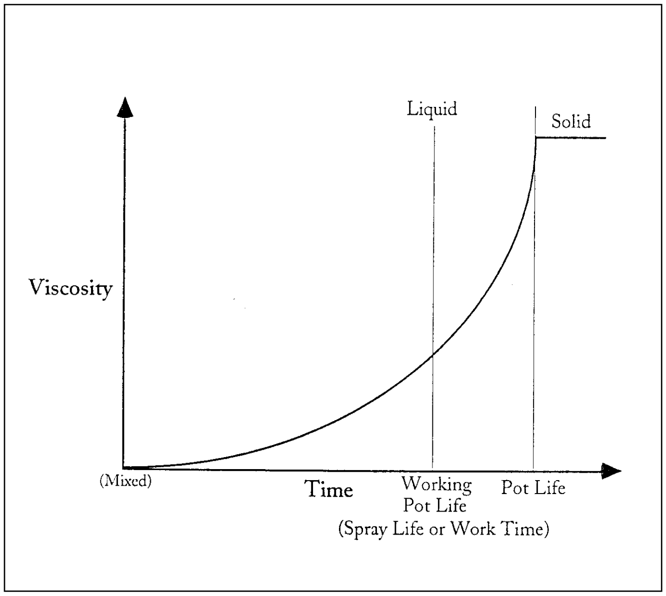

Fig. 4: As time passes, the pot life of a plural-component coating decreases.

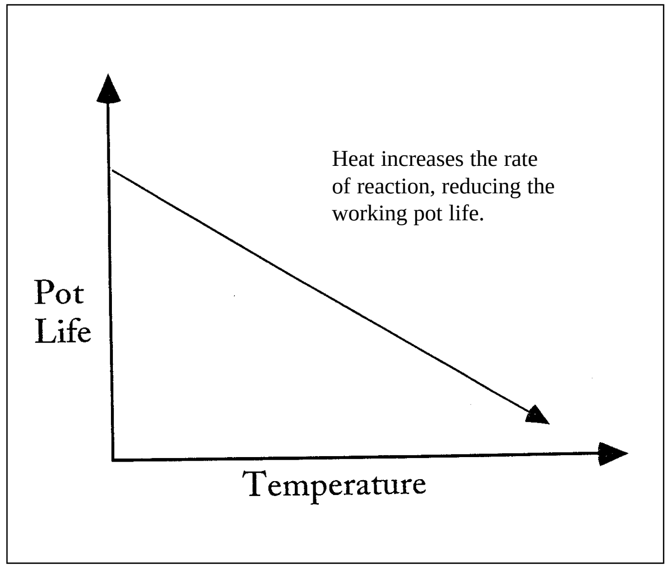

Fig. 5: Applying heat to a plural component coating often shortens pot life or speeds curing.

formed into a usable material in the process we earlier called curing, crosslinking, or polymerization. The reaction cannot be stopped or reversed. The material increases in viscosity (thickness) as the reaction continues and produces heat as a byproduct. (A reaction that gives off heat is called exothermic.)

After being mixed, the material will provide good application characteristics for a period called the working pot life. Pot life begins when the components are mixed and ends when the material hardens. Working pot life is also known as work time when applying sealants and adhesives, or as spray life when applying coatings. Figure 4 is a graph showing the relationship between time and pot life of the mixed materials. Pot life decreases as time goes on.

As viscosity increases, finish quality will no longer be acceptable for coatings; sealants will not seal; and adhesives will not bond. The material is no longer usable. Viscosity increases until the material hardens. If material hardens in the equipment, the equipment will be ruined. To prevent damage to the equipment, you must flush the material from the equipment at the end of the material's working pot life.

Mix Ratio and Its Measurement

Mix ratio is the ratio of Component A to Component B that yields the best characteristics of the end product. It is specified by the material supplier as a function of weight or volume.

The material supplier will specify the mix ratio and a margin of error, which is called ratio tolerance. Ratio tolerance tells you how far from the prescribed mix ratio you can be before you are off-ratio.

Mix ratio is the most critical factor in determining the physical properties of the end product. Too much or too little catalyst will cause problems. Mix ratio affects pot life. Off-ratio materials may not cure properly. Applying heat will often shorten pot life or speed curing. Figure 5 shows how pot life of the mixed materials decreases as heat increases.

plural-component equipment proportions chemical components by volume. If the material supplier provides the mix ratio by weight, the procedure in the box can be used to convert it to a volumetric mix ratio.

Types of Plural Component Materials

Common plural-component materials include epoxies, polyurethanes, polyesters, catalyzed lacquers, polysulfides, and silicones. The uses, typical applications, and charac-

Weight to Volumetric Mix Ratio

Weight to Volumetrix Mix Ratio =

$$\frac{\text{Weight A}}{\text{Weight B}} \times \frac{\text{Weight/Volume B}}{\text{Weight/Volume A}} = \frac{\text{Volume A}}{\text{Volume B}}$$

Note: The weight/Volume of A and B must be expressed in the same units.

Example: You are given a weight mix ratio of 16:1 (A:B).
You are also given:
A=10 lbs./gal.
B=8.5 lbs./gal.
We can now write the equation as:

$$\text{Weight Mix Ratio} = \frac{16}{1} \times \frac{8.5\text{ lbs./gal.}}{10\text{ lbs./gal.}} = 13.6:1$$

So, the volumetric mix ratio (A:B) = 13.6:1

teristics of epoxies and polyurethanes are described in Tables 1 and 2. Polyesters, catalyzed lacquers, polysulfides, and silicones have applications as decorative coatings, protective coatings, foams, sealants, and adhesives.

Table 1:
Epoxies

Uses	Typical Applications	Characteristics
Protective coatings	• gas and oil pipe lining • underground petroleum tanks • chemical processing equipment	• chemical resistance • durability
Primer coatings	• plastic and metal finishing	• promotes adhesion • corrosion resistance
Sealants & adhesives	• electrical and electronic components • sporting equipment	• excellent adhesive strength • moisture, solvent resistance • little shrinkage • electrical resistance

Table 2:
Polyurethanes

Uses	Typical Applications	Characteristics
Decorative coatings	• aircraft • machine tools • business machines • railway cars • automotive plastic • trucks and special bodies for trucks • clear topcoat on cars • electric motors • heavy machinery • farm machinery • wood furniture • lorries • plastic windows for buildings	• flexibility • high gloss • impact resistance • corrosion resistance • cures at low temperatures
Protective coatings	• bridges • petroleum tanks • ships	• chemical and abrasion resistance
Sealants & adhesives	• composite components, aircraft, recreational vehicles • wall supports	• strong bond and seal • good fatigue life
Foam	• roof insulation • refrigeration equipment • truck trailers • boats and marine equipment	• high insulation factor • high buoyancy • sound absorption

The Pros and Cons of plural-component Materials

plural-component materials have excellent material characteristics when properly blended, including durability, abrasion resistance, chemical resistance, flexibility, adhesion, and appearance.

They are environmentally friendly, emitting low amounts of volatile organic compounds. Many of these materials do not require heat to cure. And the mixed, cured material can be disposed of as non-hazardous waste.

plural-component coatings are cost-effective in shop painting. For example, ovens may not be required for curing the coatings. Because the coatings cure quickly, time is reduced on the assembly line. In addition, the coatings may not require stainless steel application equipment.

Despite these advantages, plural-component materials also have the following limitations.

First, plural-component materials are typically more expensive than single component materials.

Second, incorrect mix ratios result in costly failures because material characteristics do not develop properly. Production time and profits are lost because the material must be stripped off the product and reapplied, and scrapped products must be disposed of. Warranty costs are incurred for rework and scrapping of products.

Many defective units may be produced because the off-ratio condition may not be noticeable on the production line. To prevent this, production systems are required to monitor and control the mix ratio to assure the quality of the finished products.

Third, exceeding pot life causes costly problems. Equipment fails or becomes clogged when mixed materials exceed pot life before the equipment is cleaned. You must clean, replace, or repair clogged equipment. In addition, equipment cleaning generates wastes that are expensive to properly dispose of.

Conclusion

This month we introduced the basics of plural-component materials. An upcoming Applicator Training Bulletin will look in more detail at mixing or proportioning the materials.