"CHOOSING A STATIC MIXER"

"HOW TO CHOOSE A STATIC MIXER TO PROPERLY MIX A 2-COMPONENT ADHESIVE"

BY
David W. Kirsch

Choosing a static mixer requires more than reading a sales catalog and selecting a part number. Adhesive manufacturers and end users both should investigate many variables when evaluating mixer characteristics for specific applications. This article is a guide to help make the right decision when choosing a static mixer to properly mix a 2-component adhesive.

A static mixer, which sometimes is called a motionless mixer, is a simple device with no moving parts, and consists of a series of internal baffles or elements within a plastic tube. Yet this seemingly elementary product is used to effectively mix 2 flowable liquids in what can be a very complicated process. As adhesive components are forced through the mixer, they are repeatedly divided and recombined, thus creating a complete and uniform mixture.

Static mixer systems are frequently chosen when users encounter too many difficulties with conventional adhesive handling systems, such as when components are scooped into a cup, hand mixed and transferred to a dispensing container. Utilizing a static mixer provides many benefits, including consistency of mix and eliminating the introduction of air into the mixing. The latter is an essential precaution, since air represents a source of voids in cured bond lines and the possibility of a bonding failure. Overall, process control in hand mixing is difficult to maintain, which can create serious bonding problems, as well as problems with waste, cost, and safety.

This overview will not evaluate or compare a static mixer vs. hand mixing, rather, it focuses on an adhesive manufacturer or end user's choice of a particular static mixer for mixing and dispensing 2-component adhesives.

APPLICATIONS

In general, applications using a static mixer can be divided into two categories - for use with a cartridge and a hand held dispenser, or for use with Meter Mix and Dispense [MMD] equipment.

Flow rate is a key factor to consider when choosing between hand held cartridge and MMD systems. In any 2-component adhesive operation, the components are kept separate in a pre-proportioned, molded plastic cartridge or in machined steel cylinders before they are introduced into a static mixer. The user must calculate the amount of pressure necessary to keep the two liquids flowing at the appropriate rate for a specific application.

For example, with high viscosity components, it may require a significant force to move the liquids at a proper flow rate. Understanding the maximum flow rate that a hand held cartridge system can generate provides a data point for making a cartridge vs. MMD equipment decision.

MMD systems are automated and can dispense higher volumes of liquid than is possible with hand held cartridge systems. Don Leone, General Manager, Ashby Cross Co., Inc., notes, "Volume is one of the widely used reasons for switching to an MMD solution, although volume alone is not a deciding factor. In many instances, the use of MMD systems is an upgrade from hand held cartridge systems, particularly when time-controlled adhesive shots are needed. This is frequently the case with assembly line and robotic applications, which often are handled with MMD systems."

Airplane manufacturers, in contrast, use hand held cartridge systems because their bonding operations are spread out over large factory areas. Also, inside the airplane being fabricated a worker must work in an extended area that has many tight locations. Plant maintenance operations are likely to use hand held systems for similar reasons.

Complex manufacturing or maintenance operations often use many different adhesives in a wide range of applications. Changing adhesives with MMD systems is generally laborious, whereas many operators feel that changing adhesives in a hand held system is no more difficult than changing a cassette in a VCR. Simplicity of use is a reason that hand held systems are chosen in many industrial settings. Even in a less complex operation, such as repairing cracks around swimming pools, an end user will find a hand held cartridge system beneficial because of the size and unique qualities of each area needing repair.

MMD systems are primarily used inside buildings and plants; hand held systems are used both inside and outside.

Hand held cartridge systems are manufactured in a limited number of volumetric ratio systems - 1:1, 3:2, 2:1, 4:1, and 10:1 - whereas MMD systems are always customized, which yields a nearly unlimited set of volumetric ratios. Many ratios, if not most, outside of structural applications, are not compatible with the discrete ratios offered in cartridge systems. A ratio such as 100:36 or 100:28 requires the use of MMD equipment.

"CHOOSING A STATIC MIXER"

Each specific application frequently represents a simple decision for adhesive manufacturers and end users because flow rate, volume, production and related requirements often dictate a straightforward choice between hand held cartridge and MMD systems. Nonetheless, a hand held cartridge system is often an excellent choice to simulate an adhesive application before moving to the more expensive MMD solution. An adhesive manufacturer or end user can experiment with hand held cartridge systems to test variables that affect static mixer performance for specific applications, such as temperature, humidity, length or diameter of the mixer, and curing time and work life of the adhesives.

RELIABILITY

Reliability in adhesive operations is paramount. Every operation needs to have consistent results.

Moving from hand mixing systems to using a static mixer is a positive change for an end user. Although a static mixer generally gives consistent results, there are some important variables that can affect its performance. For example, temperature and humidity can have a significant impact on chemical and physical reactions and processes; therefore, static mixers should be tested under various climatic conditions.

The need to achieve a consistent mix underscores the importance of experimenting with both manual and pneumatic dispensers, since the type of dispensing gun and how it is used can influence adhesive outcomes. Each person operating a manual gun may have a different dispensing style and hand strength.

Although hand held system solutions are the most prevalent, for a given application a pneumatic gun may be needed for static mixer usage. Pneumatic guns can provide constant pressure on the cartridge and mixer, and thereby can minimize problems caused by constant flexing. However, Rich Wilson, ConProTec Business Manager, suggests, "Problems arising from such flexing can be mitigated to some degree by using plastic cartridges with thick walls, which are more rigid and stronger. This introduces another variable in the decision process for manufacturers and end users."

Wilson adds, "A user can take an integrated approach and select dispensing tools and static mixers made specifically for the cartridge being dispensed. This can help avoid a situation in which a company utilizes dispensers that are too powerful. In such situations the dispenser's mechanical advantage may be offset by flexing and subsequent mixing problems."

When using a hand held plastic cartridge, an important step is to experiment with a manual gun to measure the effects of flexing and the individual characteristics of the different employees who apply the adhesives. Combining this approach with testing various static mixer configurations can provide a comprehensive testing model.

"CHOOSING A STATIC MIXER"

PHYSICAL ASPECTS

Key physical aspects of a static mixer, such as the number of elements or special attachments, should be identified, analyzed and tested. Each of these physical dimensions can affect the success of the adhesive operation. As a result, adhesive manufacturers and end users should test many different static mixers to determine which features are important for a specific application, as well as for consistency of mix.

The following set of questions is an example of an outline that can be used to structure the testing of physical aspects of various static mixers:

- Is the static mixer's outlet orifice the appropriate size to deliver the correct amount of adhesive?
- What inside diameter and number of mixing elements create the right flow rate? Is the static mixer the right length for the application?
- Is the adhesive being dispensed in locations that are difficult to reach? Consider using an adhesive to glue a metal fastener inside a hole in concrete. The application may require that the adhesive bottom out at the base of the hole to avoid trapped air. A custom mixer with an extension would be an effective solution in this case.
- Does the application require specialized attachments, such as a luer lock adapter, ribbon spreader tip, bent ending, and/or customized flexible tubing?
- How much "content volume" waste can be afforded?
- In an MMD application, will the pressure drop during the mixing operation require the use of a shroud? Are the pressures high enough to require stronger elements, such as substituting polyacetal for polypropylene elements, which means a higher cost? If there is too great a pressure drop, a static mixer may not keep its shape and the components could pass along the mixer walls instead of being properly mixed. Likewise, if the elements were to break, the system could pass along broken plastic fragments.
- Would a shroud help with equipment positioning? Or in an application that involves heating?

CONCLUSION - TESTING AND EXPERIMENTING

Testing or experimenting should be viewed as a reliable process to help choose the right static mixer, rather than a mere "trial and error" approach. This decision will determine the success of adhesive manufacturers' and end users' applications. Both technical and financial implications must be included in this decision making process.

Ken Lambert, Product Manager, ITW Plexus, emphasizes the importance of proper selection: "We view the static mixer as a central part of the adhesive system. Choosing a device with the proper configuration should not be an afterthought. Our approach is to recommend static mixer combinations that have been successful in our laboratory testing and field experience. It is an important support we provide as an adhesive manufacturer."

"CHOOSING A STATIC MIXER"

Adhesive manufacturers often run tests and experiments that are more extensive and rigorous than end users would themselves implement. An adhesives manufacturer might chart work life, gel and curing times for various adhesives. This data is then distributed to end users with disclaimers outlining chemical properties and operating limits based on specific applications of the adhesives, and the conditions under which they are dispensed. An end user then can take the specifications and test various dispensing systems under different operating conditions, such as varying temperature or humidity, or with different lengths or special attachments.

Another useful experiment involves evaluating how the curing rates of adhesives interact with various static mixers. If there are pauses in the dispensing phase, over time any curing that occurs in the tube could alter the effective diameter of the mixer. Changes in the effective diameter can negatively impact the chemical and physical properties of the adhesive. Useful experiments must consider the consequences of hardening of the materials in the tube.

If the application requires frequent replacement of the static mixer due to hardening, the end user may have to weigh the benefits of a low cost static mixer versus a more expensive mixer configuration that would eliminate the need for frequent replacements. Such a choice may mean a higher materials cost, but ultimately a lower operating cost.

By measuring content volume, cost of the static mixer, and different dispensing routines, various process models can be evaluated and the results used to select a static mixer. For example, contrasting the costs and efficiencies associated with (a) running the mix and purging, versus (b) stopping a dispensing process with some frequency and throwing away the mixer, represents what could be a valuable financial test.

Finally, financial considerations can influence end users to adopt different testing approaches. Some end users report that initial testing which incorporates off-the-shelf hand held cartridges is the most cost-effective method. Users that rely on MMD equipment manufacturers to perform a range of tests and experiments sometimes conclude that added costs make outside testing less attractive. To be sure, all outside testing represents an additional cost, but it also includes significant non-recurring expenses, such as charges for parts used in the testing operation itself, as well as the basic cost differentials when using customized MMD equipment.

In short, there is no formula that provides consistent answers. Simple guidelines like "all epoxies need 24 elements" can be dangerous. An acceptable mixer configuration for one use may not be appropriate for a different application, even if the same adhesive is being dispensed.

"CHOOSING A STATIC MIXER"

Testing and experimenting is a reliable path to choosing the right static mixer for a 2-component adhesive. It is the shared responsibility of the adhesive manufacturer and end user to identify the static mixer that consistently mixes the adhesive in such a way that when cured, the adhesive meets peel strength, shear strength, tensile strength, and other specifications reliably. Both the static mixer manufacturer and the MMD equipment manufacturer play an important role: to actively assist adhesive manufacturers and end users in identifying the variables to consider and test, and thereby help them choose the right static mixer for a specific 2-component adhesive.

* * *