TECHNOLOGY BRIEF:

Temperature plays a very important role in many mixing processes – it can dictate viscosity, solubility, reaction rates and other parameters that directly affect mixing performance. This bulletin identifies some strategies for optimizing heat transfer during mixing.

Heat transfer and mixing

Heat transfer often accompanies the mixing operation. Temperature control is important because it can dictate viscosity, reaction rates, solubility and other parameters that directly affect mixing performance. As a result, inefficiencies in heat transfer could lead to long cycle times, low yield, steep energy costs, rejects or intensive clean-up (due to product ‘baking’ on vessel walls, for example).

Some strategies for optimizing heat management

- Utilize a properly-sized heating/cooling unit. Your vendor will need a complete picture of your process (initial/final temperatures, cycle times, specific heat of materials being mixed, batch size, type and source of heat transfer fluid, etc.) and details of the mix vessel (dimensions, jacket volume, size and number of inlets/outlets, etc.).

- The mix vessel must be jacketed on the sidewalls and bottom. Make sure the pressure rating on the jacket can safely accommodate your heating/cooling unit. Baffling on the jacket is recommended especially for vessels 10 gallons or larger. Baffles prevent short-circuiting of the heat transfer fluid and allow the jacket inlet and outlet ports to be located on the same side of the vessel, a practical, operator-friendly configuration.
• The addition of scrapers on an anchor agitator is highly recommended, particularly when a cooling step is involved. Scrapers not only improve heat transfer efficiency but also product homogeneity. However, for viscous materials processed on double planetary mixers, testing should be done to confirm if a scraper arm is necessary or advantageous. Many applications made on planetary mixers are materials that temporarily stick to the walls during mixing but reincorporate into the batch due to the planetary stirring action alone and without additional scraping assistance. In these cases, when scrapers are used, material collected from the vessel wall can potentially build up on the scraper arm above the product level where it is not reincorporated back into the batch unless by manual scrape down. This migration of batch material out of the mix zone reduces mixing efficiency, necessitates intensive clean-up and can increase contamination risks.

• For critical processes that require accurate temperature readings, choose a thermoprobe that goes into the center of the batch rather than one installed on the vessel sidewall. On mixer systems with fixed-shaft agitators, thermoprobes mounted through the vessel cover are relatively inexpensive. On planetary mixers, rotating RTD thermocouples installed on heavy-duty shafts can be supplied. These are more elaborate features but essential for applications that are poor heat conductors.

• In mixing/drying processes, vacuum can be utilized to lower the boiling point of volatiles and shorten cycle time. It is an excellent method for drying heat-sensitive materials without fear of thermal degradation.

• Integrate heating/cooling into the main mixer controls. This will allow the heater or chiller to react to real time batch temperature as opposed to simply maintaining a set temperature based on the heat transfer fluid.

Installation Snapshot:

A Ross VersaMix Multi-Shaft Mixer installed at an adhesives plant is being used to prepare various rubber solutions. Different types and combinations of rubbers (butyl, nitrile, styrene butadiene, polyurethane, polychloroprene, silicone, etc.) are dissolved and mixed into various solvent blends (toluene, methyl ethyl ketone, acetone, hexane, methyl isobutyl ketone, etc.) The 200-gallon mix vessel is jacketed on the sides and bottom. The agitation system includes a three-wing anchor with staggered Teflon wall and bottom scrapers. A condenser unit captures solvent vapors and allows them to drain back into the batch, keeping the formulation consistent. Preventing the release of solvents is also essential from an environmental standpoint.

For more information on Ross Mixers
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