Prevent localized overheating in your batch mixer.

During mixing, uniform batch temperature is generally more difficult to achieve in viscous materials than in free-flowing fluids.

Localized overheating in viscous applications

Localized overheating is a mixing issue that happens more commonly in viscous applications. Utilizing the appropriate mixer for a given viscosity range is the best way to avoid localized overheating and product degradation.

Localized overheating tends to manifest in viscous applications that require high speed agitation in order to produce an acceptable level of dispersion. A saw-tooth disperser, for example, turns at high tip speeds and creates vigorous flow in a liquid batch. It also generates a powerful vortex into which solids can be added. Generally, as powders are added and viscosity climbs, the rate of turnover decreases and the vortex diminishes. Above 50,000 cP or so, product near the blade may begin to heat up considerably faster than the rest of the batch. Eventually, materials near the vessel periphery can become stagnant, further contributing to the problem. This becomes a serious concern not only in the sense of poor homogeneity but also because of the risk of product degradation due to overheating.

To combat this issue, many operators resort to stirring the batch manually or moving the vessel around as needed. Blade position can be adjusted, but most systems equipped with a hydraulic lift allow up/down movement only. In large vessels, it is not uncommon for the disperser to be mounted to the tank and hence operate from a fixed height and position. Consequently, localized overheating is even more difficult to resolve once it occurs. Running at a slower blade speed mitigates the problem but it also prolongs cycle time and reduces the mixer’s ability to disperse any agglomerates in the batch.

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Supplemental agitation

The addition of a slow moving anchor agitator extends a disperser’s viscosity range to several hundred thousand centipoise. Typical anchor designs feature two or three wings that travel around the vessel periphery. Like the high speed disperser, the anchor has a fixed axis of rotation but its vertical and helical flights run at close proximity to the vessel surfaces, constantly moving product from the sidewalls and bottom. The anchor agitator basically supplies a steady exchange of materials from different parts of the vessel and “feeds” the high speed disperser blade. Removable scrapers can be attached to the anchor; these elements contact the walls which significantly increases heat transfer efficiency in jacketed vessels. Applications that undergo an exothermic reaction during mixing greatly benefit from the improved bulk flow and energy dissipation achieved by using an anchor agitator.

Planetary mixers

However, as viscosity climbs to a million centipoise and higher, even an anchor agitator will be inadequate at turning over a very viscous product. It may simply carve a path as it moves through the batch or in some cases, product will sit on the anchor and move as a single mass instead of flowing to different areas of the vessel.

At these viscosities, planetary-style mixers perform better than agitators with a fixed axis of rotation. For instance, a disperser shaft that revolves around the mix vessel (instead of waiting for product to come to it) prevents localized overheating. The presence of a planetary stirrer blade further improves bulk flow and temperature uniformity throughout the batch. This patented agitator combination (US Patent No. 4,697,929) is called the Ross PowerMix and is recommended for viscosities up to 2.5 million cP.

For even higher viscosities, double planetary mixers are used. These systems are the least prone to localized overheating because they utilize two identical stirrer blades that run at relatively low speeds. Double planetary mixers rely on high product viscosity to impart shear as the blades knead materials against the vessel surfaces and between each other. Depending on the blade configuration, this type of mixer can handle formulations as high as 6 million cP.

Sample Application: Fuel Cell Paste

A developer of portable fuel cell technologies is using a Ross PowerMix to prepare fuel cell pastes. Sodium borohydride powders are dispersed into an alkaline solution which produces an exothermic reaction. Cooling water is circulated through the vessel jacket. The rapid product turnover produced by the planetary stirrer and disperser ensures a uniform temperature throughout the batch even as the material gets thicker as the reaction and level of dispersion progresses. The finished mixture is a smooth, glossy paste.