

SIMPLIFY YOUR MIXING OPERATION

Production efficiency depends on a well-developed strategy

By Christine Banaszek, Charles Ross & Son Company

A well-developed mixing strategy is essential to production efficiency. Ideally, mixing equipment and procedures are evaluated periodically, as production needs change or when new formulations come through the pipeline. However, mixing is often overlooked in terms of upgrades, at least until it becomes a source of drastic losses whether because of low yield, recurring contamination, inconsistent product quality or excessive labor hours.

In mixing, it is not too difficult to find “something that works.” Yet, while there may be several ways to make good product, not all are efficient, competitive or even sustainable. Limitations in capital expenditure and overreliance on legacy equipment are common obstacles that keep processes stagnant for years and decades even as various aspects of the business are constantly undergoing significant changes. The irony is that a careful re-evaluation of mixing procedures can reveal achievable steps to significantly reduce costs.

One technique is to examine the entire produc-

tion flow and determine if multiple mixing operations can be performed in a single machine without sacrificing product quality. One major benefit to “one-pot processing” is the reduction of energy consumption though many other incentives are equally justifiable including faster throughput, easier cleanup, less transfer steps and lower operating cost.

Table 1 shows a few examples where multiple mixing steps were successfully consolidated into a single mixer. In each case, the simplified mixing operation gained tremendous competitive advantage for the manufacturer.



Figure 1. Multishaft mixer equipped with three independently driven agitators: three-wing anchor, high-speed disperser and high-shear rotor/stator mixer. This configuration is well-suited for medium- to high-viscosity applications such as slurries, pastes and suspensions up to several hundred thousand centipoise (cP).

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Figure 2. Planetary disperser used for highly filled viscous products up to around 2 million cP. The rectangular stirrer blade and high-speed disperser revolve around the batch while rotating on their own axes at variable speeds.



Figure 3. A batch-style, ultra-high shear mixer capable of reducing measured particle size comparable to one or two passes through a media mill

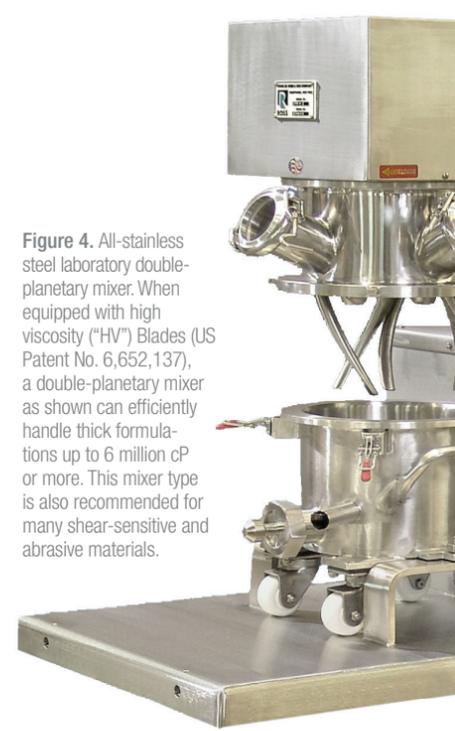


Figure 4. All-stainless steel laboratory double-planetary mixer. When equipped with high viscosity (“HV”) Blades (US Patent No. 6,652,137), a double-planetary mixer as shown can efficiently handle thick formulations up to 6 million cP or more. This mixer type is also recommended for many shear-sensitive and abrasive materials.

| Step 1 of old process | Step 2 of old process | New consolidated process | Comments |
|---|--|--|--|
| Prepare liquid pre-polymer in a reactor. | Transfer pre-polymer into a mixing vessel. Disperse fillers, plasticizers and other additives into the pre-polymer under vacuum. | Prepare pre-polymer and mix finished product in a vacuum-rated multishaft mixer/reactor (see Figure 1). | The new process was first tested in a laboratory setting and later scaled up to a 300-gallon multishaft mixer. |
| Mix highly filled epoxy formulation in a double planetary mixer, followed by a let-down step to lower viscosity. | Continue mixing using a saw-tooth disperser to provide extra shear needed for completion. | Process the formulation from start to finish in a hybrid planetary mixer equipped with two agitators: A rectangular blade and a high-speed disperser (see Figure 2). | The manufacturer was able to move away from a cumbersome two-step process that was labor-intensive. Cycle time was reduced from one hour to 20 minutes. |
| Add pigment powders into liquid vehicle. Batching tank is equipped with a saw-tooth disperser. | Mill pigment-resin premix in a media mill for four hours to achieve an "off-the-gauge" dispersion. | Perform powder wet-out and deagglomeration in a single vessel using a batch-style, ultra-high shear mixer. | The same end point is achieved in 30 minutes total mix time (see Figure 3). |
| Prepare medical gel base in a bench-top chilled glass reactor. | Blend active ingredient (granular solid) into the sterile gel in a single planetary mixer. | Produce gel and thoroughly mix active ingredient in a laboratory double planetary mixer (see Figure 4). | Double planetary mixers are ideal for viscous and sticky applications. Sanitary design features ensure product purity and easy cleanup between batches. |
| Mix thickened solution in a 2,000-gallon stirred reactor. Cycle time is up to six hours or more because operators have to slowly add gum powders and other thickeners as the batch is vigorously agitated. Adding the gums too quickly creates lumps, which ruin the product. | Charge talc powders into the reactor. The powders tend to float on the surface of the thickened solution. As a remedy, recirculate the material through an inline rotor/stator mixer for hours. This step allows the powders to gradually fold into the mixture. | Introduce all powders to the 2,000-gallon tank utilizing an inline mixer specially designed for powder injection (see Figures 5 and 6). | By replacing its inline rotor/stator with the powder injection mixer, the coatings manufacturer was able to introduce all solids sub-surface, which eliminated the lumping and floating issues. The simple mixer upgrade drastically reduced cycle time by more than 50 percent. |

Table 1. Examples of multiple mixing steps consolidated with a single mixer

Conclusion

It is important to note that mixing results are always formulation-dependent. Whenever practical, perform simulation trials using your own raw materials to confirm a new mixing strategy. Ask your mixer supplier about testing and demonstration services or rental equipment, which you can use for trial production runs in the convenience of your own plant.

Lastly, a mixer's control system plays an important role in optimizing overall efficiency. A well-specified control system minimizes human errors, improves batch-to-batch consistency and lessens downtimes. Recipe controls also enable automatic data logging.

Supervisory control and data acquisition (SCADA) packages support complete traceability and make it easier to pool statistical information on workloads, bottlenecks and maintenance history. Source both mixer and controls from the same vendor to ensure seamless execution. 



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Figure 5. Inline rotor/stator mixer designed for high-speed powder induction

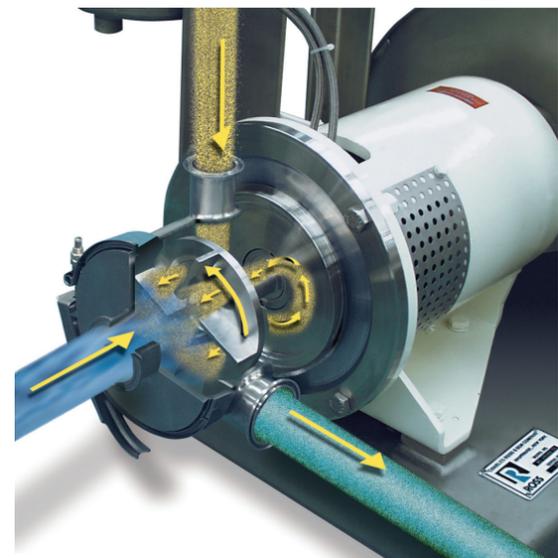


Figure 6. How a powder induction mixer works: The liquid stream (blue) enters the mixer and immediately encounters the powder addition. Drawn by a powerful vacuum generated by the ported rotor, powders (yellow) are injected directly into the high-shear zone and dispersed instantaneously. The resulting mixture (green) is expelled centrifugally through the stator openings at high velocity.