featured columnist

Five common mixing mistakes to avoid or resolve

Lost value due to poor mixing is worth billions of dollars annually across the process industries. This includes wasted income due to low yield, corrections and reworks, prolonged cycle times, unrevealed full functionality of mixture components, product contamination and even worker safety issues. Effective mixing is not a simple task. On the other hand, either out of habit, lack of awareness or capital funding, ineffective mixing is incredibly easy to do and keep on doing. If your company is planning to improve overall production at minimal expenditure, avoiding or resolving the following common mixing mistakes can help you make great strides closer to your manufacturing goals.

BUYING WITHOUT TESTING

Sure, the resident genius at R&D made this new incredible product with relative ease using her bench top laboratory mixer. Sure, the big bosses are giddy and have approved to spend serious money for a similar design production mixing equipment. But what took place in the beaker is not necessarily what one should expect in a large tank.

In general, the key parameters considered during a scale-up process include tip speed, horsepower, agitator location in the mix vessel, batch turnover rate, vessel size, aspect ratio, and range of working volumes for full and partial batches. Yet, mixing rules of thumb lose predictability as batch sizes get larger. Eventually, horsepower requirements, blade diameters and shaft lengths become impractical or uneconomical.

Prior to equipment purchase, it is recommended to perform scaleable tests on the proper mixer in batch sizes not less than 10 percent of the targeted production. For inline or continuous mixing operations, the amount of experimental material used is not significant, but testing is still important in determining actual flow rates at set speeds, power consumption, heat generation, particle size reduction and possible foaming, if applicable.

When mixing in a small container, issues like viscosity peaks and heat transfer rates may be too short or minute to be recognizable, same as how the methods and order of addition or discharging may appear to be uncritical. On the production floor, these events can result in bottlenecks, and testing diminishes the element of bad surprise. Mixer tests may be done at the equipment manufacturer's facility or with rental equipment right in your own plant.

OVER-PROCESSING

In the case of inline mixers, desired results are generally achieved in a single pass, if the appropriate equipment is selected, that is. Multiple passes may produce improved results, but usually with diminishing returns. Blending of dry solids or powders is typically completed in short periods of time with very little possibility of over-blending or un-mixing. Except in extremely prohibitive capacities, if a batch takes more than an hour to completely mix in a blender, chances are there is another mixer design more appropriate for the application. If one is willing to pay the price, there is usually blending equipment that can produce the desired mix in just 15 minutes.

Over-processing not only consumes time and power, but also subjects mixing equipment to unnecessary wear and tear. In addition, some products are shear-sensitive and will yield off-spec properties when over-processed. This mixing mistake is best avoided by careful mixer selection and again, testing before buying.

UNDER-PROCESSING

The opposite extreme, under-processing, is also a common mixing mistake. This takes the form of mixing too slow or not mixing long enough. Many are reluctant to run their mixer at the maximum speed setting for fear of overworking the machine. As long as the power draw (amperage) is within the machine's range, running at the maximum speed is desirable, as you benefit from the highest tip speed that the mixer can deliver. Well-designed mixers work just as optimally running at maximum speed as at lower speeds.

A certain tip speed yields a corresponding mixing equilibrium, which is sometimes represented through the particle size distribution of a mixture or emulsion. Processing longer at this tip speed, as explained before, gives diminishing returns. Processing under this speed, however, could result to an equilibrium well below the desired particle or droplet size. In this case, mixing longer will not get you to the end point, but increasing the tip speed will. Under-processing is also a result of improper scale-up when horsepower to volume ratio is not considered or when simply not enough mixing time is allowed for scale.

REFUSING TO UPGRADE/CHANGE

Take the following scenario as an illustration of this mixing mistake:

When introduced into liquid media under insufficient shear, powders like fumed silica, carrageenan or carbomers resist wet-out, float for hours, or form lumps which are dry in the center. Adding them slowly into a small batch of vigorously agitated liquid provides enough time for individual solid particles to hydrate. But in a full-scale production setting, this method of addition is very costly and time-consuming. Moreover, if powders are added too slowly, an uncontrolled viscosity build-up can occur mid-processing, thus preventing the rest of the solids from being fully dissolved.

In contrast, manually adding the powders too fast can cause particles to clump up; the same way that insufficient shear causes them to do so. The clumps solvate to form a tough outer layer which prevents complete wetting of the interior particles. This results in solution defects such as grainy texture, reduced viscosity, or the presence of insoluble particles resembling "fish eyes." The high shear conditions usually needed to break up these agglomerations can also over-shear the already hydrated particles, resulting in a permanent viscosity loss.

Hence, many process engineers and operators are caught in the middle, and have gotten used to carefully sifting and slowly adding these 'challenging' powders. It's easy to settle on a process that takes long but works…most of the time. "That's how we've always done it."

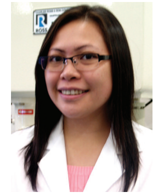
But in fact, the field of high shear mixers is not lacking in newly developed powder injection systems that prevent agglomerates from forming by applying intense shear immediately as the powder enters the liquid stream. By simultaneously combining and mixing powders and liquids, these injection systems shorten mixing cycle times by up to 50 percent or more. Eductor-based systems of the past do not offer the same benefits, due to the distance between the induction point and the high shear mixing element.

NOT UTILIZING VACUUM

When trying to reduce air entrapment, the first impulse is often to reduce the agitator speed, but this also reduces the amount of shear and batch turnovers provided by the agitator. Processing under vacuum is a better solution. Vacuum mixing will allow full-speed agitator operation without entraining air.

In paints and inks, pigment powders or crystals could form loose clusters containing entrapped air. When processed under vacuum, adhesives and composites develop higher densities and possess better tensile properties as a result of improved shearing and contact of the different components. In food applications, keeping entrapped air (or oxygen) to the minimum ensures longer lasting flavors. Syrups, pastes and dough-like materials will contain unwanted voids after agitation under atmospheric pressure. Pulling vacuum while mixing thus eliminates costly downstream de-aeration steps and decreases processing time.

By knowing, understanding and tailoring mixing technologies to your specific needs, you can save time, energy, manpower and raw materials.



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