Five Tips for Exceptional Agitation

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Vital to almost every liquid process is proper mixing. However, with lower budgets for capital equipment, those of us responsible for chemical manufacturing are asking: What do we compromise and where do we cut?

Back when I was in the automotive coatings industry, I would get new products thrust down to me at the plant level with an expectation—make it work with what you have. That is not always possible, but there are some ways that you can increase the likelihood of making it happen, at least when it comes to agitation.

1. Experiment with adding ingredients in different orders. You would be amazed at the time savings achieved by changing formula additions. Many see a decrease in solvating time by adding approximately 20 percent of their solvent, then introducing dry ingredients, and finally coming up to full dilution. This raises power/volume when you need it most.

   Think about making pancakes: I always get annoyed with recipes that instruct you to add all the milk, then the dry ingredients. You end up wearing your arm out swirling clumps of flour around in milk. Next time, try adding just some of the liquid, then all of the dry ingredients. You would find that the thicker mix does not let the flour clumps avoid the path of your impeller (whisk), and they are blended quickly.

2. Experiment with adding the ingredients at different speeds. Don’t always just dump additions into your vessel in one lump. In fact, it may behoove you to specify an addition duration, so operators or lab technicians know to take their time. This allows your batch to reach some level of equilibrium before introducing anything else, releasing equalizing forces to work in your favor. This can be very important if you are working with a solid that can clump or aggregate if it is not imparted directly.
   Similar viscosities mix easier than dissimilar ones—use this to your advantage. Going back to the pancake illustration: after getting your thick mix, add the balance of your milk slowly and mix to uniformity between each addition. Every small addition brings the viscosities closer and makes uniformity quicker to attain. In the end, the time you gain getting to uniformity far outweighs the time consumed during sequenced additions. Your underpowered mixer has a higher probability of successfully producing the batch when this type of process optimization is used.

3.

Figure 1

Figure 2

Align the mixer at various angles and positions in the tank. When mixers work to create a swirl in the tank, they use energy in a less productive manner than they would by achieving a top-to-bottom motion. By changing the angle and placement of the impeller, you can help eliminate swirl and

more effectively use your power input.

Basically, you want to create a self-baffling situation (Figure 1). The impeller and shaft are vertically oriented in the drum. The fluid circles in the drum with a high velocity, but mixing is more than just getting a fluid to move. Your goal is to get each molecule to exchange the molecule next to it for a new one. In a swirling situation, the same molecules stay next to each other, while moving around and around inside the vessel. If you move the mixer to an angled situation (15? is a rule-of-thumb starting position), the side of the tank acts as a baffle for the swirling liquid and forces the fluid into a more asymmetric motion, which leads to increased molecular changeout (Figure 2).

Of course, if you can't angle your mixer, you can make your own baffles to disrupt the swirl. Optimally, you would use a flat bar that is 1/11 the diameter of the vessel and set it 1 to 2 inches off the side wall. Don't worry if you don't have the exact measurements, though. In this case, something remotely close works better than nothing. Continuing to add more baffles produces diminishing returns, with the addition of a fifth baffle to a tank producing almost no effect.

4. Try different impeller geometries, quantities and sizes. Rather than buying a new mixer, try replacing the impeller with one that generates more shear or flow. Every impeller converts the power fed to it into a ratio of shear and pumping. Each application can be optimized when the correct ratio is found. For example, in some coatings operations, you want to minimize the shear so as to not kick off the cure package of the coating, but without some level of shear in the mixing process, the cycle takes days rather than minutes.

   Measure your current draw and see if your motor could use a larger impeller. Many mixer companies oversize equipment to accommodate various situations. Once you measure the draw, compare it to the full-load current on your motor. You may have some margin to increase impeller size. Also consider the benefit of installing two smaller impellers in place of one large one to create several mixing points inside a vessel. This can be effective when attempting to impart a powder into a high-viscosity fluid. Try to keep two impeller diameters of distance between the impellers to minimize the likelihood of forming a single flow pattern, thereby lowering mixing effectiveness.

5. Try a pre-batch mix. You can speed up blending times by creating pre-mixes, which can be made in a laboratory. Add your inert ingredients to a small container using a fraction of the solvating agent, then take advantage of the high-speed capabilities of lab equipment. When it comes time to mix a large batch, most of the heavy lifting of solids wetting and de-agglomeration have already been done for you.

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