Front & Center

On-Demand Film Coating Process Is Close to Continuous Processing

Film coating dispersion batch sizes in manufacturing can reach hundreds of liters depending on the scale of coating and may require large tank and mixing areas that can lead to batch to batch variation. Colorcon set out to evaluate the feasibility of on-demand, and continuous coating dispersion preparation using an innovative powder injector system. This new system allows for rapid and consistent preparation of coating dispersion, enabling the coating process to be truly continuous.

The batch size for film coating dispersions in manufacturing can reach hundreds of liters, depending on the scale of manufacture, and may require large tank and mixing areas. In current batch manufacturing processes, mixing times for coating dispersions usually take 30–60 minutes to ensure homogeneity and avoid the presence of lumps or agglomerates that clog spray guns. Tank size, mixer configuration, mixer placement, volume of liquid in the mix tank, and many other factors affect the process. Improperly designed mixing processes can result in foam or lumpy dispersions that require additional time for deaeration or further hydration. If mixer diameter and stirring speeds are not optimized, excessive settling of suspended solids can occur over time. In addition, preparation in advance of large batch sizes intended for use over several days, may introduce the risk of microbial growth.

At the 2017 AAPS Annual Meeting, a poster session presented by Colorcon highlighted the results of a dispersion preparation study using the ILC Dover PST Jet Mixer. The goal of the study was to evaluate whether this "on-demand," continuous coating preparation avoided some of the aforementioned challenges often faced with batch process film coating preparation.

Dispersion Preparation

Typically for film coating preparation, a large tank of water with a propeller-type mixing blade (one-third of the vessel diameter) is used. The goal is to use sufficient mixer speed to prevent large clumps as powder is manually added to the water, but low enough speed that excessive foam is not generated. This is often a difficult balance to reach. Further, as the tank level depletes upon use, the mixing blade can often become exposed above the liquid surface resulting in further foam generation or settling of solids.

The ideal scenario is to create a homogenous dispersion that can be maintained throughout the coating process. One objective of Colorcon's study was to completely do away with the traditional mix tank and mixing blade and find a better way of incorporating the solid coating polymer into the water.

Colorcon found that better way with the ILC Dover PST Jet Mixer, and began a series of pilot tests. "The idea was to incorporate the powder into the water in a very controlled fashion so that no lumps are formed and there is no settlement," says Charles Cunningham, senior manager of product development, Colorcon. "When powder is added to a traditional mix tank, you have to let it mix for 25–45 minutes to an hour to get all the lumps to dissolve and become totally dispersed. With the Jet Mixer, we were able to incorporate the powders into the liquid stream uniformly and evenly to avoid any lumps."

Cunningham explains that the process begins by pumping water through an injector restriction to create a high velocity jet and vacuum. The powder valve is opened and the powder gets drawn into the liquid jet. The liquid travels down a pipe and into a small holding tank. Once powder addition was completed, the powder valve was closed and the dispersion was continually recirculated from the holding tank through the pump and injector.

Sieves Study

At periodic intervals, the dispersion was passed through individual 60-mesh sieves for a fixed time of 45 seconds. The screens were dried at 60 °C for one hour. Based on the dried screen retains, Colorcon could see how much lumping had occurred.

Two coating systems were studied: Opadry QX at 30% solids and Opadry II at 20% solids. "The sieve study confirmed that the mixer eliminated the lumping seen with traditional batch mixing processes," explains Scott Patterson, vice president of commercial sales, at ILC Dover.

Within one minute of recirculation, less than 0.5% dry solids were retained on the screen. The QX system performed slightly better as it contains a very rapidly hydrating polymer that can be used at 30% solids concentration.

A Top-Off Operation

As part of the experiment, Colorcon looked at the volume of dispersion in the holding tank. A "top-off" operation or system replenishment was performed using Opadry QX at 20% solids. As the tank was depleted, the powder valve was manually opened and powder flowed into the injector. At this time, a second valve is opened to add water to the injector in such a ratio that keeps the solids concentration consistent. Samples taken throughout the process indicated no change in solids concentration of the dispersion being recirculated from the holding tank.

"It is really compelling that companies are used to putting hundreds of liters of powder in a tank, but this study shows that a company can work with smaller amounts and add only what they need, reducing waste," says Patterson.

Neither Pigment nor Polymer Affected

Colorcon wanted to be certain that constant recirculation over time would not impart enough shear to change the polymer or change the mix color. Thus, further tests using Opadry QX at 30% solids concentration were performed to determine if constant recirculation over time, through the jet mixer, would change coating color or polymer properties. Colorcon used a red iron oxide-based Opadry QX and let it recirculate for five hours. Periodically, in as little as three minutes or as long as 300 minutes of recirculation, samples were taken and tablets were coated. A spectrophotometer measured the color and showed no color change after five hours of recirculation.

"We took each of these samples to our analytical lab to make sure that we hadn't made any changes to the molecular weight distribution of the polymer itself," adds Cunningham of Colorcon. "There were no changes to the polymer."

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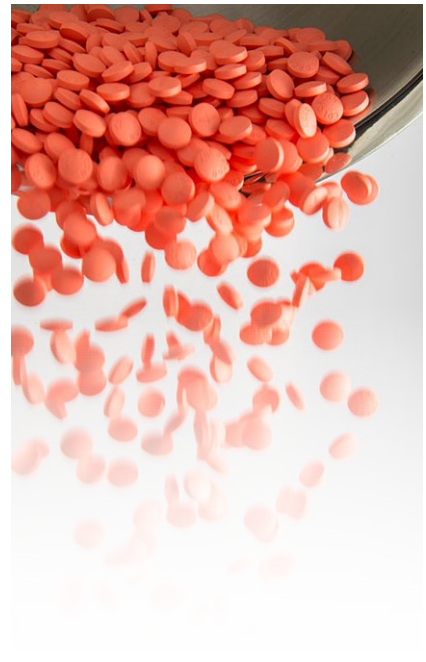
—Scott Patterson, ILC Dover



Almost Continuous Processing

After reviewing the results of all Colorcon's experiments, Patterson is confident that the PST Jet Mixer performed beyond expectations. "All of the challenges associated with film coating dispersion preparation that Colorcon set out to eliminate, they eliminated," he says.

The ILC Dover PST Jet Mixer provided Colorcon with a rapid method for preparing fully formulated coating dispersions. This will allow for dispersions to be prepared as needed or in a continuous manner. The study found that the injector was extremely unique from anything that was being used in the marketplace in batch mixing, as well as the future of continuous processing.

"We all know that the future is continuous processing," says Patterson. "What doesn't exist is a real-time continuous process for coating preparation. We are approaching that with this on-demand system, which does meet the FDA definition of a continuous process."