Real time measurement in fluidized beds

In-line Particle measurement in fluidized bed processes

In-line particle characterization is a useful tool for fluidized bed operators. It offers opportunities for improved manual control and the development of automated control strategies. For the powders and granulates produced by, and used in, the pharmaceutical industry, particle size distribution is an important parameter. It influences the handling properties of a material, its flow behaviour for example, and also the rate at which it dissolves. Particle size distribution can therefore affect not only how easy or how difficult the material is to process and transport, but also its rate of uptake within the body.

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In-line particle size measurement in a batch- fluidized bed Granulator with the probe IPP 50-SE

As the pressure on pharmaceutical manufacturers to operate more efficiently increases, the use of in-line particle size measurement within the industry grows. In-line particle size analysis allows product quality to be monitored continuously and process efficiency to be improved. Product quality is, of course, critically important for pharmaceutical manufacturers, whilst increasing cost pressures are driving the industry towards improved process control and efficiency.

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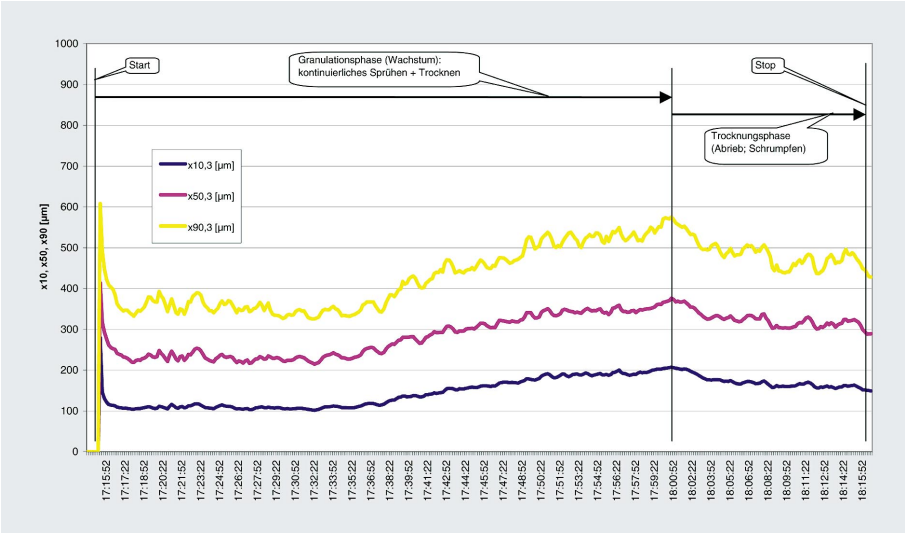
Conventionally off-line analysis is used to generate data for the control of fluidized bed processes but this approach is fairly limited in its effectiveness. Time delays are introduced by the need for a pragmatic approach to sampling frequency and also by the time taken for sampling and analysis. For batch processes the results may not be available until the batch is finished and hence the data cannot be used in any meaningful way for responsive process control.

With in-line particle size analysis dynamic processes such as batch granulation can be monitored continuously and as a result controlled effectively. A full picture of granulate growth and/or decay, with time, can be captured. With this degree of process knowledge, effective plant control becomes much easier and a basis for automated control is provided. In this article an in-line instrument for particle size measurement is described, and its application in the control of a batch fluidized bed granulation process, used in the production of pharmaceutical products, is discussed.

Monitoring granulate growth

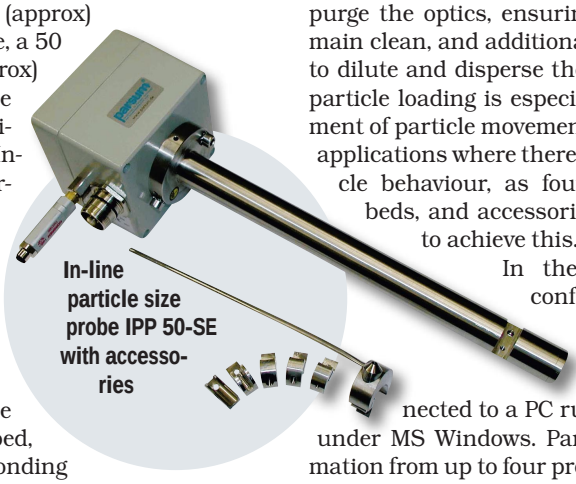
Trials were carried out at Merck, using a Parsum probe (available from Malvern Instruments), in a co-operative venture designed to assess the feasibility of using the probe to continuously monitor particle growth in a batch fluidized bed granulator. Merck was looking to fully optimize its granulation process and selected the IPP 50-SE to meet the demands of the application. The effectiveness of this measurement system had already been proved at the site as probes were installed on various particle gravity chutes to monitor the size of material produced in a range of unit operations.



Trend of the particle size characteristics x10, x50, x90 during a batch granulation process in a fluidized bed Granulator. Product: Lactose; Bonding agent: Hydroxymethyl of cellulose

The issue for this application was whether the probe could produce representative data given the turbulent flow conditions in the bed and the differences in density and size distribution across it. From a practical point of view there were also concerns that contamination/product build-up in the measurement zone would be an issue as a result of the damp conditions in the bed and high fine particle loadings.

Tests were carried out in a WSG5 Glatt granulator using lactose and hydroxymethyl cellulose as a binder. Granulates were produced in a batch process consisting of a 5 minute (approx) warm-up phase, a 50 minute (approx) spraying phase and then 25 minutes drying. Investigations carried out during these tests showed that providing the probe was positioned around the lower to middle third of the bed, and that the bonding agent was not sprayed directly on to it, representative particle size data could be acquired successfully.



In-line particle size probe IPP 50-SE with accessories

The data shown in figure 1 is typical of that obtained during the tests. Increases and decreases in particle size during the spraying and drying phases can be clearly seen, demonstrating the ability of the probe to track particle size evolution effectively during the granulation process. All the data presented - x(50), x(10) and x(90) – is useful for process monitoring for this application as each of these values is important for product performance.

Measurement procedure and system

The probe used simultaneously determines the speed and size of particles as they pass through the measurement zone. Simplistically this is achieved by measuring the length of time that the particle interrupts a light beam, and how quickly it sequentially blocks a series of detectors. The technique measures particle chord lengths, from which particle size distributions can be determined.

Software provided with the instrument allows calculation of alternative representations of particle size, so that the data produced can be compared easily with analogous measurements using, for example, laser diffraction or sieving techniques. In addition, because speed is also measured, the results can be configured to include flow rate, mass throughput and particle concentration data. Results presentation is therefore easily customized to the individual monitoring application for which the probe is being used.

The IPP 50 probe used for this work is constructed from 316L stainless steel and has sapphire windows with a wear-resistant coating. The SE version of the probe, which has an intrinsically safe design, was selected. The IPP 50 is suitable for the measurement of particles in the size range 50 – 4000 ìm, travelling at speeds of between 0.01 and 50 m/s and has an operating temperature range of –20 to 100oC. An internal air supply in combination with various accessories allows the instrument to be configured to meet the demands of different applications. This supply is used to purge the optics, ensuring that they remain clean, and additionally can be used to dilute and disperse the sample flow if particle loading is especially high. Alignment of particle movement is required for applications where there is chaotic particle behaviour, as found in fluidized beds, and accessories are available to achieve this.

In the basic system configuration a patented IPP-50 particle size probe is connected to a PC running software under MS Windows. Particle size information from up to four probes can be processed using a single PC installed as far as 200m away from the probes. Particle size data is transferable to a control system in the form of 4 to 20 mA signals, whilst a RS-485 interface allows data to be transferred over larger distances for data analysis.

Conclusions

The trials indicate that the probe can be used effectively for in situ monitoring of the granulation process. The measured data allows the effect of operating parameters on particle size to be closely monitored and more clearly understood, and will therefore lead directly to the development of increasingly effective control strategies. This in turn will result in more optimal operation of the granulation unit. ■

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