

# Avoiding Blender Blunders

When blending dry materials the question is, 'Continuous or Batch?' as balancing the merits of batch or continuous machinery is not always simple. Hosokawa Micron explains all.

The fundamental operating principle of an ideal batch mixer is that all particles can move in every possible direction, or in other words they are set in random motion within the vessel boundaries. After long enough time the position of an individual particle becomes independent of its point of origin, and eventually a uniform mixture is obtained.

In a continuous mixer the random motion is confined to a radial direction and in a perfect world there would be no mixing along the axis. A well designed continuous mixer produces conditions approaching plug flow, while achieving mixing whose thoroughness is dependent only on residence time.

Of course the world is not perfect, and it has to be conceded that in reality batch blenders will have dead pockets, and continuous mixers will suffer from axial dispersion. But for purposes of comparison, the theoretical distinctions are sound.

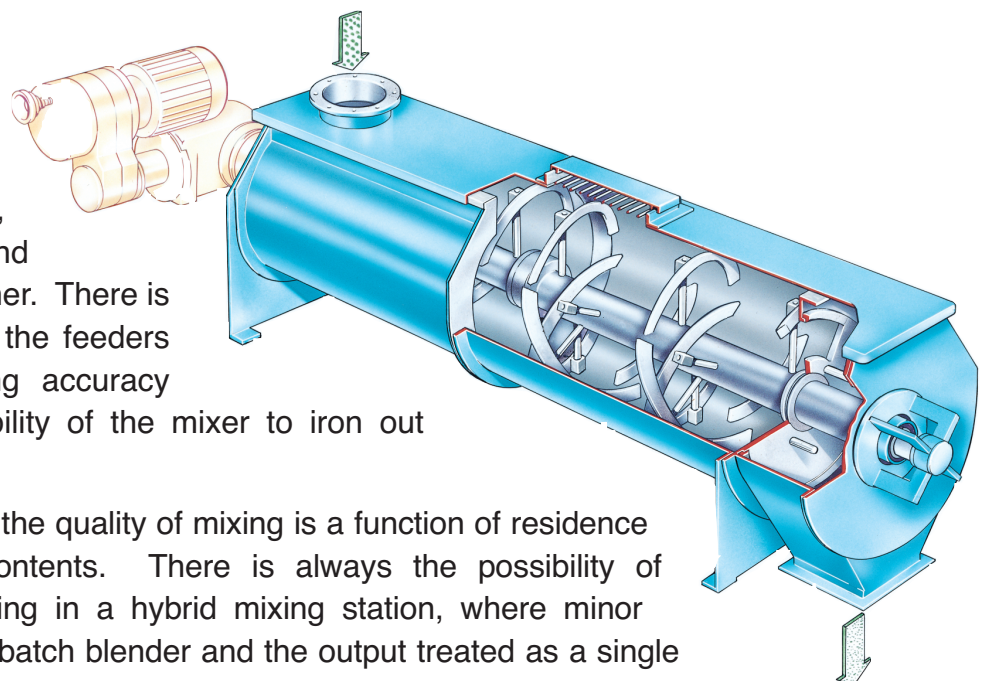
Batch mixing is generally characterised by a sequence of three stages: weighing or otherwise proportioning components; blending; and discharge. Weighing of ingredients can be done inside or outside the mixer, and in a case where there is one dominant component and a number of smaller additives, there will frequently be a combination of both.

Unloading may occupy a considerable proportion of the total batch cycle time. It is not always desirable to completely discharge mixer contents at once, and it can be convenient to use a batch mixer as a live hopper to feed a subsequent process stage. Residence time for achieving satisfactory blending may be extended due to a mix having poor flow characteristics, or need to operate rotating internals slowly because materials may be heat sensitive or fragile.

## Full Flow

Continuous mixing depends on the three stages being simultaneous. Once in full flow, material proportioning, blending and discharge are all happening together. There is considerable interaction between the feeders and the mixing device. Feeding accuracy required is dependent on the ability of the mixer to iron out fluctuations in feed rates.

A second influential feature is that the quality of mixing is a function of residence time distribution of the mixer contents. There is always the possibility of incorporating both modes of mixing in a hybrid mixing station, where minor ingredients may be premixed in a batch blender and the output treated as a single component for introduction alongside a major component to the continuous mixer.



In general terms continuous mixing requires less labour than batch operation, although batch systems can be highly automated and modern electronics can provide great flexibility. Continuous mixing systems are less prone to segregation against free fall of final product than is the case in batch mixing.

Properly designed, continuous mixers can yield good results in short residence times, meaning a small space requirement in relation to throughput. A possible drawback with small volume content is that fluctuations in feed are less easy to level out, so that component feeding accuracy has to be high, and investment costs rise sharply with the number of components in the input.

In continuous mixing a control loop for maintaining consistent product quality can only be applied if the system response time and the response time in the control loop are short, or there is a risk of discharging large quantities of product out of specification.

Continuous systems are more sensitive to malfunction of system components. Frequent calibration of feeding devices is required to preserve accuracy and consistent output, particularly if flow properties of ingredients are expected to vary widely. There can be problems in accurate feeding of cohesive minor ingredients, such as titanium dioxide and other pigments.

Batch identification, commonly demanded in pharmaceutical manufacturer, is possible only in batch mixing systems. Continuous systems are generally designed for a specific application and are more difficult than batch systems to adapt to other purposes. Flexibility is a main feature of the batch mixer, and by its nature a continuous mixer is not well suited to operating changes.

## The Factors

Choice between a batch and a continuous system is determined by several factors. The properties of the components and their interaction during and after blending, particularly any tendency to segregation, is important. Need for flexibility, frequency of formulation changes and contamination hazards between successive compositions should be taken into account. Quality control and the time lag of a control loop can be significant. Requirements set by upstream and downstream processes could decide the issue.

When one or more of the above factors leads to selection of a continuous system, there remains a choice between equipment types according to desired mixing characteristics.

If the purpose is to blend two or more components which will be fed in proportions within tight tolerances required for consistently accurate output, the recommendation is for a continuous mixer within a minimum of axial dispersion. This can be small and compact in relation to its output, provided radial mixing is rapid.

Where fluctuations in the feed are beyond the specification of the product they may have to be levelled out by the mixer. Such fluctuations are not necessarily related to variations in weight proportioning, but may include deviations in chemical or physical properties of the feed which cannot be adequately controlled in previous process stages. The best solution requires long residence time and significant back mixing.

Size of the blender can be difficult to determine due to a lack of data on the feed available. As well as the fluctuations in components, expressed, as a variance around a mean value, the average delay between successive upper and lower extremes, expressed as an auto-correlation time, is needed for dependable calculation.

Counterflow continuous mixing systems are suitable for processing a wide range of powders, granules, pellets, fibres, flakes, liquids and many sensitive materials. typical duties include: mixing solid materials which may be of different densities, particle sizes and physical properties; moistening dry solid materials with small additions of low viscosity liquids; and mixing low viscosity materials which generally do not have a tendency to stick.