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KNOWLEDGE

Technology Simplifies Continuous Operations

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The right blend every time

Blending is defined as combining raw materials in exact proportion to meet specific recipe requirements. Blending is very basic to many consumer products because each product needs to have a specific taste, smell, texture, viscosity and appearance. For example, a slight error in the viscosity of ketchup is very noticeable at the dinner table.

Blending operations also are important for consumer products such as animal feed additives, soaps, detergents, and shampoos. Premixes for different types of reactors, such as continuous, continuous stirred, plug and loop reactors, also require blending.

Many chemicals, including caustics, acids and hydrogen peroxide are shipped in concentrated form to lower shipping costs, and precise blending operations are required to dilute the raw materials before they can be used in a manufacturing process. Hydrogen peroxide is extremely reactive to use in concentrated form and caustic will freeze if cooled in concentrated form. To effectively use these raw materials in exact proportions, precision blending is important.

Blending operations can be used to produce different grades of finished, compounded products. Because many facilities use the same equipment for multiple "recipes," the equipment instrumentation and control valves must be able to operate with precision across a high range.

Inefficiencies from batching

There are at least four ways that traditional batch blending — mixing induced ingredients in a tank — can affect a plant's overall efficiencies. The first way is the excessive time it takes to add one ingredient after another, called sequential addition. It can take up to three hours in accumulated time to start up and shut down the batch, which extends the cycle and reduces on-stream time. Numerous startups and shutdowns in any chemical operation make the process less efficient.

In addition, batch blending requires a great deal of floor space because of additional mixing and storage tanks. Mixing and storage tanks take up valuable real estate, and space is at a premium in most plants.

Thirdly, batch blending requires large inventories of finished products that must be stored in anticipation of sales volume until the next batch can be produced. If intermediate products are required, additional storage tanks are also necessary.

And finally, batch blending involves more equipment. Weigh scales are required, and they can be expensive to maintain, especially if any forces are exerted from the piping system that feeds the batch operations. Weigh scales also need to be recalibrated frequently. There are also oversized pumps, agitators and control valves that are highly fluctuating. This oversized equipment requires maintenance more often that continuous operations.

Volumetric flowmeters are often used to measure materials going into a mixing tank. Volumetric measurements must be compensated with temperature and pressure sensors, or the contents of the tank must be weighed.

Continuous processing

Continuous blending presents another option. Continuous blending is measuring and mixing raw materials within the pipe as the material flows to produce exact proportions and meet specific recipe requirements. Continuous blending delivers the same accuracy, sometimes better accuracy, than batch blending.

Although continuous blending can alleviate many of the shortcomings of batch blending, some facilities resist the change because of "corporate culture." Manufacturers like to stay within their comfort zone, and might be wary of an unfamiliar procedure. Many plants have invested heavily in batch blending equipment and may be unwilling to replace it.

Even when facilities want to go with continuous blending, as most do, the design details can be difficult. However, after doing the research, engineering and justification, many companies eventually decide to use continuous blending to expand an existing plant or build a new facility.

Even when evidence is convincing that continuous blending will be more efficient, plants may use both batch and continuous blending until operators are fully trained and the process proves successful.

Benefits of continuous blending

Continuous blending offers the advantages of improved on-stream time, minimal floor space requirements, reduced inventory levels and less maintenance.

Improved on-stream time is achieved by simultaneously adding raw materials, which eliminates the necessity to stop and start the batch systems. Without the stopping and starting, the operators are doing the same thing all the time, and only need to adjust the amounts of materials. The chances of introducing inaccuracies are reduced. Production proceeds steadily, and new recipes can be initiated without stopping, which minimizes the waste to just that small amount between recipes.

Continuous blending requires less floor space, because the equipment is smaller. And because the equipment is operating continuously, the smaller equipment can produce more. The finish storage tanks may still be needed but might only have to be large enough for surge capacity immediately upstream of the discrete filling of containers. Unfortunately, the process can't continuously feed discrete filling operations, but a lot of operations now feed directly into a railcar or a truck.

For some of the same reasons that continuous blending requires less floor space, it also reduces inventory levels. Less intermediate product is required and only as much product as needed is produced.

Reduced maintenance is one of the biggest benefits of continuous blending. Not only is the size of the equipment smaller, but Coriolis mass flowmeters that replace the traditional volumetric flowmeters require almost no maintenance. Routine maintenance and calibrations are eliminated for Coriolis meters. The mixer is usually a static type that has no moving parts, and therefore, requires no maintenance. And because the control valves are not cycling as much and they are usually smaller, the valves require less maintenance. Even if continuous blending includes inline high-sheer motorized mixers and pumps, the size of the equipment is smaller and they are not cycled on and off.

Frequent startups and shutdowns cause the equipment to wear out more quickly. By eliminating startups and shutdowns, the equipment lasts longer. Startups also can cause damaging equipment failure; for example, starting up a turbine meter can spin the turbine off its shaft. When startups are eliminated, so is the possibility of that type of headache.

However, the automatic controls for blending raw materials simultaneously require reliable and accurate meters, control valves and instrumentation because, unlike batch processing, there is no way to stop the process to check specs.

When a transition is made from manual to automatic control, less staffing is required, product quality is improved, and safety is enhanced. Manual operations require more operator attention. Product quality is difficult to attain under manual control because so many parts of the process must be monitored simultaneously. Automatic control will reduce scrap and rework to just the small amount of interface between recipe changes.

One advantage that batch processing offers is the identity of a batch through the entire operation. With automatic controls on continuous blending, the reporting time can be any start-stop time management chooses: by the hour, shift, day or week. Saving the information digitally is helpful in tracing continuous blending batches, similar to batch identification.

Whether required to trace product quality or not, reliable product delivery is directly related to the quality of the metering instrumentation and control valves. Coriolis mass meters are chosen for their excellent accuracy and low maintenance. Accuracy to 0.5% or less is available with Coriolis technology.

Another benefit of continuous blending is less capital. In addition to eliminating mixing vessels and associated accessories, the pipeline sizes are smaller in continuous blending because the materials are flowing constantly.

In batch blending, larger pipes are used to fill the tank as fast as possible. In a batch operation, a 2-inch Coriolis or other type of flow device might be required, while in a continuous operation, a half-inch meter may be used to produce the same amount of material. As an alternative, the larger line may be kept and will produce many times more material.

One major benefit of continuous blending with automatic control is enhanced opera-

PC&E was founded on January 1, 1986 with 14 ex-Monsanto engineers who had been displaced by Monsanto's second downsizing. The company now employs about 300 people. In 1997, PC&E became part of Emerson Performance Solutions.

tor safety. Eliminating mix tanks reduces operator risk from exposure to materials, as well as eliminating inert blanketing of vessels, entry permits and associated risks.

Continuous processing allows a smaller amount of noxious materials at any one location.

Experience the difference with Coriolis

One processor of home products, whose representatives asked that it not be identified, has successfully installed 16 lines of continuous blending at one location and eight lines at a different location. One stringent requirement of this processor is that the finished products must be perfect. This producer is absolutely intolerant of product changes in any aspect; he uses only Coriolis meters.

Positive displacement (PD) and turbine meters have accuracies that approach the accuracy of a Coriolis meter, but because of their moving parts, PD and turbine meters have high maintenance. Vortex meters are not as accurate and do not have the rangeability of Coriolis meters, but magnetic flowmeters (mag meters) provide volumetric measurements of 0.5% accuracy.

Typically, the continuous blending units are designed and shipped in modules that measure about 12 feet wide but 50 feet long and 8 feet high. Each module will contain about 12 Coriolis meters, many transmitters for pressure, several static mixers, a control panel for the programmable logic controller (PLC) and other instrumentation.

To eliminate individual control wiring in these compact modules, the systems use Modbus, which is an older master-slave digital communications system that uses RS-485 serial communications. A communications card that interfaces from the Coriolis meters to the PLC allows the 4-20 mA output of pressure transmitters to be directly wired to the Coriolis meters and utilized without additional instrumentation that is usually required. It also eliminates the need for fieldbus but fieldbus can be added later.

The process utilizes mass flows, temperatures, meter pressure differentials, and density to calculate relative viscosity from a proprietary algorithm. This algorithm calculates a viscosity that is not in the normal units, such as centipose, SSU or centistokes, but is repeatable and accurate for consistent product quality.

Summary

In summary, the benefits of continuous blending with automatic control, whether upgrading an existing process or installing a new process are as follows:

- Improved product quality
- Enhanced on-stream time
- Optimized floor space
- Reduced staffing costs
- Improved safety
- Better process information from control system
- Reliable product delivery
- Minimized waste disposal

About the author

Jerry Donovan has been an applications engineer for PC&E in St. Louis, Missouri for ten years. Prior to PC&E, Donovan spent sixteen years with Gas Distribution Utility and then twenty-five years in the corporate engineering department of Monsanto.

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