Advantages of PLC Recipe Controls
in Mixing and Blending
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Abstract

In many processes throughout the world of modern-day manufacturing, the use of Programmable Logic Controls (PLCs) is well-established as a strategic tool for building competitive advantage. However, it is still quite common to find mixing and blending equipment – even those designed for high-volume or high-value products – that continue to rely on manual operation presumably because automation is viewed as excessively expensive or complicated. Manufacturers must consider that this assumption is not always correct and can result in significant opportunity losses.

This white paper aims to shed light on the subject and presents five benefits that PLC Recipe Controls can bring specifically to mixing and blending processes.

Introduction

Mixing and blending are general terms used to describe a broad range of operations whose ultimate goal is to achieve a homogeneous multi-component material. Many variables contribute to the various classifications of mixing and blending classifications: the state of materials being mixed (solid, semi-solid, liquid, gas), their flow characteristics, the level of agitation or shear required, sensitivity to heat, etc. These all come to play when selecting the appropriate mixer design to a particular application.

Over the years, as new ingredients and processing techniques gave rise to advanced and improved products, from adhesives and pharmaceuticals to coatings, inks and everything in between, the mixing technologies employed for such processes also evolved along the way, both in terms of intrinsic design and in how to operate them most efficiently. Today, manufacturers are realizing that they need to go beyond the process of matching the right mixer to a certain viscosity, desired particle size, density or other attribute. Equipment selection should also tackle the subject of controls if one wants to get the most out of their mixer or blender. It is not hard to imagine how a single-speed mixer that an operator would turn off after two hours on his watch or when the mix “looks good” no longer serves well in a highly competitive or regulated environment.

To be sure, not all mixers and blenders require advanced control systems. Off-the shelf turbine and propeller mixers, for instance, are operated with just a simple motor starter or variable frequency drive. But with specialty mixers and blenders that produce high-volume or high-value applications, the benefits of PLC Recipe Controls are too great to disregard. In the following pages, these advantages are explained in detail and presented with examples.
Consistent Product Quality

The most obvious benefit to applying PLC recipe controls to a mixing process is arguably batch-to-batch consistency. Barring any variations in the raw material supply chain, a mixer with well-specified controls virtually guarantees the exact conditions for achieving statistically repeatable end product quality.

Below is a sample ten-step recipe for a Triple-Shaft Mixer. For each step, the speeds for all three agitators (Three-Wing Anchor, High Speed Disperser and High Shear Mixer), heater set-point, vacuum level and mixing duration are all pre-defined. A programmable pause can be built into any step in order to load raw materials, take samples or perform other activities.

With PLC recipe controls, operators are able to focus on the actual process instead of manually timing the mixer while having to adjust temperature, pull vacuum, manipulate agitator speeds, open and close valves, etc. Manual tasks like these can affect an operator’s concentration and subsequently impact how precisely a recipe is followed from one batch to another. By eliminating human variability, PLC recipe controls ensure that the exact same processing steps are followed each time.
Increased Process Efficiency

Automating a mixing or blending operation not only lessens operator error and variation; ultimately, it increases overall process efficiency in multiple ways:

- **Higher product yield** (less rejects) especially for applications that are highly process-sensitive.

- **Lower production cost.** A well-designed mixer with control system does not require as much labor to operate, produces less waste and is more energy efficient.

- **Shorter cycle time.** Delays attributed to frequent rework, incorrect mixing instructions, weighing errors are significantly reduced, if not eliminated.

- **Faster changeovers.** Automated product discharge, draining and cleaning-in-place helps minimize machine idle time.

- **Longer service life.** An appropriate control system provides electronic soft start for the agitator(s), overload protection and other features that help prevent pre-mature wear and mechanical failure. Proper routine maintenance and calibration can also be programmed into the PLC recipe controls so operators are less likely to overlook such procedures.

Planetary Disperser equipped with two interchangeable mix vessels and touchscreen recipe terminal. This system is designed for semi-continuous processing (one mix could be at the loading stage while the other is under the mixer), an arrangement that maximizes both machine and labor utilization.
Better Monitoring and Recordkeeping

PLC’s with customized HMI (human machine interface) and SCADA (supervisory control and data acquisition) packages enable automatic data logging. Such systems support complete traceability and comply with regulatory requirements covering sensitive applications like food, pharmaceutical and medical products. As a managing tool, PLC’s also make it easier to pool statistical information on typical workloads and bottlenecks.

For more practical monitoring, recipe controls can be configured for access through a smart phone or tablet so that operators and managers can have full visibility into a mixer’s performance and status wherever they are in the plant. On the right is a NEMA 4X Control Panel built for a Ross Mixer. Start/stop/speed controls, speed and load displays, temperature display, cycle timer, vacuum pump on/off controls and Emergency Stop are all accessible from the panel and from multiple mobile devices. The interactive phone and tablet configurations developed by Ross are designed to help users save time and conveniently stay connected. The mixer controls may also be programmed to automatically send text or e-mail messages regarding operating status, production concerns and alarm notifications.

Sample batch report.

Ross PLC Recipe Controls can be accessed from multiple internet-capable wireless devices.
The NEMA 4X PLC recipe terminal on this custom-fabricated pharmaceutical mixing system includes a chart recorder compliant with the FDA’s 21 CFR Part 11 guidelines on electronic records and electronic signatures (ERES). It monitors and controls the following components:

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>PROCESS VARIABLES / CONTROL FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ten (10) RTD Temperature Sensors at Steam Traps</td>
<td>Temperature</td>
</tr>
<tr>
<td>Two (2) Feed Vessels</td>
<td>Pressure, tank light on/off</td>
</tr>
<tr>
<td>Emulsification Vessel</td>
<td>Speed, amperage/load, timer, temperature, pressure, conductivity, flow, mixer raise/lower, tank light on/off</td>
</tr>
<tr>
<td>1HP Inline High Shear Mixer</td>
<td>Speed, amperage/load, timer, pressure, flow</td>
</tr>
<tr>
<td>1/2 HP Metering Pump</td>
<td>Speed, amperage/load, time, flow</td>
</tr>
<tr>
<td>Recirculation Vessel</td>
<td>Pressure, temperature, weight, tank light/off</td>
</tr>
<tr>
<td>Diafiltration System</td>
<td>Pressure from transducers at three locations, flow</td>
</tr>
<tr>
<td>Buffer Tank</td>
<td>Speed, amperage/load, pressure, weight, tank light on/off</td>
</tr>
<tr>
<td>Waste Vessel</td>
<td>Pressure, tank light on/off</td>
</tr>
</tbody>
</table>
Improved Safety

Automation offers improved safety to mixing processes by limiting operator exposure to hazardous chemicals and extreme temperatures. But even in straightforward, non-hazardous mixing operations there is more to meeting safety codes than simply wiring the right motor starter or variable frequency drive.

For one, a mixer must have lockout/tagout provisions. OSHA, NEC and local codes require an energy-isolating device that can be locked out and has a prominent warning tag to protect employees from unexpected start-up or release of energy during service and maintenance. Emergency Stop buttons, primary fusing and main disconnects are just a few other safety features that must not be neglected. Any variable frequency drive will need to be programmed to accommodate all safety switches and E-Stop devices as well as provide short circuit and overload protection to the motor.

All this can make it difficult for the owner of a new mixer to tie in all the pieces together without hiring an electrical contractor. Usually, it is ideal for the mixer manufacturer to supply, wire and mount the mixer controls prior to shipment. Thus, the end user need not rely on multiple vendor manuals and limited technical support from different manufacturers. The more complex the mixer and the more auxiliary equipment present, the more it makes sense to source PLC recipe controls from the supplier that knows your machine best.

Some Mixer Controls Options

- **Double Planetary Mixer with NEMA 4X Control Panel** mounted to the side of the mixer and supplied with single-point power hook-up.

- **600-gallon Multi-Shaft Mixer/Reactor** featuring two variable speed agitators, high-accuracy flow meters and pumps, a complete vacuum system, and elaborate valve manifold. All components are controlled from a 15" color touchscreen on a skid-mounted control cabinet.

- **In lieu of a panel or cabinet, PLC controls may be built into an ergonomic standing workstation.**
More seamless start-ups

One way to ensure a smooth start-up upon delivery of your mixer is to source the control system direct from the equipment manufacturer. As discussed in the previous section, extensive integration may be required depending on the complexity of the mixer and auxiliary devices such as vacuum pumps, temperature probes, load cells, flow meters, etc. Mounting and wiring challenges are typical reasons behind start-up delays.

When PLC recipe controls are offered as an option, they are especially worth considering if you need the mixer or blender to be completely production-ready immediately upon set-up. Ultimately, the up-front cost associated with built-in controls offer great value to end users on a tight budget and schedule.