ROSS

How a Control System can help increase profits

Creating an efficient mixing or blending system is a balancing act. Throughput must be balanced against batch size, agitator sizes, motor sizes, shear and tip speeds, viscosity, the thermal capacity of your product, energy costs, labor costs…and a many other variables. With the wide range of equipment choices and competitive pressure to optimize performance, the mixing process itself has never been more complex. But in most cases today, the most challenging balancing act of all is still the specification of your process control equipment.

The control system must balance your need for accuracy, consistency, flexibility and reliability against your need to control costs. The control system is therefore much more than the interface between the operator and the machine; it's a direct interface between your process system and profitability! If the control equipment right your production line will run smoothly. Under-specify – *or over-specify* – the control system, and you're in for additional costs and production delays.

In the past, the control system was often little more than an after-thought assigned to a local contractor (who knew little about the process he was trying to control) and an overworked in-house engineer. Those days ended with the realization that current control systems are far more than an ON/OFF switch.

With the technology available today in sensors, integrated PID control logic, intelligent valves and central SCADA systems, every function in your processing system can be automated to operate at a high level of accuracy. But as accuracy increases, costs increase, too – and at an even faster rate. And this is where the most important balance of all becomes apparent: the balance between the accuracy we can achieve and the accuracy you truly need.

How much accuracy do you need?

In the typical production operation, raw materials are stored under specific conditions, then measured and transferred to a mixer/blender where they are transformed into an intermediate or final product. Often they pass through transitional vessels and intermediate processes along the way.

Each step along the process path is usually marked by well-defined tolerances associated with such parameters as product temperature, pH, viscosity, flow rate, and vacuum. These often relate to specific thresholds as well as the *rate* at which the set point must be acquired.

Imagine a mixing process that consists of several distinct phases in a 500-gallon vessel. The transition from one phase to the next may require that we elevate the product temperature from 90^{o} C to 120^{o} C in 20 minutes. Our tolerance for both the target temperature level and the duration of the transition period is 2% (± 1%).

That data – the performance specs and the required tolerance – invariably sets a dozen design wheels in motion.

- What type of heat transfer system is now available in the plant? Hot oil, steam or hot water?
- Does the current heat transfer method rely on media with high momentum? This is a critical question. These processes must be controlled more carefully, and they require a more sophisticated control strategy to avoid overshooting the target.
- What is the capacity of the present heat transfer system and the vessel jacket? Can we drive enough heat into the batch in that period of time?

- What is the volume of the vessel, the nature of the flow within the vessel, and the ability of the product to transfer heat from the vessel walls to the interior of the mass?

Before we move forward, lets pause and ask ourselves a question.

In this process, is a 2% tolerance acceptable? What are the implications of performing this operation within a 5% tolerance? Often performance is unaffected and a lot of cost for unnecessarily sophisticated gear is eliminated!

In the real world, “tolerances” are not stationary.

Process tolerances are generally initiated in the R&D process before the hand-off from R&D to engineering. That is the point where the first of many adjustments are made.

Naturally, the project manager wants to make sure that the system works correctly when it hits the process line. So, when he sees a 5% (±3%) tolerance, he adds an extra margin of safety. He tells his equipment suppliers to work within a 3.5% tolerance.

The equipment supplier also wants to make absolutely sure that the final system performs as required. He also adds an extra measure of safety by tightening the spec. Now the 3.5% tolerance becomes 2.5%, and this degree of required accuracy triggers many expensive – and unnecessary – additions to the system design.

Often this cascade of tolerance “adjustments” is even longer, and the end result is even more dramatic.

How serious is it?

Here is a rule of thumb that suggests where the key cost thresholds generally occur in the average mixing system.

5% tolerance	A 5% tolerance is easy to hit with the simplest control systems. An inexpensive dead band control with OPEN/CLOSE valves, for

	example, will usually suffice for batch heat control.
2% tolerance	When tolerances are pushed to 2%, the project requires significantly greater expertise in control engineering. Operation within a range of ±1% often necessitates using such equipment as proportional loop control or duty cycle control and a fast-acting OPEN/CLOSE valve arrangement. Equipment costs can increase substantially, depending on the specific equipment that you have standardized on.
1% tolerance	In many applications, this requires a step up to PID loop control and *fast-acting* control valves. (Don't even consider using a motorized valve that requires 15 seconds to open and close!) This degree of accuracy requires far more costly equipment. You'll need to tune your controller carefully. Even with auto-tune, the process will still require multiple cycles as the PID controller gradually improves.

To optimize performance and lower costs, match your controls to your "real" needs.

What does it take to build a control system that optimizes performance *and* cost-efficiency?

1. Establish accurate and complete specifications.

Tolerances are probably the best example of input that can distort the control design – and blow the budget. But the same can be said about many process specifications. Even when specifications are "adjusted" to serve the best of intentions, "specification creep" can cause big problems.

2. A control engineer who is intimately familiar with your process.

A control designer who sees only the electrical dimensions of your project is working at a terrific disadvantage. Involve the designer/engineer in the dynamics of the process itself, and he will be able to contribute meaningfully at every step along the way.

Ideally, the control engineer should communicate closely with the process equipment manufacturer throughout the project. If their designs evolve together, they're likely to produce much better results.

Balance is important.

When should you apply sophisticated process control technology?

When should you choose a simple solution?

There is no substitute for experience. Choose a process control expert who has done this before *in applications like yours*. This is your best insurance against winding up with a process control system that is over-designed, under-designed…or just plain poorly designed for your needs.

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