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"The Machine is Qualified. Why Won't it Control my Process Air Temperature Set Point?" Tips for Tuning of PID Loops – Part 1.

Phases in the life of a machine installation include IQ (installation qualification), OQ (operational qualification) and PQ (performance qualification). At some point during this progression of events, the controllers for the devices that achieve and maintain the desired set points for the recipe parameters must be 'tuned'. No matter the product or process, they must perform in a narrow operating range. This may not be as easy as it sounds…

Many companies purchase equipment that is intended to operate using multiple processing inserts (differing in size and/or configuration). Combined with a variety of product characteristics (heat sensitivity, particle size, density, etc.), the PQ phase of the installation is extremely critical. Imagine a 32" Wurster requiring 2,200 cfm of process air at 90°C for an economical aqueous drug layering onto core pellets. The resulting product temperature will likely be around 40°C. For this type of process, the incoming dew point should be set at 10°C to enhance the drying capacity. A +/- 2°C oscillation around the set point is not a problem because of the 'distance' from the product temperature. Additionally, since this is the upper end of the performance of the process air handler, the expectation is that it will be easy to control the temperature within a narrow operating range. Now imagine coating of these pellets using a heat sensitive polymer that restricts the product temperature to 25°C. This low temperature mandates the use of a low dew point, and if 10°C is the low end of the qualified range, this would be the selected value. However, a +/- 2°C oscillation around the set point with *this* low product temperature would be a problem. As well, the low drying capacity would yield a low process air temperature – maybe as low as 40 - 45°C. The narrow oscillation seen at 90°C may balloon to several degrees due to the fact that the PID parameters were chosen for the higher temperature.

How do you solve these issues? The first step is to identify whether the fluctuations are due to parameter interactions, PID tuning, an unsteady utility or even an issue with the machine installation. An easy 'first step' is to observe the behavior of the rogue parameter during experimental batch processing. Process parameters are interactive – the inlet air temperature may be adversely impacted by an out of control pre-heater temperature (a component of a humidification section in the air handling unit). The process air dew point may also be affected by the pre-heater (if its oscillations take its trough value below the dew point set point) or erratic behavior of the dehumidifier section. The related variables will move in tandem. Troubleshooting of this 'lack of control' should start with the support variable, not the final CPP (process air temperature or dew point).

You must be logged in at a level sufficient to permit a PID loop to be switched from 'auto' to 'manual'. If the observed trend is a regular oscillation (sinusoidal), this is typically indicative of overly aggressive tuning parameters. If the loop is shifted to manual, the output to the control device will be frozen. If this causes the parameter to 'flat-line', the problem is in fact the values selected for the PID loops. If the parameter still behaves in an erratic manner, it is likely the fault of a utility. As an example, the temperature of steam changes as its pressure changes. If the air handler is fed by steam that is not at constant pressure it will be very difficult to control the process air temperature. A steam boiler cycles between its high and low pressure control limits – it fires when the pressure is low and shuts off when it reaches the upper limit. The frequency varies with the demand for steam. As the pressure varies, so does the temperature of the steam. An air handler installed without a pressure regulator on the steam supply will have difficulty in reacting to the variation in steam pressure and temperature during the course of a day.

If a temperature or dew point parameter has a tendency to drift slowly (up or down), then experience a sudden and significant change, the likely culprit is a sticking control valve. Drifting from the desired set point would cause the PID control loop to increase (or decrease) its output. When the output is sufficient, the valve will suddenly 'break away' and the change in the parameter will be substantial. No amount of PID tuning can change this – it is a hardware issue.

A future insight will focus primarily on tactics for selecting the values for the PID loops.

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