How P.I.D. Control Works on Boilers

Boilers are normally furnished with a proportional (P) only type modulating control. That type of control is the least expensive up front but its use results in significantly higher fuel costs.

A PID type control is far superior *if properly tuned*

Here is why:

Proportionally controls position the firing rate motor on a burner solely based on how far the actual value (say actual steam pressure) is from the set point (the steam pressure desired). Proportional control can work well when the load on the boiler is high enough that the burner never shuts off but when the load falls off there can very erratic control – especially on low mass boilers.

For example,

> A steam boiler with a 2:1 turndown ratio burner is to provide steam at 5 psi. The boiler is sized for the maximum load which happens once every few years, so the boiler is normally too large and cycles on and off. The burner shuts off at 7 psi. The system continues to take steam and the pressure drops in the boiler. The controls call for heat at 4 psi and the burner's fan starts purging the boiler. 30 seconds of blowing cold air through the boiler has caused the steam pressure to drop down to 1 psi but then the burner starts.
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> The proportional only control "sees" that the steam pressure is WAY below the set point so it makes the burner go to maximum firing. It takes about 20 seconds to get from low fire to high fire and since the boiler has "cooled" it takes a little time to get things heated up again (like a flywheel effect). The pressure is up to 5 psi by the time the burner gets to high fire and it is rising rapidly. But the proportional control keeps the burner on high fire until the pressure hits 6 psi. Once it gets to 6 the burner starts moving to low fire but it never gets a chance to get there before it shuts off.
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> The boiler engineer notes that the whole steam system is screwed up because the boiler can't supply a reasonable constant pressure. He is also sick of the waste of energy. Fortunately the burner came with a potentiometer (some don't) that he can use to limit the maximum firing rate. He almost solved his problem by making the maximum firing rate

be close to the low firing rate. But when the steam system needs a lot of steam his boiler won't be able to supply it. Further, he made his modulating burner be very close to on/off.

There is a better way!

With a properly set (that can't be stressed enough) PID control, the control changes the firing rate so that the burner remains on low fire when that is all that is needed. The PID control also turns the burner on and off, so that it can begin it's start cycle before the steam pressure drops too far.

Short cycling is greatly diminished which yield high fuel savings and reduces wear and tear on the burner. The set point is better maintained which yields better control of processes and reduces wear and tear on control devices.

A PID control adds integral and derivative action to the proportional action of the normal OEM control. Derivative action means that the control "looks" at how rapidly the actual value (steam pressure or water temperature) is changing compared to the set point and changes the firing rate accordantly. Integral action changes the firing rate after the control calculates how far the actual value is from the set point over time. The firing rate is raised when the actual value doesn't seem to be getting to the set point fast enough and lowered if too fast.

For those really oversized burners the control has a sort of timer that keeps the burner on low fire after light off unless the actual value doesn't increase.

A PID control in the example above would turn the burner on when the steam pressure dropped to 8 psig even when that is above the set point. That keeps the steam pressure from dropping so far during the light-off sequence. Once the burner lights off it stays at low fire and observes. If the steam pressure isn't rising then the firing rate increases a bit. After a minute or so the firing rate will be right at set point. If the load is higher than the low fire capacity of the burner, then the burner just stays on and maintains the steam pressure to plus or minus 1 psig.