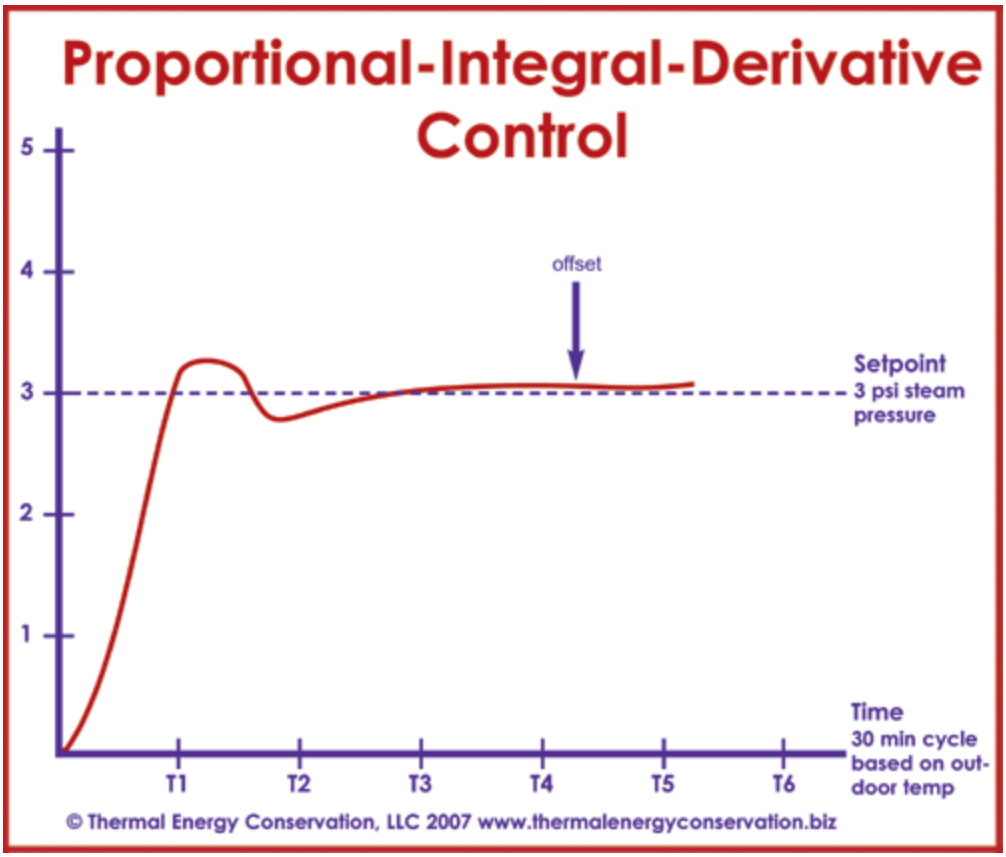
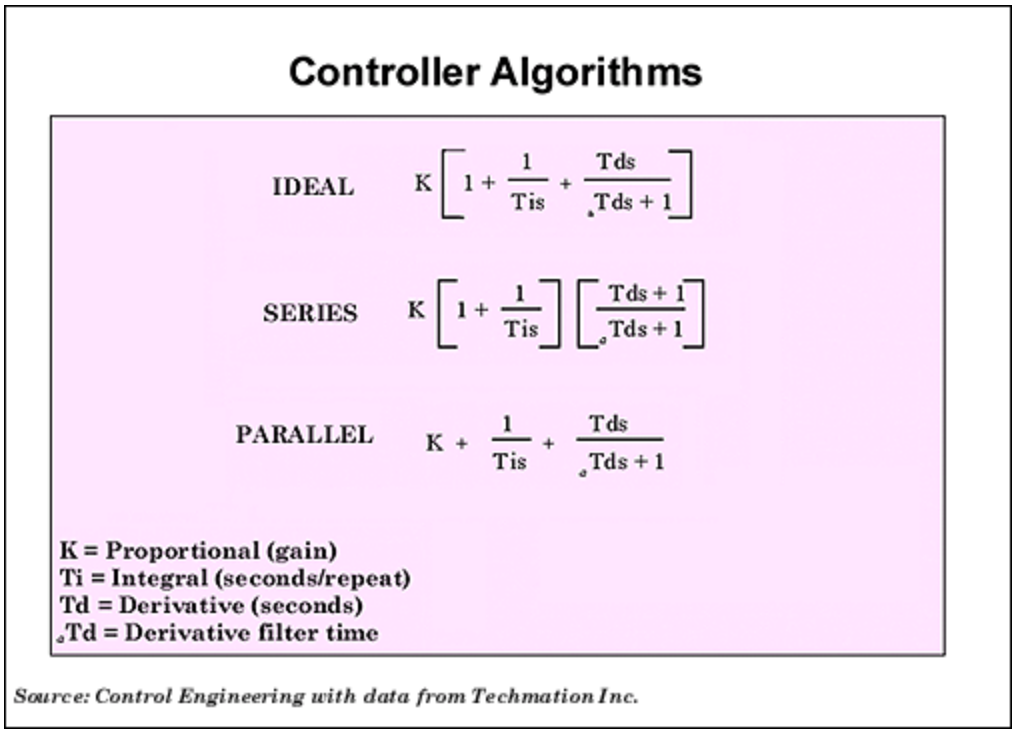
PID Control Theory

- An Introduction to the Fundamentals of Digital Controllers -



There are essentially three types of algorithms in use: ideal, parallel and series. Ideal algorithms are generally found only in textbooks. Parallel control algorithms have three independent (parallel) calculations for Proportional (Gain), Integral, and Derivative. An advantage of parallel calculation construction is changes in the values to one do not affect the other two. A disadvantage is they are difficult to manually tune. Series control algorithms are constructed so the output of one calculation is part of the input to the next calculation, thus "upstream" calculation changes affect "downstream" calculations. This is frequently referred to as controller tuning interaction. Series control algorithms are the most common used in analog and digital controllers.



Proportional term definition Proportional Band % = 100/Propotional Gain	
Proportional Band (Proportional Gain)	**Gain**

1%	100.0
10%	10.0
50%	2.0
100%	1.0
500%	0.2
1,000%	0.1

Source: Control Engineering with data from Techmation Inc.

Comparison of units used for controller integral settings

Seconds per repeat	Repeats per second	Minutes per repeat	Repeats per minute
1	1.00	0.0167	60.0
5	0.20	0.0833	12.0
10	0.10	0.1667	6.0
60	0.0166	1.0	1.0
120	0.0083	2.0	0.5
240	0.00417	4.0	0.25
480	0.00208	8.0	0.125
1,000	0.0010	16.6667	0.06

Source: Control Engineering with data from Techmation Inc.

PID controllers operate on an error feedback where the output is normally characterized when there is a difference between the PV and SP. However, it is not always advantageous for a controller to operate on an error signal. It is common practice to allow a controller to respond differently to SP changes verses load (PV) changes. It is important to understand which algorithm variables will be affected when the SP is changed versus when the PV is changed. Continuous processes normally have PV load changes, while batch processes tend to have more SP changes. Depending on how the controller is being used, how the algorithm reacts to SP and PV changes, and how tuning constants are determined/calculated, it is possible to have a controller perform better one way than another.

