Ziegler-Nichols Tuning Rules And Limitations

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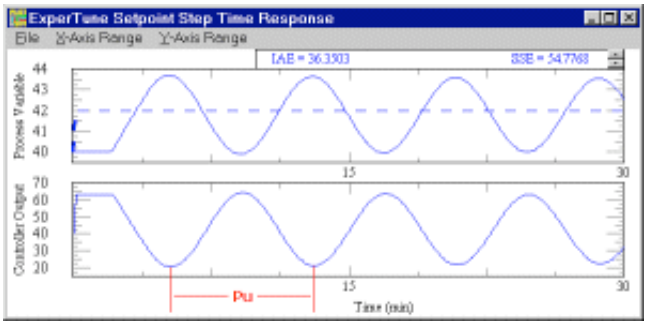
The standard reference for PID tuning seems to be the Ziegler-Nichols tuning rules developed in 1942 on a pneumatic controller. Here is how to tune a controller using these rules:

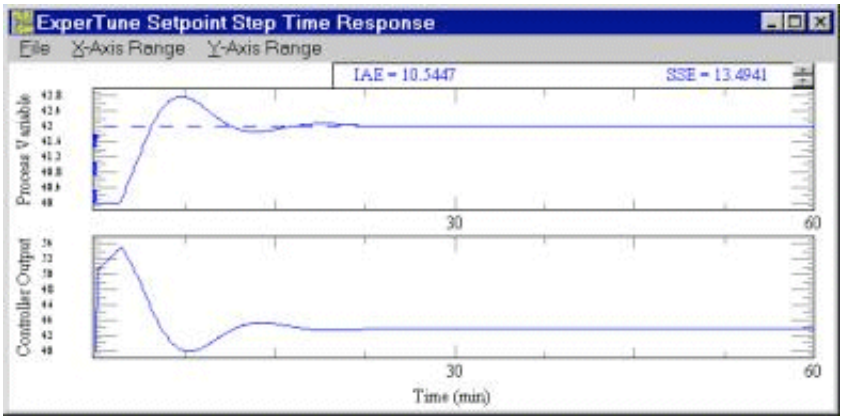
1. Remove integral actions from the controller by setting it to either 0 if it is in units of reset. If in units of integral set it to be very large. In some controllers that use integral, setting to 0 also removes the integral action.
2. Set the controller derivative time to 0.
3. Increase the gain of the controller until the loop is continuously cycling in the shape of a sine wave. When cycling, the controller should **not** be hitting limits. After each gain increase, you may need to make a setpoint change to see if the loop oscillates. Record the gain where the loop is continuously cycling as Ku. Record the period (time between peaks) of this oscillation as Pu.



Here are the settings for series type controllers based on Ku and Pu:

for PI controllers:

Gain = .45 Ku
Integral = Pu/1.2



for PID controllers:

Gain = .6 Ku
Integral = Pu/2
Derivative = Pu/8

That is it! However, you **must** be sure to get all the units correct: You must convert your measurement of period, Pu to the same time units your controller uses. Depending on the controller, you **must** convert the gain to Proportional Band, and the integral to reset if necessary. You also **must** convert to your appropriate controller structure: ideal or parallel.

These rules give starting values that will work with many processes but are **not** generalized to work with all processes.

Ziegler-Nichols used a specific single-stage pneumatic controller to come up with these rules. Their controller was a series one, but also had the further complication of (1 - D/I) factor in their effective Proportional Band. Consequently their PID settings are more conservative in D.