

# Modeling in ExperTune's PID Tuner/Analyzer and PlantTriage

ExperTune PID Tuner and PlantTriage provide process modeling and identification for a variety of process model structures. The models are derived from plant operating data.

| Description   | Laplace Equation   | To obtain this structure with PID Analyzer |
|---|--|--|
| Dead time with gain   | $K_p e^{-\theta s}$  | force first order with dead time           |
| First order with dead time and gain   | $\frac{K_p e^{-\theta s}}{1 + \tau s}$                       | force first order with dead time           |
| Second order with dead time and gain  | $\frac{K_p e^{-\theta s}}{(1 + \tau_1 s)(1 + \tau_2 s)}$     | force second order with dead time          |
| Second order over-damped with dead time (Imaginary roots) and gain                              | $\frac{K_p e^{-\theta s}}{(1 + P_1 s)(1 + P_2 s^2)}$         | force second order with dead time          |
| Integrator with dead time   | $\frac{e^{-\theta s}}{\tau s}$                               | force integrator with dead time            |
| Integrator with first order and dead time   | $\frac{e^{-\theta s}}{\tau_1 s + \tau_2 s^2}$                | force second order with dead time          |
| Inverse response process or shrink-swell: Integrator with first order, lead time, and dead time | $\frac{(1 + \tau_l s) e^{-\theta s}}{\tau_2 s + \tau_3 s^2}$ | select shrink-swell option                 |
| Double integrator with dead time  | $\frac{e^{-\theta s}}{\tau s^2}$                             | force second order with dead time          |

$s$  = Laplace Operator

$K_p$  = Process Gain

$\theta$  = Dead Time

$\tau, \tau_1, \tau_2$  = Time Constants

$\tau_l$  = Lead Time

$P_1, P_2$  = Polynomial Coefficients for Under-damped Process

Each of these model structures is available within the software. Both PID Tuner/Analyzer and PlantTriage automatically choose one of the above, as a best model structure, and find model parameters based on that structure. The exception to this is for the rare inverse response or shrink-swell process - for this process, you must specify the structure.

## **Forcing a model structure**

In PID Tuner/Analyzer, you can force a particular model structure. In PlantTriage to see a forced structure, use PID Tuner/Analyzer on the data PlantTriage used to find the model:

1. From within PlantTriage, bring up a trend display of the loop
2. From the menu select: Trend Display|Show data for process model
3. Visually confirm the time data
4. Click on the Start PID Tuner icon
5. Select Tuner/Analyzer Offline window
6. Click the Tune button

## **Allowing gain to float or forcing steady state**

You can choose to fit the model best at either low frequencies or higher frequencies.

Choose “Force steady state gain” so the model’s steady state gain is fit perfectly based on the data. Use this option when you will use the model for feedforward compensators, simulating loops with very slow or sluggish tuning or other cases where the long-term steady state gain must be fit perfect.

Choose “Allow gain to float” for the model to fit best at frequencies where stability would be important using a well tuned controller. Use this option if your purpose of using the model is for viewing robustness, stability and responses of control loops where you are tuning for optimal load rejection.