

PITOPS

System Identification & PID Tuning Optimization



A New Process Control
Technological Breakthrough
Impacting Industry and Colleges




PID Tuning, APC (Advanced Process Control) Design, System Identification

- See the next few slides illustrating
 - Identification of system dynamics (transfer functions) using closed-loop short-duration data amidst noise and unmeasured disturbances
 - Optimization of PID tuning for Slave PIDs, Cascade PIDs and all complex PIDs in DCS/PLC.
- See the power, uniqueness and simplicity of Pitops
- Improve Plant Operation and Control Quality
- Improve Process Control Teaching/Training

Use Excel File Containing Plant Data (or use OPC communication to DCS/PLC)

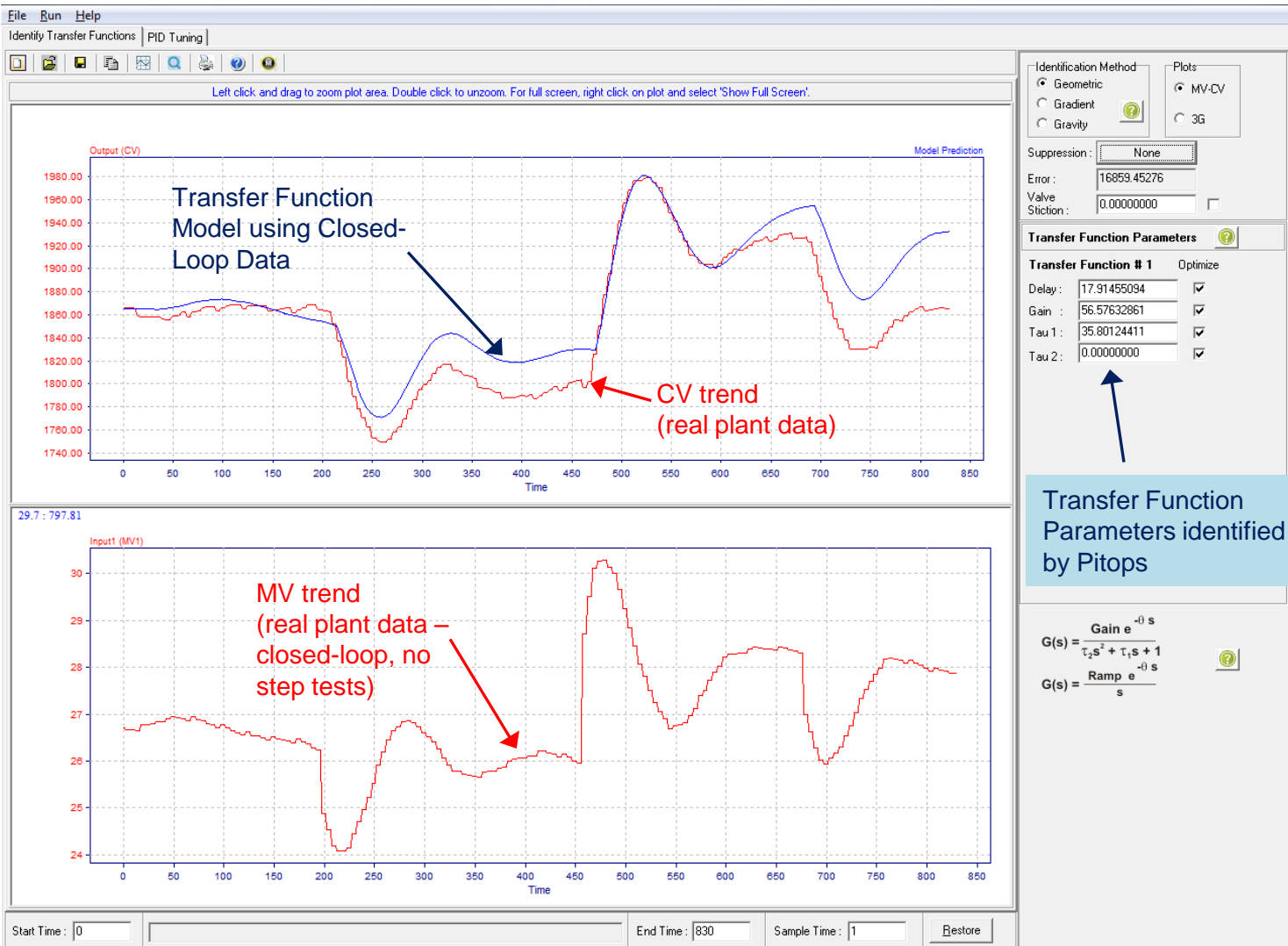
Get Excel file
with plant data
from plant
historian, or
use OPC to
directly collect
data from any
DCS/PLC



1	Timestamp	AC7777.PV	FC7777.SP
2		PPM	KG/HR
3		Composition	Gas Flow SP
4	1/11/2012 11:00	1865.624218	26.70827938
5	1/11/2012 11:01	1865.816931	26.70827938
6	1/11/2012 11:02	1866.009482	26.66449574
7	1/11/2012 11:03	1866.026692	26.66449574
8	1/11/2012 11:04	1865.985292	26.66449574
9	1/11/2012 11:05	1865.943729	26.66449574
10	1/11/2012 11:06	1865.902329	26.66449574
11	1/11/2012 11:07	1865.860929	26.666217
12	1/11/2012 11:08	1865.819529	26.666217
13	1/11/2012 11:09	1865.778129	26.666217
14	1/11/2012 11:10	1865.736729	26.666217
15	1/11/2012 11:11	1865.695328	26.666217
16	1/11/2012 11:12	1865.653928	26.63603313
17	1/11/2012 11:13	1860.346917	26.63603313
18	1/11/2012 11:14	1858.689125	26.63603313
19	1/11/2012 11:15	1858.676461	26.63603313
20	1/11/2012 11:16	1858.663635	26.63603313
21	1/11/2012 11:17	1858.650809	26.76411484
22	1/11/2012 11:18	1858.637983	26.76411484
23	1/11/2012 11:19	1858.625157	26.76411484
24	1/11/2012 11:20	1858.612332	26.76411484
25	1/11/2012 11:21	1858.599506	26.76411484
26	1/11/2012 11:22	1858.58668	26.77162262
27	1/11/2012 11:23	1858.573854	26.77162262
28	1/11/2012 11:24	1858.561028	26.77162262
29	1/11/2012 11:25	1858.548202	26.77162262
30	1/11/2012 11:26	1858.535376	26.77162262

Read Excel Data from Plant into Pitops


Identify Closed-Loop Transfer Function



Chose PID Eqn., PID Scan Rate, Set CV and MV Range matching DCS/PLC

Single PID Config

PID Scan Time

1/120 1/10 1/2 3 10 30 90
 1/60 1/4 1 4 15 45 120
 1/20 1/3 2 5 20 60 

CV Range

Low : High :

MV Range

Low : High :

Auto Derivative Filtering ON/OFF : Off On PID Tuning Time Unit:

PID Equation

<input type="radio"/> A0 $P (dE + E dt / I + D d(dE) / dt)$	<input type="radio"/> A4 $P dE + E dt / I + D d(dE) / dt$
<input checked="" type="radio"/> B0 $P (dE + E dt / I + D d(dPV) / dt)$	<input type="radio"/> B4 $P dE + E dt / I + D d(dPV) / dt$
<input type="radio"/> C0 $P (dPV + E dt / I + D d(dPV) / dt)$	<input type="radio"/> C4 $P dPV + E dt / I + D d(dPV) / dt$
<input type="radio"/> A1 $100/PB (dE + E dt / I + D d(dE) / dt)$	<input type="radio"/> A5 $P dE + E dt I + D d(dE) / dt$
<input type="radio"/> B1 $100/PB (dE + E dt / I + D d(dPV) / dt)$	<input type="radio"/> B5 $P dE + E dt I + D d(dPV) / dt$
<input type="radio"/> C1 $100/PB (dPV + E dt / I + D d(dPV) / dt)$	<input type="radio"/> C5 $P dPV + E dt I + D d(dPV) / dt$
<input type="radio"/> A2 $P (dE + E dt I + D d(dE) / dt)$	<input type="radio"/> A6 $100/PB dE + E dt / I + D d(dE) / dt$
<input type="radio"/> B2 $P (dE + E dt I + D d(dPV) / dt)$	<input type="radio"/> B6 $100/PB dE + E dt / I + D d(dPV) / dt$
<input type="radio"/> C2 $P (dPV + E dt I + D d(dPV) / dt)$	<input type="radio"/> C6 $100/PB dPV + E dt / I + D d(dPV) / dt$
<input type="radio"/> A3 $100/PB (dE + E dt I + D d(dE) / dt)$	<input type="radio"/> A7 $100/PB dE + E dt I + D d(dE) / dt$
<input type="radio"/> B3 $100/PB (dE + E dt I + D d(dPV) / dt)$	<input type="radio"/> B7 $100/PB dE + E dt I + D d(dPV) / dt$
<input type="radio"/> C3 $100/PB (dPV + E dt I + D d(dPV) / dt)$	<input type="radio"/> C7 $100/PB dPV + E dt I + D d(dPV) / dt$

Optimize PID Tuning for SP Change

File Inputs Run Help
Identify Transfer Functions PID Tuning

Simulation Time: 200 Minute

Left click and drag to zoom plot area. Double click to unzoom. For full screen, right click on plot and select 'Show Full Screen'.

Slave PV

SP Change

CV Response

Slave SP

Slave OP (Output)

PID Output

Slave PID Contrib. Prop. Int. Deriv.

PID Tuning Parameters (Optimized)

Single PID Cascade PID

Tuning

P: 1.017691

I: 43.377098

D: 2.387059

Filter: 0.000000

Process Transfer Function

Delay: 17.914551

Gain: 56.576328

Tau1: 35.801243

Tau2: 0.000000

Input From: TF1 TF2 TF3 User

$$G(s) = \frac{\text{Gain } e^{-\theta s}}{\tau_i s^2 + \tau_i s + 1} \quad G(s) = \frac{\text{Ramp } e^{-\theta s}}{s}$$

SP Old: 1500.000000

SP New: 1700.000000

Error: 151.920

Valve Bump: 0.000000

Valve Stiction: 0.000000

OP Limits:

Max RDC: 10000.000000

Current RDC: 4.20

Disturbance Transfer Function

Delay: 0.000 Tau1: 1.000

Gain: 0.000 Tau2: 0.000

Input From: TF1 TF2 TF3 User

Feedforward Transfer Function

Delay: 0.000 Lag 1: 0.000

Gain: 0.000 Lag 2: 0.000

Lead: 0.000

Input From: Calculate User

Model Transfer Function

Delay: 0.000 Tau1: 0.000

Gain: 0.000 Tau2: 0.000

Input From: TF1 TF2 TF3 User

Add Disturbances, Noise and Optimize PID Tuning for SP Change + Disturbances

File Inputs Run Help

Identify Transfer Functions PID

Simulation Time: 500 Minute

Effect of disturbance on PV

Slave PV

Slave SP

CV Response

SP Change

Disturbance Signal (Pulse + Ramp + Sine)

Add Simulated Disturbance to PV

Slave OP (Output)

PID Output

Feedforward Signal

Slave PID Contrib. Prop. Int. Deriv.

Model Prediction

Disturbance Transfer Function

Feedforward Transfer Function

Model Transfer Function

Single PID Cascade PID

Tuning

P: 1.455064

I: 45.734360

D: 2.998693

Filter: 0.000000

Process Transfer Function

Delay: 17.914551

Gain: 56.576328

Tau1: 35.801243

Tau2: 0.000000

Input From

TF1 TF2 TF3 User

$$G(s) = \frac{\text{Gain } e^{-\theta s}}{\tau_s s^2 + \tau_i s + 1} \quad G(s) = \frac{\text{Ramp } e^{-\theta s}}{s}$$

SP Old: 1500.000000

SP New: 1700.000000

Error: 305.623

Valve Bump: 0.000000

Valve Stiction: 0.000000

PID Raw OP

OP Low Limit: 0.000000

OP High Limit: 100.000000

Max ROC: 10000.000000

Current ROC: 6.74

Delay: 0.000

Tau1: 5.000

Gain: 1.000

Tau2: 0.000

Input From

TF1 TF2 TF3 User

Delay: 0.000

Lag1: 0.000

Gain: 0.000

Lag2: 0.000

Lead: 0.000

Input From

Calculate User

Delay: 0.000

Tau1: 0.000

Gain: 0.000

Tau2: 0.000

Input From

TF1 TF2 TF3 User

Pitops Uniqueness

- Multivariable identification– can handle multiple input and multiple outputs.
- Uses Closed-Loop Data (does not need Open-Loop Step Tests).
- Works well even if noise and unmeasured disturbances are present.
- Requires short data window for successful analysis.
- Calculated PID tuning parameters match exactly with DCS/PLC.
- Pitops identification and simulation looks like the real DCS/PLC trends.
- Displays PID output trends explicitly to ensure safe control action.
- Equipped with latest 3G (geometric/gradient/gravity) technology for rejecting noise and disturbances and calculating true transfer functions.
- Super-fast execution and super compact code size.
- Pitops technology is far superior to ARMAX identification, Step Response Coefficient models, Ziegler Nichols, Lambda tuning, frequency domain, Z-discrete domain etc.
- Pitops is far superior and easier than any other product or technology.
- Pitops 4GRG algorithm and technology is a revolutionary, novel and a 21st century genuine breakthrough.
- Does not need advanced education degrees, does not need complex math and theory.
- Visit www.PiControlSolutions.Com, or send an email to Info@PiControlSolutions.Com.