DESIGN AND IMPLEMENTATION OF PI CONTROLLER IN A TWO TANK INTERACTING PROCESS USING LAB VIEW SOFTWARE

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ABSTRACT

In process industries, it is quite difficult to control the level of liquid in the tank. The processes having more than one controlled loop are called as multiple input multiple output or multivariable process, which are very often found in power plants, refinery processes, and chemical industries and in many industrial processes. The process with MIMO system (Two tank interacting process) is difficult to control the multiple variables so the level of fluid in the tanks and interaction between tanks need to be controlled. The problem of level control in interacting tank processes are system dynamics and interacting characteristics. The PI controller is equipped with the MIMO system to obtain good performance of the system by using LABVIEW software.

KEYWORDS: Interacting Tank, LABVIEW & PI Controller

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INTRODUCTION

Mathematical modeling gives a simple description of how the process reacts to various inputs. PI controllers are prominent in chemical industries and also it is easily accessible with standard components. For eminent attainment the PI controllers can deteriorate quite fast in nonlinear system. It is necessary to develop nonlinear PI controllers for controlling nonlinear processes.

PROCESS DESCRIPTION

Fig.1 shows the photograph of the laboratory level process station. It consists of three pumps, two motorized control valves, six process tanks, two overhead tanks, two differential pressure transmitters, five level transmitters and rotameters. Instrumentation panel consists of two PID controllers, main power supply switch, pump switches, motorized control valve switches and auxiliary switches for individual components.

Figure 1: Real time two tank process

The Piping and Instrumentation Diagram of the coupled tank level process setup is shown in Figure 1. This process loop consists of two cylindrical tanks (T1 and T2) interconnected by a flow channel which causes the level of the two tanks to interact via HV25. Pump1 discharges water from reservoir to overhead tank (OHT1). T1 receives water from the overhead tank (OHT1) through the rotameters (R1 and R4) and motorized control valve (MCV1) via HV4. Pump 2 discharges water from reservoir to overhead tank (OHT2). T2 receives water from the overhead tank (OHT2) through the rotameters (R2 and R5) and motorized control valve (MCV2) via HV10.

The flow rate of water in the pipeline is indicated in rotameters. The Accumulation of the Process liquid in the tank is level in the tank. It is sensed by Capacitance level transmitter. The level transmitter output is in terms of current (4-20mA) and is given to VDAS-01 Data Acquisition Card. A digital control algorithm is developed and configured into the controller. The controller output is also a digital signal which is converted into the analog signal by DAC.

Figure 2: PI diagram of two tank interacting process.

Mathematical Modelling of a Two-Tank Level Process

Figure 3: Mathematical Modelling of two tank interacting system

$$A_1 \frac{dh_1}{dt} = q_{in1} - q_{o1} - q_{12}$$

$$A_2 \frac{dh_2}{dt} = q_{in2} - q_{o2} + q_{12}$$

$$A_1 \frac{dh_1}{dt} = q_{in1} - c_d a_1 \sqrt{2gh_1} - c_d a_{12} \sqrt{2g(h_1 - h_2)}$$

$$A_2 \frac{dh_2}{dt} = q_{in2} - c_d a_2 \sqrt{2gh_2} + c_d a_{12} \sqrt{2g(h_1 - h_2)}$$

$$\frac{dh_1}{dt} = \frac{q_{in1}}{A_1} - \frac{c_d a_1}{A_1} \sqrt{2gh_1} - \frac{c_d a_{12}}{A_1} \sqrt{2g(h_1 - h_2)}$$

$$\frac{dh_2}{dt} = \frac{q_{in2}}{A_2} - \frac{c_d a_2}{A_2} \sqrt{2gh_2} + \frac{c_d a_{12}}{A_2} \sqrt{2g(h_1 - h_2)}$$

The finalized equation of tank process are

$$h_1 = \frac{R_1}{\tau_1 s + 1} [q_{in1} - q_{12}] ;$$

$$h_2 = \frac{R_2}{\tau_2 s + 1} [q_{in2} + q_{12}]$$

SPECIFIC COMPONENTS OF TWO TANK INTERACTING PROCESS

PI controller setting of two tank process

Description	Quantity
Cross sectional area of the tank 1 & 2 (A_i)	1130.4cm ²
Cross sectional area of the pipe outlet 1 & 2 (a_i)	3.9cm ²

Cross sectional area of the connecting pipe (a_{12})	1.274cm ²
Maximum allowable height of the tank 1 & 2 (h_i)	0-25cm
Range of inflow rate for tank 1 & 2	0-100LPH
Nominal inflow rate of q_{in1}	26LPH
Nominal inflow rate of q_{in2}	20.75LPH
Nominal level of h_1	12.6cm
Nominal level of h_2	12.1cm
Specific gravity (g)	9.81(cm ² /s)
Discharge co-efficient (c_d)	0.6

MODE	K_c	T_i (sec)
PI	1.87	0.666

SIMULATION RESULTS

Servo responses for two-tank interacting level process with PI controller

The height of tank 1 and tank 2 is controlled with PI controller from 8 to 10 cm, 10 to 8 cm. Also corresponding changes in level h_1 and controller output q_{in} . The controlled output of tank 1 and tank 2 is represented in the below figures 4, 5, and 6.

Figure 4: Servo response of level h_2 with PI controller.

Figure 5: Response of level h_1 with PI controller.

Figure 6: Response of PI controller output (q_{in}).

Performance Measures for Servo Response of Two Tank Interacting System

Controller	Settling	Integral square
PI	150	1520.8

CONCLUSIONS

White box model of interacting tank is equipped with PI controller to retain the height of two tanks T1 and T2.. The servo and regulatory responses were obtained with PI controller using Lab view software. The level of the tank is controlled by the PI controller and the performance is tabulated.

REFERENCES

1. George Stephanopoulos, "Chemical Process Control - An Introduction to Theory and Practice", PHI Learning Private Limited, New Delhi, 2009.
2. KUMAR, N. DINESH, et al. "BATTERY HEALTH MONITORING FOR MINI HYBRID POWER SYSTEM USING LABVIEW." *International Journal of Electrical and Electronics Engineering Research (IJEER)* 3. 4, Oct 2013, 29-34
3. Jovitha Jerome, "Virtual instrumentation using LabVIEW", PHI Learning Private Limited, New Delhi, 2010.
4. Peelamedu, Coimbatore. "ANALYSIS OF A PART USING DYNAMIC SIMULATION AND REAL TIME EXPERIMENTS IN PART FEEDERS." *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)* 8. 5, Oct 2018, 133-142
5. Harshkaji, Shruti Annigeri and Prafulla Patil, "Designing PID Controller using Lab VIEW for Controlling Fluid Level of Vessel", *International Journal of Engineering Research and Applications (IJERA)*, ISSN: 2248-9622, Vol.3, Issue 2, pp.1329-1333, March-April 2013.
6. Khan, Sher Afghan, et al. "Flow control with aero-spike behind bluff body." *Int. J. Mech. Prod. Eng. Res. Dev. (IJMPERD)* 8.3 (2018): 1001-1008.
7. N. Deepa and S. Arulselvi, "Modeling and Intelligent Control of Two Tank Level Process", *International Journal of Recent Technology and Engineering and Innovative Technology (IJRTE)*, ISSN: 2277-3754, Volume-3, Issue-9, pp.97- 106, March 2014.