Analysis Of Liquid Level Control Of Coupled Tank System By Pi, Pd, Pid Controller

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Abstract: This paper presents the approach to design the comparative study or tuning of PI, PD & PID Controllers for Interactive Coupled Tank System to Control Water Level. In this paper MATLAB is used for modeling and testing of the control system. The experimental results of the interacting water level process can be satisfyingly illustrated the transient response and the steady state response.

Index Terms: transient response , steady state response , Interacting Coupled Tank System, Interacting Water Level Process, P, PI, PD and PID Controller.

1 INTRODUCTION

To model the industrial process is necessary to design the linear controller such as PI, PD & PID. Liquid level control is a typical representation of process control and is widely used in iron and steel, chemical, petroleum and other industries. The control quality directly affects the quality of products and safety of equipment [1]. However, the liquid level control system of water tank is a large lag, time- varying and nonlinear complex system and is very difficult to control. Now, the liquid level control has been an active area in the process control over last decades and various different approaches have been devised.In this exercise, the system is model, calibrate, and control a single & twin or two tank level control system. In particular, this exposes the fundamental modelling principle of fluid mass balance, pressure sensor calibration, and a feedback control design methodology for a state-coupled, twin or two tank level control system.

2 METHODOLOGY

Interacting Coupled Tank System Process:

According to Figure 1, The nonlinear equation can be obtained by mass equivalent equation and Bernauli's law is given by:

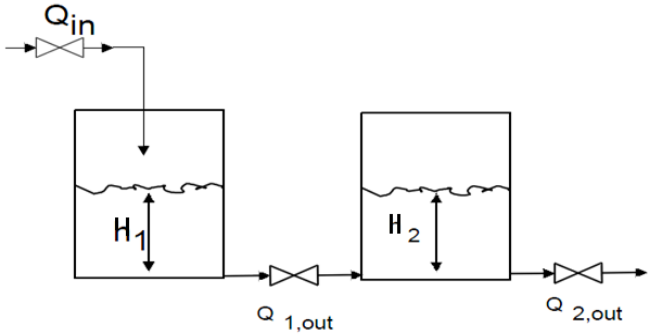

Figure 1: *Interacting Coupled Tank System*

$$\frac{A_1 dH_1}{dt} = Q_{in} - Q_{1,out}$$

$$\frac{A_2 dH_2}{dt} = Q_{1,out} - Q_{2,out}$$

The flow out of the second tank is determined by the liquid head in that tank, i.e.

$$Q_{2,out} = k_2\sqrt{H_2}$$

However, because of the coupling between the two tanks, the flow out of the first tank is determined by the difference in levels of the two tanks, i.e.

$$Q_{1,out} = k_1\sqrt{H_1 - H_2}$$

Thus the final set of ODE's that describe system behaviour is given by:

$$A_1\frac{dH_1}{dt} = \left(Q_{in} - \alpha_1\sqrt{H_1 - H_2}\right)$$

$$A_2\frac{dH_2}{dt} = \left(\alpha_1\sqrt{H_1 - H_2} - \alpha_2\sqrt{H_2}\right)$$

After Linearized the above non-linear equations and taking Laplace Transform, we get

$$\frac{h_2(s)}{q_1(s)} = \frac{k_{21}\ k_1}{(T_1 s + 1)(T_2 s + 1) - k_{21}}$$

$$T_1 = 6.1459,\ T_2 = 6.0109,\ K_1 = 0.06557,\ K_{21} = 0.549$$

After taking values, the Transfer Function obtained is:

$$TF = \frac{0.036}{36.942s^2 + 12.1568s + 0.451}$$

3 Simulation & Results

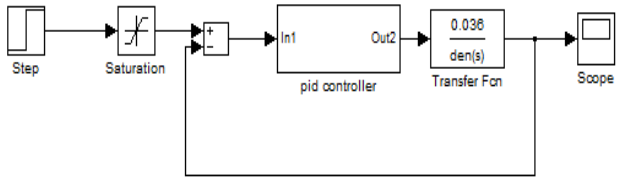

Figure 2: *PID Controller Simulink Diagram*

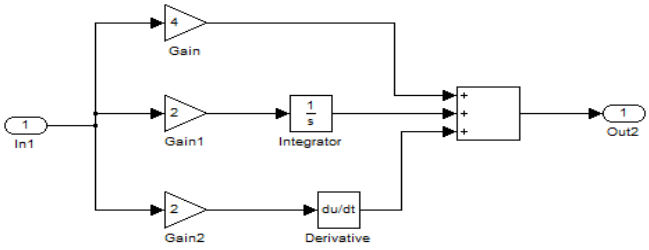

Figure 3: *PID Constants*

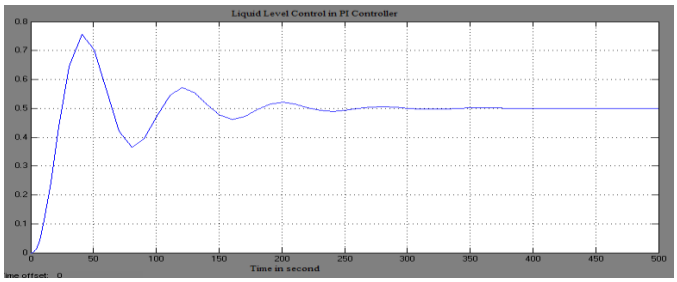

Figure 4: *Response for PI Controller*

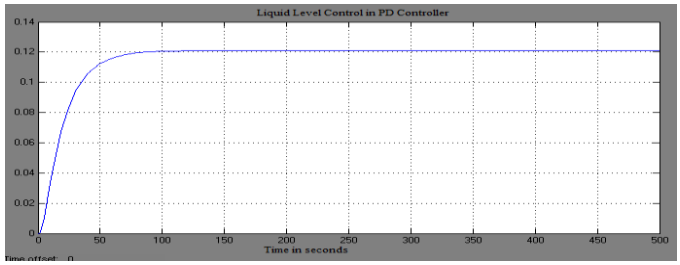

Figure 5: *Response for PD Controller*

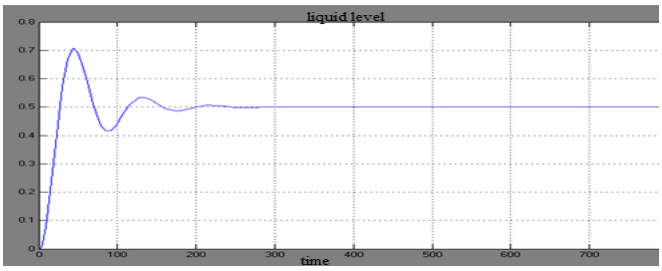

Figure 6: *Response for PID Controller*

4 Conclusion

As a conclusion, PID Controller had been successfully designed to controlled liquid level at tank2 on coupled tank system using simulation or matlab. The matlab simulation analyse the PD and PI, where PD shows higher accuracy and much less speed of response than PI type of controller and we generally used error and trial method. PI Controller gives more oscillatory System which, gives higher speed response result, higher overshoots implies the system run towards the instability than PD Controller which gives much less oscillations or negligible oscillations, thus system goes towards stability or system becomes stable. The PID Controller shows the optimal solution than PI or PD Controller. It removes all limitations of PI & PD Controllers. Thus it is called implemented form of PI & PD Controller. It gives increase speed of response, accuracy, control oscillations and minimize the steady state error of system, and system become stable or increase the system stability. A model for a coupled tank system has been designed and several controllers have been tested (PD, PI or PID controllers) and calculated by error and trial methods. The PID Controller is best controlled undergo fine tuning to get the best performance

REFERENCES

[1] Book by Graham C. Goodwin. "Control System Design",

[2] Sabah Abd Elmonem, Muawia Mohamed Ahmed Mahmoud,"Design of Tunned PID Controller for 2-Tank System"International Journal of Innovative Reasearch in Science Engineering and Technology (IJIRSET) ISSN:2319-8753 Vol.3,Issue 11, Nov. 2014

[3] Liuping Wang," Discrete Time Model Predictive Control Design Using Leguerrre Function" Proceedings of American Control Conference Arlington VA June 25 27,2001

[4] Jianming Huang, Liuping Wang, Yang Huang,"Continuous Time Model Predictive Control For a Magnetic Bearing System" PIERS ONLINE, Vol.3, No.2, 2007

[5] Elke Laubwald ,"Coupled Tank Systems" www.controlsystems principles.co.uk.

[6] Elizabeth Rani T1, Samson Isaac J 2 ," Modelling and Design Aspects of PI Controlle for Coupled Tank Proces International Journal of Computer Applications (0975 – 8887) international Conference on Innovations In Intelligent Instrumentation, Optimization And Signal Processing"ICIIIOSP-2013 - 4847

[7] Jutarut Chaorai-ngern, Arjin Numsomran, Taweepol Suesut, and Vittaya Tipsuwanporn "PID Controller

[8] Design for Coupled-Tank Process Using Various Strategies" Faculty of Engineering, King Mongkuts Institute of Technology Ladkrabang, Bangkok 10520, Thailand.

[9] Satean Tunyasrirut, Tianchai Suksri, Arjin Numsomran, Supan Gulpanich, and Kitti Tirasesth "The Auto–Tuning PID Controller for Interacting Water

Level Process",World Academy of Science, Engineering and Technology 12 2005

[10] Maziyah Mat Noh, Muhammad Sharfi Najib, Nurhanim Saadah Abdullah. "Simulator of Water Tank Level Control System Using PID-Controller", Faculty of Electrical &Electronic Engineering, Universiti Malaysia Pahang, Karung Berkunci12,250 Kuantan, Pahang, Malaysia.

[11] Marlin "Process Control: Designing Processes and Control Systems for Dynamic Performance" 2nd Ed, , McGraw-Hill, 2000

[12] "Matlab software", Help guide.

[13] Paul H. Lewis and Chang Yang "Basic Control Systems Engineering", , Printice hall 1997.

[14] "Simulator of Water Tank Level Control System using PID Controller", 3rd IASME WSEAS Int. Conf. on Water resources, Hydraulics & Hydrology, University of Cambridge, UK, Feb,2008.

[15] B. Nagaraj, S. Subha and B. Rampriya, "Tuning Algorithms for PID Controller using Soft Computing Techniques", IJCSNS Int. J. of Computer Science and Network S278 security, april,2008 73-4451- 7/12/2012 IEE