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Review on controller for flow control applications

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***Abstract*— Flow control is important in industrial applications such as chemical reactors, heat exchangers and distillation columns. Many industrial process can limit the performance of conventional PID controller scheme because of inherit dead time and nonlinearities. The objective is to defeat the problems such as handling unpredictable disturbance, unmeasurable noise and it can improve the transient state and steady state response performance. The proposed control scheme is implemented in Flow Control and Calibration of Pilot Plant. The design is done using MATLAB software package and directly it is connected to the Pilot Plant through by DAQ card. Simulation and implementation result of PID controller will gives less overshoot, good control performance, better disturbance handling ability and it is more flexible and intuitive to tune. It is expected that this advanced controller (like plc,scada,dcs) can improves efficiency and production rate in industrial process through by handling of any disturbance.**

Keywords—Software package, Pilot Plant, Flow Control

I. INTRODUCTION

A flow control valve regulates the flow or pressure of a fluid. Control valves normally respond to signals generated by independent devices such as flow meters or temperature gauges. Control valves are normally fitted with actuators and positioners. Pneumatically-actuated globe valves and Diaphragm Valves are widely used for control purposes in many industries, although quarter-turn types such as ball, gate and butterfly valves are also used. Control valves can also work with hydraulic actuators (also known as hydraulic pilots).These types of valves are also known as Automatic Control Valves. The hydraulic actuators will respond to changes of pressure or flow and will open or close the valve. Automatic Control Valves do not require an external power source because fluid pressure is enough to open and close the valve. Automatic control valves. include pressure reducing valves, flow control valve, back-pressure sustaining valves, altitude valves, and relief valves.

To reduce the effect of these load disturbances, sensors and transmitters collect information about the process variable and its relationship to some desired set point. When all the measuring, comparing, and calculating the process. Final control element must implement the strategy selected by the controller. The most common final control element in the process control industries is the control valve. The control valve manipulates a flowing fluid (such as gas, steam, water, or chemical compounds) to compensate for the load disturbance and keep the regulated process variable as close as possible to the desired set point.

II. PID CONTROLLER

In general PID controller is the combination of P-proportional, I-integral, D-derivative controllers. The values of these three parameters are interpreted in terms of time, where, 'P' depends on the present error, 'I' on the accumulation of past errors and 'D' is a prediction of future errors, based on current rate of change. By tuning the three parameters, PID controller can provide control action designed for specific process requirements. The proportional, integral and derivative terms are summed to calculate the output of the PID controller equation and final output [3] defined by u (t) and it given (1) by

$$u(t)=k_p\, e(t) + k_i \int_0^t e(t)\,dt + k_d \left(\frac{de(t)}{dt}\right) \quad (1)$$

Most of the industrial processes are pneumatic valve with PID controller. In industrial PID controller contain box, not an algorithm, Auto-tuning functionality of both pre-tune and self-tune, Manual or cascade mode switch, Bump less transfer between

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different modes, set point ramp, Loop alarms, Networked or serial port would give a simple model design of PID controller. Model-based tuning is Look at the closed-loop poles and Numerical optimization of the performance index over the PID controller. Basically PID controllers are used in Cohen coon method or Zeigler-Nichols method for tuning purpose.

A. Ziegler–Nichols method

Ziegler-Nichols proposed rules for determining the values of the proportional gain K_p, integral time K_i and derivative time K_d based on the transient – response characteristics of a given plant. PID controller is implemented in plant and it can be transfer function to oscillate and then stabilize of output. In the Ziegler-Nichols method is used in plant and it can be neither integrators nor dominant complex conjugate poles. The conventional PID controller gives some overshoot, large amount of settling time and rise time. But in Ziegler Nichols method the overshoot is completely eliminated but rises time and settling time is greater than the conventional PID. In general, Ziegler Nichols methods have provided starting point and tuning is necessary to get the appropriate value. After tuning of the PID controller both the rise time and settling time will be reduced in large amount and there is some overshoot but anyway it is very less compare to conventional PID controller. Ziegler-Nichols method table [6] is shown in Table.1

Table.1 Ziegler Nichols Method

Control Type	K_p	K_i	K_d
P	0.5 *K_u	-	-
PI	0.45*K_u	1.2*K_p/T_u	-
PID	0.60*K_u	2*K_p/T_u	K_p*T_u/8

The response of the PID controller can be described in terms of the responsiveness of the controller to an error, the degree to which the PID controller overshoots the set point and the degree of system oscillation. It should be noted that the use of the PID algorithm for control and it guarantee optimal control of the system or system stability. The Conventional PID controller and its output to a step input response as achieved with some particular control parameter values.

PID Controller is used in the areas like mechanical, hydraulic, pneumatic techniques. Basically controller is a device. Recently PID controller is used in form of software package like MATLAB. Typical applications of controllers are used to hold settings for temperature, pressure, flow or speed. A system can either be described as a multiple inputs and multiple outputs system (MIMO). MIMO system is requiring more than one controller. In case of single input and single output (SISO) system, it is required only a single controller. Depending on the set-up of the physical (or non-physical) system, adjusting the system input variable will affect the operating parameter; otherwise, it is taken as the controlled output variable. Upon receiving the error signal that marks the disparity between the desired value (set point) and the actual output value, the controller will then attempt to regulate controlled output behavior. The controller achieves by either attenuating or amplifying the input signal to the plant so that the output is returned to the set point.

III. EXPERIMENTAL SETUP DIAGRAM

Controller techniques are directly connected to the plant through Daq card and the matlab software is used to control the entire plant [2]. Data from Pilot Plant are in 4-20mA and converted to 1-5V using series 250 Ohm resistors. Data acquisition is the process of sampling signals and it measures real world physical conditions.so that it converts the resulting samples into digital numeric values that can be manipulated by a computer [1]. Set up is shown in figure.1

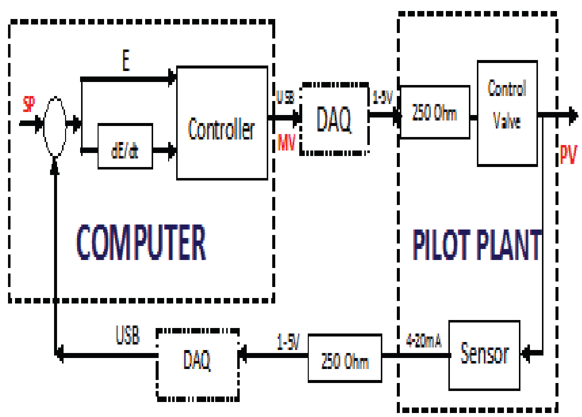

Fig.1 Setup Diagram

IV. PILOT PLANT SETUP

The Pilot plant is simply two series tanks with the objective of transferring the fluid from Buffer Tank to Calibration Tank; while controlling the fluid flow rate between the two tanks. Two pumps are used to circulate the fluid between the two tanks. Computer controls the flow rate by controlling the opening of the Control Valve, and measurements are obtained via Coriolis flow transmitter. The plant is composed by two water tanks, T1 and T2, interconnected via a system of pipes enabling liquid flow between the tanks. The plant works so that one can transfer the liquid from T1 to T2 and from T2 to T1.The flow from T1 to T2 occurs by gravity, since T1 is positioned above T2, through a valve V1. The flow from T2 to T1 requires the action of a centrifugal pump to raise the liquid level, through a valve V2.pilot plant setup diagram is shown in figure.2

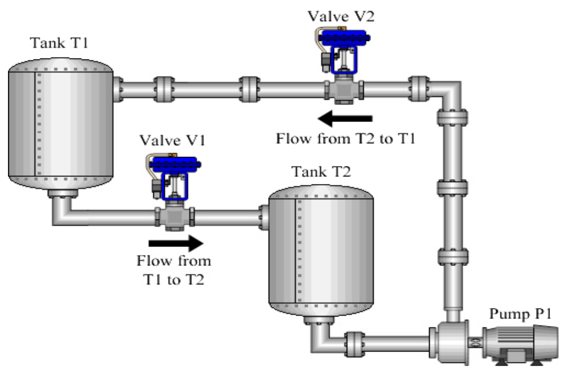

Fig.2 Pilot Plant Setup Diagram

V. RESULT AND DISCUSSION

The simulation of PID and fuzzy logic controller (2) are based on FODT model in equation [5]

$$G(s) = \frac{Ke^{-\tau_d s}}{\tau s+1} \qquad (2)$$

The result of empirical modelling of pilot plant (3) is in form of FODT.

$$G(s) = \frac{0.7e^{-0.63s}}{0.17s+1} \qquad (3)$$

A. Simulation of PID Controller

The output of PID controller simulation result obtained with the help of MATLAB. Simulation of PID [4] controller has step input with transfer function as well as tuning of PID controller gives output in steady state performance with some oscillations and it can be directly measured by water tank is shown in figure.3

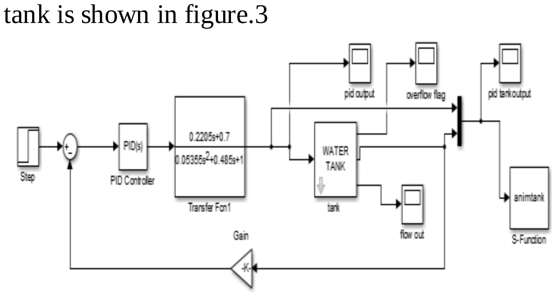

Fig.3 Simulation of PID controller

B. output of PID Controller

The output of PID controller has minimum overshoot and fastest response is required. A PID controller has been used for industrial purpose due to their simplicity, easy designing method, low cost and effectiveness. In conventional PID controller contains some overshoot but steady state control performance at the output is shown in figure.4

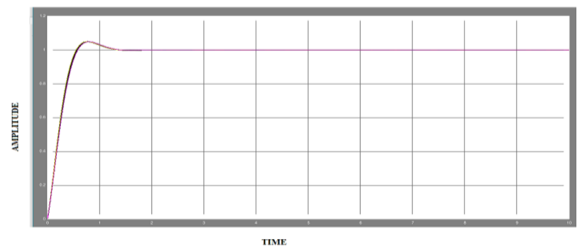

Fig.4 Output of PID controller

VI. CONCLUSION

Controller has various types like PID, fuzzy logic. Plant is to test the performance in cascade system and to tune the according to PID controller. The steady state of output value is one for PID controller. Pilot plant can able to control with the PID controller. The performance of PID controller is to tune and optimize according to pilot plant. It is expected that the designed PID controller into other processes (such as temperature and pressure) can able to measure and control. The various types of controllers (like neuro fuzzy, neural network, fuzzy PID, plc)can able to control this processor at final stage.

REFERENCES

[1] Tareq Aziz Hasan AL-Qutami, Rosdiazli Ibrahim, "Design of a Fuzzy Logic Process Controller for Flow Applications and Implementation in Series Tanks Pilot Plant" IEEE 2015 International Conference on Industrial Instrumentation and Control (ICIC), May 28-30,2015.

[2] E. Pathmanathan and R. Ibrahim, "Development and implementation of Fuzzy Logic Controller for Flow Control Application," in Intelligent and Advanced Systems (ICIAS),2010 International Conference on, 2010, pp. 1-6.

[3] G. Zaidner, S. Korotkin, E. Shteimberg, A. Ellenbogen, M.Arad, and Y. Cohen, "Non linear PID and its application in process control," in Electrical and Electronics Engineers in Israel (IEEEI), 2010 IEEE 26th Convention of, 2010, pp.000574-000577.

[4] Ritu Shakya1, Kritika Rajanwal2, Sanskriti Patel3 and Smita Dinkar (2014), “Design and Simulation of PD, PID and Fuzzy Logic Controller for Industrial Application” International Journal of Information and Computation Technology. ISSN 0974-2239 Volume 4, Number 4, pp. 363-368.

[5] M. Yukitomo, Y. Baba, T. Shigemasa, M. Ogawa, K.Akamatsu, and S. Amano, "A model driven PID control system and its application to chemical processes," in SICE 2002. Proceedings of the 41st SICE Annual Conference,2002, pp. 2656-2660 vol.4.

[6] J. Jantzen, "Tuning Of Fuzzy PID Controllers," Technical University of Denmark, Lyngby, 1998.