Level Control of Tank System using PID Controller-A Review

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Abstract— This paper discusses the review of level control of tank system using PID controller. PID controller use for one or more tank system. PID has fast response. Paper present different methods of level control. Eliminate the steady state error. It is most common way of solving problems of practical control systems.

Key words: Ziegler-Nichols tuning Method, PID controller, Open loop method

I. INTRODUCTION

PID controller is combination of three modes that is proportional integral, derivative. PID controller is nonlinear processes. It is most useful in industrial applications because of its more benefits like, fast response, very less oscillations. It can be operated by two modes either automatic or manual mode. PID decreases steady state error due to this stability increases. Ziegler-Nichols tuning method is the most use method in tuning of PID controller. PID controller is a powerful and complex controller. It eliminates offset error. Proportional control provides better control due to its output operate linearly early. PID controller is widely used in industrial process. Most of the industries, petrochemical plants and nuclear power plants are depend upon tank level control systems.

A. Methods of level control using PID

Bijay kumar introduced an implementation of PID controller for liquid level tank system. This paper gives a method to determine the optimal PID controller parameter using particle swarm optimization (PSO) and genetically algorithm (GA). This reference gives a modelling of lower water tank system. GA & PSO are used to exact dynamic nature water level system. PSO first introduced by Kennedy & Eberhart.

Maziyah Mat Noh, proposed a water tank level in control system have a difficulty in adjusting level of liquid. That is operating under unstable conditions above as well as below set point. As compare P controller PID controller gives mote fast response.

C. Dinesh, state that many industries uses a PID controller because of fast response and their performance, while in case of level control specially level control of a conical tank system, PID fails to give fast response so heuristic method used. It is also called as fuzzy logic controller; this method gives better response than PID.

Mostafa.A.Fellani, gives the development of PID controller for controlling specific liquid level of tank two systems. In this PID tuning method tasted for obtaining PID parameters. This paper presents the design of PID controller to control tank system by using MATLAB software.

Sankata.B.Prusty, proposed the liquid level control tank system using Lab View of fuzzy-PID controller which important task in industry. Output of process is nonlinear which is converted in linear form by using Taylor series method. This paper describes PID controller cannot used for complex processes, to solve this problem fuzzy controller used. For that fuzzy PID controller firstly design & then applied to liquid level. PID eliminates steady state error. If fuzzy controller and PID controller are together then it will gives more benefits paper also describes the responses of tank level processes.

Nitin Goyal gives necessity of tuning of couple tank system, which is based on MATLAB and simulation.

Sharad Kumar gives comparison of fuzzy model. Artificial immune is based on computational intelligence; it is new branch to research field. This new immune controller if apply to three tank level control then it gives earlier response and very les overshoot than conventional. This method is more effective than fuzzy and PID.

Muhd Asran Bin Abdullah gives method of level sensor and controller. Paper gives implementation of PID controller into designing an intelligent automatic level control. This system gives accurate level control and as stead with smooth transition process. This system can use in nonstop day and night level control process. This method uses different sensors to control level of system, like radar which is useful in dusty environments ultrasound, ultrasound, and capacitance level sensor.

A.Ikhlef gives the method of level control by using Remote control, for this Ziegler-Nichols method reference is necessary, the target of the paper is control the level by using remote. So user can handle a system with a remote. Result from these methods is satisfactory. Remote control gives a practical solution. This method needs a internet connection.

Farhad Aslam states that after implementation, PID controller is complete then it generates large overshoot with undershoot. But if auto tuner of PID controller is used, then overshot get reduced. This paper describes liquids auto tuning .method for three tank liquids level control. Auto. Tuning is basically used to tune PID gains. PID tuner allows getting a good balance between performance and weakness. By this method optimization can be achieved.

B. PID Controller:

It is combination of three modes, proportional, integral, derivative. PID is most used controller because it gives more fast response and also eliminates offset error from system. For fast response PID controller have to adjust a one level where no error occur between process variable and set point. PID controller limited in their capabilities especially when complex processes are required to perform task.

PID is based on computer system. If PID controller parameters are taken incorrectly then input of control process is unstable. PID do not provide optimal control. By using PID controller we can control level of one tank or more tanks. PID controller reduces rise time to make system

response fast. The various methods are given for level control like Ziegler-Nichols method, Cohen-coon method. Most PID implemented in PLC, using Ziegler-Nichols method, Cohen-coon method. The block diagram of PID controller consists of:

- PLANT- it is part of process which is to be controlled.
- FEEDBACK- it measure the variable from device which user want to control
- CONTROLLER- it is important part of process. It read and process error.
- SET POINT- also called integral and measured in seconds.

PID controller can be used for regulation of speed, temperature, flow, pressure. The gains of PID controller can be obtained by trial and error method. Roll of controller is maintained point at given value and accept new set point. PID controller cannot be used for complex process.

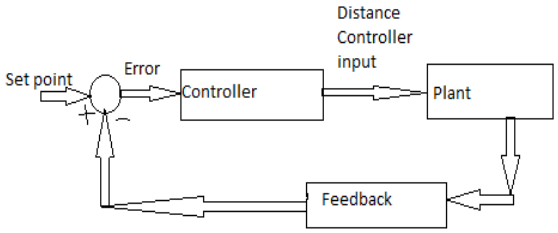

Fig. 1: structure of PID controller

C. How PID Controller Works

A water mixture of hot and cold water use to fill a tank at a fix level. The water level in a tank is a process variable and desired level is set point. The input to system and output of PID controller called the manipulated variable. Error defined as difference between liquid level and set point. After measurement of process variable controller decides how to set top position. In process control application control of level is very important especially fluid level control is must, fluid level can control by controlling input flow in tank and for level maintenance of input and output flow have to adjust.

II. TUNING OF PID CONTROLLER

The responses for both methods are analyzed using simulink in MATLAB software. The several methods for tuning PID controller is given below:

- Ziegler-Nichols method
- Cohen-Coon method

A. Ziegler-Nichols tuning Method:

This method is developed by John G. Ziegler & Nathaniel B Nichols. This method invented in 1940, had a large impact in making PID feedback control acceptable to control engineer's .with the Ziegler Nichols rules, engineers finally had a practical and systematic way of tuning PID loops for improved performance. After taking measurements of actual system response, tuning rule confidently recommends the PID gains to use. This method valid for open loop plants follows following steps:

- First set plant with a small gain and increase the gain up to oscillations get started.
- Then linear oscillation required for detection of controller output. Finally adjust the controller parameter. Ziegler-Nichols method is based on frequency response.
- The Ziegler-Nichols rules have to attempt to produce good value for PID gain parameter.

In this method two methods are involved

1) Open loop method
2) Closed loop method

1) Open loop tuning method

The Ziegler- Nichols open loop tuning method is a way of relating the process parameters like delay time, constant process gain. It has been developed for use on delay-followed by-first-order-lag processes and also adopted for real processes. This method used for rectify error quickly for open loop controller gain. The process reaction-curve method, often called the Ziegler-Nichols method.

2) Closed loop tuning method:

This method not works for unstable processes If controller in manual mode and process variable oscillates then this method cannot used. Ziegler-Nichols method is related to process parameter like delay time, process gain & time constant. This method is also called as 'ultimate cycling method'.

3) Cohen-Coon method:

This method based on first order system. After Ziegler-Nichols method, Cohen-Coon *method is most used method. This method is developed* in 1953. Cohen-Coon rules were designed for controllers with non interactive controller algorithm. It is more flexible than Ziegler-Nichols method, if objective a fast response, then this method is used.

Cohen-Coon tuning method uses three process elements, which is process gain, dead time and time constant. For calculating gain and integral time Cohen-Coon method is not used, because it requires a measurement of the process time constant. But Ziegler-Nichols method does not require a measurement of the process time constant. Cohen-Coon method is requiring the response of open loop system. Cohen-Coon tuning method work on process,where the dead time is less than the time constant. It also provides quarter-amplitude damping, Cohen-Coon rules target is quarter amplitude response damping. This type of tuning provides very fast disturbance rejection. The Cohen-Coon margin for stability is low. The small error pushes system into instability. As compare Z-N method settling of P and PI controller are less. This is good process models, offline and good for first order system. It corrects steady state error response given by Ziegler-Nichols method. In this tuning method first obtain the process reaction curve then measure the response.

III. CONCLUSION

In this paper, an attempt has been made to review for various methods for level control of tank system using PID controller. Level control of tank system is very important task in process controller.

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