Auto Tuning of PID Controller For Single Tank Process

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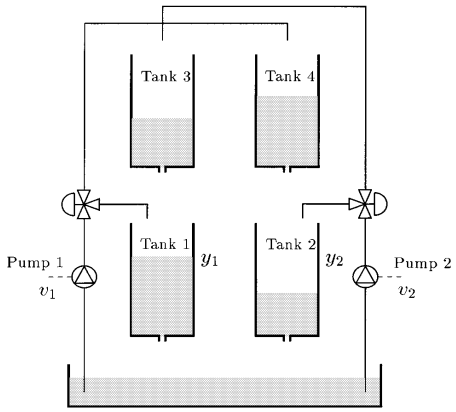
Abstract- *The paper is about auto tuning of PID controller for a single tank process. The process proceeded here is a SISO process. Most of the industrial processes are SISO process. SISO process finds a application as a reservoirs in chemical industries. Increase of efficiency in a SISO process requires a minimum set point. The settling point should not exceed. A four tank system is used for this process. Single tank is taken as it is a single tank process. TOP tank is taken for this process. Manual readings are taken for TOP tank.*

Keywords- Increase of efficiency, Set point, SISO process

I. INTRODUCTION

The hardware component that is used here as a four tank system is MULTIVARIABLE CONTROL TRAINER 327A.It consists of four tanks namely T1,T2,T3,T4.This component has four drain valves, two control valves, motor, two pumps for its operation. TOP tank is used for taking manual readings. The manual readings are taken by observing the level of the tank for every three seconds. Therefore the sample time for this process is three seconds. System validation model is done. System validation model is done for TOP tank. System validation model is done using various methods. Best method is analysed after viewing the results of each method. Tuning process is proceeded after the system validation model. Tuning process is the also done using various methods. Best tuning method is analysed by viewing the results of each method. Valve coefficient is now included in the process. Valve coefficient is used for measuring the efficiency. Now the process is applied in both the open loop and closed loop system. While applying the process in the open loop system the output is obtained without any error. While applying the process in the closed loop system the output is obtained with error. It is because the output of the top tank becomes as input to the bottom tank. The interaction between these two tanks is avoided using a decoupler. The diagrammatic representation of the hardware component used for this process is given below:

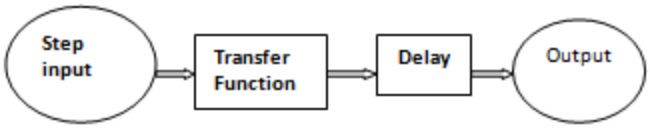


II. SYSTEM VALIDATION MODEL

System validation model is done to define the compliance of any element. Empirical approach is proceeded for the system validation model. Empirical approach is done based upon the time domain analysis. System validation model can be done using various methods. The methods employed for this process are SK method, TWO POINT method, PROCESS REACTION CURVE method. Transfer function is required for the process of system validation model. Formulas are used to calculate the transfer function required for the system validation model. As various methods are used here for the system validation model transfer function is calculated by using the formulas of corresponding methods. By using the transfer function simulation process is done. Best method for the system validation model is chosen after analysing the simulation results. Manual readings are required for the system validation model. Manual Readings for the process of system validation model

System validation model representation is given below:

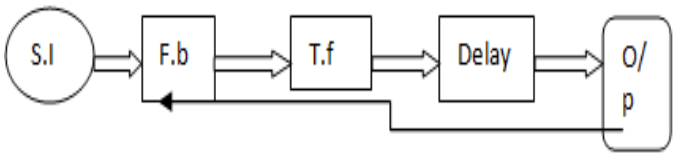
The block diagram of the system validation model for TOP tank is given below:



In the above representation step block is used for entering the set point. Transfer function is calculated using the formulas and used for the system validation model process. Delay is also used for the system validation model process and it is calculated using formula. Scope block is used for viewing the output graph.

III. TUNING

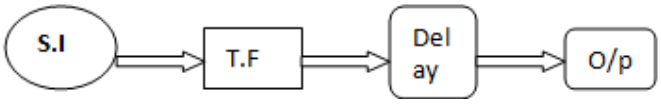
Every process is proceeded to obtain a high output. Obtaining of high output requires an optimal value. The process that is used for obtaining an optimal value for a process is termed as Tuning. There are various methods used for the tuning. The tuning methods used for this process are ZIEGLER NICHOLAS method, MODIFIED ZIEGLER NICHOLAS method, DAMPED OSCILLATION method. P, I, D values are required for the tuning process. P, I, D values are obtained using the formulas given in the above mentioned methods. After tuning using various methods the outputs of all the methods are compared. After analysing the outputs from various methods best tuning process is chosen. The process is now applied in both the open loop system and closed loop system. Open loop system means it do not contain a feedback. Closed loop system means it contains a feedback. While applying the process in open loop system and closed loop system the outputs are obtained without any disturbance .Step block is used for entering the setpoint.PID controller is taken and the values of PID are entered that are computed using formulas. Transfer function is calculated using formula and entered in the transfer function block. Delay is also calculated using formula and entered using delay block. Scope block is used for viewing the output graph. Multiplexer is used for connecting the outputs obtained from each method. The representation of tuning process for TOP tank:



S.I-step input, F.B-feedback, T.F-transfer function, O/P-output

IV. PROCESS IN OPEN LOOP SYSTEM

After tuning process is completed using various methods, tuning results of various methods are compared. ZIEGLER NICHOLAS tuning method is found to be the best method for tuning. Now the process is applied in the open loop system. The process is preceded without a feedback. The representation for the process applied in open loop system is given below:



S.I-step input, T.F-transfer function ,O/P - output

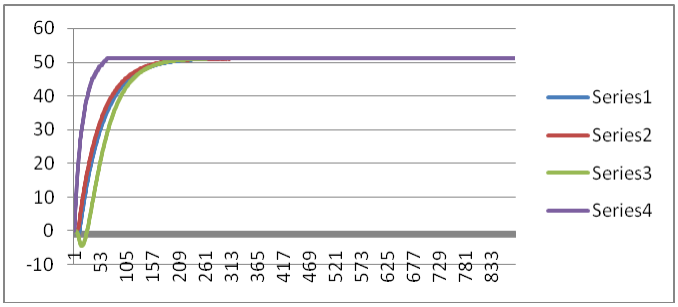
V. PROCESS IN CLOSED LOOP SYSTEM

The process is applied in closed loop system. The representation is quiet same as that of open loop system.The diff. In closed loop system is a feedback is added.

VI. RESULTS

The graphical result of system validation is as follows:

TOP TANK

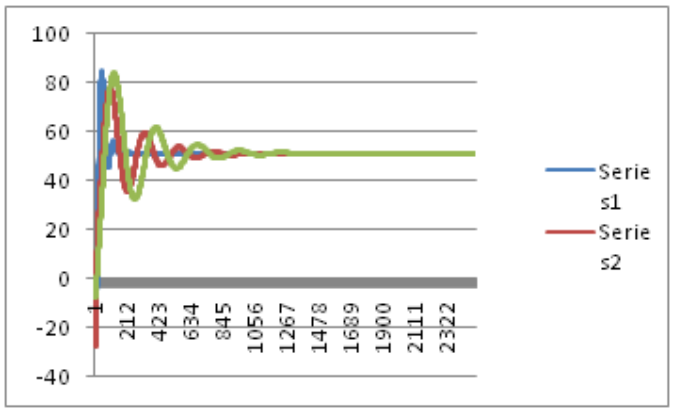


Series1: **SK method**
Series2: **Process reaction curve method**
Series3: **Two point method**
Series4: **Manual reading**

Process reaction curve method was found to be the best method after comparing the results of various methods of system validation model.

The graphical result of tuning process is as follows:

TOP TANK

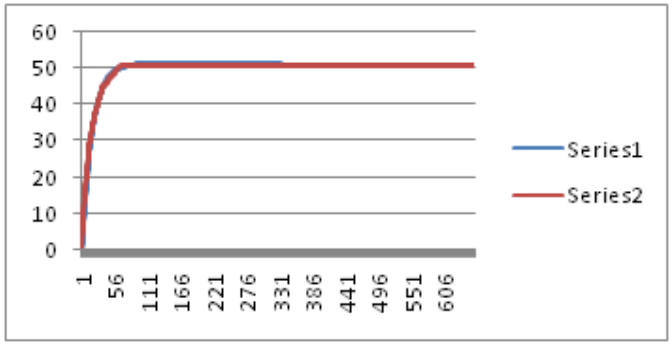


Series1: **Zeigler Nicholas method**
Series2: **Damped oscillation method**

Series3: **Modified Zeigler Nicholas method**

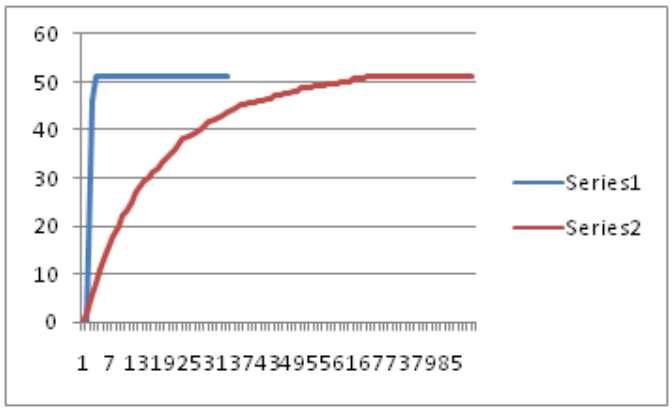
Zeigler Nicholas method was found to be the best method after comparing the results of various methods of tuning.

The graphical result of the process when applied in open loop system:



Series1: **TOP tank**
Series2: **Manual reading**

The graphical result of the process when applied in closed loop system is as follows:



Series1: **TOP tank**
Series2: **Manual Reading**

VII. FORMULAS USED

Formulas for system validation model are listed below:

1. SK METHOD:

$t_d = 1.3t_{35.3} - 0.29t_{85.3}$

$\tau = 0.67(t_{85.3} - t_{35.3})$

2. TWO POINT METHOD:

$t_d = t_{63.2} - t_{28.3}$

$\tau = 1.5(t_{63.2} - t_{28.3})$

Formulas for tuning process are listed below:

METHODS	KP	KI	KD
ZEIGLER NICHOLAS	$K_c = 0.6\,K_U$	$t_i = P_U/2$	$t_d = P_U/8$
MODIFIED ZEIGLER NICHOLAS	$K_c = 0.2\,K_U$	$t_i = P_U/2$	$t_d = P_U/3$
DAMPED OSCILLATION	$K_c = 1.1\,G_d$	$t_i = P_d/3.6$	$t_d = P_d/9$

VIII. CONCLUSION

Thus auto tuning of PID controller for a single tank process is completed by using employing system validation model process and tuning process.