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# TO REVIEW ON LIQUID LEVEL SYSTEM USING P,PI AND PID CONTROLLER

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***Abstract*— The liquid level control in the tanks and flow between tanks is the major problem in the industries like paper industries, water treatment plant, petro chemical industries. All industries have interacting tank or non interacting tank system. Hence the level of the tank must be controlled and flow of tank must be regulated. It is essential to control the level of the tank to understand the system which is required to control the level. Process dynamics are present in the system like shape of the tank , size of the tank , which manner tanks is connected. For the control the level of the tank different controller is required .**

*Keywords*— **liquid level system , process dynamics, P,PI,PID.**

## I. INTRODUCTION

Water tank systems are used in many resident areas. Most of the time they are functioning well, but some condition the system faces the problem of overflows because the system cannot detect whether the water level have properly reach the desired level or the flow-in rate of the water are not proportional with the flow-out rate[1]. The aim of process control is to achieve the target value of the given variable. The main task is to properly design the controller. The controller should also provide some flexibility in case an unexpected failure, change of conditions, etc[2]. To accurately control a system, it is beneficial to first develop a model of the system. The main objective for the modeling task is to obtain a good and reliable tool for analysis and control system development. A good model can be used in off-line controller design and implementation of new advanced control schemes. In some applications, such as in an industrial sewing machine , it may be time consuming or dangerous to tune controllers directly on the machinery. In such cases, an accurate model must be used off-line for the tuning and verification of the controller[3]

## II.PROCESS DESCRIPTION

### A. Working Principles

The real time interacting fabricated system was used for collecting the input, output data. The setup consists of supply tank, pump for water circulation, rotameter for flow measurement, transparent tanks with graduated scales, which can be connected, in interacting and non-interacting mode. The set up is designed to study dynamic response of single and multi capacity processes when connected in interacting and non-interacting mode. It is combined to study Single capacity process, Non-interacting process and Interacting process. The experimental set up is shown in Figure 1. The specifications are tabulated in Table 1[3].

Fig. 1 Experimental setup

Table 1 Specification of process

| Components | Details |
|---|---|
| Rotameter | 10-100 lph |
| Process tank | Cylindrical, diameter 92mm |
| Overall dimentions | 550W×475D×520H mm |
| Pump | Ss304 , submersible |

*B. Mathematical modeling of two tank interacting level process*

The process consisting of two interacting liquid tanks is shown in figure 2. The height of tank1 and tank2 is $h_1$ (cm) and $h_2$ (cm) respectively. Input flow in tank 1 is $q_{in}$ ($cm^3$/min), the volumetric flow rate from $q_1$ ($cm^3$/min) and the volumetric flow rate from tank 2 is $q_0$ ($cm^3$/min). Area of tank1 is $A_1$ ($cm^2$) and area of tank2 is $A_2$ ($cm^2$).

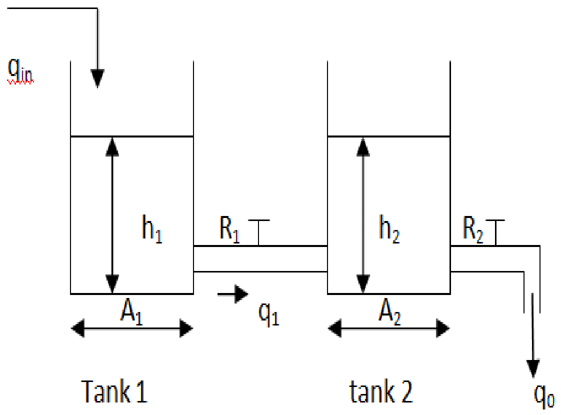


Fig. 2 Interacting system

Table 2 Experimental result taken from realtime system

| Flow (lph) | $h_2$(mm) | $h_1$(mm) |
|---|---|---|
| 20 | 35 | 43 |
| 30 | 43 | 85 |

*C. Transfer function model for interacting system*

The steady state and dynamic data obtained for Interacting process are tabulated in the Tables 2 from which the steady state graph and process reaction curve are plotted.

From the slope of the graphs, the following parameters are measured

Resistance R1 = dh1/dt = 1.5ohm (sec/$cm^2$)
Resistance R2 = dh2/dt = 1.7ohm
Diameter of tank T2 = 9.2cm
Diameter of tank T1 = 9.2cm
Initial flow = 20 lph
Step amplitude 40 – 20 = 20 m3/sec
Time constant τ1 = A1R1 = 0.9
Time constant τ2 = A2R2 = 1.02

Using the above parameters, the transfer function for the interacting system obtained is

$$\frac{h_2(s)}{q_{in}(s)} = \frac{1.7}{0.918s^2 + 2.94s + 1}$$

II. SIMULINK BLOCK DIAGRAM DESCRIPTION

Simulink model for liquid level control with open loop close loop with P, PI, PID controller in MatlabR2013a. Where input flow in tank 1 is 20 $cm^3$/s. Figure 3 is a graph of open loop response of the interacting system.

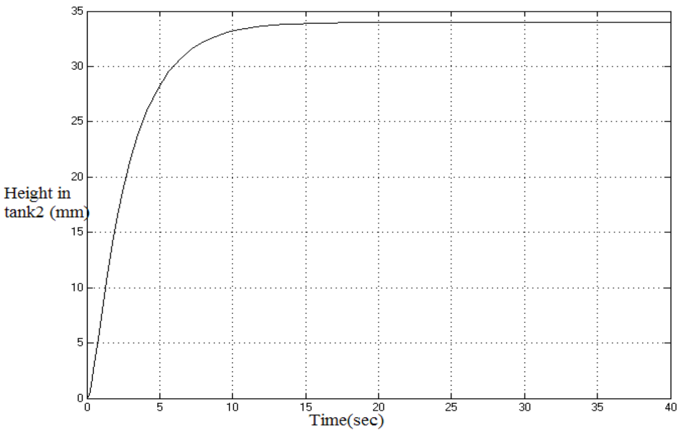


Fig. 3 Open loop response for interacting system

The liquid will constantly overflow. This situation happen because of system running without any controller to control the speed of pump, so the Pump will continuously pump the liquid out from the tank until it overflow. Controller must be put as a control element so that the liquid will not overflow and will indicate as required.

## III. DESIGING OF CONTROLLER

### A. PROPORTIONAL CONTROLLER

When we show the result of open loop model , it gives constant overflow so it is required to use the controller. As a controller, proportional controller is taken .

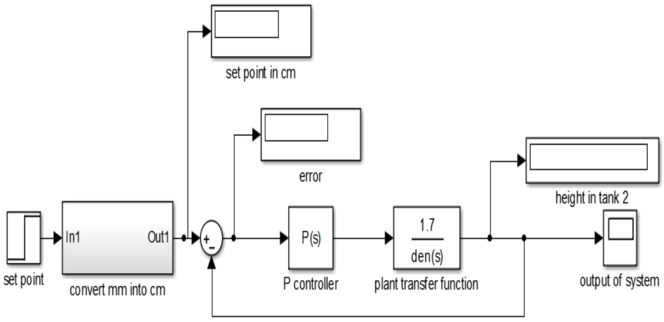


Fig. 4 Close loop model with P controller

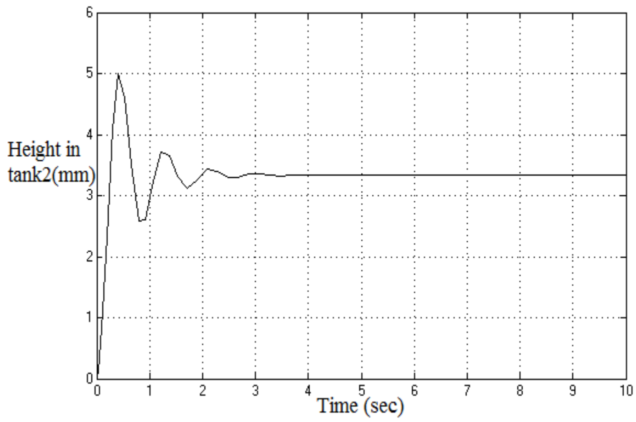


Fig. 5 Simulation result of process with P controller

Figure 5 shows the performance of proportional controller. The set point is set equal to 34 and the proportional gain is set 30. The plot shows that proportional controller reduce both the rise time and the steady state error. Proportional controller also increases the overshoot and decreases the settling time by small amount.

### B. PROPORTIONAL INTEGRAL CONTROLLER

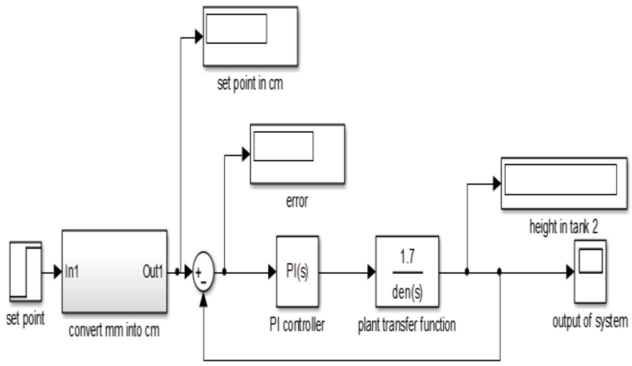


Fig. 6 Close loop model with PI controller

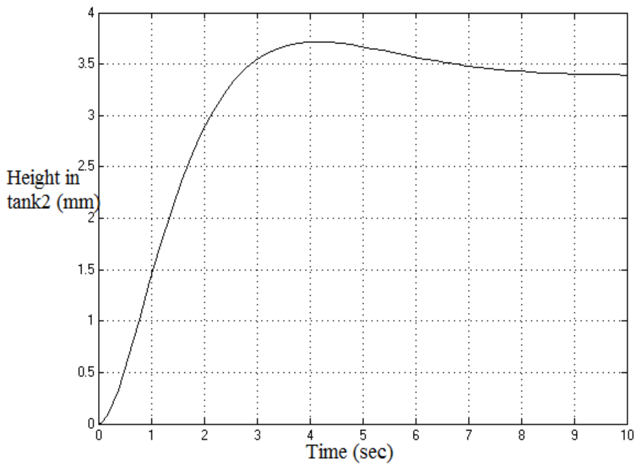


Fig. 7 Simulation result of process with PI controller

Figure 7 shows the performance of proportional-integral controller. The set point is set equal to 34. The plot shows that the overshoot is less as compared to proportional controller but the settling time is increased.

The integral controller also eliminates the steady state error .

C. PROPORTIONAL INTEGRAL DERIVATIVE CONTROLLER

| Parameter | Settling Time | Peak Overshoot | Rise Time |
|---|---|---|---|
| $K_p$ | Decreased | Increase | Small change |
| $K_i$ | Decreased | Increase | Increase |
| $K_d$ | Small change | Decreased | Decreased |

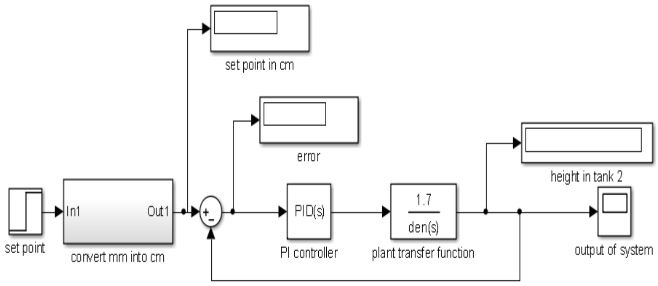


Fig. 8 Close loop model with PID controller

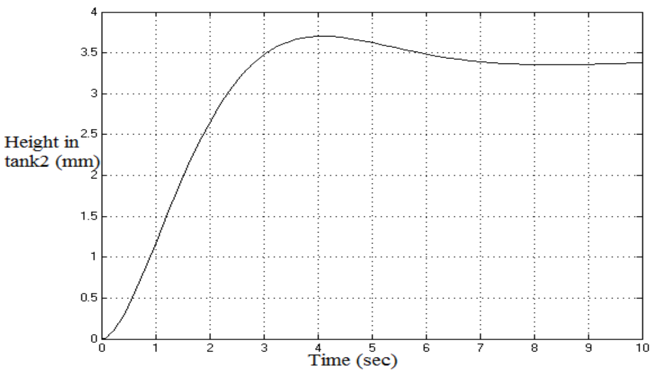


Fig. 9 Simulation result of process with PID controller

Figure 10 shows the performance of PID Controller. The set point is set equal to 34. The plot shows that the output level achieves the set point at time equal to 6 sec.

III. DISCUSSION

Table shows the effects of increasing proportional, integral and derivative parameters.

Table 3 the effects of increasing parameters

The objective of comparing the result of P,PI,PID Controller that control liquid level at tank 2 on interacting tank the simulation to investigate to find the better result of PID Controller. Their performance is evaluated base on time response parameters like percentage overshoot, settling time and Rise time.

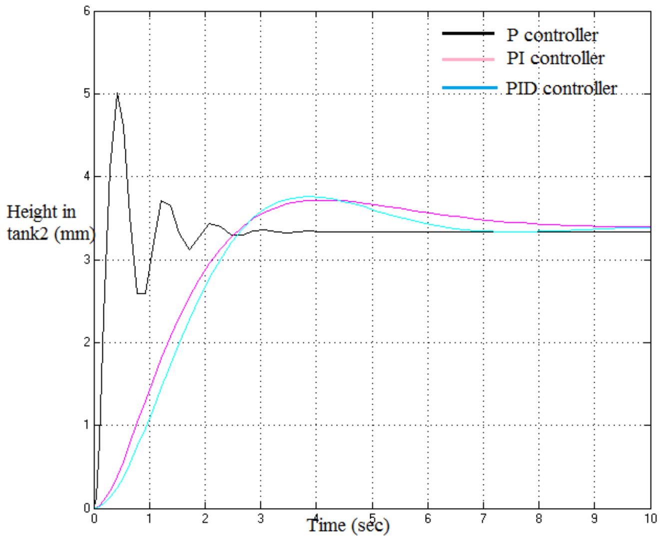


Fig. 10 Comparison of simulation result of P, PI, PID controller

IV. CONCLUTION

Controller had been successfully designed to controlled liquid level at tank 2 on interacting tank system using simulation. When only P controller is used at that time overshoot is more present in the system so it is removed using PI controller . But PI controller also increases the rise time and settling time. So PID controller is required and it gives better response compare to P and PI . Its Time response parameters comparison given below :

| Controller | P | PI | PID |
|---|---|---|---|
| Rise time | 0.162 | 1.81 | 1.93 |
| Overshoot | 50.4% | 9.32 % | 8.84% |
| Settling time | 2.27 | 7.21 | 6.14 |

As a future work one can develop design a FLC for a couple tanks system as adaptive Fuzzy Logic Controller like PID algorithm, which gives high performance for systems and high intelligence.

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