Industrial Plant Monitoring System

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***Abstract*—This is a simulation based project built in LabVIEW to perform two segments of an industrial operation, where one segment is a example of the ON/OFF Controller for appropriate mixing of fluids and another is the PID controller for the Tank level controlling.**

Keyword-[LabVIEW, on/off controller, PID controller, Water Level Control System]

I. INTRODUCTION

Industrial plant monitoring system consist of many operations performed together, each operation can be divided into segments. Segments such as monitoring the intermixing of chemicals and tank level control system in any Industrial plant. For a perfect Product /Chemical, ingredients should be mixed in proper proportions, thus there is a need of monitoring system in Industrial plants. Also for some functions in the plant there is a need of fluid level maintenance.

II. LABVIEW

A. *What Is Labview?*

- LabVIEW is a software development environment for creating applications that have the ability to connect with the data we provide or signals.
- The Benefit of LabVIEW is that higher quality projects can be completed in less time with fewer people involved .and due to its widely available tools and single environment, compatibility and integration to a real system.
- LabVIEW software consist of two working panels namely Front panel and Block Diagram:-
  - Block Diagram screen is seen where we graphically program the required system.
  - Front panel is collection of visuals that indicates the output to the users.

III. CONTROLLERS

A controller is a device or set of devices that manages, commands, directs or regulates the behaviour of other devices.

Large Industrial control systems are used for controlling processes or machines.

A. Controller Working

The feedback control system is introduced to control a plant, so its output follows a control signal. The control system compares the output of the system, to the sent signal, and applies the difference as an error signal to minimize the error.

B. The On And Off Controller

The on off controller's control element has only two position either it is fully closed or fully open. When process variable crosses certain level, the output valve of the system is suddenly fully opened and gives 100 % output.

Due to effect of output, the process variable again starts changing next in reverse. When process variable crosses a set level, the output valve of the system is closed and output is reduced to 0%.

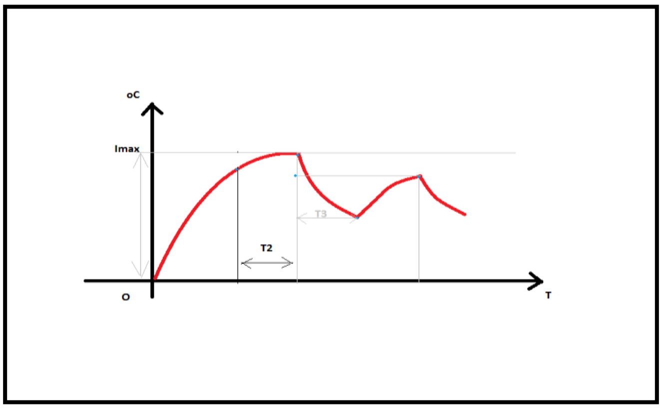

Fig.1.Time response of a simple on/off

C. *The Pid Controller*

A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism (controller) commonly used in industrial control systems. A PID controller repeatedly calculates an error value e(t) from the difference between a desired setpoint and a measured variable's value at the instant and applies a correction with respect to the on proportional, integral, and derivative terms based on error.

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IV. BLOCK DIAGRAMS

A. Mixing Of Liquids

In industrial process engineering, mixing is a unit operation that involves intermixing and correlation of a heterogeneous physical system so as to make it more homogeneous. Be any industrial process, mixing process is highly required. Some classes of chemical reactors are also mixers. With the right equipment used, it is possible to mix solid, liquid or gas with another solid, liquid or gas.

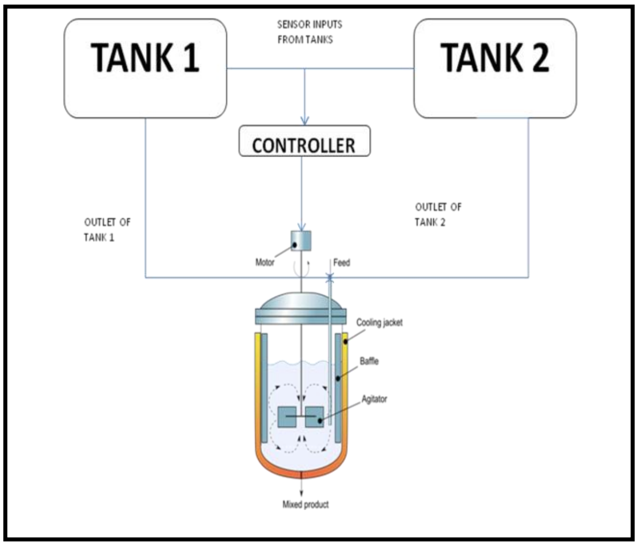

Fig.2.1Basic Block Diagram of intermixing of two liquids

B. Tank Level Controller

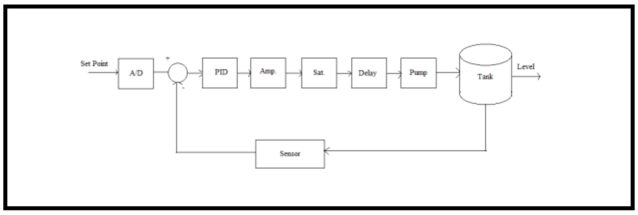

Fig.2.2.Block Diagram of tank level control system

- The set point given by the user is fed to the system in digital form by the ADC and is sent to the summation block where the feedback is added to it.
- The PID controller gives the output according the given set value of the gains set in it. These gains are in proportion, integrated or derivate form that help in control of the system
- The amplification block is used to amplify the input. Since input after the ADC conversion is very small, amplification is done by multiplying it with a gain factor.
- A saturation block is required for the control of the range of the pump. If the rate of flow from the pump exceeds the given range then there would be sudden excess flow of liquid in the tank which is quite undesirable.
-
- In practical implementations we use a small delay factor for the processing of the entire system, thus Transport Delay is a block used to provide a small delay in the incoming signal. Pump measures the incoming rate of flow of the liquid in the system entering the tank.
- The tank then receives this input and sets the corresponding level accordingly and then sends a feedback to the summation block for an error correction.

V. EQUATIONS FOR GENERATING PROCESS-PARAMETERS

Following equations were used for maintaining the level of liquid in a tank using PID controller

Assume,

R1 = Rate of flow of liquid into the tank

R2 = Rate of flow of liquid from the outlet

H = Height of water level in tank

A= Tank Cross sectional area

$$R_1 - R_2 = A\frac{dH}{dt} \quad \text{.............(1) Rate flow condition}$$

$$R2 = a*\text{sqrt}(2gh) \quad \text{...........(2) outgoing flow from outlet}$$

$$H = \int \frac{1}{A}(R1-R2)\,dt \quad \text{.........(3)Level of tank}$$

PID equations-

Proportional term $\quad P_{out} = K_p.e(t)$ ....(4)

Integral term $\quad I_{out} = K_i \int e(t)\,dt$ ....(5)

Derivative term $\quad D_{out} = K_d \frac{de(t)}{dt}$ ....(6)

$$u(t) = K_p.e(t) + K_i \int e(t)\,dt + K_d .\frac{de(t)}{dt} \quad \text{signal.........(From 4,5,6)}$$

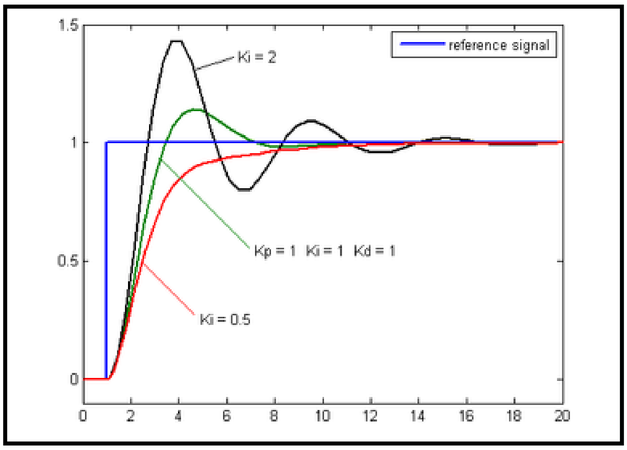

Fig.3.System Response

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VI. WORKING IN LabVIEW

A. Mixing Of Liquids

The LabVIEW front panel consists of various components such as: Container Tanks, Numeric Input, Mixing Tank, Numeric Indicator, LED, Control And Simulation loop.

Level of liquid has to be maintained at the set level for smooth running of the process and for accurate quality products.

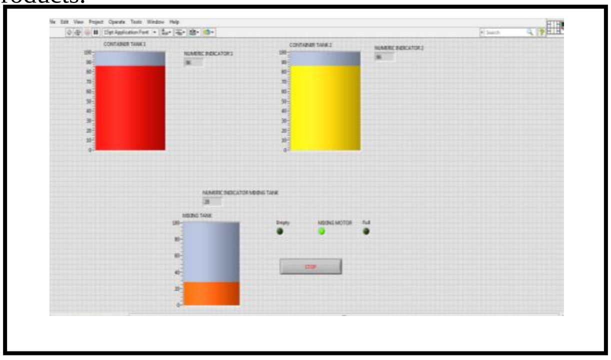


Fig.4.1 Front Panel of mixing liquids

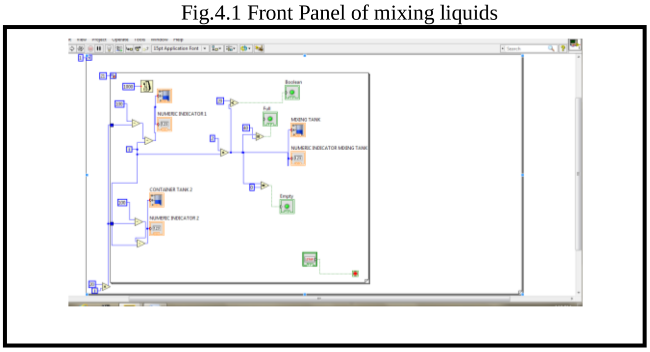


Fig.4.2. Back Panel of mixing of liquids

B. Tank Level Controller

The LabVIEW front panel consists of various components such as: Container Tanks, Numeric Input, Mixing Tank, Numeric Indicator, LED, Control And Simulation loop, Transfer Function Block, Array, Gain, Summation, Transport Delay, Saturation Block.

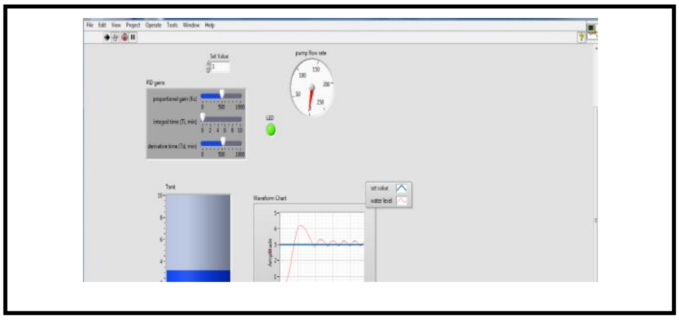


Fig 4.3. Front Panel of water level controller

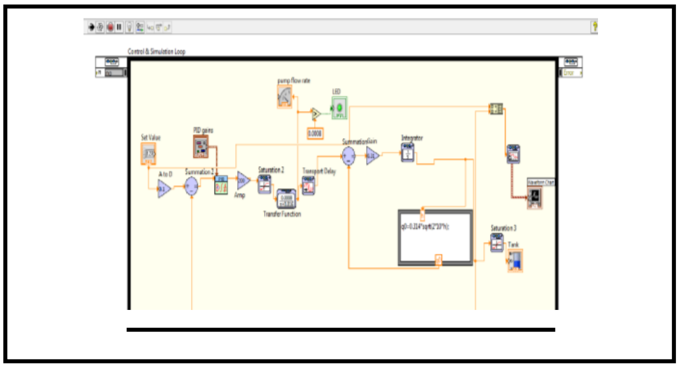


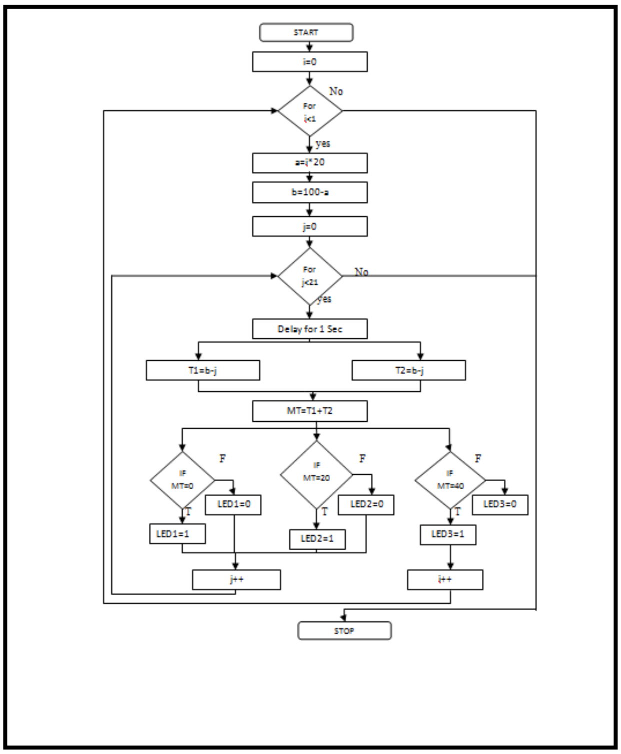
Fig 4.4 Back Panel of water level controller

For this system, the aim is to maintain a constant set water level, which can be achieved using a PID controller. This system can adjusting itself so as to maintain a proper set level. After the user has selected a water level, the system, by constant calculations generates an error by the input value and the output value such that the output value is adjusted to be as close to the desired level as possible.
The controllers performances in the actual design are usually defined by parameters such as overshoots, rising time, settling time, steady state error, Kp, Ki and Kd, etc.

A PID controller applies a correction based on proportional(Kp), integral(Ki), and derivative(Kd) terms, respectively (sometimes denoted P, I, and D).

VII. TABLES AND FLOWCHARTS

A. Flowchart of Mixing Of Liquids



Tabular Chart 1:Flowchart of Mixing of liquids

B. Tabulated Readings Of PID Parameters

The manual tuning` method is thoroughly a trial and error basis tuning method. One cannot determine the KP, KI, KD values of any system without tuning it to match the desired performance parameters.

(Values generated using the manual tuning method)

Sr.	Kp	Ki	Kd	Graph analysis	System Analysis
1.	800	0	200	Overshoots more	More time to be stable
2.	500	50	500	Process becomes slow	less time to be stable
3.	500	0	500	Lesser overshoot and process without lags	Moderate time to get stable

Table 1: Readings Of PID Parameters

Hence by trial and error method, that is, the manual tuning method various values of Kp, Ki, Kd are tested on the system and it is observed that the system depends on these process parameters,

- The proportional coefficient, Kp if increased results in the overshoot of the response of the system. This results in longer settling time and more time to achieve stability
- The Integral coefficient, Ki, If increased results in slowing down the response of the system. But achieves stability much faster than kp
- The Derivative term, Kd, when increased makes the system fast but error is not reduced. This makes the system unstable.

VIII. CONCLUSION

As automation in industries is a growing part of today's world, such monitoring system is need of the hour. When the set level is reached system automatically stops, there by conserving resources and making Operational process easy. In the first segment it is to show how the process stops after completely filling the mixing tank to the specified set level. while in the second segment the tank has an outlet, and with the help of PID controller the water flowing into the tank is controlled and the set level is maintained.

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