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Auto tuning of three tank process for glucose level monitoring

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ABSTRACT: Tuning of PID controller plays a major role in process control applications. Here we are going to control the level and flow of a three tank process. Three tank process is used in many industrial applications such as food processing industry, Concentration controlling etc., Controlling the level and flow is a difficult process since the non-linearity which exists in the process will not allow the parameters /system to be stable . Tuning of PID controller helps in achieving proper control of the process parameter and also ensures stable working of the system. Flow and level are directly interlinked with each other in process control application.

Keywords*: Nonlinear System, PID Control, Auto Tuning, Solenoid Valve, Float Sensor.*

I. INTRODUCTION

In industrial applications liquid level control is very important in food processing industry, dairy, filtration, effluent treatment, nuclear power generation plants, pharmaceutical industries, water purification systems, industrial chemical processing and spray coating and boilers in all the industries. The level control is a type of control method for common in process system. It must be controlled by the proper controller. The objective of the controller in the level control is to maintain a level set point at a given value and be able to accept new set point values dynamically. The conventional proportional-integral-derivative (PID) is commonly utilized in controlling the level, but the parameter is not enough for efficient control. The main objectives of PID tuner are closed loop stability (in which system output remains bounded for bounded input), adequate performance (in which closed- loop system tracks reference changes and suppresses disturbance as rapidly a.s possible) and adequate robustness (the loop design has enough gain margin and phase margin to allow for modelling errors or variations in system dynamics).the flow is controlled by the float sensor. The float sensor detects the rising and falling level of liquid in the tank .the liquid flows through the solenoid valve. A solenoid valve is an electromechanical valve .It is use with liquid or gas controlled by running or stopping an electrical current through a solenoid, which is a coil of wire, thus changing the state of the valve. The major role of the solenoid valve is to control the flow of liquid. The non-linear system is also known as three tank system. The nonlinear system is a system in which the change of the output is not proportional to the change of the input.

II. PROCESS SETUP

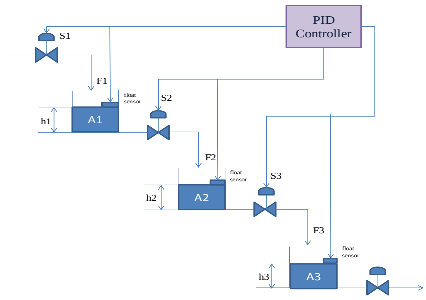


Fig: 1 Three tank setup

Initially the set pint is manually given to the PID controller the liquid will flow from reservoir tank. Now the two types of process will be takes place either the liquid level will be above the set point or the liquid level will be below the set point. If the level is below the set point, the float sensor senses the level and give signal to the PID controller. Now the PID controller opens the solenoid valve and allows the reservoir to flow the liquid in the first tank .If the liquid level is above the set point, PID controller opens the second solenoid valve (s2) and the error will be partially corrected in the second tank. Then the accurate set point will be obtained in the final tank of the non-

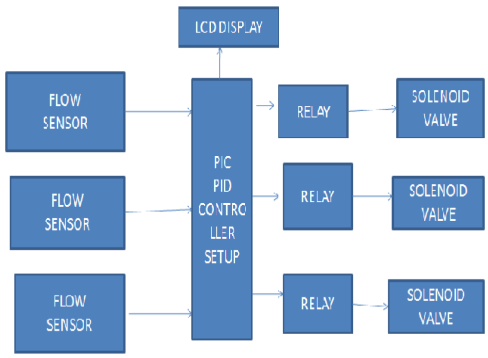


Fig:2 Block diagram

linear system.

Block diagram of the setup

The float sensor senses the liquid level and the signal is given to the PID controller. PID controller takes the decision either to open or close the solenoid valve.A relay is an electrically operated switch. Relays allow one circuit to switch a second circuit which can be completely separate from the first.

III. EXISTING METHOD

Now a day's intravenous therapy is important in medical field. The liquid Medicine in the glucose bottle continuously flows to through the tube in the human body, if the liquid medicine tends to be low there need a person to change the glucose bottle. If the person is absence at that time then this will leads to entering of oxygen bubbles in human vein. This will leads the patient to affect by stroke. .so, this method is not safety for human being.

IV. PROPOSED METHOD

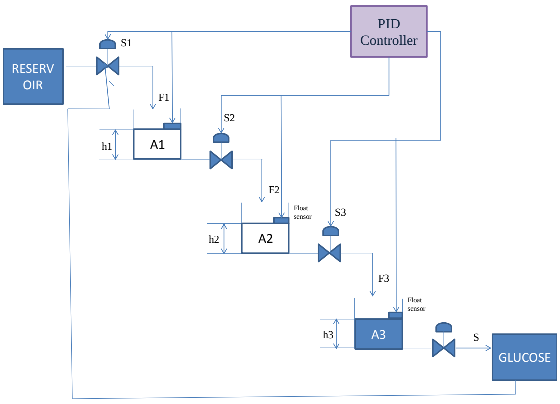


Fig: 3 Glucose monitoring system

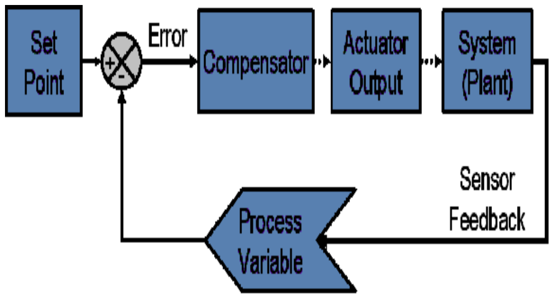
In this method we had implemented the three tank process to monitor the level of glucose bottle .in this process. We are going to control the liquid level by processing in the three tank with the help of tuning the PID controller. When the liquid level of the glucose bottle decrease automatically the valve gets opened and the liquid will fill in the glucose bottle according to the set point given to the controller. So there is no need to change the glucose bottle and the liquid level will be maintained at the set point until the bottle is removed and the error will not occurred .So this method is safety and better than the present method.

V. CONTROL TECHNIQUE

Proportional-Integral-Derivative(PID) control is the most common control algorithm used in industry and has been universally accepted in industrial control. The popularity of PID controllers can be attributed partly to their robust performance in a wide range of operating conditions and partly to their functional simplicity, which allows engineers to operate them in a simple, straight forward manner. As the name suggests, PID algorithm consists of three basic coefficients; proportional, integral and derivative which are varied to get optimal response. Closed loop systems, the theory of classical PID and the effects of tuning a closed loop control system are discussed in this system. When implementation of the conventional PID controller is done to the process, it generates a very large overshoot together with undershoot. This is not the desired requirement. So after implementing auto tuner of PID controller, it can be seen that both overshoots and undershoots are reduced to a greater extent as compared to the conventional PID control. Finally the optimization is achieved in the extended design mode of the PID controller. The tank level control is such a process which is perhaps more often used in all industrial processes including electrical, petroleum industry, power sectors, development sites, paper industry, beverages industry, etc. so the controlled stable operation of this drive attracts the always, still keeping more and more future scope in it.

Fig: 4 Controller setup

VI CONTROLLER TUNING



More than six decades ago, P-I controllers were more widely used than P-I-D controllers. Despite the fact that P-I-D controller is faster and has no oscillation, it tends to be unstable in the condition of even small changes in the input set point or any disturbances to the process than P-I controllers. Ziegler-Nichols Method is one of the most effective methods that increase the usage of P-I-D controllers. We are using the Ultimate Cycle Method as given by Ziegler and Nichols Rules, which uses the results of the experiments performed, with the controller already installed in the loop.

1. Complete the closed loop by connecting the controller before the plant.
2. Disconnect I and D control modes. Initially set KP at a small value.
3. Increase KP till the plant begins to exhibit sustained oscillations.

4. Measure the time period of oscillations (Pu) and the corresponding ultimate gain (Kp).
5. Use Pu and Kp along with table to find the values of KP, TI and TD.

The PIC microcontroller is one of the most renowned microcontrollers in the industry. This controller is very convenient to use, the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it use FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output. An EEPROM is also featured in it which makes it possible to store some of the information permanently like transmitter codes and receiver frequencies and some other related data. There are 5 input and output ports namely PORTA, PORTB, PORTC, PORTD and PORTE which can be digital as well as analog. We will configure them according to our requirements. But in case of analog mode, the pins or the ports can only act as inputs. There is a built in A to D converter which is used in such cases. Multiplexer circuits are also used.
But in digital mode, there is no restriction. We can configure the ports as output or as input. This is done through programming. For PIC the preferable compiler is micro C pro which can be downloaded from their website.
There is a register named as 'TRIS' which controls the direction of ports. For different ports there are different registers such as TRISA, TRISB etc.If we set a bit of the TRIS register to 0, the corresponding port bit will act as the digital output .If we set a bit of the TRIS register to 1, the corresponding port bit will act as the digital input.
A small number of fixed-length instructions Most instructions are single-cycle (2 clock cycles, or 4 clock cycles in 8-bit models), with one delay cycle on branches and skips One accumulator (W0), the use of which (as source operand) is implied (i.e. is not encoded in the opcode)All RAM locations function as registers as both source and/or destination of math and other functions. A hardware stack for storing return addresses .A small amount of addressable data space (32, 128, or 256 bytes, depending on the family), extended through banking Data space mapped CPU, port, and peripheral registers ALU status flags are mapped into the data space The program counter is also mapped into the data space and writable (this is used to implement indirect jumps).There is no distinction between memory space and register space because the RAM serves the job of both memory and registers, and the RAM is usually just referred to as the register file or simply as the registers.
The architectural decisions are directed at the maximization of speed-to-cost ratio. The PIC architecture was among the first scalar CPU designs and is still among the simplest and cheapest. The Harvard architecture, in which instructions and data come from separate sources, simplifies timing and microcircuit design greatly, and this benefits clock speed, price, and power consumption.
The PIC instruction set is suited to implementation of fast lookup tables in the program space. Such lookups take one instruction and two instruction cycles. Many functions can be modeled in this way. Optimization is facilitated by the relatively large program space of the PIC (e.g. 4096 × 14-bit words on the 16F690) and by the design of the instruction set, which allows embedded constants. For example, a branch instruction's target may be indexed by W, and execute a "RETLW", which does as it is named – return with literal in W.
Interrupt latency is constant at three instruction cycles. External interrupts have to be synchronized with the four-clock instruction cycle, otherwise there can be a one instruction cycle jitter. Internal interrupts are already synchronized. The constant interrupt latency allows PICs to achieve interrupt-driven low-jitter timing sequences. An example of this is a video sync pulse generator. This is no longer true in the newest PIC models, because they have a synchronous interrupt latency of three or four cycles.

VII. PERFORMANCE EVALUATION CRITERIA

As mentioned before tuning for ratio often leads to oscillatory responses and also this criterion considers only two points of the closed loop response (the first two peaks). The alternative approach is to develop controller design relation based on a performance index that considers the entire closed loop response. Some of such indexes are as below

1) Integral of the absolute value of the error

$$IAE = \int_{\infty}^{0} [e(t)]dt$$

2) Integral of the square value of the error (ISE)

$$ISE = \int_{0}^{\infty} [e(t)]\text{^2 dt}$$

3) Integral of the time weighted absolute value of the error (ITAE)

$$ITAE = \int_{0}^{\infty} t[e(t)]dt$$

Lopez et al developed tuning formulas for minimum error criteria based on a first order plus dead time transfer function. The tuning relations for disturbance inputs. Again keep in mind that these formulas are empirical and should not be extrapolated beyond a range of d/ τm of between

0.1 and 1.0 the tuning relations for set point tracking which has been developed by Rovira et al , who considered that the minimum ISE criterion was unacceptable because of its highly oscillatory nature. These formulas are also empirical and should not be extrapolated beyond the range of d/ τm.between 0.1 to 1.0.

VIII. Conclusion

When implementation of the conventional PID controller is done to the process, it generates a very large overshoot together with undershoot. This is not the desired requirement, so after implementing auto tuner of PID controller, it can be seen that both overshoots and undershoots are reduced to a greater extent as compared to the conventional PID control. Finally the optimization is achieved in the extended design mode of the PID controller. The tank level control is such a process which is perhaps more often used in glucose processes including electrical, petroleum industry, etc. so the controlled stable operation of this drive attracts the researchers always, still keeping more and more future scope in it.

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