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# IoT Based Boiler Drum Level Control using PID in LabVIEW

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**Abstract:** In this paper, a solution is proposed for maintaining and controlling the boiler drum level in industries using PID controller. The inlet flow is also monitored. The software part of the project has been developed using LabVIEW. NI myRIO is used as a controller. The monitored parameter is transferred using IoT.

**Keywords:** NI LabVIEW, level, myRIO-1900, IoT, IBM Watson Bluemix

## I. INTRODUCTION

Over the past two decades, automation has become one of the most important areas in development of Industrial processing. The significant development of Automation technology has covered several technical aspects and is due to advances in the production, computing power, testing facilities, and most importantly due to the acceptance by various industries. Drum water level maintaining is essential in boiler working. Any variation in water level may lead to the explosion of boiler. This project mainly focuses on the methodology of maintaining the boiler drum level using PID controller. The myRIO is used as the controller which is interfaced with LabVIEW, a graphical user interface. The ultrasonic sensor is used to measure the level of the water in the drum. The set point is given to the PID controller and the set point is compared with the desired value and the speed of the 12V dc pump is controlled. By controlling the pump, the level is maintained at the set point. The flow sensor YF-S20 is used to measure the flow rate of inflow. IoT-Internet of Things is used to transfer the monitored values of the level via internet. We have shortlisted three IoT platforms which includes Google cloud, Microsoft Azure and IBM Watson. They provide a better and more secure IoT platform for the student.

[1] This paper presents the level of the boiler can be controlled by controlling the inflow and outflow of the boiler drum. [2] This paper shows the new way of controlling the boiler level by using a single closed-loop control system combined with the technology of frequency conversion. [3] This paper presents boiler water level control system based on Kingview software development program and the main controller is realized with PLC.

[4] In this paper, by using matlab2013a to build a simulation model, the control of boiler drum water level based on nonlinear valve characteristics compensation is studied. [5] In this paper, Fuzzy control Technology was applied to design a two-input and three-output self-adapting fuzzy PID controller to control the water level of boilers drum. The designed controller was simulated in MATLAB environment. [6] This paper presents the boiler level can be controlled by introducing three external variables and a fuzzy controller can be used to control its volume. The results of modeling and simulation which are based on MATLAB show that the algorithm has better results than the conventional PID control. [7] This paper presents the control strategy for boiler water level by using self-adjusting PID fuzzy controlling process and to compare the effectiveness of the self-adjusting PID fuzzy control with the general PID. [8] This paper presents the implementation of intelligent controller (fuzzy logic) to tune the conventional controller automatically in online process. The simulation results are achieved by using LabVIEW software.

## II. WORKING AND HARDWARE COMPONENTS

In this paper we discussed the maintaining and controlling of the boiler level using PID controller. Here the level and flow are the process variables. The above figure shows the block diagram representation of the boiler level control. The water is pumping from the reservoir by 12V dc submersible pump to the boiler through the pipelines. The YF-S20 is placed in the middle of the pipeline which measures the inflow of the boiler. The ultrasonic sensor is placed at the top of the drum which measures the level of the water. The values of the PID were estimated.

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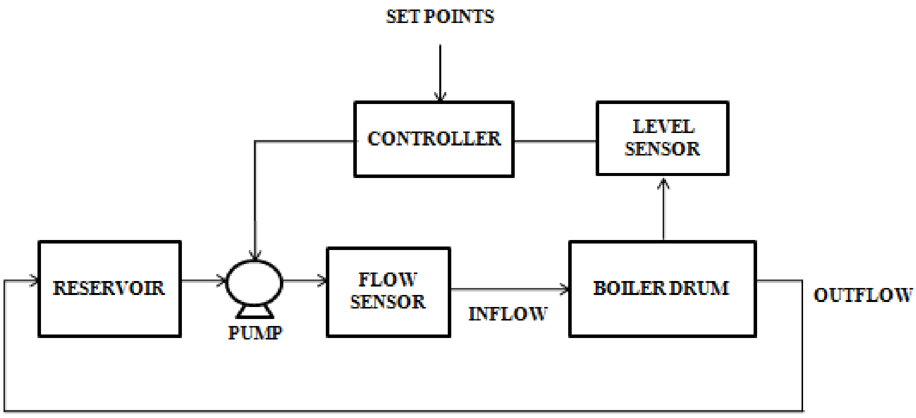


Fig 1: Block diagram of Boiler level control

## III. DETERMINING THE TRANSFER FUNCTION

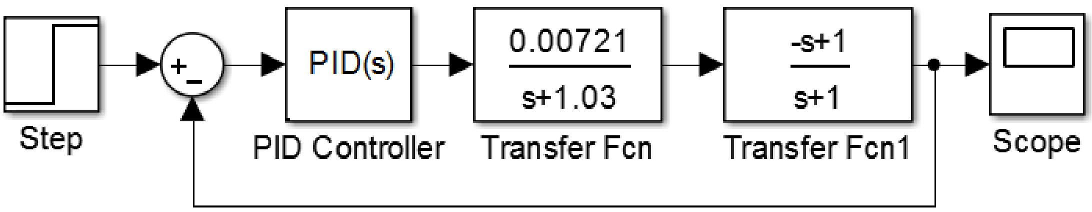


Fig 2: Mathematical model of Boiler level control

The transfer function is estimated by taking an open loop analysis of the process. The open loop test is taken for the boiler and characteristics of level and time are obtained. By this process the gain constant k, time delay α (alpha), time constant Ʈ (tou) and from those the transfer function and the PID gain values were estimated using the Cohen-coon method. The response curve is estimated from MATLAB simulation.

| LEVEL in cm | TIME in sec |
|---|---|
| 0 | 0.00 |
| 1 | 9.36 |
| 2 | 19.67 |
| 3 | 30.67 |
| 4 | 41.50 |
| 5 | 53.84 |
| 6 | 65.21 |
| 7 | 76.01 |
| 8 | 89.34 |

Fig 3: Tabulation of open loop test

From this tabulation, the process reaction curve is obtained and the slope value is determined.

- Slope (S) $=\frac{dy}{dx}$
- K $=\frac{B}{A}$
- α =2 sec
- Ʈ =0.623 * α

From this equation, the slope (S), gain value K and time delay α were determined.

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## IV. MEHODOLOGY OF THE LEVEL CONTROL PROCESS

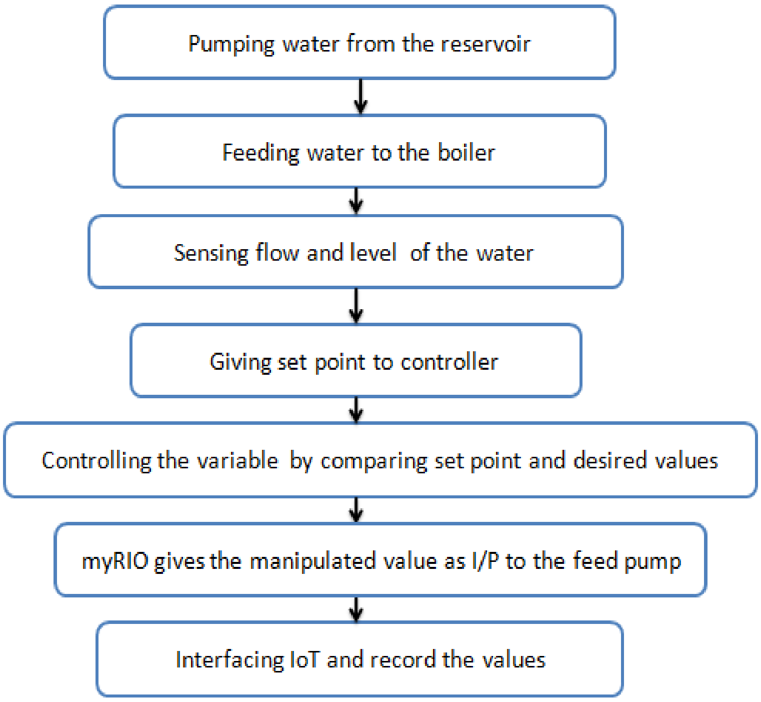


Fig 4: Methodology of the process

## V. EXPERIMENTAL SETUP AND SCHEMATIC DIAGRAM

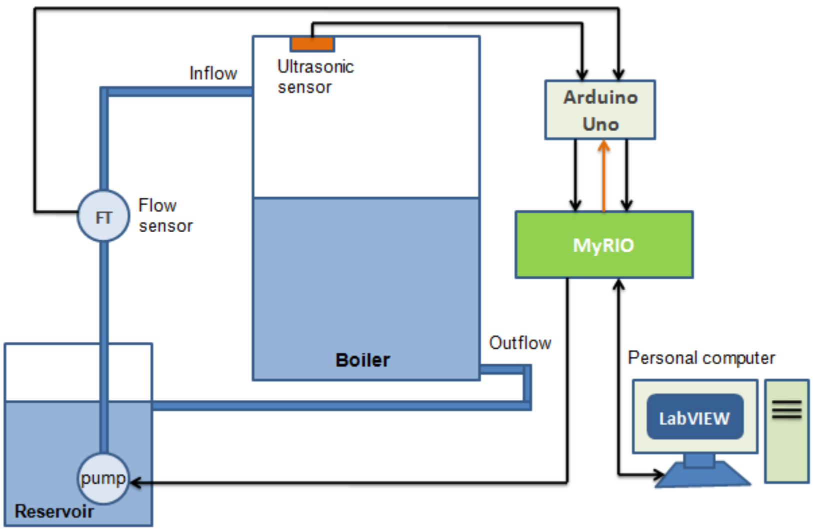


Fig 5: Schematic diagram for boiler variable management

The above figure is the schematic representation of boiler level control. The flow of the process is shown clearly in this figure. The water from the reservoir is fed to the boiler by using 12V dc pump. The flow sensor is placed between the reservoir and boiler. The ultrasonic sensor is placed at the top of the boiler to measure the level. The outflow of the water from the boiler is feedback to the reservoir. The output signal of ultrasonic and flow sensor are given as the input to the Arduino Uno controller. The power supply for Arduino is given by MyRIO controller. The Arduino and MyRIO are interfaced to transfer the signal to each other through UART. The set point was already initialized in the PID controller. The output signal of level sensor from the MyRIO controller is compared with the initialized set point value. The difference between these values varies the speed of the pump. The myRIO is interfaced with the LabVIEW. The LabVIEW is a software to display the manipulated value of the level. IoT is used to transfer the data from the measurand. The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines,

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objects, animals or people that are provided with Unique Identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

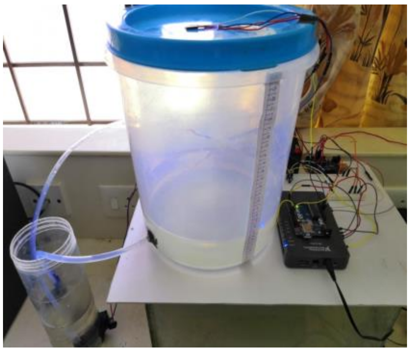

Fig 5: Experimental setup of the boiler drum

## VI. RESULT AND DISCUSSION

The level of the boiler drum is measured using ultrasonic sensor is displayed in the front panel. The setpoint is initialized in the controller. The measured value from the ultrasonic sensor is compared with the set point and controls the level of the boiler by varying the speed of the pump.

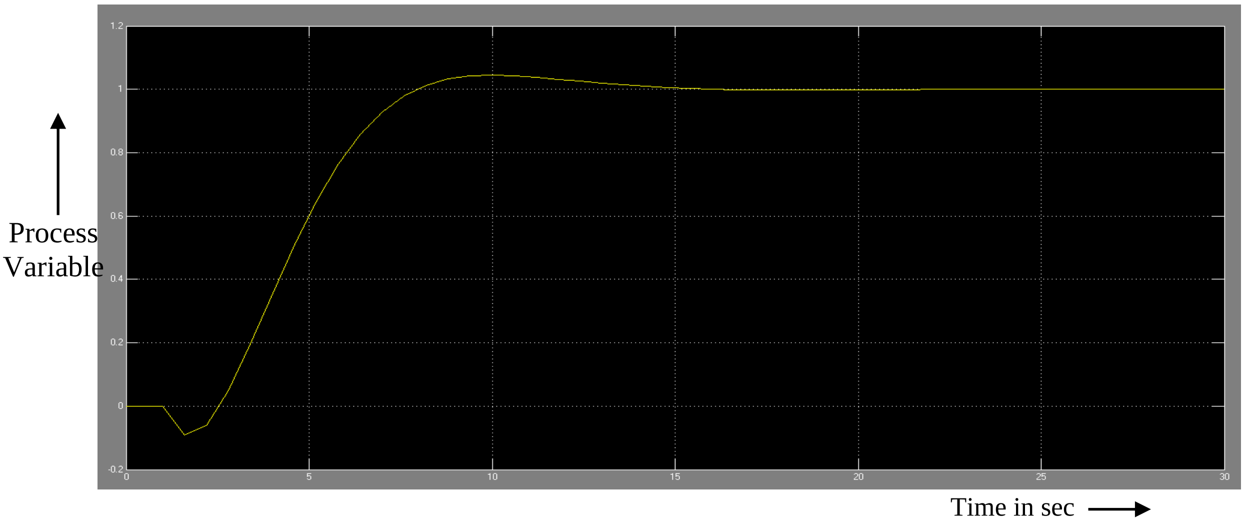


Fig 6: Graphical representation of PID controller

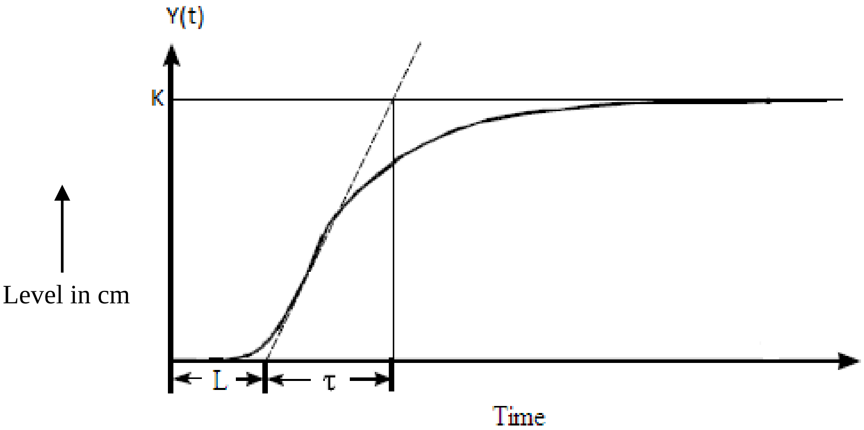


Fig 7: Process reaction curve of open loop test

The PID controller is used to control the speed of the pump. The 12V battery is used as a power source to the pump. The inflow of the boiler is measured using flow sensor. Flow rate is displayed through the output indicator in the front

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panel. Depends upon the supply and demand the set point will be varied. The IoT is used to transfer the data by network. The figure 6 shows the response curve of the system. The system settles' nearly at 15 seconds and it has minimum overshoot and rise time. The optimum operation is achieved by implementing the PID controller in the system. It acts as a self regulating since it has been designed as a closed loop system. The manipulated variable is assigned based on the current output and the feedback from the process. The open loop test is taken to the boiler and the process reaction curve of the process is shown in figure 7.

## VII. CONCLUSION

The effect of P, I and D terms in PID controller tend to make the closed system become stable. P controller will reduce the rise time but it fails to eliminate the steady state error. Integral control will eliminate the steady state error. The derivative control will increase the stability of the system. Thus the system is maintained with high stability. Figure 7 represents the Front panel of the boiler level control and Figure 8 represents Block diagram of the boiler level control of the LabVIEW program. The precise control is achieved using PID controller. The controlled output values are displayed in the IoT platform which is represented by figure 10.

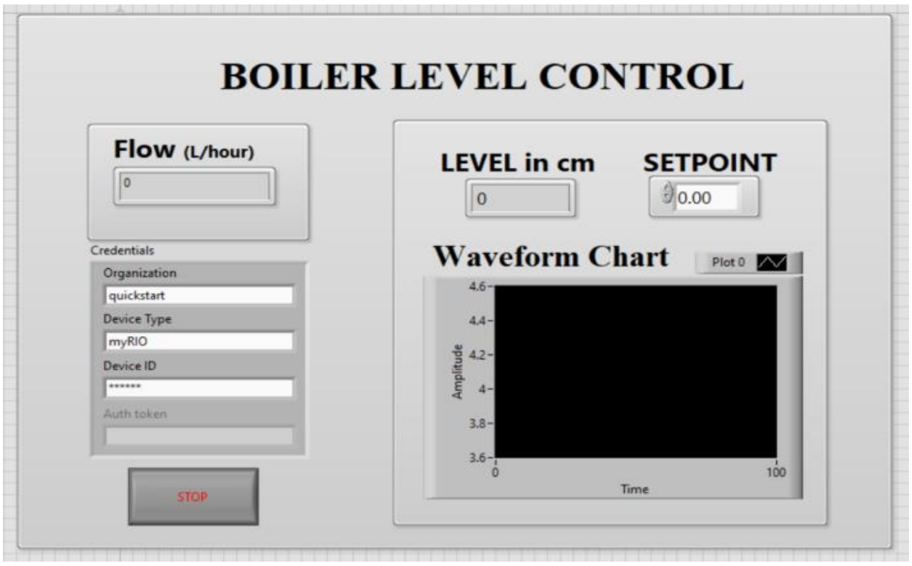


Fig 8: Front panel of the boiler level control

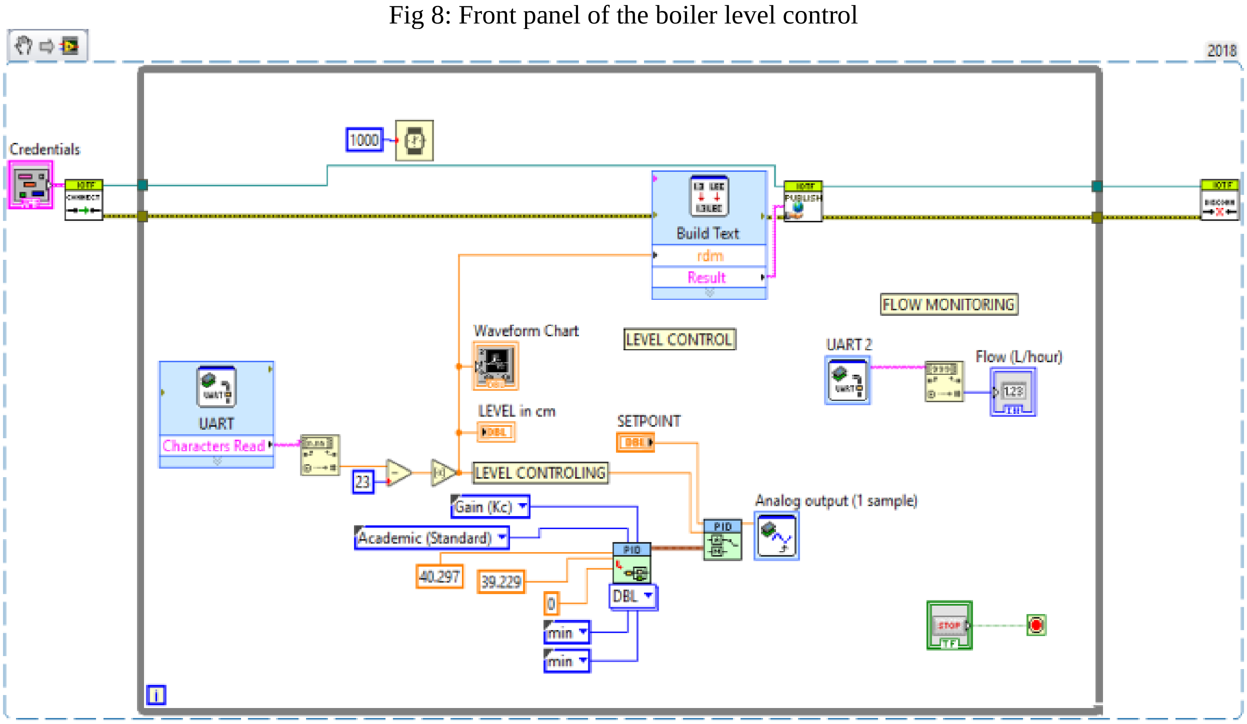


Fig 9: Block diagram of the boiler level control

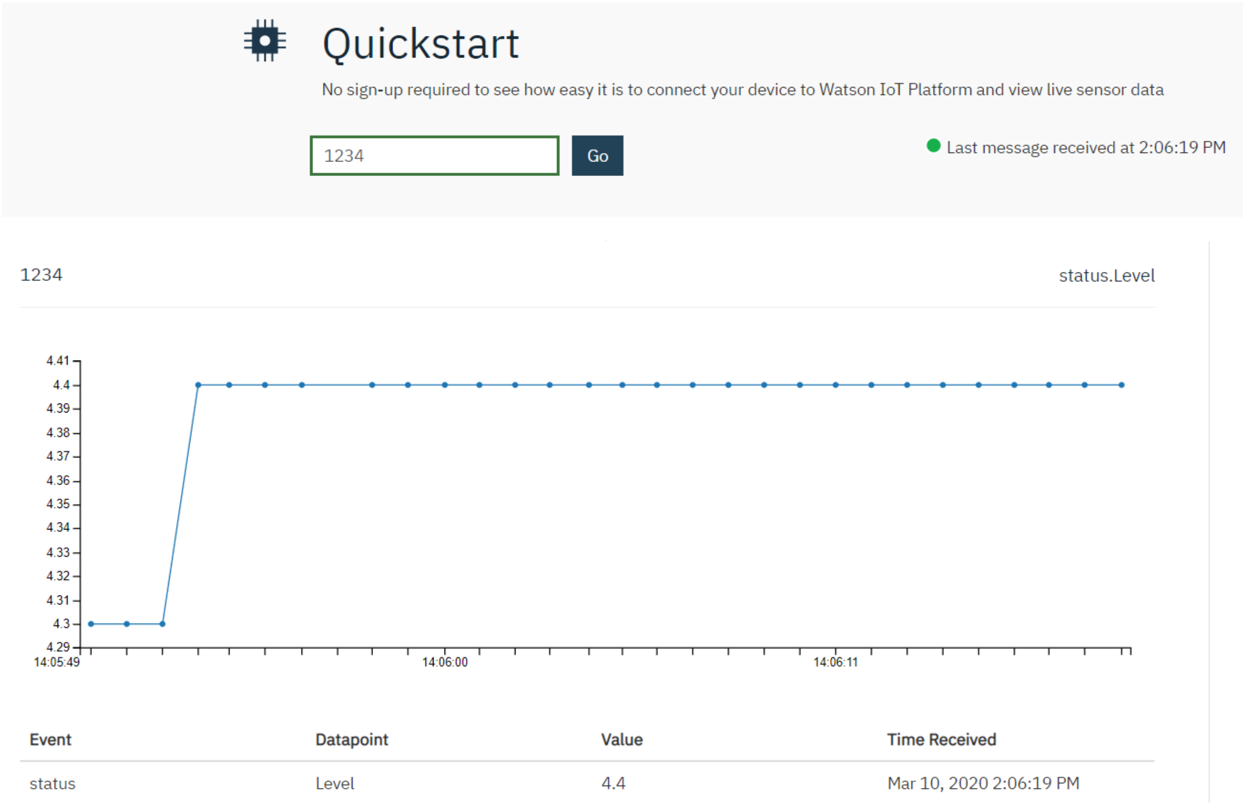


Fig 10: IBM QuickStart IoT platform to monitor level controlled output

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