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Three elements control of boiler drum using IOT

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I. ABSTRACT

The most important unit in a process industry or power station is a boiler. In thermal power plant a three element control of boiler drum includes three process variables such as drum level, feed water flow and steam flow to control boiler drum. Water interface exist in boiler drum and the level of water in the boiler drum is very difficult to maintain. If the water level becomes too low the boiler can run dry, resulting in mechanical damage of the drum and boiler piping. If the level becomes too high, water can be carried over into steam pipe work and causes damage in downstream equipment. The data from entire plant is received and logged in DCS system for experimental analysis. The data logging system of the plant DCS monitors process variables and multi loop control in a plant and measures and record the process variable manipulated variable control signal etc., of a different control process. The data logging requires huge memory forrecording different variables of the plant. The measured variables stored in cloud and used in the process with the IOT technology and hence huge memory occupation in DCS is reduced. In this project IOT concept has been implemented in the boiler drum level control in thermal power plant and variables which are monitored, recorded and controlled by using IOT.

KEYWORDS

Three element control, Boiler drum level, Feed water flow, Steam Flow, Arduino microcontroller and IOT.

II. INTRODUCTION

The major problem in boiler control is the monitoring and controlling of water level in a boiler drum. In many industries and power plants have boilers for generating process steam. Boilers are main unit to thermal power generation. In boiler drum the water and steam gets separated. Controlling its level is critical because if the levelbecomes too low, the boiler can run dry resulting in mechanical damage of the drum and boiler piping. If the levelbecomes too high, water can be carried over into the steam pipework, possibly damaging downstream equipment. Thedesign of the boiler drum level control strategy is normally

described as single-element, two-element, or three-elementcontrol.

If there is any mismatch between inflow (water) and outflow (steam) will cause a continuous change in the drum level.Integrating loops are difficult to tune, and can easily become unstable if the controller's integral time is set too short(i.e. high integral gain). The process requires for a long integral time makes the loop slow to recover fromdisturbances to the drum level.

If the drum level is low, and more feedwater is added to increase it, the drum level tends to decrease first beforeincreasing. This is because the cooler feedwater causes some of the steam in the evaporator to condense, causing the
volume of water/steam to decrease, and hence the drop in drum level. Conventional feedback control has difficulty incoping with this inverse response. A control loop using high controller gain and derivative action may work well in other applications, but it will quickly go unstable on a boiler drum level. Stability is best achieved by using a lowcontroller gain, long integral time, and no derivative. However, these settings make the controller's response verysluggish and it's not suitable for controlling a process as critical as boiler drum level.

The changes in steam flow can also cause large deviations in drum level and could possibly trip theboiler. Changes in steam flow rate are measurable and this measurement can be used to improve level control verysuccessfully.For the feedforward control strategy, steam flow rate is measured and used as the set point of the feed water flowcontroller. In this way the feed water flow rate can be adjusted to match the steam flow. Changes in steam flow rate will almost immediately be counteracted by similar changes in feedwater flow rate. To ensure that deviations in drum level are also used for control, the output of the drum level controller is added to the feedforward from steam flow.The combination of drum level measurement, feed flow measurement, and steam flow measurement to control boiler drum level is called three-element control. By using IOT technology, the three element in the boiler drum can be monitored, recorded and controlled.

II. OBJECTIVE

- To Control the boiler drum level to the set point.
- Boiler steam output and feedwaterinput should be balanced properly.
- To Perform smooth changes of the boiler drum level for different load changes in the boiler.
- To Compensate for feed water pressure variation without process upset or set point shift.

III. SYSTEM ANALYSIS

A) EXISTING SYSTEM

This system is basically cascade output of the two element system to the feedwater flow controller. It has three variables such as drum Level, Steam flow rate and Feedwater flow rate which are used to manipulate the feedwater control valve.The three element drum level control is mainly suited where a boiler plant consists of multiple boilers and multiplefeedwater pumps or where the feedwater has variation in pressure or flow. Three element control assures that the signals versus feedwater flow will

have a constant relationship byreplacing the open flow characteristics of the feedwater control valve with a closed loop feedback control of feed water flow.

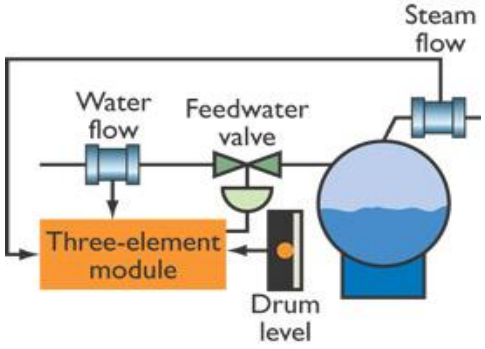

Figure 1: Three element control of boiler drum

Drawbacks:

1. Long connections are needed so, have to use more wires.
2. More spaces are needed for fitting wire communications.
3. Monitoring action has possible only in control unit.
4. In the processing unit we need to measure three parameters.

B) PROPOSED METHOD

In our proposed system it deals with the boiler drum level controlling system. The boiler drum level is controlled by the arduino Uno microcontroller from the output of sensors. Arduino Uno microcontroller receives the pulse signal and sends to the Liquid Crystal Display (LCD) or Personal Computer (PC) with the help of the Local Area Network (LAN). Another side the same level signal send to the Internet of Things (IOT) by using Wi-Fi module.

Merits:

1. In thisconcept the major advantage is boiler drum level controlling, this action is taken by the Internet of Things (IOT), which means the signal from Internet of Things (IOT) connected devices like smart phones or laptops etc.,
2. From the devicesthe signal will be sent to the arduino Uno microcontroller for controlling the feedwater flow inside the boiler drum by relay action. Through the smart phones or laptop can store the N number of data's, as well as control the drum level.
3. Inthis system the monitoring action can also done with the help of website address.
4. Using Internet of Things (IOT) instead of other communication control system we can achieve higher speed of control with less space of RAM and low power consumption.

IV. BLOCK DIAGRAM

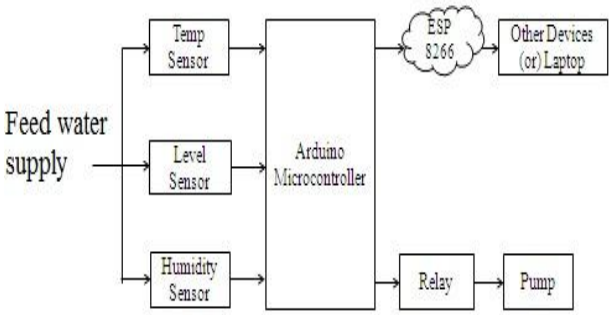

Figure 2: Three Element Control Of Boiler Drum Using IOT.

V. Elements used

A) Hardware Requirements

1. Arduino Microcontroller
2. Temperature Sensor
3. Level Sensor
4. Humidity Sensor
5. Relay
6. Personal Computer
7. ESP 8266 (Wi-Fi Module).

1. Arduino Microcontroller

Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models consists a USB interface, 6 analog input pins and 14 digital I/O pins that allows the user to attach various extension boards.

It is an easy USB interface. This allows interface with USB as this is like a serial device.The chip on the board plugs straight into your USB port and supports on your computer as a virtual serial port. The benefit of this setup is that serial communication is an extremely easy protocol which is time-tested and USB makes connection with modern computers and makes it comfortable.It is easy-to-find the microcontroller brain which is the ATmega328 chip. It has more number of hardware features like timers, external and internal interrupts, PWM pins and multiple sleep modes.

2. Temperature Sensor

LM35 Temperature Sensor which is a semiconductor based sensor. It is an integrated analog temperature sensor whose electrical output is proportional to Degree Centigrade. They are used in your daily household devices from Microwave, fridges, AC to all fields of engineering.

3. Level Sensor

Water sensor brick is designed for water detection, which can be widely used in sensing rainfall, water level, and even liquid leakage.It can be used to detect the presence, the level, the volume and/or the absence ofwater.

4. Humidity Sensor

The DHT-22 (also named as AM2302) is a digital-output, relative humidity, and temperature sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and sends a digital signal on the data pin.

Technical Details

Power − 3-5V

- Max Current − 2.5mA
- Humidity − 0-100%, 2-5% accuracy
- Temperature − 40 to 80°C, ±0.5°C accuracy.

5. Relay

Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.

6. Personal computer

A PC is an electronic device which is capable of receiving information (data) in a particular form and of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program) to produce a result in the form of information or signals.

7. ESP 8266

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266 hosts the application, and when it is the only application processor in the device.

B) Software Requirements

1. Arduino IDE
2. Proteus 8

1. Arduino IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. We can simply use a USB cable.Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

2. Proteus 8

Proteus is a simulation and design software tool developed by LabcenterElectronics for Electrical and Electronic circuit design.It also possess 2D CAD drawing feature.It deserves to bear the tagline “From concept to completion”.

VI. IOT:

The Internet of things (IOT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators,and connectivity w hich enables these objects to connect and exchange.

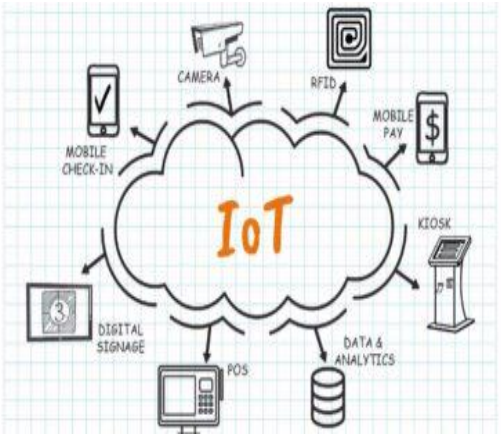

Figure 3: IOT

VII. Procedure

The temperature sensor LM35 measures the fluid temperature in the boiler drum and gives the temperature value to the arduino microcontroller. The water level sensor measures the level of the boiler drum and gives the sensor output to the arduino microcontroller. The Humidity sensor measures air present in the water level of boiler drum and gives the output to the arduino microcontroller. By using arduino IDE, proteus8 software the program has been created in the arduino board. The program can be

automatically runs to maintain the correct drum level, steam level and feedwater flow.The Esp8266 is a wifi networking device for IOT which acts as a communication cable between microcontroller and computer or PC or laptop or smartphones etc.., The personal computer can be used to receiving information (data) in a particular form and of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program) to produce a result in the form of information or signals. Due to this way the three element in the boiler drum can be monitored, recorded and controlled using IOT technology.

VIII. Significance :

A. Importance Of Three-ElementsBoiler Drum Level Control

- Conversion of water into steam is the primary function of a utility boiler.
- The steam pressure is used to turn a steam turbine thus, generating electricity.
- Within the boiler drum there exists a steam/water interface.
- Boiler steam drum water level is one of the important parameters of power plant that must be measured and controlled.

B. Real Time Monitoring And Controlling Of Boiler Drum

- The boiler drum level control unit is one of the main parameter in the thermal power station.
- Currently the boiler drum parameters are monitored only by using MATLAB software.
- There is no automatic control available.

C. Boiler Drum Level Control Using Dcs -One/Three Element Method

- The scope of this control system is to maintain the boiler drum level to the normal water level at all loads.
- Boiler drum level control is critical for both thermal plant protection and equipment safety and applies equally to both high and low levels of water within the boiler drum.

IX. Simulation Output:

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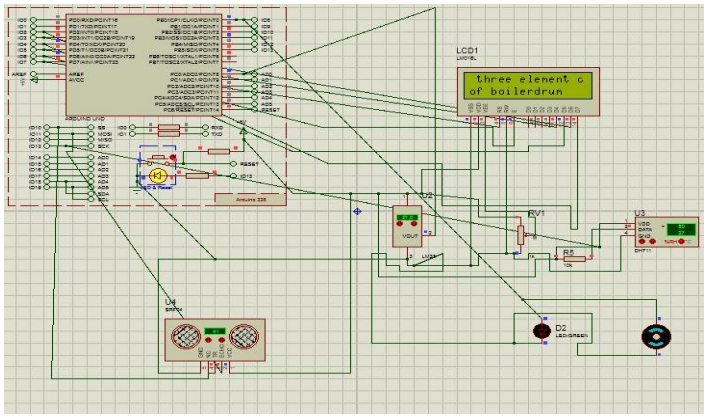

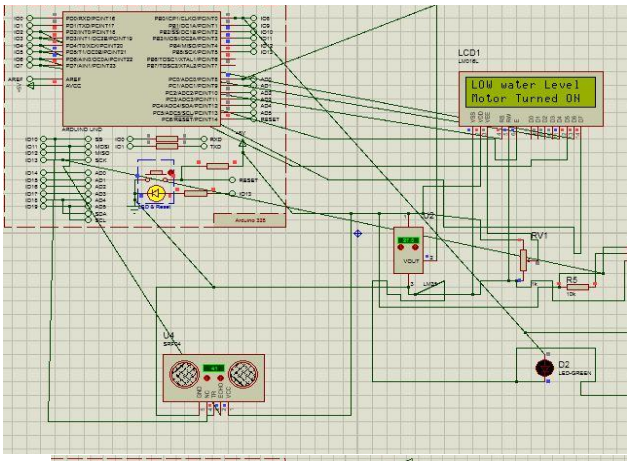

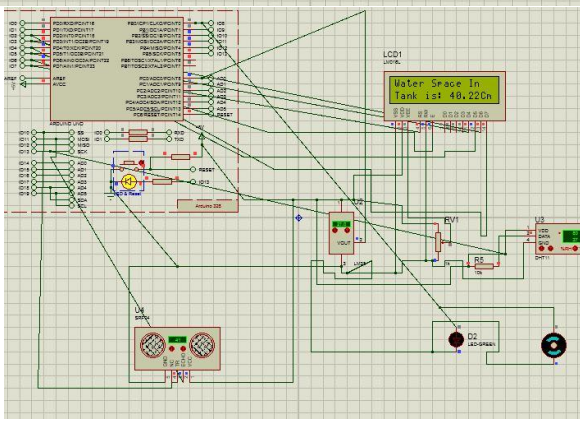

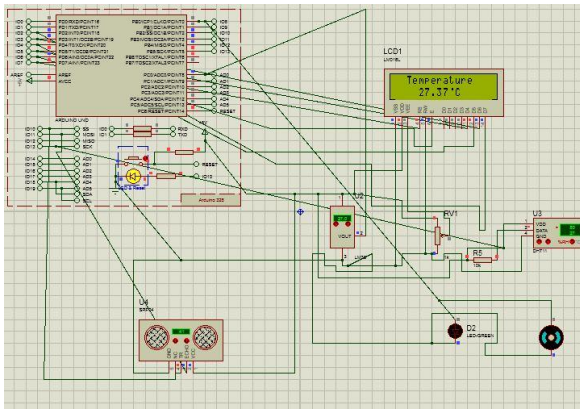

In above simulation, the three sensors such as temperature sensor(LM35), level sensor(water sensor), humidity sensor (DHT 22), senses the respective temperature of feed water, drum level and humidity of feed water and sends to the arduino microcontroller which it connected to the LCD. The LCD shows the current readings of boiler drum parameters. It automatically controls the three element in the boiler drum.

X. Conclusion and Future Enhancement:

The three element control of boiler drum i.e. Drum level, Feedwater flow and Steam flow can be controlled in a better way by using IOT. By using IOT Instead of other communication control system it has been easier to achieve higher speed of control with less space of RAM and low power consumption. Due to this three element control system the power generation and overall efficiency in thermal power plant is increased.

In Future, the five elements in the boiler drum has been controlled. The five parameters such as temperature, pressure, level and humidity of feed water in the boiler drum can be controlled using this current IOT technology. It is easier to monitor and control most of the parameters in boiler drum. In thermal power station it is most essential.

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