ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

Boiler Automation Using PLC & SCADA

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ABSTRACT: The boiler is a fundamental part of almost all industries. It varies in application from low pressure to high pressure. The paper outlines the various stages of operation involved in the conversion of a manually operated boiler towards a fully operated boiler. The boiler control which is the most important part of any power plant, and its automation is the precise effort of this paper. In order to automate a power plant and minimize human intervention, there is a need to develop a SCADA (Supervisory Control and Data Acquisition) system that monitors the plant and helps reduce the errors caused by humans. While the SCADA is used to monitor the system, PLC (Programmable Logic Controller) is also used for the internal storage of instruction for the implementing function such as logic, sequencing, timing, counting and arithmetic to control through digital or analog input/output modules various types of machines processes. Systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. The initial phase of the paper focuses on passing the inputs to the boiler at a required temperature, so as to maintain a particular temperature in the boiler, and shows the temperature/pressure relationship. To achieve desired steam pressure (2Bar) at certain temperature, the Properties of Steam Table analysis is done. A proper boiler design and modelling and safety precautions are taken into consideration. Focusing on level, pressure, temperature parameters are constantly monitored using SCADA screen which is connected to the PLC.

KEYWORDS: Automation, PLC-SCADA, Boiler, DC and AC Supply, Relay, Temperature Sensor,Analog Module

I. INTRODUCTION

Over the years the demand for high quality, greater efficiency and automated machines has increased in the industrial sector of power plants. Power plants require continuous monitoring and inspection at frequent intervals. There are possibilities of errors at measuring and various stages involved with human workers and also the lack of few features of microcontrollers. Thus this paper takes a sincere attempt to explain the advantages the companies will face by implementing automation into them. In order to automate a power plant and minimize human intervention, there is a need to develop a SCADA (Supervisory Control and Data Acquisition) system that monitors the plant and helps reduce the errors caused by humans. While the SCADA is used to monitor the system, PLC (Programmable Logic Controller) is also used for the internal storage of instruction for the implementing function such as logic, sequencing, timing, counting and arithmetic to control through digital or analog input/ output modules various types of machines processes.

II. PURPOSE OF BOILERAUTOMATION

Boiler is the foremost part in any power plant.Itrequires continuous monitoring and inspection at frequent interval. In Power plants it has number of boiling section. This boiling section produces the high temperature water of the steam. Boiler steam temperature in thermal power plant is very complex and hard to control, due to poor knowledge of the working principles; Boilers have many serious injuries and destruction of property. It is critical for the safe operation of the boiler and the steam turbine. If the level is too low it may overheat boiler tubes and damage them. If too high, a level may interfere with separating moisture from steam and transfers moisture into the turbine, which reduces the boiler efficiency. Various controlling mechanism are used to control the boiler system so that it works properly, many control strategies have been applied to it. In order to automate a power plant and minimize human intervention, there is a need to develop a Boiler Automation system. It is achieved by using Programmable Logic Controller & SupervisoryControl and Data Acquisition system that helps to reduce the errors caused by humans and avoids the catastrophic failure.

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III. BOILER AUTOMATION USING PLC AND SCADA

In order to automate a power plant and minimize human intervention, there is a need to develop a PLC &SCADA system that helps to reduce the errors caused by humans. PLC and SCADA interfaced through communication cables. SCADA is used to monitor the boiler temperature, pressure and water level using different sensors and the corresponding output is given to the PLC which controls the boiler temperature, pressure and water level. The figure shows the block diagram of boiler Automation which consists of PLC, SCADA and sensors to monitor and control the entire operation of boiler. Here Resistive Temperature detector Pt 100 (RTD PT 100) is used to measure the temperature, RT pressure switch is used to measure the pressure inside the boiler and float switches are used to detect the feed water level inside the boiler.Its temperature is measured. In one pump the flow rate is maintained at 130% and in another it is 75%. Thus the failure of any one pipe does not affect the boiler operation. Heater is switched ON by using PLC. The corresponding temperature and pressure are measured by sensors.

Water plays a major part in the generation of steam. Initially Pushbutton is switched ON then the PLC, SCADA, different sensors are switched ON. Feed water pump is switched ON by using feed water pump switch.The water from the water tank is allowed to pass through two parallel pipes to boiler and passed through economizer, thus the heat in the outgoing gases is recovered, by transferring its heat to the water. Then the heated water is made to flow through steam and water drum. In this, water should be maintained at least at 50%. For sensing water level Float switches are used. When the level is lesser than or greater than 50%, Float switches senses the level change and sends the appropriate control signal to the PLC. Thus, in spite of any changes in disturbance variable, the water level can be maintained at 50% by proper tuning of PID controller. Water in the water drum is maintained at more than 75%.When the water is less than 2000 litres then motor will be switched ON. If the temperature and pressure inside boiler exceeds then entire system will be in OFF state. The corresponding automated check valves are opened to avoid catastrophic failure.

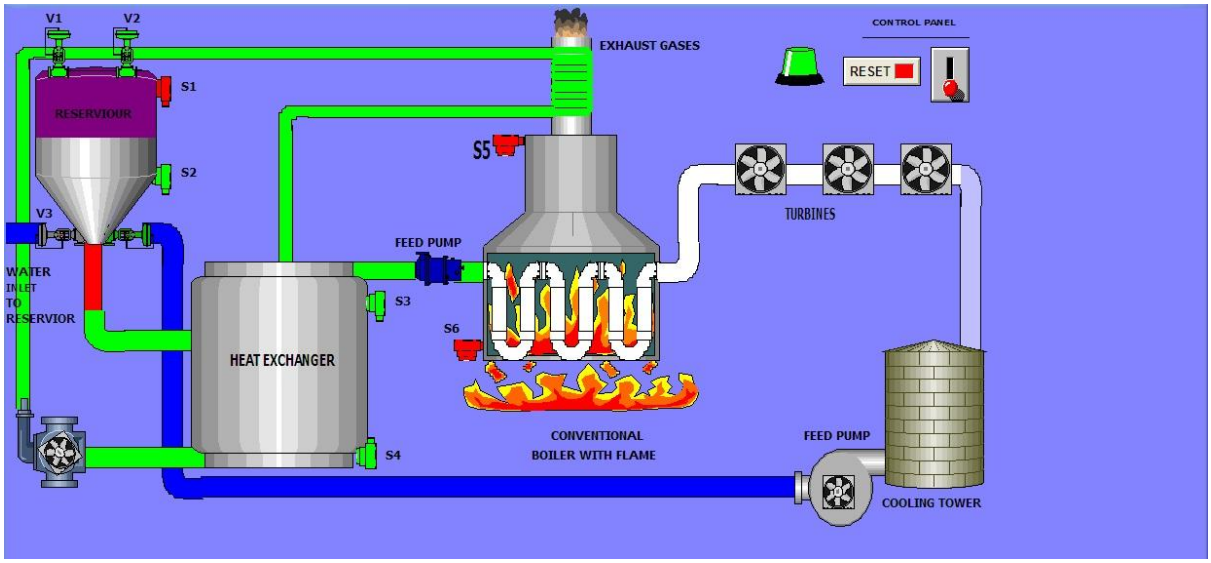

Fig 2: Run time visualisation of Boiler operation in IntouchWonderware SCADA Software

B. Control parameters:

Temperature Control:-

Steams drum temperature, underbed boiler temperature, Force draft temperature, Flue gas temperature, Induced draft temperature, feed water temperature.

Pressure Control:-

Force draft pressure, Induced draft pressure, Steam drum pressure, Turbine inlet steam pressure, and flue gas pressure.

Level Control

Steam Drum level, Water level

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C. Boiler:

Boiler is essentially a closed vessel into which water is heated until the water is converted into steam at required pressure. There are mainly two types of boiler – water tube boiler and fire tube boiler. At first Fuel (generally coal) is burnt in a furnace and hot gasses are produced which is shown in Fig.2. These hot gasses come in contact with water vessel where the heat of these hot gases transfer to the water and consequently steam is produced in the boiler. Then this steam is piped to the turbine of thermal power plant. There are many different types of boiler used for different purposes like running a production unit, sterilizing equipment, sanitizing some area, to warm up the surroundings etc.

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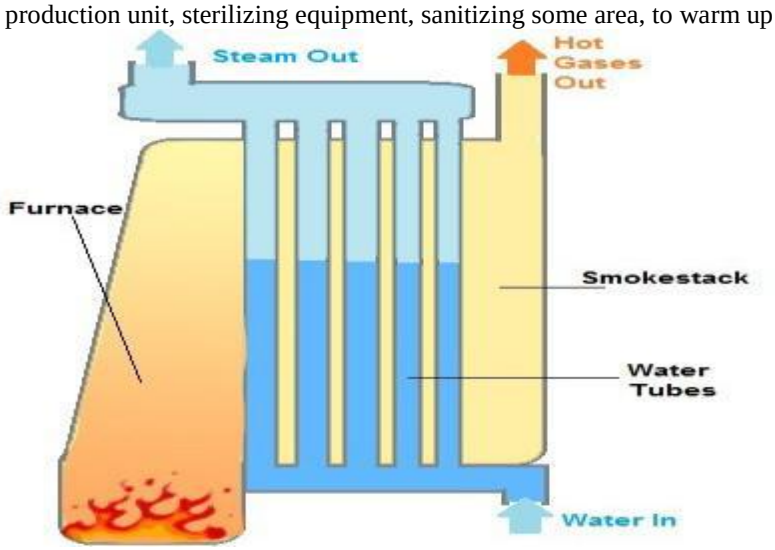

Fig 3: Water tube boiler

D. Temperature sensor:

Resistance Temperature Detector (RTD PT 100) is used to sense the temperature variation. It is a passive circuit element whose resistance increases with increasing temperature in a predictable manner. A PT-100 is a precision platinum resistor that exhibits 100 ohm at 00c.Fig.3 shows the typical RTD. To measure the resistance, it is essential to convert it to a voltage and use the voltage to drive a differential input amplifier. The differential input amplifier will reject the common mode noise on the leads of the RTD and provide the greatest voltage sensitivity.The RTD signal is usually measured one of two ways: either by connecting the RTD element in one leg of a Wheatstone bridge excited by a constant reference voltage or byconnecting it in series with a precision current reference and measuring the corresponding IR voltage drop.

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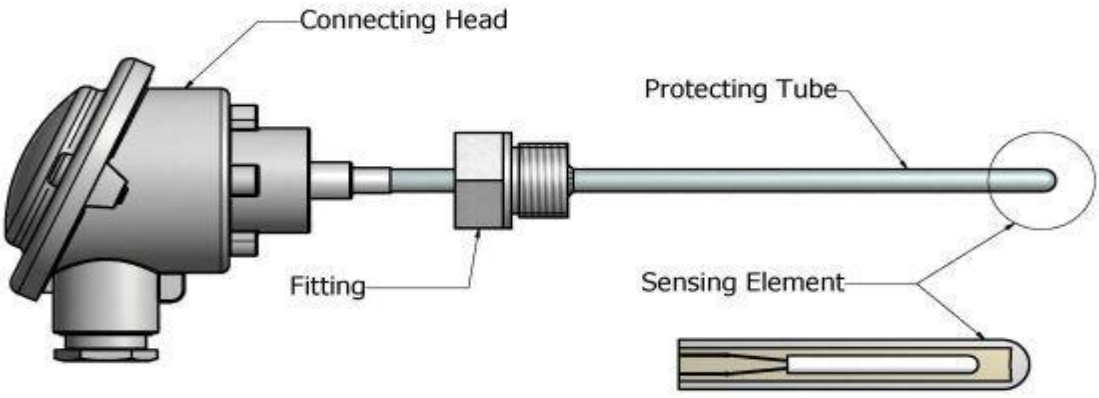

Fig 4: Resistance Temperature Detector

E**. Pressure Sensor**

RT pressure switch is used to sense the pressure inside the boiler. RT Series pressure switches utilize a seamless bellows as sensing element. The bellows can be either phosphor bronze or stainless steel to suit various kinds of process medium. The mechanism is enclosed in a weather proof (IP66) enclosure which can be of either DMC (Die Cast Aluminium).Pressure ranges between -1 to 30 bar [8].

F. **Float switches**

A float switch is a device used to detect the level of liquid within a tank which is illustrated in Fig.4. The switch may be used in a pump, an indicator, an alarm, or other devices. Float switches range from small to large and may be as simple as a mercury switch inside a hinged float or as complex as a series of optical or conductance sensors producing discrete outputs as the liquid reaches many different levels within the tank [7].

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Fig 5: Float switches

VII. CONCLUSION

In this paper, Boiler Automation using PLC and SCADA was designed and implemented. Different sensors are used to measure the temperature, pressure and water level. SCADA is used to monitor the parameters and PLC used to control the operation. If the temperature and pressure exceed predefined value then the entire setup will shut down and automatic check valves are opened to release the steam and pressure. In case of emergency alarm was energized and automatic check valves are opened to avoid catastrophic failure. Ladder diagram of Delta PLC is simulated using WPL soft and the SCADA design of boiler automation is simulated using Intouchwonderware software. The future research is to focus on the application oriented implementation of remote monitoring of boiler Automation by SCADA internet access.

ACKNOWLEDGMENT

We are grateful to our Dept. Hod sir Prof.SubrajitPradhan and weacknowledge with gratitude to our supervisor Prof.Rashmita Gouda, Department of Electronics Engineering, and all staff members for their innovative thinking, continuous guidance, genius role and encouragement throughout the whole project period.

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