Monitoring & Controlling of Temperature, Pressure & Water Level in Thermal Power Plant by Arduino UNO

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Abstract- *Boiler is one of the most important equipment in any power plants. At frequent intervals boiler requires continuous inspection and monitoring. By human workers there are possibilities of errors at measuring and various stages. So a reliable monitoring system is necessary to avoid total failure from which recovery is impossible, which is achieved by automation using Arduino UNO. This paper presents an automation of temperature and pressure monitoring and control and water level monitoring using Arduino UNO. Different sensors are used to measure the temperature, pressure and water level. Arduino UNO is used to monitor and control the operation through various parameters. If the temperature and pressure reduces below a set value then the temperature and pressure sensor will detect the difference and heater will be operated till predefined value of the parameters is reached. If the temperature and pressure exceed predefined value then the heater should turned off and automatic check valves are opened to release the steam and pressure.*

Keywords- Introduction, Related Work, Need For Arduino Uno, Operation ,Boiler Automation Using Arduino Uno, Advantages, Disadvantages, Applications, Conclusion

I. INTRODUCTION

Over the years in the industrial sector of power plants the demand for high quality, greater efficiency and automated machines has increased. At frequent intervals power plants require continuous monitoring and inspection. Power plants have number of boiling section. This boiling section produces the high temperature water of the steam level temperature. This steam level temperature is used for power generation and the steam waters are applied to the turbine section. After the power is generated, steam waters are supplied to various plants for reuses. If the supply of the high temperature is reduced to low temperature, it will be used for all other plants which needs the low temperature. By human workers there are possibilities of errors at measuring and various stages involved. In order to minimize human intervention and automate a power plant, there is a need to reduce the errors caused by humans and develop a automatic system.

In present situation conventional PID control is being used for boiler control. When there are fluctuations and, in particular, there is an emergency occurring these conventional controllers in power plants are not very stable. Continuous processes in power plant and power station are complex systems. They are characterized by nonlinearity, uncertainty and load disturbances. The conventional controllers do not work accurately in a system having nonlinearity in it hence automation is preferred.

II. RELATED WORK

The main concern during start up and shut down is usually the time necessary for these operations. This time should be minimized to save costs but without causing, for instance, thermal stresses, which would shorten the lifetime of sensitive components to an unacceptable degree. During continuous operation, efficiency is the main issue. In addition, however, environmental protection (that is, emission limits) must be taken into account, and of course safe operation must always be guaranteed. All plants can usually be operated by hand, both during commissioning and afterward. However, plants are increasingly becoming totally automated and are sometimes monitored via the Internet, so that for hours or days there is no need for a human presence.

In the existing scenario, a steam power plant produces most of the electricity throughout the world. Therefore, it is mandatory to be sure that the plants are working with their maximum efficiency. To enhance the efficiency and reliability of steam power plants thermodynamic analysis of the thermal power plant has been undertaken. On the basis of first law of thermodynamics only most of the power plants are designed by the energetic performance criteria. The real useful energy loss cannot be justified by the fist law of thermodynamics aS it does not differentiate between the quality and quantity of energy. The present work deals with the comparison of energy and energy analysis of thermal power plant stimulated by coal. Generally, a significant improvement in the plant efficiency will result if it is predicted that even a small improvement in any part of the plant is done. Factors affecting efficiency of the Thermal

Power Plant have been identified and analyzed for improved working of thermal power plant. The objective of this work is to use the energy analysis and energy analysis based on the first law of thermodynamics and second law of thermodynamics respectively, to identify the locations and magnitudes of losses in order to maximize the performance of a 15 MW thermal power plant in a paper mill, to evaluate the boiler, turbine and condenser efficiencies. In order to improve the efficiency and performance of a plant, it is necessary to regularly check and estimate the efficiencies separately and periodically.

III. NEED FOR ARDUINO UNO

Boiler produces steam at very high temperature. In existing system boiler requires continuous inspection and monitoring at regular interval. Boiler steam temperature in thermal power plant is very high .It is difficult to control boiler temperature manually as it may cause serious injury to human workers. The boiler temperature should not be too high or too low. It must be kept within permissible limits. Various mechanisms are used to control the temperature of boiler so that boiler works properly. For reliable operation it is necessary to develop automation for boiler.

By using Arduino UNO the prototype model of the system is developed. In boiler control parameters such as temperature, pressure and water level are controlled by temperature sensor, pressure sensors water level is monitored manually. Arduino boards are relatively inexpensive compared to other microcontroller platforms.

IV. OPERATION

In boiler control parameters such as temperature, pressure and water level are controlled by temperature sensor, pressure sensors water level is monitored manually.

If temperature increases above the level then heater will turn OFF and if temp drops below level then heater turns ON. Pressure sensor is used to measure the pressure of steam, if pressure increases above level then outlet will open.

The water level will be monitored manually, if water level drops below set level then feed pump manually start. We can also use LED and buzzer for indication purpose.

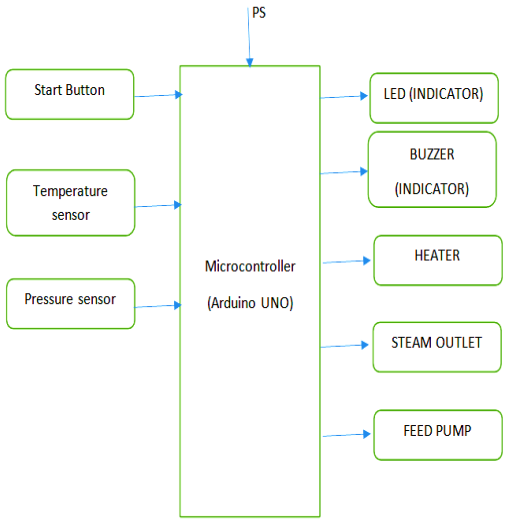

Fig no. 1: Block diagram

V. BLOCK DIAGRAM

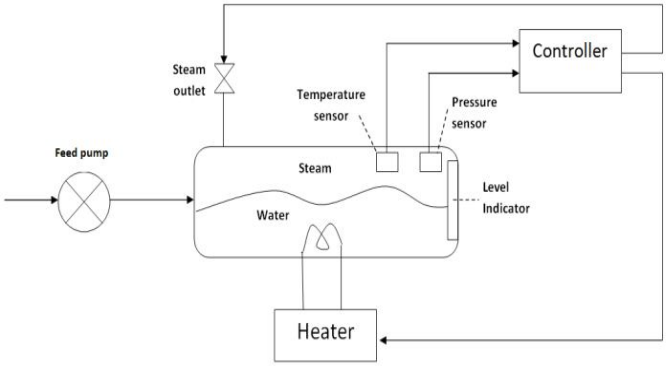

Fig no. 2: Block Diagram

VI. BOILER AUTOMATION USING A RDUINO UNO

VI.I Microcontroller: Arduino UNO

AVR: 5V, 8-bit, 16 MHz
Arduino/Genuine Uno is a microcontroller board based on the ATmega328P.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

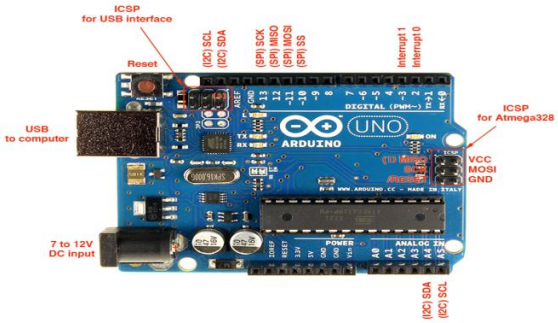

Fig no.3: Arduino UNO

VI.II Temperature Sensor (LM 35)

In general a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object.LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C).

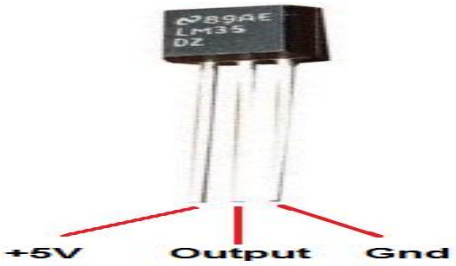

Fig no. 4: Temperature sensor [LM35]

VI.III Pressure Sensor

A pressure sensor is a device for pressure measurement of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area.

VI.IV Heater

A process in which electrical energy is converted to heat is called electric heating. Common applications include space heating, cooking, water heating and industrial processes. An electric heater is an electrical device that converts electric current to heat.

VI.V Feed Pump

To force the water into the boiler feed pump is used, to overcome the steam pressure developed by the boiler, pump must generate sufficient pressure.

VII. CIRCUIT DESIGN

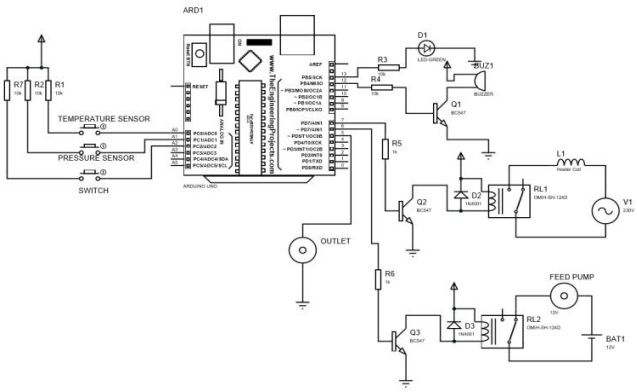

Fig no. 5: Circuit diagram

VIII. WORKING

In thermal power plant automation pressure, temperature and water level continuously monitor through sensors. Temperature of the plant measured by temperature sensor and given to micro controller. If temperature decreases below threshold then heater turns ON and if temperature increases above temperature then heater turns OFF. Pressure of the steam in thermal plant measured by pressure gauge. If pressure increases then excess steam will remove from the plant through outlet. Water level is monitored manually because we cannot use level sensor directly in plant due to its excess heat. If water level drops below minimum level then water pump turns ON.

VIII.I Algorithm

- Start
- Check temperature of water
- If temperature falls bellow threshold, heater turns ON
- Check pressure switch output
- If pressure increases above threshold, steam outlet get open.
- Check water level manually
- If level falls bellow threshold, feed pump turns ON

IX. ADVANTAGES

- System is completely automatic.
- Eliminate need for rewiring and adding additional hardware for each new configuration of logic.
- Efficiency increases.
- Safe operation
- Wastage of coal will be reduced
- Increase in life of boiler

X. DISADVANTAGES

- Limited Applications
- Requires relatively constant heat source
- Lack of customer/industry education about automation

XI. APPLICATIONS

XI.I Steam Temperature Control

Tire curing, food processing and many bio-reaction applications utilize saturated steam. Many of these processes employ a complicated steam control valve that is designed to modulate open and close to maintain a specific temperature. Steam temperature control does not have to be this complicated.

The temperature of saturated steam is directly related to its pressure, so tighter control of temperature, elimination of PID requirement and less temperature drift is easily achieved using a steam pressure controller. Simply put: If you control the pressure of saturated steam, you can control the temperature.

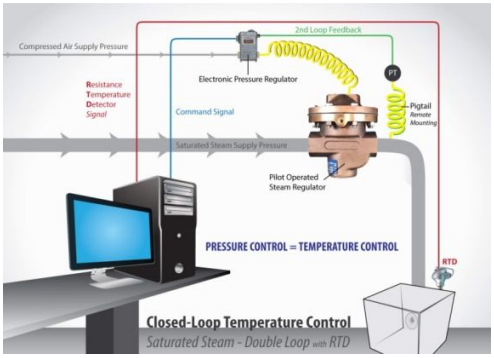

Fig no.6 Closed loop temperature control

XI.II Temperature control in AC

This Temperature based Home Automation System consists of various components like Arduino board, LCD display, Relay, and thermistor. The working mainly depends on the relay and thermistor as the temperature increased the relay will be turned on and if the temperature decreased below the preset value then Relay will be turned off. The Home appliance connected with the Relay will also turns on and off accordingly. Here we have used a CFL bulb as AC appliance. The whole triggering process and temperature value setting is performed by the programmed Arduino board. It also gives us details about the change in temperature in every half second and appliance status on the LCD screen.

XI.III Green House Effect

The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions. Since part of this re-radiation is back towards the surface and the lower atmosphere, it results in an elevation of the average surface temperature above what it would be in the absence of the gases.

XII. CONCLUSION

In this paper, Boiler Automation using Embedded System was designed and implemented. The conventional thermal power plant has an average efficiency of 32.8%. Low plant efficiency not only leads to burning of more coal in the plants but also adds to the volume of CO_2 produced. Due to automation, temperature and pressure will be monitored and controlled and maintained in predefined range leading to increase in efficiency. Unburned combustible losses can be reduced by improved boiler and burner tuning, with some plants able to gain more than 1% in net efficiency which is possible by automation.

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