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CONTROL OF BOILER OPERATION 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 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. Focussing on level, pressure, temperature parameters are constantly monitored using SCADA screen which is connected to the PLC.**

Keywords: **Automation, PLC-SCADA, Boiler.**

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 implement-ing automation into them.

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.

II. DRAWBACK OF CONVENTIONAL SYSTEM

Conventional equipment systems are prone to errors due to the involvement of humans in the data collection and processing using complicated mathematical expressions. Thus what we require is a system that collects raw data, processes it and presents it in values which can be verified and compared with the standard values.

In the coding process of this implementation with micro-controller, it requires a fast and efficient processing which on the other part depends on the length and sub-routines of the coding process. Thus it provides a real challenge with systems involving

III. TYPE OF BOILER

Electric boilers are noted for being clean, quiet, and easy to install, and compact. Because there are no combustion considerations, an electric boiler has minimal complexity (no fuels or fuel handling equipment) with easily replaceable heating elements.

An electric boiler may be the perfect alternative to supply low or high pressure steam or hot water where the customer is restricted by emission regulations. In areas where the cost of electric power is minimal, the electric boiler could be the best choice. Electric Boiler shows some good signs such as-High efficiency, low maintenance, space factor, fuel limitations.

IV. CRITICAL CONTROL PARAMETERS IN BOILER

- Level Control:
  Steam Drum level, High and Low
- Level Pressure Control:
  Steam drum pressure, Inner drum pressure
- Flow Control:
  Steam flow, Water flow
- Temperature Control:
  Steam drum temperature, under bed boiler temperature.

V. ALLEN BRADLEY PLC

Programmable Logic Controller or PLC is an intelligent system of modules, which was introduced in the control, & instrumentation industry for replacing relay based logic. Over a period of time, better I/O handling capabilities and more programming elements have been added along with improvement in communication.

A. PLC Working

Basics of a PLC function are continual scanning of a program. The scanning process involves three basic steps.

Step 1: Testing input status

First the PLC checks each of its input with intention to see which one has status on or off. In other words it checks whether a switch or a sensor etc., is activated or not. The information that the processor thus obtains through this step is stored in memory in order to be used in the following steps.

Step 2: Programming execution

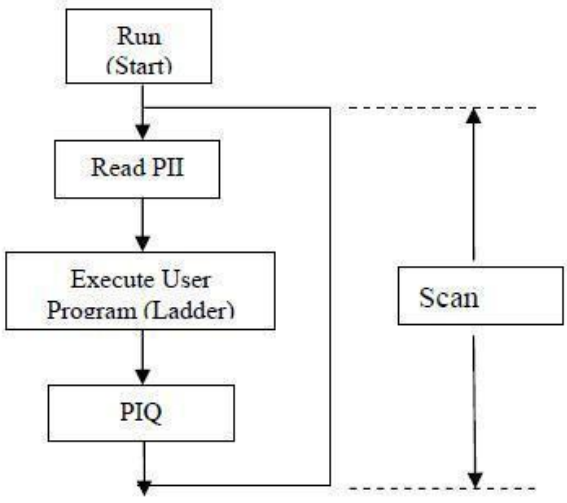
Here a PLC executes a program instruction by instruction based on the program and based on the status of the input has obtained in the preceding step, and appropriate action is taken. The action might be activation of certain outputs and the results can be put off and stored in memory to be retrieved later in the following steps.

Step 3: Checking and Correction of output status

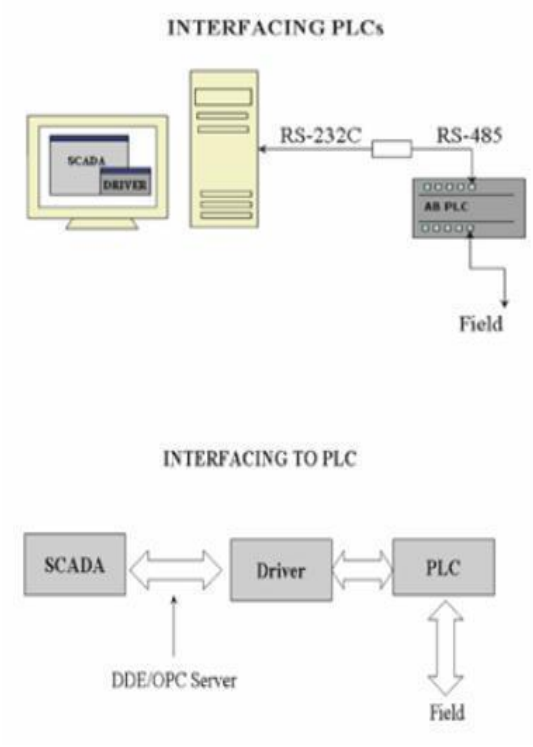
Finally, a PLC checks up output signals and adjust it has needed. Changes are performed based on the input status that had been read during the first step and based on the result of the program execution in step two following execution of step three PLC returns a beginning of the cycle and continually repeats these steps. Scanning time = Time for performing step 1+ Time for performing step 2+ Time for performing step 3.

At the beginning of each cycle the CPU brings in all the field input signals from the input signals from the module and store into internal memory as process of input signal. This internal memory of CPU is called as process input image (PII).

User program (Application) will be available in CPU program memory. Once PII is read, CPU pointer moves in ladder program from left to right and from top to bottom. CPU takes status of input from PII and processes all the rungs in the user program. The result of user program scan is stored in the internal memory of CPU. This internal memory is called process output image or PIQ. At the end of the program run i.e., at the end of scanning cycle, the CPU transfers the signal states in the process image output to the output module and further to the field control.



B. Interfacing



C. Input-Output Configuration for PLC

1) Input Configuration:
   - Feed Pump
   - RTD Transmitter
   - Level Switch
   - Pressure Transmitter.
2) Output Configuration:
   - Solenoid Valve for water inlet
   - Solenoid Valve for Steam Outlet
   - Heater.

VI. SCADA

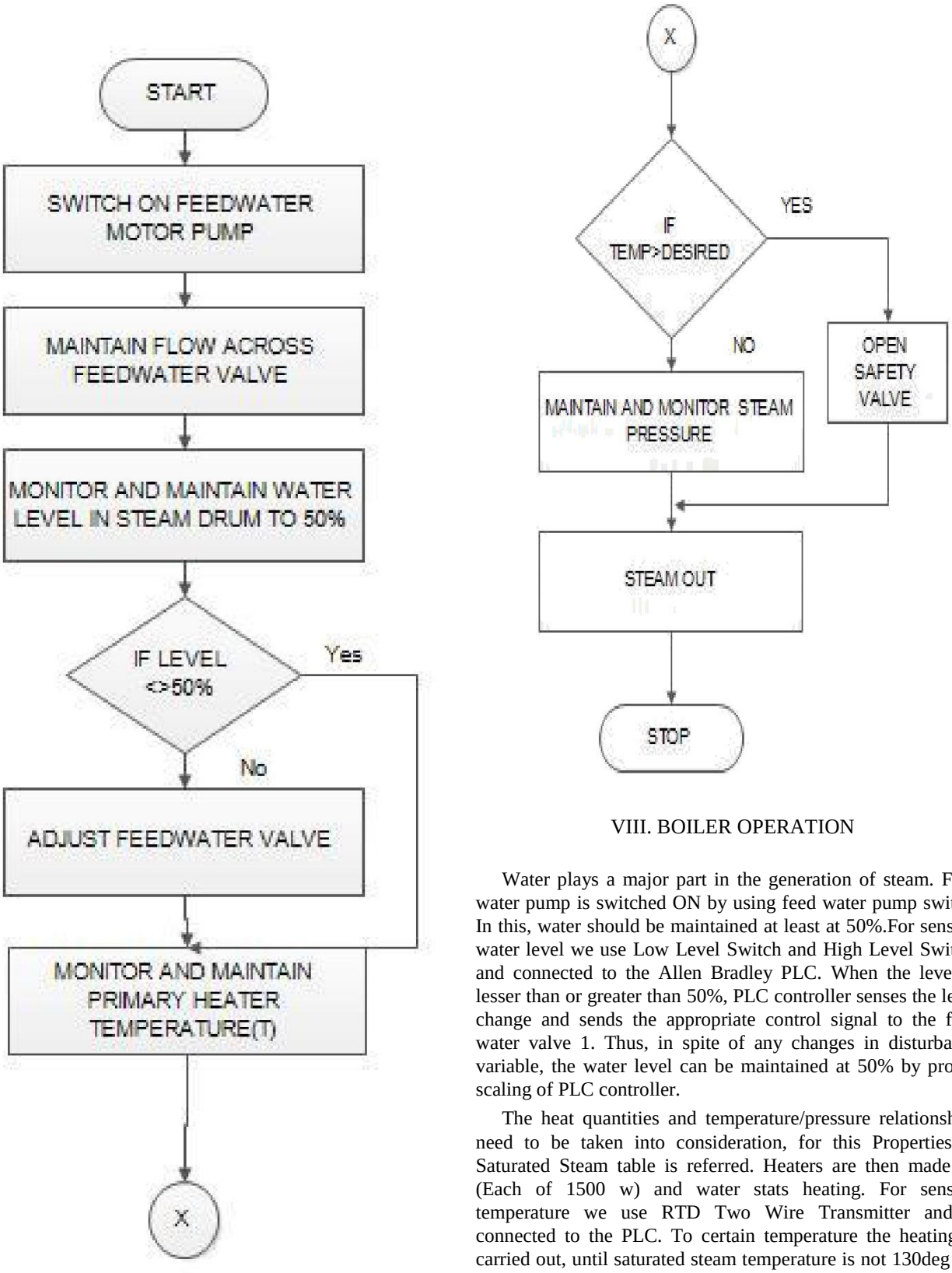
SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level.

What is SCADA? It is used to monitor and control plant or equipment. The control may be automatic or initiated by operator commands. The data acquisition is accomplished firstly by the RTUs scanning the field inputs connected to the RTU (it may be also called a PLC programmable logic controller.). This is usually at a fast rate. The central host will scan the PTUs (usually at a slower rate). The data is processed to detect alarm conditions, and if an alarm is present, it will be displayed on special alarm lists.

Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system.

Proficy software enables you to configure a system environment that provides: Supervisory control, batch processing, data acquisition, continuous control, and statistical process control for industrial applications.

VII. FLOWCHART



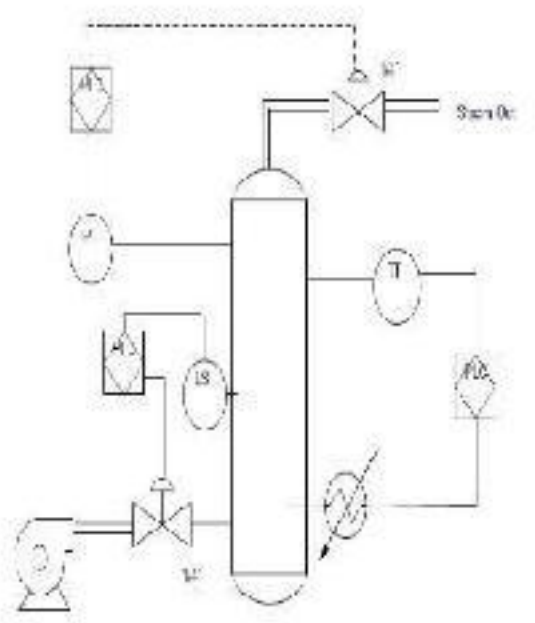
VIII. BOILER OPERATION

Water plays a major part in the generation of steam. Feed water pump is switched ON by using feed water pump switch. In this, water should be maintained at least at 50%.For sensing water level we use Low Level Switch and High Level Switch, and connected to the Allen Bradley PLC. When the level is lesser than or greater than 50%, PLC controller senses the level change and sends the appropriate control signal to the feed water valve 1. Thus, in spite of any changes in disturbance variable, the water level can be maintained at 50% by proper scaling of PLC controller.

The heat quantities and temperature/pressure relationships need to be taken into consideration, for this Properties of Saturated Steam table is referred. Heaters are then made on (Each of 1500 w) and water stats heating. For sensing temperature we use RTD Two Wire Transmitter and is connected to the PLC. To certain temperature the heating is carried out, until saturated steam temperature is not 130deg the heating is carried out. Steam Pressure is building up as the temperature in the cylindrical tank is increasing. Temperature and Pressure are continuously monitored through sensors and

signals are fed into PLC, and controlling action is taken as per desired objective. When desired temperature and pressure gets achieved the steam outlet valve is made on and flow of steam is regulated through that same valve and simultaneously heaters is made off. If in case pressure exceeds the specified value then safety valve gets open to remove excess pressure generated. While heating water, level of water is continuously monitored because low water level can burst heater coils.

When water is heated at atmospheric pressure, its



temperature rises until it reaches 212F, the highest temperature at which water can exist at this pressure. Additional heat does not raise the temperature, but converts the water to steam. The heat absorbed by the water in raising its temperature to boiling point is called sensible heat or heat of saturated liquid. The heat required to convert water at boiling point to steam at the same temperature is called latent heat. The unit of heat in common use is the Btu which is the amount of heat required to raise the temperature of one pound of water 1F at atmospheric pressure. If water is heated under pressure, however, the boiling point is higher than 212F, so the sensible heat required is greater. The higher the pressure, the higher the boiling temperature and the higher the heat content. If pressure is reduced, a certain amount of sensible heat is released. This excess heat will be absorbed in the form of latent heat, causing part of the water to flash into steam.

IX. CONCLUSION

The most important aspect of any power plant is the boiler control. Several techniques can be implemented to control the boiler in power plant. The method that has to be used relies on varied objectives like superior quality, increased efficiency, high profit and other such points depending upon the purpose of the company that implies it. With the prime objective of catering to these necessities and the needs of the industrial sector, significance has been given here to automation.

X. RESULT

Temperature	Pressure(psia)	Pressure(Bar)
110	14.696	1.012
120	21.968	1.72
130	29.427	2

XI. ACKNOWLEDGEMENT

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