Simulation of boiler using PID controller and Automation (PLC & SCADA): A Comprehensive Study

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***Abstract*— This paper deals with the comprehensive study of simulation of power plant boiler with the help of PID controller and automation.Aproportional integral derivative (PID) control system that monitors boiler`s temperature and pressure and volume via different sensors PID controller using Ziegler-Nichols method have a large overshoot and settling time. So far, the steam generator is controlled only by manually. Now the process is fully automatic and analysis of status obtained in SCADA. Applying Steam is controlled by PLC. So, efficiency of heating the boiler by use of steam is to be high. . The output of PLC controls the boiler temperature and pressure and gives out the user required volume of steam. All pressure and temperature variations are shown on SCADA screen and are controlled through SCADA.Different automated check valves are used to release pressure and to inform the concerned authority through alarm in case of an emergency.Thus this paper takes a sincere attempt to explain the advantages the companies will face by implementing 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.**

***Index Terms*— PID controller, 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 implementing 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 in reducing the errors caused by humans [1]. Along with the monitoring of the system.PID controllers are widely used in process control industry due to relatively simple structure and easiness inimplementation. Since last few decades different methods are proposed to tune PID controller, however, everymethod have some limitations. Existing control loop uses PID controller more than 90%. Design of PID controller still remains a challenge before researchers and engineers.To design and tune the controller to achieve the better performance it is essential to,

1. Obtain the dynamic model of a system to control.
2. Specify the desired closed loop performance on the basis of known physical constraints.
3. Adopt controller strategies that would achieve the desired performance.
4. Implement the resulting controller using suitable platform.
5. Validate the controller performance and modify accordingly if required.

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II. PID CONTROLLER

A Proportional-Integral-Derivative (PID) controller is a general feedback control loop mechanism widely used in industrial process control systems [2]. A PID controller corrects the error between a measured process variable and the desired set point by calculating the value of error. The corrective action can adjust the process rapidly to keep the error minimal The PID controller separately calculate the three parameters i.e. the proportional, the integral, the derivative values [3].The proportional value determines the reaction to the current error. The integral value determines the reaction based on the sum of recent errors as past error. The derivative value determines the reaction based on the rate at which the error has been changing as a future error. By tuning these three constants in the PID controller algorithm, the controller can provide control action designed for specific process control requirements [4].

III. 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. As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware

modules[5]. SCADA systems are used not only in most industrial processes: e.g. steel making, power generation (conventional and nuclear) and distribution, chemistry, but also in some experimental facilities such as nuclear fusion. The size of such plants range from a few 1000 to several 10 thousands input/output (I/O) channels [6]. However, SCADA systems evolve rapidly and are now penetrating the market of plants with a number of I/O channels of several 100 K. We know of two cases of near to 1 M I/O channels currently under development. SCADA systems used to run on DOS, VMS and UNIX; in recent years all SCADA vendors have moved to NT. One product was found that also runs under Linux.

IV. BOILER

Boiler is defined as a closed vessel in which steam is produced from water by the combustion of fuel. Generally, in boilers steam is produced by the interaction of hot flue gases with water pipes which is coming out from the fuel mainly coal or coke. In boilers, chemical energy of stored fuel is converted into the heat energy and this heat energy is absorbed by the water which converts them into a steam [7]. Due to poorly understand 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. Too low a level may overheat boiler tubes and damage them. 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.Boilers have many applications which are as follows:

- These can be used in stationary applications to provide heat, hot water and steam for domestic use in many industries.
- These can be used in mobile applications to provide steam for locomotion in applications such as trains, ships, and boats.

V. SIMULATION USING PID CONTROLLER

The single loop controller configuration is shown in Fig.1

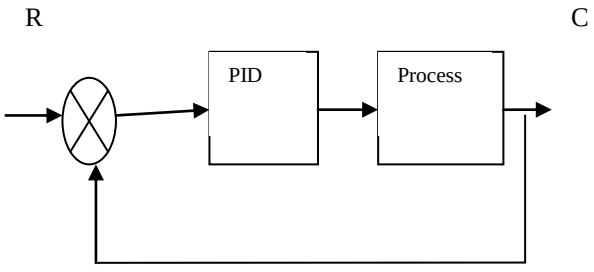

Fig.1 .Block diagram of Control Architecture

PID controller and theprocess are in series where as a feedback from the output isgiven to the input. The boiler of chemical plant ismathematically modelled using experimental data availableand the transfer function is achieved.PID is used for continuous control during the normal plant operation.

VI. SIMULATION USING PLC & SCADA

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.

VII. RESULT

Basically PLC comes into picture during the start up and safe shutdown of the plant. There is a vast difference between a current PLC\SCADA system and PID control from a functional stand point. The DCSsystem tends to be more expensive and tends to use proprietary hardware and software cost also is generally higher and can cause manual error. Thus this paper has shown if there is a need to control multiple value, we need only one SCADA where as multiple PID controller is needed to control individual value, and there will be complex circuitry for PID controller.

VIII. CONCLUSION &SCOPE

The most important aspect of any power plant is the boiler control. Several techniques can be implemented but, the method that has to be used relies on varied objectives like superior quality, increased efficiency, and high profit depending upon the purpose of the company that implies it.

• The ceaseless changes that are relentlessly taking place in the contemporary scenario of the industrial segment. Emphasis has been given to the automation process that is now rapidly taking its place in all the power plants across the globe.

• The Paper has furnished itself to study the integral parts of the entire process involved, their implementation and the problems that may show up have also been given their due importance. Automation is continuous and regulatory control software providing advantages as:

- Material and product tracking.
- Automatic loop tuning.
- Process alarm reporting and logging.

The future work deals with the purification of water to the boiler and the air circulation for the boiler to burn the fuel using same automation technique. Continuous monitoring and inspection of boiler parameters can also be done using internet sitting at home.

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