International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

AUTOMATIC PRESSURE CONTROL OF BOILER USING DISTRIBUTION CONTROL SYSTEM

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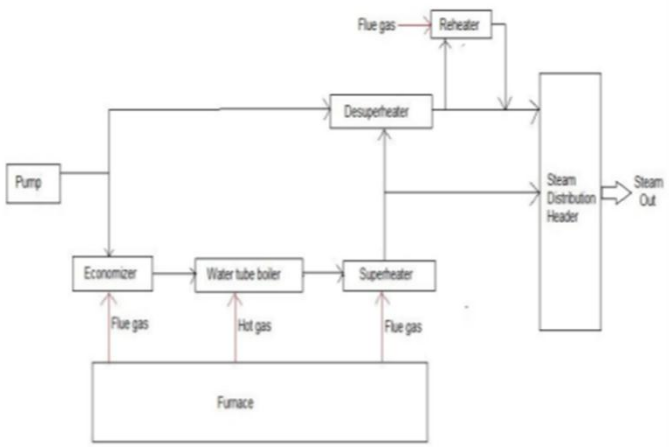
Abstract - *A steam boiler is a sealed vessel designed for the purpose of generating steam pressure at a higher level than atmospheric pressure. "Harnessing" the steam raises the pressure and consequently the boiling temperature. This also increases the energy content of the resulting steam. Essentially, two designs are offered to generate high pressure steam with a higher output range: The water tube boiler and the flame tube/smoke tube boiler (also referred to as boiler with large water chamber). This designs conventionally used as a quick steam boiler up to approx. 30 bar or as a water tube boiler up to approx. 300 bars. The boiler control which is the most important part of any power plant, and its automation is the precise effort. In order to automate a power plant and minimize human intervention, there is a need to develop a DCS. This system controls and monitors the plant and helps to reduce human errors. So, there are different constraint problem like time wastage, human resource management, delaying of the plant financial loss, low productivity exposure. A larger majority portion of the problems can be solved by our project, replacing the existing technology.*

1. INTRODUCTION

The DCS is a system of sensors, controllers, and associated computers that are distributed throughout a plant. Each of these elements serves a unique purpose such as data acquisition, process control, as well as data storage and graphical display. These individual elements communicate with a centralized computer through the plant's local area network – often referred to as a control network. As the 'central brain' of the plant the DCS makes automated decisions based on production trends it sees them in real-time throughout a plant.

1.1 Boiler Process Description

A boiler consists of various sections such as, Economizer, Boiler, Super heater, De-super heater, Re-heater, Steam Distribution header, Condenser, Cooling tower.



1.2 Functional Block Diagram

A function block diagram describes a function between input variables and output variables. A function is described as a set of elementary blocks. Input and output variables are connected to blocks by connection lines. In FBD, program elements appear as blocks which are "wired" together in a manner resembling a circuit diagram.

1.3 Control Drawing Builder

The Control Drawing Builder is used to configure the basic control functions of the FCS. With the Control Drawing Builder, operations such as registering function blocks in the drawing file and determining the flow of data between function blocks can be performed graphically.

1.4 Blocks Used in the Control Drawing Builder

Several blocks are used in the control drawing builder for various operations. They are, MLD block which is used to create a simple closed loop using MLD block in the control drawing builder. The PID Controller Block (PID) provides the most general control function to perform proportional integral derivative control based on the deviation of the process variable (PV) from the set point value (SV). Control Signal Splitter Block (SPLIT) is capable of distributing the manipulated output signals from the upstream control loop to two output destinations via a signal distribution. Addition Block (ADD) is used when performing addition processing or subtraction processing. The Temperature and Pressure Correction Block (TPCFL) is used to correct the flow rate that is measured by a differential pressure flow meter is on the basis of temperature and pressure. Calculations blocks receive analogue signal (analogue values) or contact signals (digital values) as input values, and perform calculation according to the set parameters. Sequence table block (ST16) is a decision table type function block that describes the relationship between input signal and output signal in a Y/N (Yes/No) fashion. Timer block are used to time a process or a sequence. They can also be used to generate delays in a sequence. Relational expression block Actions based on the comparison of two values can also be done in sequence table. A relational block (RL) is used for this purpose. All the values that need to be compared are written in the RL block and then invoked in the sequence table.

1.5 Operations and Monitoring Window

Information regarding the process is gathered as well as monitored by the Standard Operation windows on the HIS. There are two types of Operation and monitoring windows provided by the HIS; System Windows and user defined windows.

System defined windows

System defined windows are inbuilt in the system and includes; System Message Window, Instrument Faceplate Window, Tuning Window, Process Report Window, Graphics Window, Navigator Window, System Alarm Window, Process Alarm Window.

User defined windows

These windows are defined by the user based on the applications and display contents of the operation and monitoring. These includes, Control Group Window, Overview Window, Trend Window, Graphic Window User defined windows can be customized to the end user requirements.

1.6 Economizer

Economizer is designed in such a way that the pipes carrying the feed water are coiled into many loops inside the chamber. This is done to maximize the water exposure to the flue gas. The amount of feed water inflow is monitored and controlled by the flow indicator (FCI101) and control valve CV1. The control valve actions are shown in table.

Operation of control valves in economizer.

Flow (FCI101)	Open	Close
HH		CV3
NR	CV3	
LL	CV3	

The process can be clearly observed from the tabulation. The action of the control valve can be noted from the tabulation. If FC 101indicates HH alarm, which means the flow of the incoming water is very high and then CV3 valve will be in close condition by this action the inflow is stopped. If FCI101 indicates NR alarm which means the flow of the water is quite normal, then the CV3 valve will be opened .by this action the normal amount of water is allowed into the chamber. If FC [1] indicates LL alarm,

which means the flow of the incoming water is very low and then CV3 valve will be in open condition, by which more water inflow is allowed into the chamber.

1.7 Water Tube Boiler

This is the main section of the water tube boiler, which converts water into vapor. According to the output steam, the inlet flow is controlled; we are using Flow sensor FT2 and valve CV4 to control the process. When HH alarm is triggered, valve CV4 is kept closed to restrict inlet water flow. During NR alarm and LL alarm, valve CV4 is kept open to constantly allow water inlet. The control valve actions are shown in table.

Operation of control valves in Water tube boiler.

Flow (FT2)	Open	Close
HH		CV4
NR	CV4	
LL	CV4	

1.8 Super Heater and Desuperheater

De Super heater section exclusively consists of three control valves and as the name suggests, performs the action of de superheating the inlet hot steam.

1.9 Reheater

Reheater performs the action of the reheating when inlet steam temperature is low.

1.10 Steam Distribution Header

Stream distribution header serves are a storage tank for steam collected from super heater, desuperheater and reheater. Besides storing steam, steam header performs the task of delivering the right amount of steam at the needed pressure.

1.11 Food and Beverage System

In this system the high-pressure steam from the steam distribution header is filtered and is used as ―filtered steam‖ for various purposes such as heating, cleaning etc. The piping and instrumentation diagram for food and beverages system for filtering steam.

1.12 Cooling Section

Condenser

Used steam from the application is collected and sent to the condenser section. The impure steam is condensed to its water state in this section

Cooling tower

Cooling tower cools the water and also adjusts the ―pH and and conductivity, so that the water is suited for reuse. Water should be at the pH value of 7, for reusability. pH is corrected by using a set of 2 control valves and one sensor. pH is measured by pH sensor.

2. RESULT AND DISCUSSION

After proper control of parameters like temperature, flow, pressure and level in numerous sections of the boiler with the assistance of Distributed control System (DCS), the output steam from the steam distribution header encompasses a temperature of 1300-1600 degrees Celsius and a pressure rate over 3200 psi. This output steam is filtered and used in food and

beverages industry. The low- pressure steam obtained from this application is then condensed and is re-circulated to the reservoir/tank.

3. CONCLUSION

Increasingly, and ironically, DCS are becoming centralised at plant level, with the ability to log into the remote equipment. This enables operator to control both at enterprise level (macro) and at the equipment level (micro), both within and outside the plant, because the importance of the physical location drops due to interconnectivity primarily thanks to wireless and remote access. The more wireless protocols are developed and refined, the more they are included in DCS. DCS controllers are now often equipped with embedded servers and provide on-the-go web access. Whether DCS will lead Industrial Internet of Things (IIOT) or borrow key elements from remains to be seen. Many vendors provide the option of a mobile HMI, ready for both Android and iOS. With these interfaces, the threat of security breaches and possible damage to plant and process are now very real. Modern DCSs also support neural networks and fuzzy logic applications. Recent research focuses on the synthesis of optimal distributed controllers, which optimizes a certain H-infinity or the H2 control criterion.

References

[1]. Water Level Control of Boiler Drum Using One IEC61131-3-Based DCS, IEEE Control Conference, 2007. CCC 2007. Chinese, Pages 252 – 255.

[2]. A burner management system for utility boilers-a DCS solution, Vidyarthi, S.; Piping Centre, BHEL, Madras, India, Industrial Automation and Control, 1995 (IA & amp; C'95), IEEE/IAS International Conference on (Cat. No.95TH8005), Pages 179 – 183.

[3]. The intelligent boiler control system of self-learning and self-optimizing, International Conference on Automatic Control and Artificial Intelligence (ACAI 2012), Pages: 2137 - 2140