BOILER DRUM LEVEL CONTROL WITH ONE AND THREE ELEMENT STRATEGY USING PLC AND SCADA

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Abstract The main objective of our project is to maintain the boiler drum level, feed water flow and outlet steam flow from the boiler using cascade controller by applying a bias calculation and a compensated steam flow and the design have been stimulated using Programmable Logic Controller (PLC) and interfaced with SCADA (Supervisory Control and Data Acquisition).

Keywords—One Element, Three Element, Plc. and SCADA

I. Introduction

A very common problem and one used in many examples elsewhere, is that of controlling the level in a boiler drum. Many industrial plants have boilers for generating process steam, and of course boilers are central to thermal power generation. The boiler drum is where water and steam are separated. Controlling its level is critical – if the level becomes too low, the boiler can run dry resulting in mechanical damage of the drum and boiler piping. If the level becomes too high, water can be carried over into the stem pipework, possibly damaging downstream equipment. The design of the boiler drum level control strategy is normally described as single-element, two-element, or three-element control. This article explains the three designs.

One of the main hazards in operation of recovery boilers is the smelt-water explosion. This can happen if even a small amount of water is mixed with the solids in high temperature. Smelt-water explosion is purely a physical phenomenon. The liquid - liquid type explosion mechanism has been established as one of the main causes of recovery boiler explosions. In the smelt water explosion even a few liters of water, when mixed with molten smelt can violently turn to steam in few tenths of a second. Char bed and water can coexist as steam blanketing reduces heat transfer. Some trigger event destroys the balance and water is evaporated quickly through direct contact with smelt. This sudden evaporation causes increase of volume and a pressure wave of some 10 000 – 100 000 Pa.

Proposed system

The proposed system of our project is to maintain the boiler drum level, feed water flow and outlet steam flow from the boiler using cascade controller by applying a bias calculation and an compensated steam flow and the design have been stimulated using Programmable Logic Controller (PLC) and interfaced with SCADA (Supervisory Control and Data Acquisition).

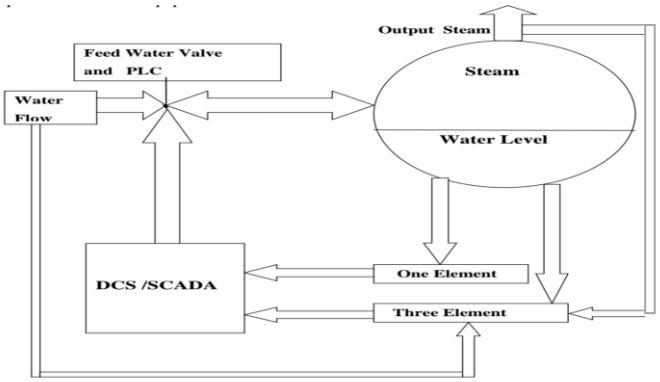


Figure 1: Proposed system block diagram

The proposed system of this paper outlines the various stages of operation involved in the conversion of a manually operated boiler towards a fully automated boiler. Over the years the demand for high quality, greater efficiency and automated machines has increased in this globalized world. The initial phase of the paper focuses on passing the inputs to the boiler at a required temperature, so as to constantly maintain a particular temperature in the boiler. The Air preheater and Economizer helps in this process. And the paper mainly focuses on level, pressure and flow control at the various stages of the boiler plant. Thus the temperature in the boiler is constantly monitored and brought to a constant temperature as required by the power plant. The automation is further enhanced by constant monitoring using SCADA screen which is connected to the PLC by means of communication cable.

A. ONE ELEMENT

One or more boiler feed water pumps push water through one or more feed water control valves into the boiler drum. The water level in the drum is measured with a pressure and temperature-compensated level transmitter. The drum level controller compares the drum level measurement to the set point and modulates the feed water control valves to keep the water level in the drum as close to set point as possible. Variable-speed boiler feed pumps are sometimes used to control the level instead of valves.

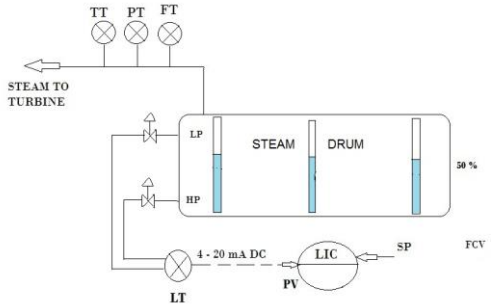


Figure: One Element

B. THREE ELEMENT

Similar to feed flow, changes in steam flow can also cause large deviations in drum level, and could possibly trip the boiler. Changes in steam flow rate are measurable and this measurement can be used to improve water level.

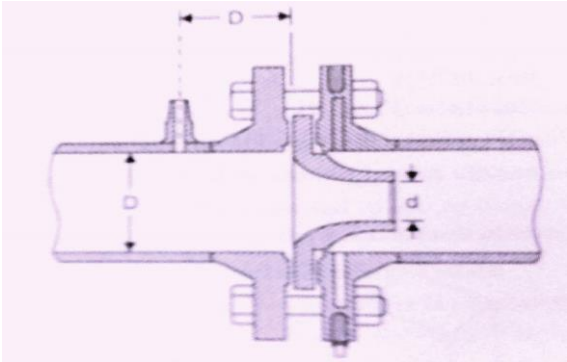
For the feed forward control strategy, steam flow rate is measured and used as the set point of the feed water flow controller. In this way the feed water flow rate is adjusted to match the steam flow. Changes in steam flow rate will almost immediately be counteracted by similar changes in feed water flow rate. To ensure that deviations in drum level are also used for control, the output of the drum level controller is added to the feed forward from steam flow.

C.TEMPERATUIRE SENSOR

Steam Boiler Operation with Outdoor Air Sensor. A steam boiler must heat the water to the boiling point (2120 F) to create steam. The same amount of steam is created whenever a boiler is on. However, the temperature of the space being heated can be adjusted at the radiator or heating unit.

D.FLOW NOZZLE

The flow nozzle is a smooth, convergent section that discharges the flow parallel to the axis of the downstream pipe. The downstream pipe end of a nozzle approximates a short tube and has a diameter of the venacontracta of an orifice of equal capacity. Thus the diameter ratio for a nozzle is smaller or it flow coefficient is larger. Pressure recovery is better than that of an orifice.



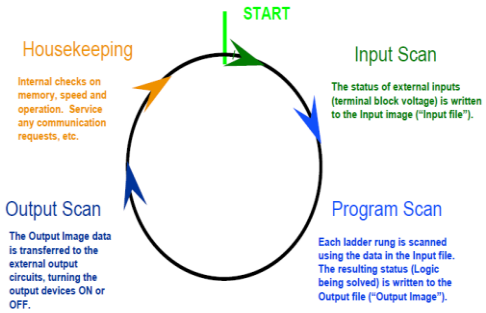
D.DRUM LEVEL TRANSMITTER

The top boiler connection to the transmitter will be filled with condensate. On higher pressure boilers, typically above 1000 psi, a considerable error in level measurement at other than the operating pressures exist when a differential pressure is used to measure level due to water density changes in the drum. Controlling the water level requires sophisticated techniques as the level measurement must be accurate and transmitted to the control system. Combustion of black liquor in the recovery boiler furnace needs to be controlled carefully. high concentration of sulfur requires optimum process conditions to avoid production of sulfur dioxide and reduced sulfur gas emissions. in addition to environmentally clean.

E. PROGRAM LOGIC CONTROLLER

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 programmable logic controller (plc) or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnoses.



II.SOFTWARE SPECIFICATIONS

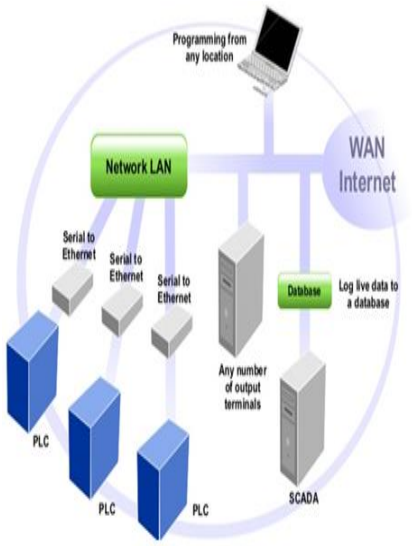
SCADA

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to:

- Control industrial processes locally or at remote locations
- Monitor, gather, and process real-time data
- Directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software
- Record events into a log file In the 1990s and early 2000s, building upon the distributed system model, SCADA ado

Effective SCADA systems can result in significant savings of time and money. Numerous case studies have been published highlighting the benefits and savings of using a modern SCADA software solution such as Ignition.

To understand the origins of SCADA, we must understand the problems industrial organizations are trying to solve. Before the concept of SCADA was introduced in the mid-20th century, many manufacturing floors, industrial plants, and remote sites relied on personnel to manually control and monitor equipment via push buttons and analog dials.



The SCADA station refers to the servers and it is composed of a single PC. The data servers communicate with devices in the field through process controllers like PLCs or RTUs. The PLCs are connected to the data servers either directly or via networks or buses. The SCADA system utilizes a WAN and LAN networks, the WAN and LAN consists of internet protocols used for communication between the master station and devices. The physical equipment's like sensors connected to the PLCs or RTUs. The RTUs convert the sensor signals to digital data and sends digital data to master. According to the master feedback received by the RTU, it applies the electrical signal to relays. Most of the monitoring and control operations are performed by RTUs or PLCs.

In large industrial establishments many process occur simult actually a complex task. The SCADA systems are used to monitor an which include water distribution, oil distribution and power distributio time data and control the large scale remote industrial environment. In for a remote plant operation is take.

The temperature sensors are connected to the microcontroller, which is connected to the PC at the front end and software is loaded on the computer. The data is collected from the temperature sensors. The temperature sensors continuously send the signal to the microcontroller.

SCADA Link Products and Modbus Protocol

Modbus protocol (ASCII and RTU) originally developed by Gould Modicon for their PLC family has become a defect standard in industrial control communications.

A relatively simple protocol, Modbus has been implemented by many manufacturers of instrumentation and control equipment to offer system interoperability. Equipment supporting Modbus protocol variants include PLCs, RTU's, VFD's (Variable Frequency Drives), SCADA Hosts, MMI's, Flow Computers, Power Meters, Power Line Reclosers, Valve Actuators, Intelligent Instruments, and Protocol Converters.

Supported by a wide range of manufacturers, Modbus protocol has been the protocol.

Working Procedure of SCADA System

The SCADA system performs the following functions:

- Data Acquisitions
- Data Communication
- Information/Data presentation
- Monitoring/Control

Data Communication

The SCADA system uses wired network to communicate between user and devices. The real time applications use lot of sensors and components which should be control remotely. The SCADA system uses internet communications. All information is transmitted through internet using specific protocols. Sensor and relays are not able to communicate with the network protocols so RTUs used to communicate sensors and network interface.

Data Acquisitions

Real time system consists of thousands of components and sensors. It is very important to know the status of particular components and sensors. For example, some sensors measure the water flow from the reservoir to water tank and some sensors measure the value pressure as the water is release from the reservoir.

Information/Data presentation

The normal circuit networks have some indicators which can be visible to control but in the real time SCADA system, there are thousands of sensors and alarm which are impossible to be handled simultaneously.

Monitoring/Control

The SCADA system uses different switches to operate each device and displays the status at the control area. Any part of the process can be turned ON/OFF from the control station using these switches. SCADA system is implemented to work automatically without human intervention but at critical situations it is handled by man power.

III. RESULT

In our project we are combined both the strategies of one and three element controlling strategies so for the initial boiler tank can be filled by following the one element strategy. When the boiler has reached the constant feed water level with some considerable amount of water steam the controlling strategy will follows the three element controlling mechanism.

From the conclusion by adapting our project considerable amount of energy
And unwanted use of three element strategy at the initial tank filling stage can be avoided.

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