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# Review on Boiler Control Automation for Sugar Industries

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***Abstract:*** *Controlling boiler is at very typical operation to do, so the automatic controls are setup in steam turbines system within the boilers in power plants. It principally focuses on dominant the speed of the rotary engine by mounting a pulse encoder on the rotary engine shaft. So the boiler parameters within the boiler are perpetually monitored and therefore the steam is generated according to the necessity. The automation will be simply done by PID controller (SCADA). The rotary engine speed will be controlled and monitored. The SCADA is employed to observe the system, PLC (Programmable Logic Controller) is additionally used for the internal storage of instruction for the implementing operation like arithmetic, counting, timing, sequencing and logic to control through digital or analog input/output modules varied styles of machines processes. The water level within the steam drum is maintained by a three part controller. The feed water into the boiler is regulated by the steam flow whereas corrected for abrupt changes in water level. The steam drum diameter incorporates a vital impact on the management. The pressure management the combustion rate by alternating the speed of the fuel feeders. At constant time quantitative relation by adjusting the air provide by the FD fan. it's common observe to watch the oxygen levels within the fuel gas and trim the air to fuel ratio when necessary. The furnace pressure is controlled by alternating the speed of the ID fan. Each a positive and a negative pressure cut back boiler potency. Ideally the pressure ought to be just under gas pressure.*
*In this project, I have been gotten a chance to work with the skilled team of Sunlax Systems and Technologies Pvt. Ltd. Mumbai that provides solutions for industrial automation. Its experience within the field of automation, and know how are setting the standards and its accountable development is anchored during a method of continuous improvement. Sunlax could be a sturdy and vivacious business unit serving the process industries, that embrace water and sewer water applications, Electrical, Cement plant automation, Refining, Oil and gas, Sugar business, Boiler automation, pharmaceutical etc.*

***Key words:*** *boiler automation, ControlLogix, ControlNet, Flex I/Os, DCS based boiler automation, advanced boiler automation, advanced boiler control.*

## 1. Introduction

There has been tremendous increased in the demand of automated machine in industrial sector of power plants and with the greater efficiency and high quality. Continuous monitoring and frequent inspection has to done in power plants. There are possibilities of occurrence of errors while measuring. As microcontroller lack some features and also various stages involved with the human workers. That is what this explains the need of the automation in the industries.

The boiler is the most crucial part of the power plant and to increase the efficiency of automation the precise efforts is been taken. Sugar plants are totally based on boiler system. The very critical operation in any boiler system is to control the level of the water in the drum of the boiler. Nowadays, modern techniques are being used in the industries in place of the conventional techniques. The boiler systems which are multipurpose and which produce the by products such as Heat, Steam and Chemical Gasses etc. are installed in the sugar industry. In many industries the steam generated by the plant instead of going to waste it is used for the generation of electricity generation. Various new methods of controlling the boiler system are installed so that the system works finely.Fig.1 below is the basic structure of boiler. The greater source as input to the sugarcane plant are fuel which is easily available, feed water and the air. The main output of the system is the steam pressure, steam temperature and the flue gasses electrical power and some of the heat loss. Boilers do have much strength which make them the greater feature of the system. They are durable have long life and can with stand with the climatic changes in surroundings, they can achieve the efficiency up to 95% or can go even further. They provide the effective method of heating and in case of system which is based on the steam may require little pumping or no pumping energy.

## 2. Boiler system

The race for better energy efficiency, lower environment load and minimized use of raw materials is on at every production plants. Every Boiler is looking for new ways to boost performance. The answer often lies in advanced automation solution that provides a multitude of tools for many needs.

*Drawback of Conventional System:*

Conventional equipment systems are prone to errors due to involvement of humans in the data collection and processing using complicated mathematical expressions. Thus what we tend to need may be a system that collects information, method it and presents it in values which may be verified and compared with the quality values. Within the cryptography method of this implementation with micro-controller, it needs a quick and economical process that on the opposite half depends on the length and sub-routines of the cryptography method. Therefore it provides a true challenge with system concerned in.

## 3. Methods

All the values can be filled up by the introduction of the automation technique into the boiler. The automation technique involving the automatic control of all the process which includes the monitoring and inspection needs provides for a very efficient system. This could be applied to every process in the plant. The automation process helps the company having the boiler to reduce the amount of the errors that occur, reduction in the human resources, increased efficiency and most important very cost effective. Automation makes it possible to measure, calculate, estimate and monitor the production efficiency, direct cost lifetime costs, emission and all the interdependencies between them. It enables the plant to optimize and control its operations correspondingly. The operators and contractors of new, large sugar / power plants understand well the benefits of automation. But in smaller units, it is not yet clear to every user that a modern automation system gives clear benefits when compared with compared with a Manual system is, for instance, in connection with the modernization of boiler combustion technology or the system controller. While an average industrial power boiler has a lifespan of up to 50 years or more, replacing one can be a costly investment. The natural consequences of associate degree aging are reduced dependableness, exaggerated maintenance value and lower performance. Betting on the age of a specific boiler and its projected remaining helpful life, makers typically have sturdy economic incentives to retrofit system elements to stay the boiler operative at optimum capability and potency. the choice of once and the way to upgrade associate degree existing boiler may be driven by variety of things. Let's say,

How previous is that the boiler and once was it last upgraded?

Is the system meeting desired dependableness and potency goals?

Are major operative elements changing into expensive to take care of or replace?

Is there a requirement to exchange the burners to accommodate a special sort of fuel?

Are there associate degree close restrictive changes on the horizon that will need an update in operative or management specification?

A good beginning purpose is examination of the boiler's operation and maintenance prices.

Are period or labor prices overly high?

Are replacement elements changing into too overpriced or troublesome to find?

Many time these value are hidden among your overall maintenance budget. Obviously, it doesn't add up to stay investment in associate degree superannuated unit once a discount within the in progress operation and maintenance value can justify a brand new or well upgraded unit.

Another variable which will issue into the upgrade equation is fuel value. let's say, if your existing unit is meant to fireside inferior heating oil, you will wish to gauge a higher-performing, additional cost-effective fuel different. During this case, subsequent step would be to look at the conversion value, alongside operation, maintenance and potency projections to envision if it is smart to contemplate exchange the prevailing burner to accommodate a special fuel supply.

### 3.1. Drum Level Control

The main aim of the drum level controller is to maintain the level at the boiler startup and at constant steam load. Decrease in the level damages tubes due to overheating. Increase in the level may disturb the process of separating moisture from steam present in the drum, and thus reducing the boiler efficiency.

- Function control module are
- Operator adjust the setpoint of boiler
- Shrink and swell effects
- Automatic drum control
- Feed water valve controlled manually
- Easy transfer between auto and manual mode
- Drum level and steam flow indication
- Indication of feed water valve and flow
- Deviation alarms for drum level

*Level Element & Steam Flow Element:* This is to correct the unvalued unwanted interruption present within the system like Boiler blow down , Boiler and super heater tube leaks.

*Feed water Flow element:* This is quick in response and rapidly to the difference feed water requirement From either steam flow rate feed water signal or the feed water pressure or the flow fluctuations

If we want to achieve the optimum control over both steam feed water flow it is necessary to correct the values for density.

The three element system provides compact control for the drum level with unsteady steam load.

*Enhanced three element drum level control:* The three element system is used only when there is demand of high steam. The two element system is used only when there is a failure in the measurement of steam flow and the single element system is used when there is need of low steam.

The drum level will be derived from up to three freelance transmitters and is density remunerated for pressure among the boiler drum.

This is the process which removes the oxygen form water and the other gases like carbon dioxide and other non condensable gases from feed water and by doing this is the reducing of the corrosion in the parts of the boiler and equipment longevity and safety of operation.

Deaerations are of two type viz. Mechanical deaeration and chemical Deaeration. The Henry's Law of physics that works in the Mechanical deaeration .In Deaeration before feeding water to the boiler the dissolved gasses in the water is removed .usually the oxygen and the carbon dioxide are present in the water which is natural and those gases are of more concern to the steam plant operation. The gasses present in the untreated water oxygen and carbon dioxide cause the steam plant material to corrode. And the rate of corrosion is directly proportional to the amount of gasses present in the water and as the heat increase any reactions multiply and accelerate the rate of the reaction.

## 4. Upgrading controls

Due to the quality and importance of economical boiler operation, one variety of update that sometimes pays high dividends may be a system upgrade. Today's advanced boiler automation and combustion system square measure capable of reducing price whereas providing resources for larger flexibility within the plant management and management. Boiler steam masses square measure invariably unsteady and today's subtle system will mechanically observe changes and answer conditions quicker and a lot of accurately than operated by hand devices.

Boiler potency, within the simplest terms, represents the distinction between the energy input and energy output. to attain optimum potency, operators usually try and run boilers at more or less eighty p.c. load. In application with multiple boilers and variable masses, achieving the foremost economical combination of boilers might mean sometimes motility down some to permit others to work at a harder firing rate. One effective strategy in periods of sunshine production demands is to possess your less economical boilers operate in standby mode and interact a lot of economical boilers to satisfy the load necessities. This will be accomplished by programming the boilers system to mechanically manage the required boilers reverse sequence. The controls should be properly adjusted and coordinated for continues delivery of steam or quandary to those dynamics processes. This includes on-line operation moreover as management and observance of burner start-up and ending sequences. Boilers control methods can improve operational consistency and reliability and protect against damage to combustion process equipment and surroundings areas due to other undesirable events. Following are some advance control techniques.

Minimize excess air – economical operation of any combustion equipments is very enthusiastic about a correct air-to-fuel magnitude relation. the quantity of turn fuel and excess air within the exhaust is a sign of a burner's combustion potency and needs energy to heat and move excess air. In actual operation, boilers and different fuel burning systems don't do an ideal job of blending the fuel and air, even below the most effective potential condition.

Regular of stack gas oxygen content can indicate what quantity excess air (O2) is accessible within the stack gas once the fuel/air combustion. High levels of O2 within the stack gas are corrected by incorporating as excess air trim loop into the boiler controls. A stack gas oxygen instrument is put in to ceaselessly monitor excess air and change the boiler fuel-to-air magnitude relation for optimum potency. The reduction of excess air within the boiler combustion method provides a far better heat-transfer rate, advanced warning of potential flue gas issues and considerably lower fuel prices. By reduction the quantity of air inquiring the combustion chamber, the boiler is in a position to soak up additional of the warmth within the method. Since the proportion of oxygen in exhaust stack is closely concerning the quantity excess air, by adding oxygen trim controls, operators have tighter management over flue gas emission, additional precise management of excess air to oxygen point, and quicker come to line purpose following disturbances.

Plants that use a jackshaft (single purpose positioning), parallel positioning or different automatically coupled system will gain important blessings by changing to a cross-limiting, absolutely metered combustion management strategy. This management methodology helps improve safety by minimizing the possibility of a dangerous ration air and fuel inside a combustion method. this can be enforced by perpetually raising the air flow before permitting the air flow to drop. Cross-limiting combustion management is very effective and might simply provide: higher improvement of

fuel consumption, safer operative condition by reducing the chance of explosion; quicker combustion characterization setup; improved cosmology and troubleshooting; and higher method visibility. Combining firing of multiple fuels at the same time may also be simply accomplished inside this sort of system.

### 4.1 Critical Parameters

*Level Control:*

Stem Drum level

De-aerator level

Hot well level

*Pressure Control:*

Force draft pressure

Induced draft pressure

Steam Drum pressure

De-aerator pressure

Turbine inlet steam pressure

Balanced draft pressure

*Flow Control:*

Air flow

Steam flow

Water flow

*Temperature Control:*

De-aerator temperature

Steam drum temperature

Under-bed boiler temperature

Turbine inlet steam temperature

Flue gas temperature

## 5. Efficient process operation:

In today's economic environment, power operation must be cost-effective and undisturbed. Every plants aims for top performance and higher availability. However, this is possible only if you know your plant efficiency at all times and rate able to react to problems immediately. Today, there are numerous automation applications that assist in all areas of power plant operation, from management to production and maintenance.

Plant Management Application provide the plant with modern tools for optimization and automation plant reporting routines, for improving performance and availability, as well as for maximizing revenues and minimizing production costs.

One of them is that the solid fuel management application that integrates method information from the D.C.S. load information from the deliberation system and fuel quality laboratory analysis. It mechanically reports fuel amounts, prices and energy use. Reliable and seamless management of the solid fuel information is that the basis for quality observation and economical reportage of fuels, as well as for follow from the plant performance.

An up-to-date performance watching application calculates stores and displays the most performance applied to boilers, steam turbines, gas turbines, HRSGs, pumps and fans, flue gas desulphurization plants, heat exchangers, and more.

Energy management controls also play a major role in every Production plant; it is important to be able to balance between different energy forms in real time and its usage throughout plant. There are many ways to lose energy through reduced energy efficiently, due to lack of coordination in the plant's energy production, and many more. Energy management controls for production plants include an optimal coordination of boilers and turbines in order to minimize production costs while maintaining environment compliance.

### 5.1 Energy management Solution

Energy Management System (EMS) is a suite of energy management software tools used to monitor, and optimize the performance of systems. This intelligent energy management software control system is designed to reduce energy consumption, improve the utilization of the system, increase reliability, predict electrical system performance, and as well as optimize energy usage to reduce cost. (EMS) Energy Management System applications use real-time data such as frequency, actual generation, tie-line loads flows, and plants units' controller status to provide system changes.

There square measure several objectives of associate degree energy management code, as well as associate degree application to keep up the frequency of an influence Distribution System and to keeping tie-line power on the brink of the regular values. In Energy Management System, schedule values are maintained by adjusting the MW outputs of the AGC generators therefore on accommodate unsteady hundreds demands. The energy management code application will calculate the specified parameters to optimize the operation of the generation units below energy management action.

### 5.2 Environmental Reporting the easy way

As well power plant operators know, the EU directives on environment performance will tighten in the future and palace more demands on emission monitoring. However, with the help of modern automation, this will not be a problem. Online emission management application, such as Emission Monitoring and Reporting Solutions, provide production plants with real time information about current emission levels and limit excesses, and forecast the flue gas emission, making it possible to react proactively to potential problems on time.

The solutions fulfill the requirements of the EU directives for large combustion plants and waste incineration, thus also enabling effective authority reporting.

### 5.3 Better performance through optimization

Getting the foremost out of warmth and/ or electricity production over the whole plants cycle is actually on the terribly high of each power producer's priority list. It's potential by putting in advanced method management applications.

Stable and economical combustion may be a primary demand for winning boiler operation. Variable combustion condition and fuel quality along with ever-changing hundreds upset combustion. As a result, boiler potency decreases, and flue gas emission additionally as flue gas oxygen content increase. By optimizing combustion \, it's potential to manage the combustion method against variations in production, fuel quantity & quality and combustion circumstances. It stabilizes the combustion method, improves boiler potency additionally as minimizes flue gas chemical element content, Nor emissions and greenhouse emission emissions.

Another challenge at plants is usually the way to specifically live the standard and quantity of solid fuel fed to the boiler. Typically, solely the conveyor speed is employed as a measure for fuel power. A Fuel Power Compensator application with that it's attainable to compensate the disturbances within the fuel enclose order to stabilize combustion and steam production. it's used on the fuel enclose order to stabilize combustion and steam production. it's supported the estimation of the fuel power (fuel energy input to the boiler). quick and correct estimation is created with a mixture of boiler balance calculations and element consumption calculation.

### 5.4 Perfect match:|| Automation and Equipment ||

Working plant automation builds on advanced solutions that every one link along dead. however to confirm the foremost economical overall plant performance, automation should be well-integrated into the plant instrumentation. an ideal match brings the most effective results.

Whether you are buildings a Greenfield plant or modernizing an existing one, it is always a major project with lots of equipment suppliers – who are perhaps not able to see the big picture. The main automation system in BOILER Automation covers the whole process, including the boiler islands, turbine islands, balance of plant, fuel handling and auxiliary processes. A huge advantage for the plant is if there is one source that can offer a complete delivery from handling to the tip of the smokestack.

*A Various parameters Indication systems for better performance of Boilers*

1. Feed Water Temperature Indicator
2. Steam Temperature Indicator
3. Flue Gas Temperature Indicator
4. Furnace Temperature Indicator
5. Temperature Indicator for Air Heater Inlet and Outlet
6. Temperature Indicator for Economizer Inlet and Outlet
7. Main Steam Pressure Indicator
8. Draught Indicator
9. PH. Indicator for Feed water
10. TDS Indicator for Feed water
11. Co2 Analyzer fro the Stack Monitoring
12. O2 Analyzer for Stack Monitoring
13. Feed Water Flow Meter
14. Vibration Indication for Feed Pump/I.D./F.D. Fan Motors

*B Various DCS Base Control System for Safety and Fine Operation of Boilers*

1. Three Element Boiler Drum Level Control System
2. Combustion Control System
3. De-aerator Level and Pressure Control System
4. Attempter Temperature Control Systems
5. Auto Blow down Control System
6. H.P. Heater Level Control Systems

*C Alarm and Annunciation System for Various Parameters*

1. Temperature
2. Pressure
3. Level
4. Feed Pump ON/OFF Condition
5. Co2 and O2 Levels
6. TDS /PH / Silica Levels

## 6. And the Future?

Automation nowadays is taking part in a serious role altogether Production plant's operation. However so much can the events go? What might the automation level be, let's say in 2050?

"I assume there'll show discrepancy varieties of inexperienced or greener energy offer processes connected to the common district heating/cooling networks and nationals grids. they're going to be controlled optimally and operated and remotely with advanced automation solutions."

"The power plants can run with biomass, solar power, process heat, biogas, waste-to-energy, wind, heat pumps, fossil fuel, energy storages, chemical process or coal with carbon capture. Automation's role is to require care of the optimum power and warmth production supported capabilities and prices."

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## OUTPUT

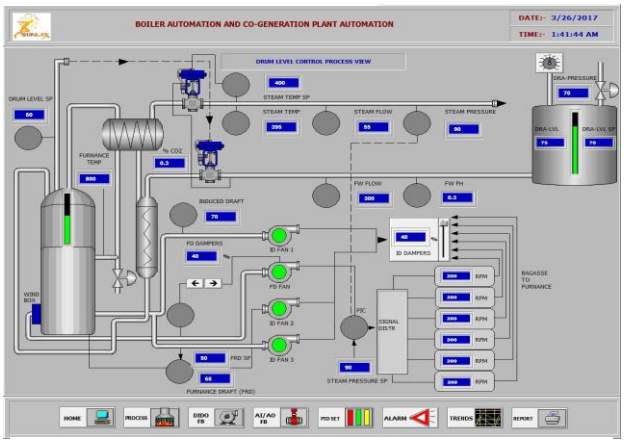


Figure 1-Process of system

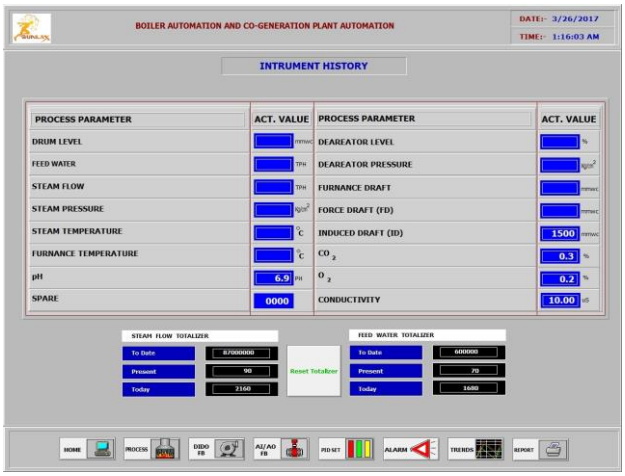


Figure 2-Analog input Analog output

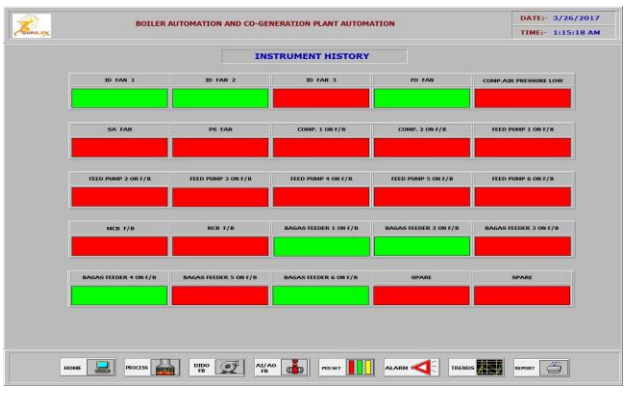


Figure 3-Digital input Digital output

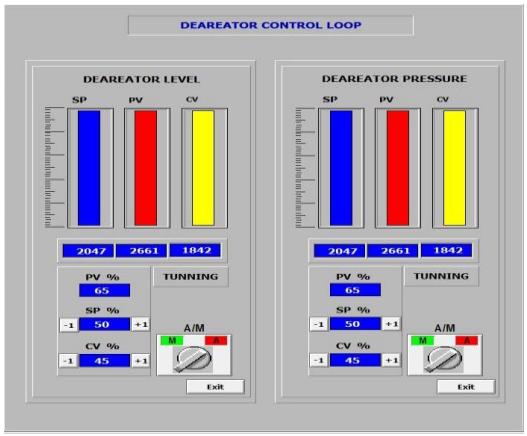


Figure 4-Deaerator control loop

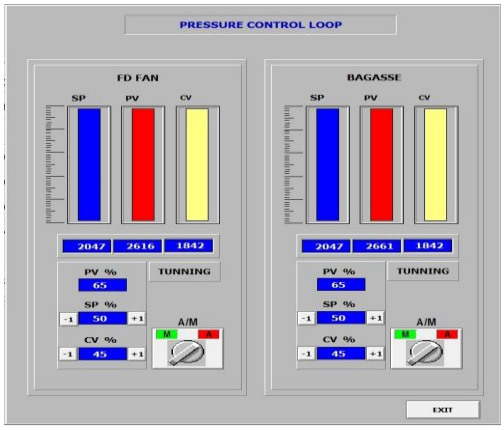


Figure 5-Pressure control loop

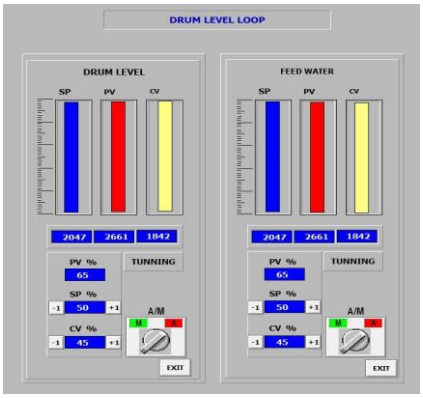


Figure 6-Drum level loop

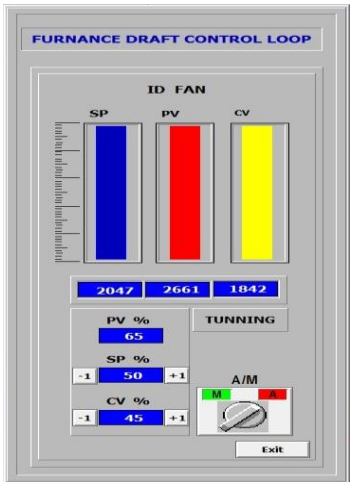


Figure 6-Furnace draft control loop


Figure 8-Alarm


Figure 9-Hist. Trends

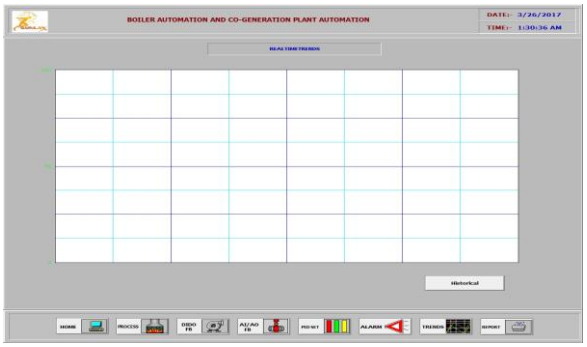


Figure 9-Real Time Trends