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Design and Manufacture of Auto-Control Boiler Panel (ACBP)

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Abstract - A Boiler Control Panel is used to operate the electrical parts of Boiler related mechanical equipments like Feed pumps, Draft Fan, etc., This projectexplains the Auto control of Electrical part of Boiler with suitable electrical and Mechanical interlocks. Switch gear selection as per equipment rating to operate automatically.By using the auto controlled Control Panel The boiler water level controls consisted of magnetic float switches set to switch the feed water pump ON and OFF at pre-determined levels. This causes the boiler water level to fluctuate dramatically, affecting the plants ability to produce steam. Each time the feed water pump switches on; cold water is pumped into the boiler causing thermal shock. To compensate for the cool water, the burner must now ramp up to high fire, increasing the thermal loading on the boiler and forever chasing its tale as the cycle repeats itself.

A variable speed drive allows the rpm of the fan motor to be reduced as the burners firing rate Decreases. Electrical savings of 60 and 75% can be achieved. Additional benefits are reduced wear and tear on the motor, reduced electrical loading on the plant on start-upand a huge reduction in noise levels at low fire.

The intelligence of the microprocessor also monitors the wave signature of the boiler, recognizes foaming at peak steam draw, monitors water temperature in, steam temperate and pressure out, and by means of calculation using the heat input of the burner also displays steam production.
The result is a higher quality of constant steam as the process requires it.

Microprocessor Based Alarm Annunciator placed to keep an alert and watchful eye on boiler processes of operation. This task is done by providing indication and Hooter sound under high temperature, pressure conditions.

1. The boiler efficiency is tended to increase approximately 10%, with the proper utilization of automated control system.
2. Energy shall be saved, comparing to manually operated boiler systems.
3. More results are awaited.

1. INTRODUCTION:

A **boiler** is an enclosed vessel that provides a means for combustion heat to be transferred into water until it becomes heated water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process. Water is a useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with utmost care.The process of heating a liquid until it reaches its gaseous state is called evaporation. Heat is transferred from one body to another by means of (1) radiation, which is the transfer of heat from a hot body to a cold body without a conveying medium, (2) convection, the transfer of heat by a conveying medium, such as air or water and (3) conduction, transfer of heat by actual physical contact, molecule to molecule.

1.1 Boiler Specification

The heating surface is any part of the boiler metal that has hot gases of combustion on one side and water on the other. Any part of the boiler metal that actually contributes to making steam is heating surface. The amount of heating surface of a boiler is expressed in square meters. The larger the heating surface a boiler has, the more efficient it becomes. The quantity of the steam produced is indicated in tons of water evaporated to steam per hour. Maximum continuous rating is the hourly evaporation that can be maintained for 24 hours. F & A means the amount of steam generated from water

1.2 Boiler Systems

The boiler system comprises of: feed water system, steam system and fuel system. The **feed water system** provides water to the boiler and regulates it automatically to meet the steam demand. Various valves provide access for maintenance and repair. The **steam system** collects and controls the steam produced in the boiler. Steam is directed through a piping system to the point of use. Throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges. The **fuel system** includes all equipment used to provide fuel to generate the necessary heat. The equipment required in the fuel system depends on the type of fuel used in the system. A typical boiler room schematic is shown in Figure 2.1

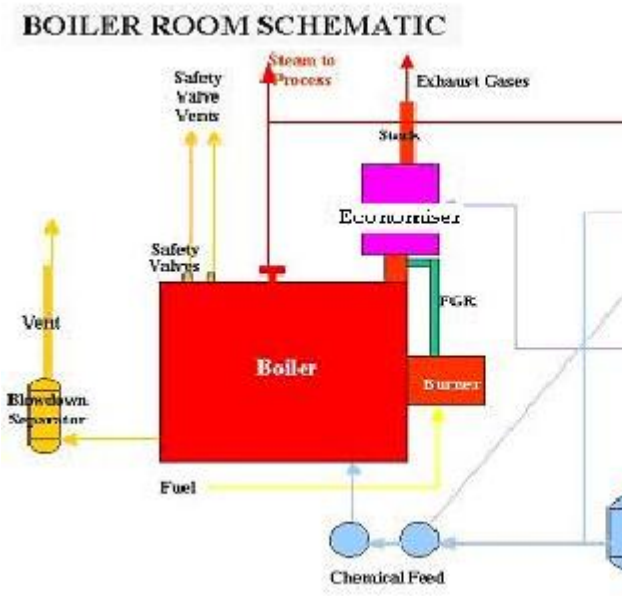


Fig:1. Boiler room schematic

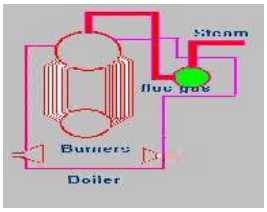
The water supplied to the boiler that is converted into steam is called **feed water**. The two sources of feed water are:

(1) **Condensate** or condensed steam returned from the processes and

(2) **Makeup water** (treated raw water) which must come from outside the boiler room and plant processes. For higher boiler efficiencies, the feed water is preheated by economizer, using the waste heat in the flue gas.

1.3. Boiler Types and Classifications

There are virtually infinite numbers of boiler designs but generally they fit into one of two categories:



1.3.1 Fire tube or "fire in tube" boilers; contain long steel tubes through which the hot gasses from a furnace pass and around which the water to be converted to steam circulates. (Refer Figure 2.2). Fire tube boilers, typically have a lower initial cost, are more fuel efficient and easier to operate, but they are limited generally to capacities of 25 tons/hr and pressures of 17.5 kg/cm^2.

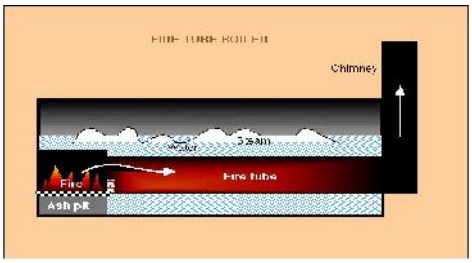


Fig: 2 . Fire Tube Boiler

1.3.2 Water tube or "water in tube" boilers in which the conditions are reversed with the water passing through the tubes and the hot gasses passing outside the tubes (see figure 2.3). These boilers can be of single- or multiple-

drum type. These boilers can be built to any steam capacities and pressures, and have higher efficiencies than fire tube boilers.

1.3.3. Packaged Boiler:

The packaged boiler is so called because it comes as a complete package. Once delivered to site, it requires only the steam, water pipe work, fuel supply and electrical connections to be made for it to become operational. Package boilers are generally of shell type with fire tube design so as to achieve high heat transfer rates by both radiation and convection (Refer Figure 4).

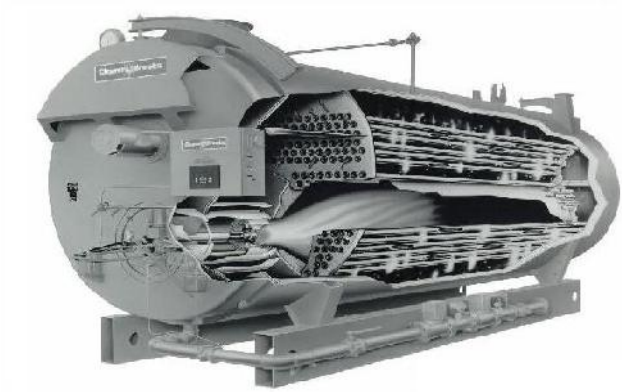


Fig : 4.Packaged Boiler

The features of package boilers are:

- Small combustion space and high heat release rate resulting in faster evaporation.
- Large number of small diameter tubes leading to good convective heat transfer.
- Forced or induced draft systems resulting in good combustion efficiency.
- Number of passes resulting in better overall heat transfer.
- Higher thermal efficiency levels compared with other boilers.

These boilers are classified based on the number of passes - the number of times the hot combustion gases pass through the boiler. The combustion chamber is taken, as the first pass after which there may be one, two or three sets of fire-tubes. The most common boiler of this class is a three -pass unit with two sets of fire-tubes and with the exhaust gases exiting through the rear of the boiler.

1.3.4. Stoker Fired Boiler:

Stokers are classified according to the method of feeding fuel to the furnace and by the type

of grate. The main classifications are:**1.3.4.1 Chain-Grate or Traveling-Grate Stoker Boiler**

Coal is fed onto one end of a moving steel chain grate. As grate moves along the length of the furnace, the coal burns before dropping off at the end as ash. Some degree of skill is required, particularly when setting up the grate, air dampers and baffles, to ensure clean combustion leaving minimum of unburnt carbon in the ash

The coal -feed hopper runs along the entire coal-feed end of the furnace. A coal grate is used to

control the rate at which coal is fed into the furnace, and to control the thickness of the coal

furnace, and to control the thickness of the coal bed and speed of the grate. Coal must be uniform in size, as large lumps will not burn out completely by the time they reach the end of the grate. As the bed thickness decreases from coal -feed end to rear end, different amounts of air are required- more quantity at coal-feed end and less at rear end (see Figure 5).

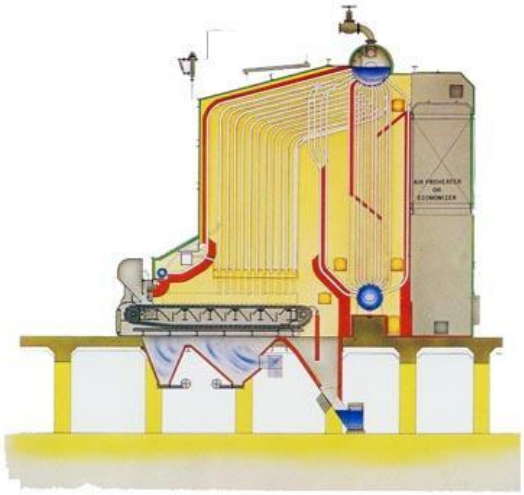


Fig:5. Chain-Grate or Traveling-Grate Stoker Boiler

1.3. 4.2.Spreader Stoker Boiler

Spreader stokers utilize a combination of suspension

burning and grate burning. The coal is continually fed into the furnace above a burning bed of coal. The coal fines are burned in suspension; the larger particles fall to the grate, where they are burned in a thin, fast-burning coal bed. This method of firing provides good flexibility to meet load fluctuations, since ignition is almost instantaneous when firing rate is increased. Hence, the spreader stoker is favored over other types of stokers in many industrial applications.

1.3.5. Pulverized Fuel Boiler

Most coal-fired power station boilers use pulverized coal, and many of the larger industrial water-tube boilers also use this pulverized fuel. This technology is well developed, and there are thousands of units around the world, accounting for well over 90% of coal-fired capacity.

The coal is ground (pulverised) to a fine powder, so that less than 2% is +300 micro metre (µm) and 70-75% is below 75 microns, for a bituminous coal. It should be noted that too fine a powder is wasteful of grinding mill power. On the other hand, too coarse a powder does not burn completely in the combustion chamber and results in higher unburnt losses.

The pulverised coal is blown with part of the combustion air into the boiler plant through a series of burner nozzles. Secondary and tertiary air may also be added. Combustion takes place at temperatures from 1300- 1700°C, depending largely on coal grade. Particle residence time in the boiler is typically 2 to 5 seconds, and the particles must be small enough for complete combustion to have taken place during this time.
receives a trip command for the following conditions or if boiler trip push button provided in the panel is depressed.

a. FD fan trip / shut down
b. ID fan trip / shut down
c. Cogeneration turbine trip
d. Drum level low / high trip

While selecting the various elements for the instrumentation care should be taken to select the correct range. A well engineered system / configuration plays a major role in the availability of the instruments. Staffing of the sugar plant maintenance crew with trained and qualified instrument mechanics is essential for calibration and maintenance of the equipment.

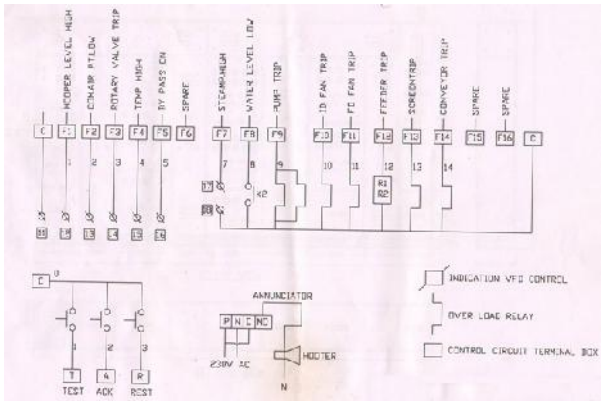
4.2.Alarms

There is a number of variables that must be monitored in a boiler system for safety reasons as well as to ensure acceptable operation. In the event that these values violate their respective conditions, an alarm should be signaled.
In this system an alarm is raised on the event that the O2 level falls outside a predetermined interval. An alarm should also be raised in case the pressure in the steam dome exceeds a specified limit. Finally a level sensor in the fuel hopper raises an alarm in the event that the fuel level is dangerously low.

4.3 Annunciator:

The annunciator will give the Indication of dangerous conditions of the boiler they are:

1. Hooper level high
2. Combustion air PT Low
3. Rotary Valve Trip
4. Temp High
5. By pass On
6. Steam Pressure High
7. Water Level Low
8. Pump Trip
9. ID Fan Trip
10. FD Fan Trip
11. Feeder Trip
12. Screen Trip
13. Conveyor Trip



With the above indications a boiler operator can easily operate the boiler in a safety and economic conditions.

5. Conclusion:

The goal of this thesis has been to investigate various techniques that improve the efficiency of boiler systems. Improvements in these boiler systems takes different forms, such as reducing the operational and maintenance costs, reduce the fuel consumption or reducing the emission of polluting gases to the environment. To get started on the thesis, an extensive study was reformed on the technical background associated with boiler systems. This was followed by an empirical study with the purpose of establishing the techniques that have been developed and tested through the years to improve boiler systems. To find out which of these techniques have been found effective and economically viable for practical use, a case study of four establishments was performed.

The case studies revealed that the economical viability of the various control techniques was in fact somewhat dependent on the size of the boiler system

The choice of which techniques covered in this thesis are best suited for implementation in a boiler control system is dependent on several parameters, such as boiler size, fuel type and implementation cost. The largest factor is the size of the system to be controlled, since it affects the other parameters as well.

5.1. Results :

1. The boiler efficiency is increased up to 8 %
2. The Energy consumption per month as reduced to 20 %.
3. Operation and Maintained became easier to operators / Technicians.

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