INTRODUCTION

Instrumentation and controls in a boiler plant encompass an enormous range of equipment from simple industrial plant to the complex in the large utility station.

The boiler control system is the means by which the balance of energy & mass into and out of the boiler are achieved. Inputs are fuel, combustion air, atomizing air or steam &feed water. Of these, fuel is the major energy input. Combustion air is the major mass input, outputs are steam, flue gas, blowdown, radiation & soot blowing.

CONTROL LOOPS

Boiler control systems contain several variable with interaction occurring among the control loops for fuel, combustion air, & feedwater . The overall system generally can be treated as a series of basic control loops connected together. for safety purposes, fuel addition should be limited by the amount of combustion air and it may need minimum limiting for flame stability.

Combustion controls

Amounts of fuel and air must be carefully regulated to keep excess air within close tolerances-especially over the loads. This is critical to efficient boiler operation no matter what the unit size, type of fuel fired or control system used.

Feedwater control

Industrial boilers are subject to wide load variations and require quick responding control to maintain constant drum level. Multiple element feed water control can help faster and more accurate control response.

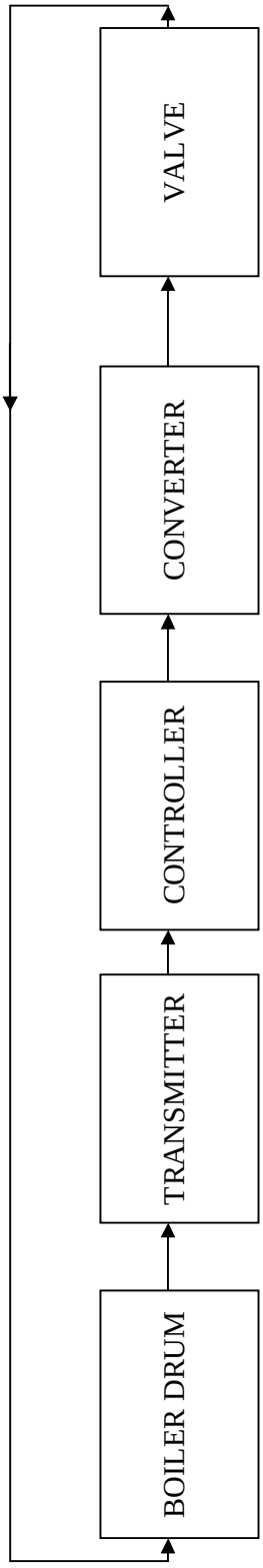


FIG. 1. GENERAL BLCOK DIAGRAM OF BOILER DRUM

BLOCK DIAGRAM DESCRIPTION

The block diagram of boiler control is shown in figure 1.the output from the boiler ie, the steam outputs and the level of water is given to transmitters. The output of transmitter is given to the controller which act as level indicator controller and flow indicator controller. If there is any error corresponding to desired set point, the signal from controller is given to the converter which will open or close the valve and the water will be drained out or filled according to required steam.

The major loops in boiler control are

1) Combustion control
2) Feedwater control

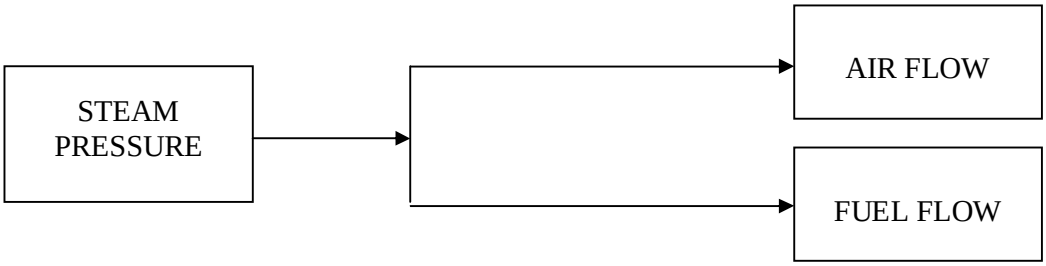
COMBUSTION CONTROL

A combustion control system is broken down into (a) fuel control and (b) combustion air control subsystems. The interrelationship between these two subsystems necessitate the use of fuel air ration controls.

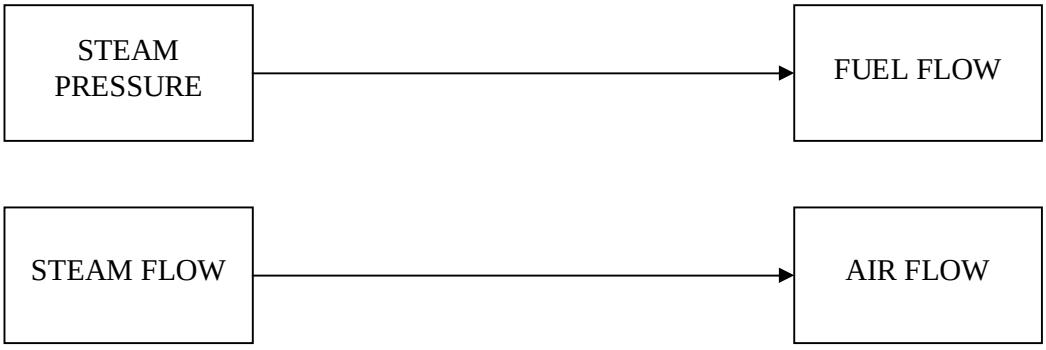
The primary boiler fuels are coal, oil and gas. The control of gas and oil fuels requires simplest controls- ie, a control valve in the fuel line.

The steam drum pressure is an indication of balance between the inflow and outflow of heat. Therefore by controlling the steam supply one can establish balance between the demand for steam (process load) and supply of water.

(a) Series



(b) Parallel



(C) Series Parallel

FIG. 2. COMBUSTION CONTROLS

DIFFERENT TYPES OF COMBUSTION CONTROLS

There are three general types of combustion control schemes used today: They are series, parallel & series-parallel controls.

In series control, variations in steam header pressure(the master control signal) cause a change in combustion air flow which in turn results in a sequential change in fuel flow. This type of control is limited to small boilers having relatively constant steam load & burning fuel.

In parallel control, variation in steam pressure simultaneously adjusts both fuel & air flows. This method is common to any size boilers.

In series-parallel, variation in steam pressure set points are used to adjust the fuel. Flow to the above boiler since steam flow is directly related to heat release of the fuel and hence the air flow, the steam flow can be used as an index of the required combustion air.

HARDWARES USED IN COMBUSTION CONTROL

The control hardware used to carryout the above schemes include ON/OFF controls, positioning & metering systems.

(a) ON/OFF controls:

Are still used in many industries but are generally used in small water tube boilers. When the pressure drops to a present value, fuel & air are automatically fed into the boiler at predetermined rate until pressure has risen to its upper limit.

(b) Positioning systems:

Respond to changes in header pressure by simultaneously positioning the forced draft damper and fuel valve to a predetermined alignment. This is not used in liquid , gaseous fuel – fired boilers.

(c) Metering control system:

In this system control is regulated in accordance with the measured fuel and air flows. This maintains combustion efficiency over a wide load ranges & over long period of time.

Both metering & positioning control systems use steam header pressure as their primary measured variable & as a basis for firing rate demand. A master pressure controller responds to changes on header pressure & positions the dampers to control air flow and fuel valve to regulate fuel supply.

FEEDWATER CONTROL

Feedwater control is the regulation of water to the boiler drum. It provide a mass accounting system for steam leading and feedwater entering the boiler. The water is admitted to the steam drum and after absorbing the heat from furnace generates the steam produced by the boiler.

Proper boiler operation requires that the level of water in the steam drum should be maintained within certain band. A decrease in this level may uncover boiler tubes, allowing them to become overheated. An increase in the level of water may interfere with the internal operation of internal devices in the boiler drum. It is important to made that the water level in the boiler drum must be above 50% all the time.

The water level in the boiler drum is related to, but is not a direct indicator of , the quantity of water in the drum. At each boiler load, there is different volume in the water that is occupied by steam bubbles. So if load is increased there are more steam bubbles and this cause water to ‘swell’ or rise, rather than fall because of added water usage.

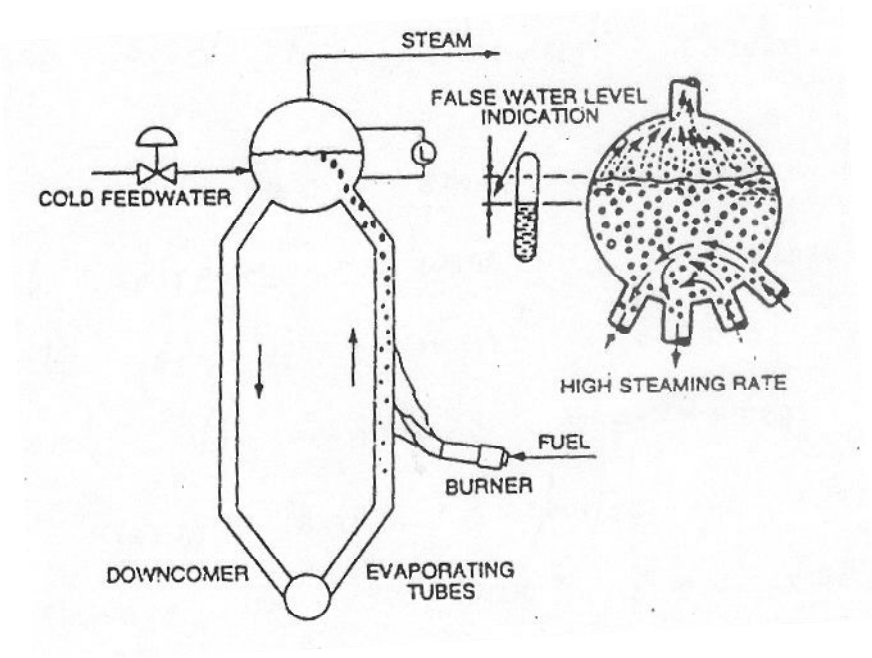


FIG 3. PARTIAL VAPORISATION IN EVAPORATING TUBES

As system for feedwater control must be designed to maintain the mass balance over expected boiler load changes so that the level in the steam drum remains within the required limits for safe and efficient operation. Control system complexity is based on number of measured variables used to initiate control action and include single element ,two element,3 – element and advanced control schemes to improve accuracy of final control action.

SINGLE AND TWO ELEMENT CONTROL SYSTEMS

For small boilers having relatively high storage volumes and slow changing loads ,single element control system is used. It controls feed water flow based on drum level. Response is very slow because a change in feedwater flow takes a long time to show up the level change. As a result the steam drum causes water to increase and decrease in volume, resulting in false measurements.

The two element system overcome these inadequacies by using steam flow changes as a feed forward signal. This control is used in intermediate boilers as well as large boilers. Here the flow and level transmitters are summed by a computing relay and will be the set point for feedwater. Here the response is faster.

THREE ELEMENT CONTROL

Boilers that experiences wide and rapid load changes require three element control. Three element control is similar to two element system except that the water flow loop is closed rather than open.

Control action, the third element based on feedwater flow. The level and steam flow signals are summed and used as an index or set point to the feedwater flow. The feedwater flow measurement provides corrective action for variation in feedwater pressure.

THREE ELEMENT CONTROL

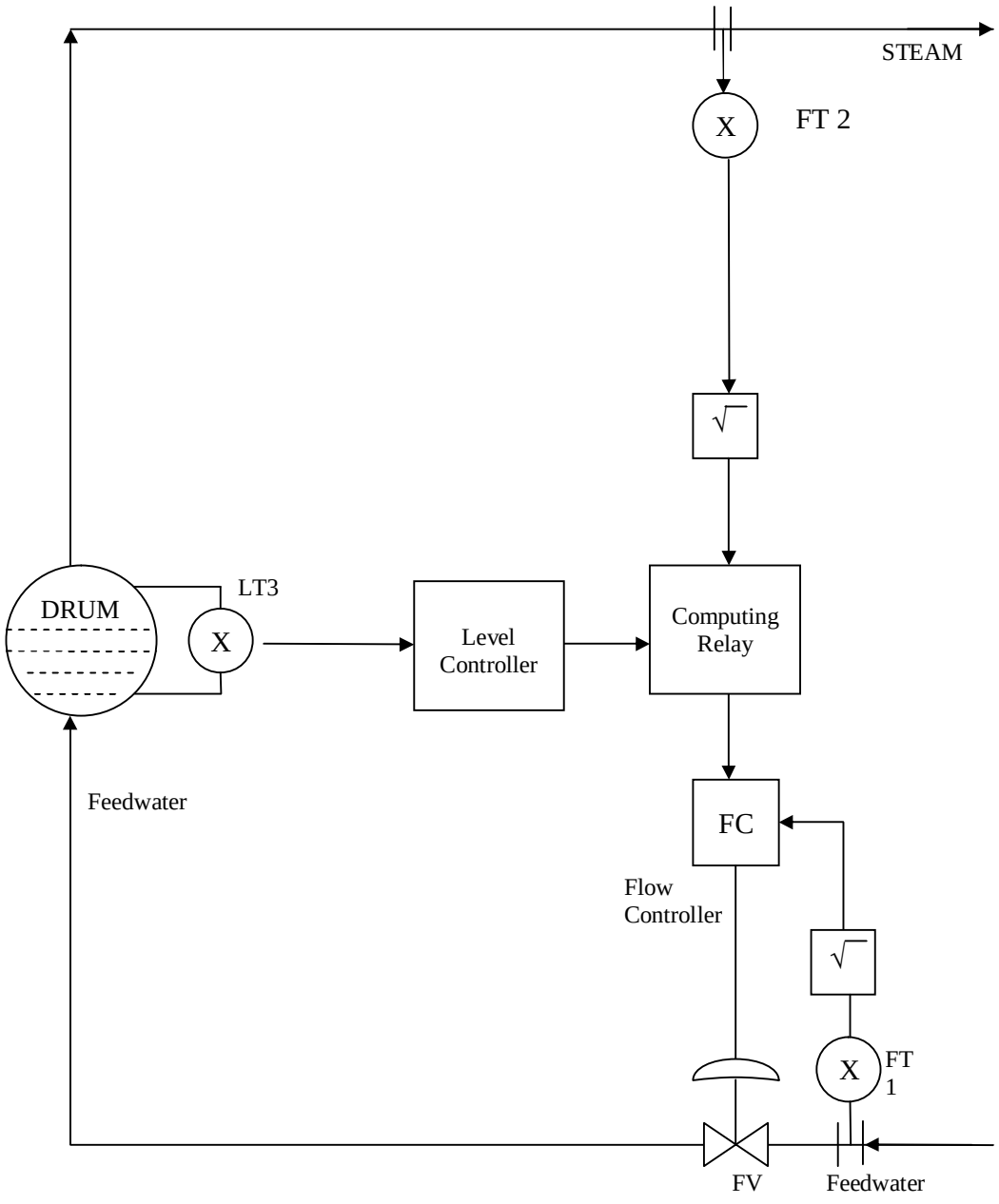


FIG. 4 THREE ELEMENT BOILER CONTROL

FIVE ELEMENT CONTROL

Additional elements can be added to a feedwater control system to improve response accuracy. A five element feedwater control system is essentially a three element configuration in which the steam flow measurement is temperature compensated and drum level measurement is pressure compensated.

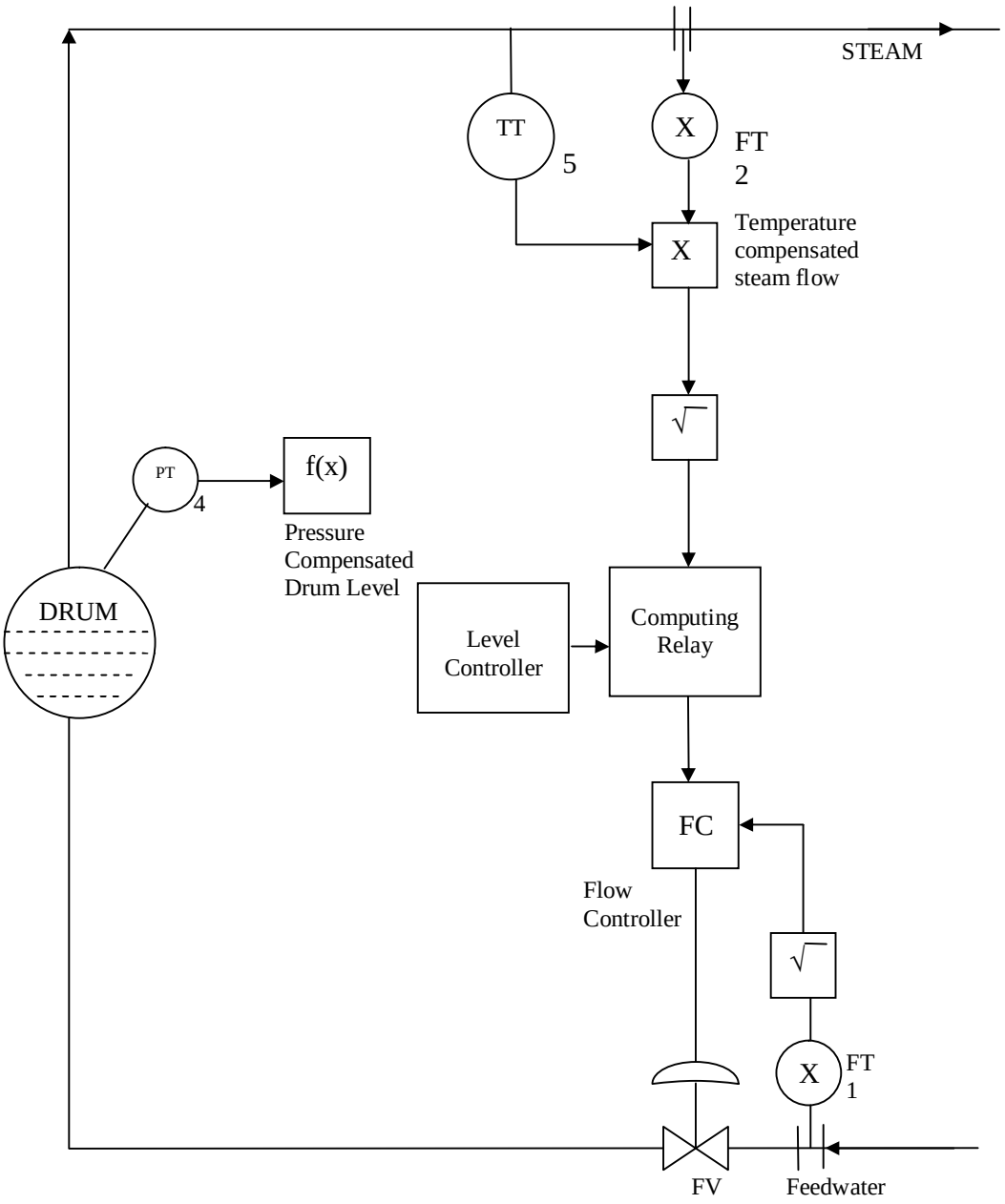


FIG. 5 FIVE ELEMENT BOILER CONTROL

SEVEN ELEMENT CONTROL

Transmitters for blow down flow and sootblower flow could be added to five element control to make up seven element feedwater control.

Types of steam

Here we are using two types of steam i.e, saturated steam and super heated steam. Steam obtained while heating is called saturated steam. It is called wet steam since moisture content is also present. Super heated steam is obtained when saturated steam is further heated above 220 degrees. It is also called dry steam.

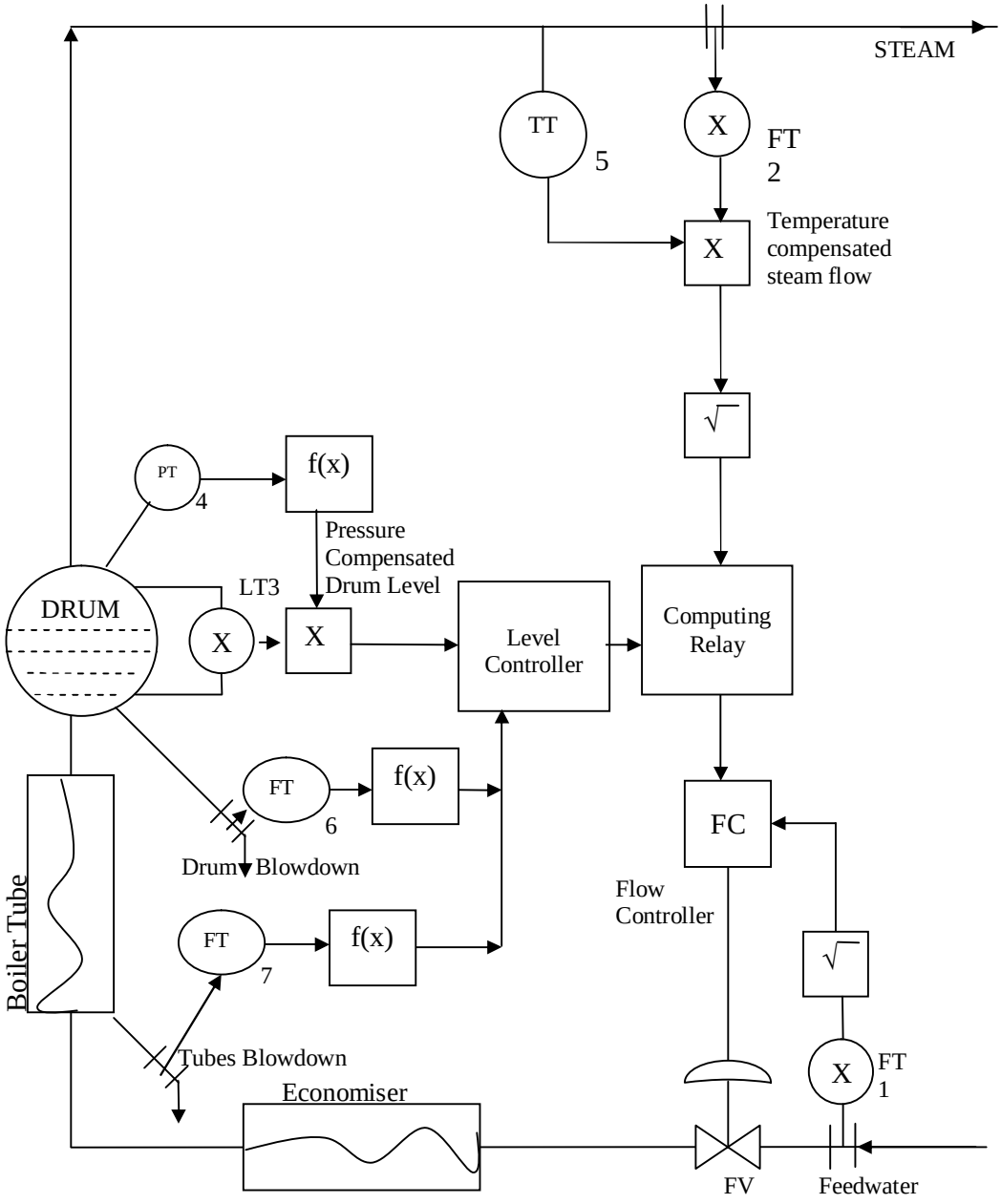


FIG. 6 SEVEN ELEMENT BOILER CONTROL

ADVANTAGES

1. Multiple element feedwater control can help:
   i. Faster response of systems.
   ii. More accurate control.
   iii. Maximum system stability.

2. Metering control system maintains combustion efficiency over wide. load changes and over long period of time.

3. Parallel combustion control can be used in any size of boilers.

DISADVANTAGES

1. Boilers require quick responding controls.
2. Level of the water in the boiler must be kept above 50% of height.

FUTURE DIRECTIONS

Microcontrollers & PLC are used as controllers.

CONCLUSIONS

The various goals of boiler control includes:

1. To minimize excess air
2. To minimize blowdown
3. To minimize steam pressure
4. To measure efficiency
5. To find when to perform maintenance