CONSIDERATIONS IN CHANGING OVER FROM OIL FIRED BOILERS TO SOLID FUEL FIRED BOILERS FOR SMALL BOILER USERS

INTRODUCTION

Small industrial boilers are extensively used in textile processing, pharmaceutical and food processing Industries. In general these industries have been very specific on using pollution free boilers so that the end products are within the international quality requirements. Competition from Industries and the rising cost of oil have started pinching the industries. Some industries who had worked out the payback on switching over to locally available solid fuels were astonished by the payback of solid fuel fired boilers. This article is written to assure the industries that there is no compromise on solid fuel firing. The various aspects to be addressed on selection of boiler are presented here. A case study of an Industry who successfully switched over is presented here.

FURNACE OIL FIRED BOILERS

FO fired boilers are generally a three pass boilers for application up to 16 TPH and 21 kg/cm2g operating pressure. The boilers are very compact and occupy very less floor space. Beyond 16 TPH, due to large furnace diameter requirement, D type water tube boilers are designed.
The response of the boiler is excellent when it comes to meeting very wide load fluctuations. With modulating control oil burners the best response is possible. The large HTA with small water volume makes the boiler to respond to sudden demand. The burner copes up with the required firing rate. The boiler runs unattended. The plant is clean as long as there is burner operates soot free.
Furnace oil fired boiler may be provided economizer with suitable deaerator and drum coil preheater or by high pressure deaerator. The feed water temperature at economizer inlet should be above 126 deg C to avoid problems due to acid condensation over the water cooled tubes. In small capacity boilers, economizers are not provided due to high initial investments on account of deaerator and its control system. Airpreheater can not be used for the same reason of acid condensation. The furnace oil fired boilers are prone for chimney corrosion if proper care is not taken.

SOLID FUEL FIRED BOILERS.

Solid fuel fired boilers are packaged shell type boiler with integral furnace up to 5 TPH capacity. Up to 3 TPH single furnace is provided. Twin furnaces are used beyond 3 TPH. The furnaces are hand fired and the grate for firing is a fixed type. Beyond 5 TPH capacity the large furnace sizes requirement leads to water wall cum shell type design. It is also possible to have a totally water wall design. Up to 8 TPH boiler capacity it has been observed that manual firing is possible. Beyond this, it is a must to go in for traveling grate furnaces due to difficulty in fuel feeding. The fuel has to be properly sized for automated fuel feed equipment. Wood chippers are used to reduce the wood logs to a size of 25 mm and below. For automated coal feeding chain grate stokers are used. These grates are also fitted in shell type boilers. (See picture above)
The fuels used for solid fuel fired boilers can be Coal, firewood, any other process waste such as plywood waste, wood shavings, saw dust.

RATE OF COMBUSTION WITH OIL/COAL/WOOD

Oil burners respond to demand immediately. This is due to the fine oil droplets by the burner nozzle and the turbulent air mixing at the burner tip and within the flame zone. A solid fuel can also be made to micron particle and the combustion can be made as rapid as furnace oil. In fact this is done in the pulverized fuel fired boilers. The coal is made as powder to a size of 76 micron and burnt like burner. It is cost prohibitive to prepare a solid fuel to such micron particle for use in small boiler. Next in order of response we have fluidized bed combustors. The response is fairly good and it has been found possible with coal the response is as good as oil. With a fluidized bed pollution is major issue. Cost effective solutions are yet to come for small boilers. Hand fired wood fired / coal fired boilers are known for less pollution. But when we use a wood log in a furnace the burning rate is slow for the reason that the oxygen has to diffuse through the wood / coal particles and react with the fuel to complete the process of heat liberation. This inherently results in poor response.

Question is how to overcome this. Most of the food processing industries require a steady steam pressure & temperature. How can this be done is the question?

This can be done in a systematic way as below.

1. Quantify the steady state steam consumption in various steam consuming ends.
2. Decide the lowest pressure required for the process at various consuming ends.
3. Find out the steam requirements for cold start of each section.
4. Find out the various combinations of steady state demand and initial start up steam consumption. The peak demand expected from the boiler is known. The steam piping itself is to be sized for this purpose.
5. Apply a factor for the slow response from the boiler and decide the steam generation of the boiler.
6. When the drawl of steam is sudden, the pressure is bound to drop. There should be a PRV to regulate the steam pressure downstream of the boiler at the plant end. When the sudden demand is required, the boiler pressure would come down. This leads to flashing of steam. The water hold up of the boiler should be available to produce the needed steam quantity.

There are four different types of plants

A. One consumer – steady load
B. One consumer – unsteady load
C. Several consumer – steady load
D. Several consumer – variable load

CASE A & C

It is simpler. The boiler has to be sized to 1.2 times the steady state requirement. This is required to meet the time lag between fuel charging and the heat release in the furnace.

CASE B &D

The boiler has to be sized to 1.2 times the peak demand required. In addition the water hold up that is available between normal water level and low level should be sufficient to meet the sudden steam drawal. The boiler pressure has to be higher and a PRV will be required at consumer end so that the pressure is regulated. The boiler responds to varying demand by flashing principle.

FLASHING OF STEAM IN BOILERS

When the pressure in the boiler comes down from a higher pressure to a lower pressure, part of the boiler water instantaneously evaporates to produce additional steam, termed as flash steam. For every pressure there is corresponding boiling temperature and the water contains fixed amount of heat. Higher the pressure, higher will be the heat content. If the pressure is reduced, heat content is reduced and the water temperature falls to lower boiling temperature. This means certain amount of excess heat is available due to the difference in the heat content of water between the two pressures.

This excess heat leads to evaporation of a portion of the water by adding necessary heat for boiling. This process is called flashing.

Flash steam produced is calculated as per the following formula

% Flash steam = (Hp1 – Hp2) / Lp2

Where,

Hp1 - Enthalpy/heat content of saturated water at operating pressure before the trap
Hp2 - Enthalpy/heat content of saturate water at operating pressure after the trap
Lp2 - Latent heat of evaporation at operating pressure after the trap

Thus amount of flash steam produced is part of the water hold up in boiler. Higher the water hold up, more will be the benefit. When the flashing occurs it should not result in low water level of the boiler. Thus depending on amount of steam required, the water hold up from NWL (normal water level) to LWL (low water level) must be provided.
For very high steam demand one has to choose external steam accumulators. Steam accumulators are designed based on the same principle where in the energy is stored in the form of hot water. The water flashes and gives steam as the pressure is dropped. See the scheme external steam accumulator below.
In a boiler, the steam space does not decide the additional capacity to offer steam. However amount of steam space will decide partly on the purity of steam.

EMISSION FROM SOLID FUEL FIRED BOILERS

The wood is low ash fuel and hence the total ash removal is very less. The dust emission would be there when the fire is kindled. For this purpose, a mechanical dust collector / simple cyclone is a must. In addition the wet ash trap should be planned for stringent dust control. A rotary feeder is a must below the dust collector, as otherwise the leakage of air through the feeder would lead to pollution.

CASE STUDY

M/S SKM egg products is an exporter of egg products. The customer desired to switch over to wood firing so that the operational cost could be brought down. At present the oil fired boiler was very close to plant.

1. The new boiler was located away from plant. The distance was 470 meters. The location was chosen by the customer as per vastu consideration. Moreover the customer did not want to take a chance on the dust pollution. The boiler was purposely kept away so that the dust due to wind would not enter to the building from air in takes.
2. There were number of steam consumption sections. The sudden drawal of steam was present in this plant, when a section starts from cold. The boiler what the customer had was with a twin drum design. In the case of elevated drum additional water hold up was available. Hence it was decided to keep the same water hold up in new boiler.
3. The operating pressure of the oil fired boiler was 14 kg/cm2g. The new boiler pressure was raised to 19 kg/cm2g. A PRV was envisaged at the present Main steam header. It was decided that the boiler pressure would swing down from 19 kg/cm2g to 14 kg/cm2g and in the process 3% flashing was expected. This additional steam would be instantaneously available to process

without dropping the pressure in the operating sections. This was essential to avoid the pressure drop in operating sections. Otherwise the product under process goes for rejection.

4. The new boiler was chosen with airpreheater so that the best efficiency is achieved.
5. The pipe line sizing as done to take care of peak steam requirement. This was calculated back from the present peak oil consumption. This was basically related to present nozzle discharge capacity of the burner.
6. The main steam valve was selected for peak steam capacity.
7. The pipe line being long pipe section insulation was advised to reduce the heat loss and the long life required.
8. Customer wanted to have a hot stand by of the present oil fired boiler, for some time till the switching over is smooth. For this purpose the burner oil nozzle capacity was reduced.
9. After the initial commissioning period, the oil fired boiler must be put into proper dry or wet preservation. The Scheme for preservation of the boiler was finalized and required piping was added. It was planned to keep the hot water under recirculation through the boiler and return to condensate cum feed water tank. Since the feed water is the boiler would be kept warm, it will ensure the boiler gas side also will be protected against atmospheric corrosion.

The plant layout and boiler features are illustrated in attached drawings. The photographs show the new boiler in operation.

CONCLUSION:

Switching over from furnace oil firing to solid fuel firing can not be taken easy. Going for same HTA in the manual fired solid fuel fired boiler may prove a blunder. A steam consumption survey is to be done. Choice of external accumulator shall be reviewed in case of sudden load swings. Modern boilers have must less HTA to water hold up as compared to old boilers.

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FIGURE 1

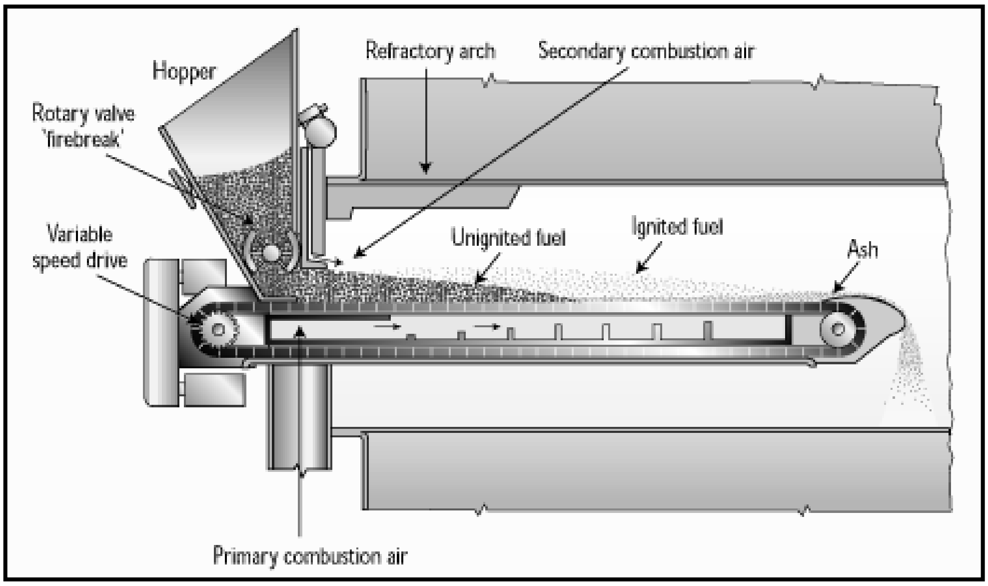


FIGURE 2

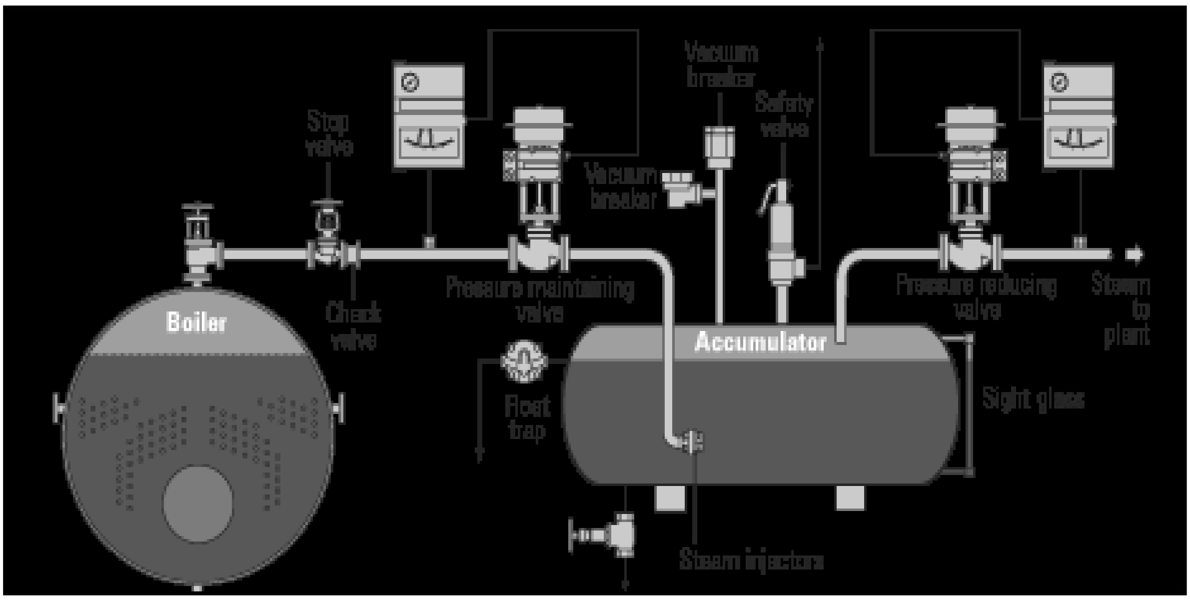
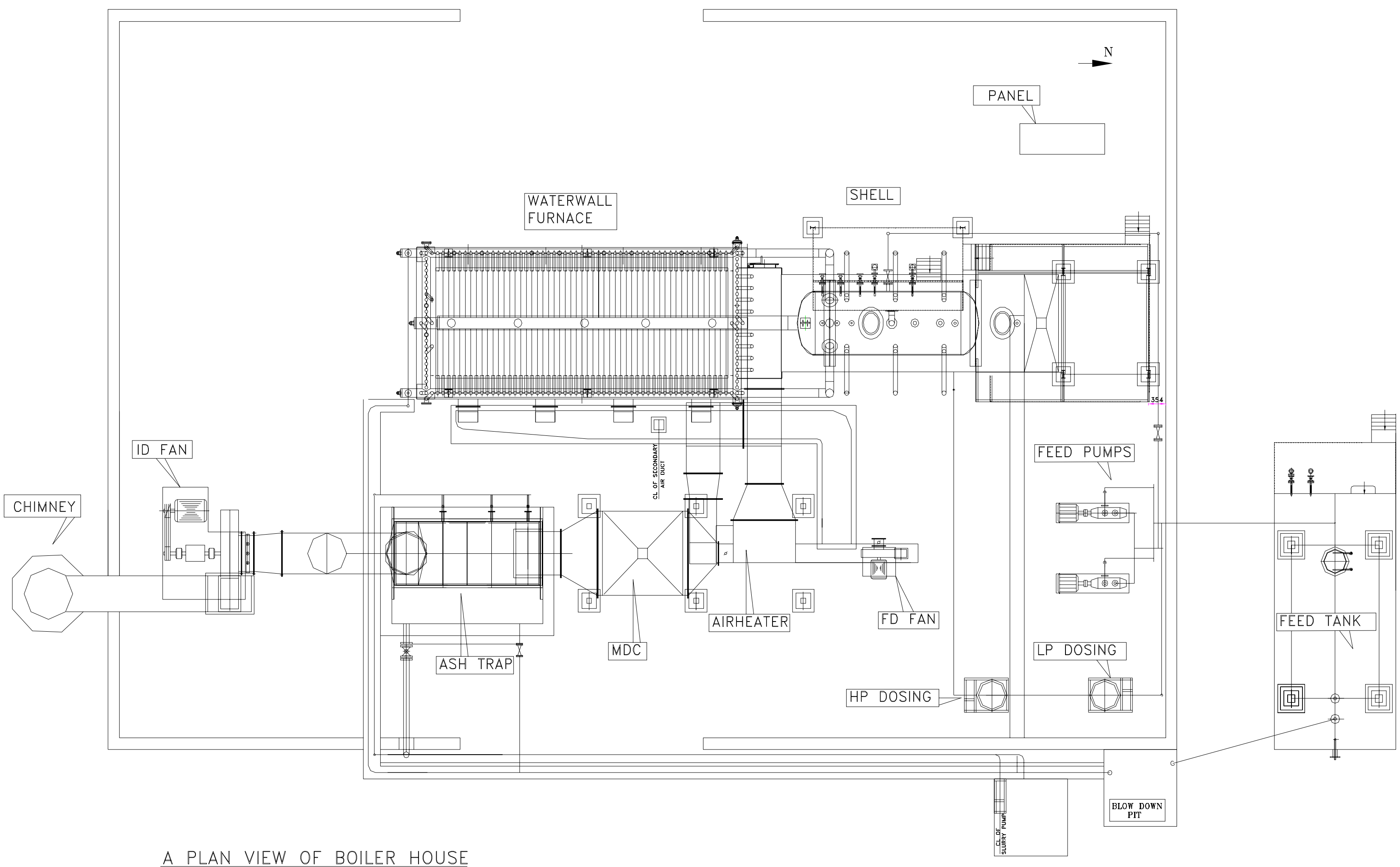
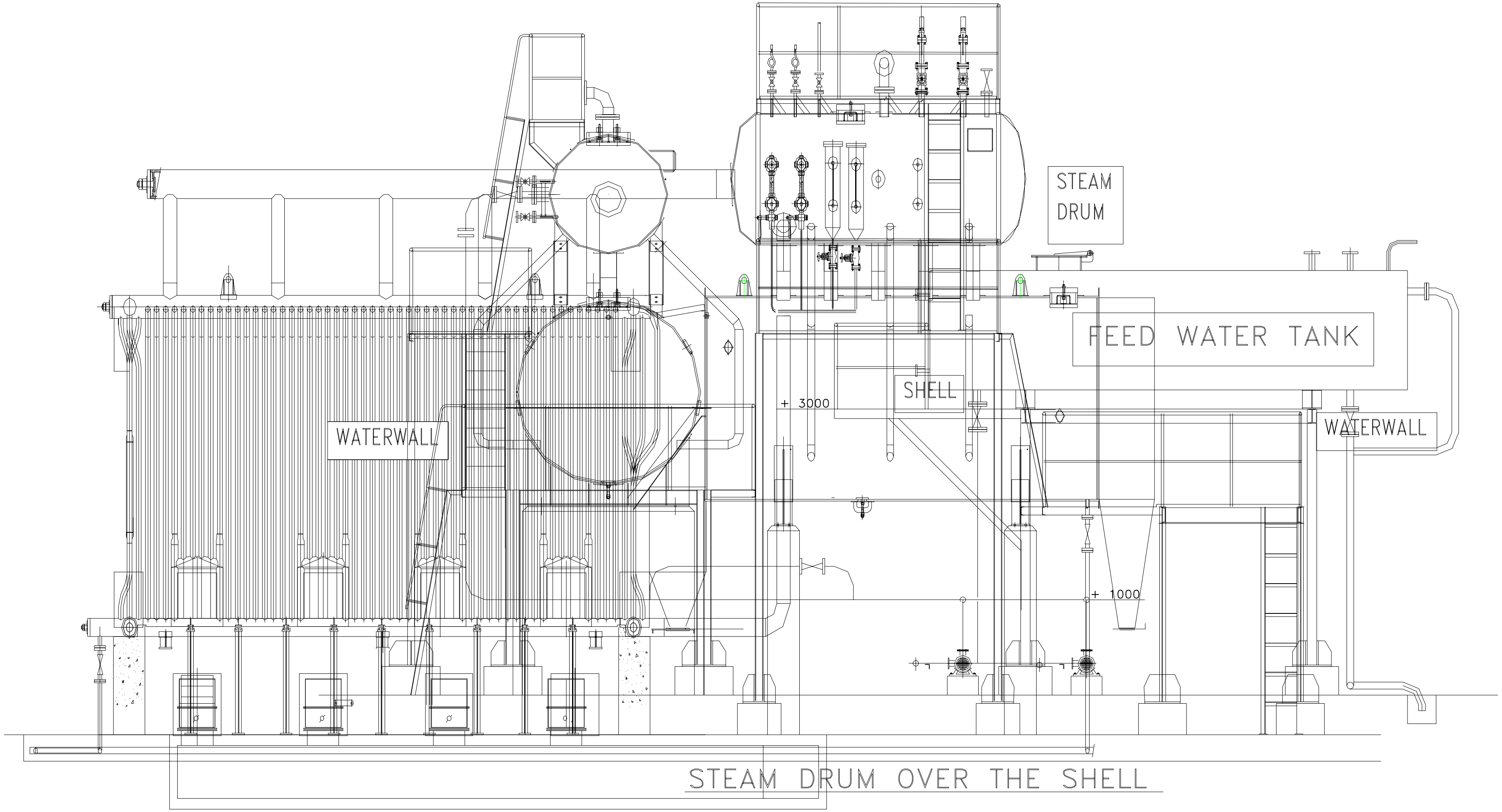


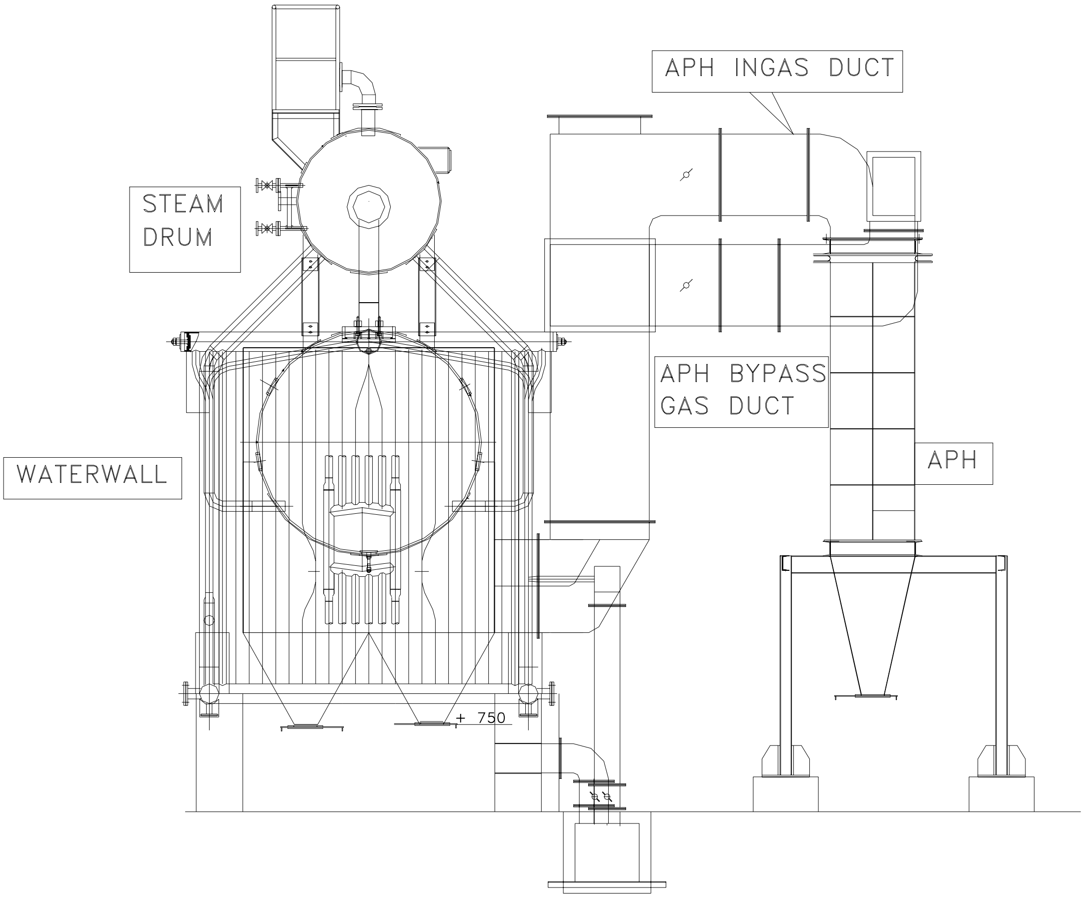
FIGURE 3



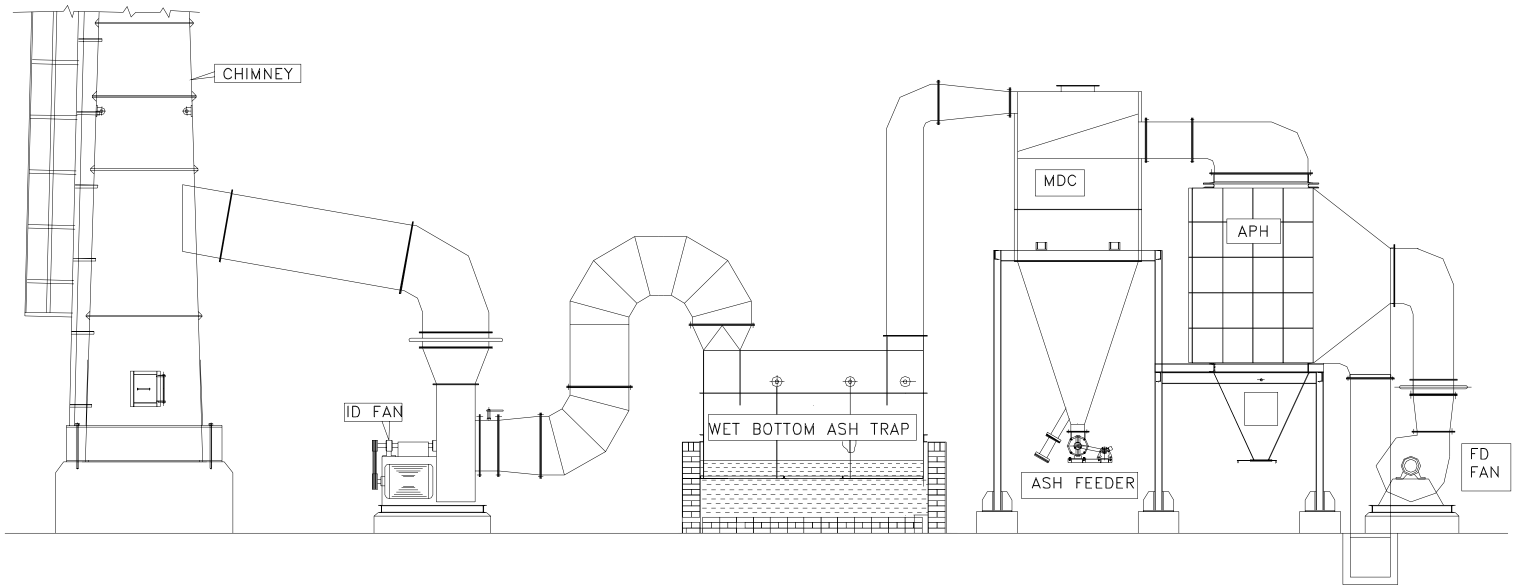
A PLAN VIEW OF BOILER HOUSE



ELEVATION OF THE BOILER WITH WATERWALL FURNACE & SHELL



CROSS SECTIONAL VIEW OF BOILER WITH SHELL & APH



VIEW SHOWING THE APH, MDC, WET BOTTOM ASH TRAP

PHOTO 1: EXISTING OIL FIRED BOILER

PHOTO 2: NEW WOOD FIRED BOILER

PHOTO 3: PHOTOGRAPH SHOWING THE BOILER FURNACE, SHELL & STEAM DRUM

PHOTO 4:PHOTOGRAPH SHOWING THE WET BOTTOM DUST TRAP