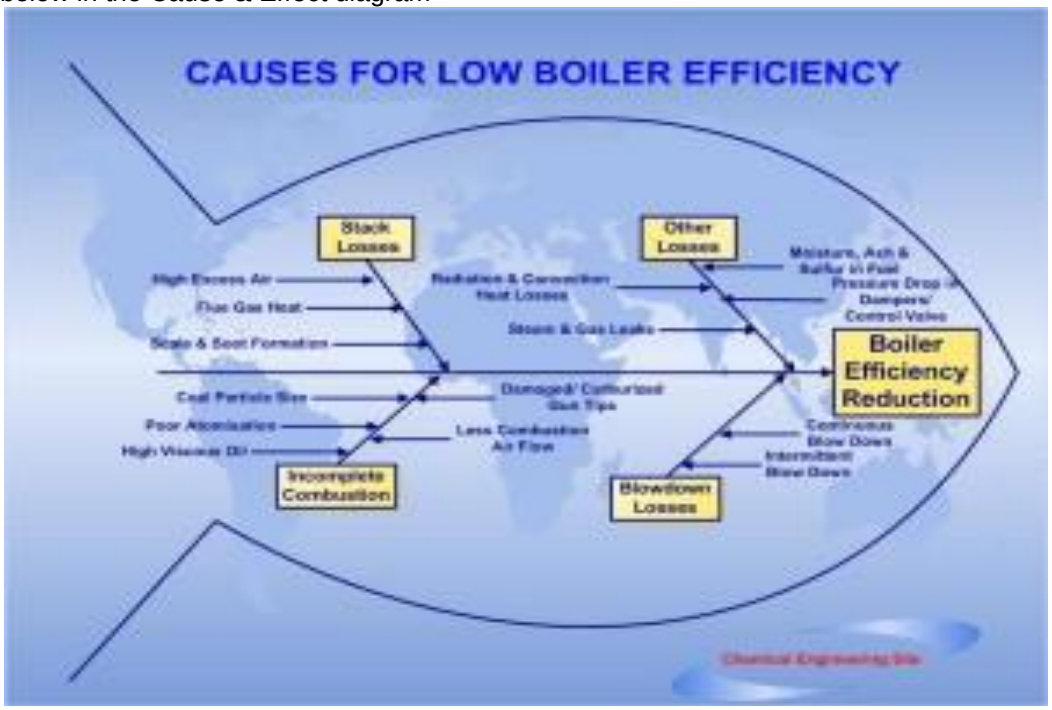
# Improving Boiler Energy Efficiency

Boilers are a part of Chemical Process Industry which is used to produce steam for Process applications and as well as power generation. There are various causes for poor efficiency for Boiler as depicted below in the Cause & Effect diagram




Let us see them in detail.

### Continuous and Intermittent Blow down

Boiler produces steam from the water in a continuous manner. But the circulating water has dissolved solids and due to evaporation this concentration will raise over a period of time. So, Blow down is given in the boiler by removing a part of circulating water from the boiler to maintain the Dissolved solid level in control. Continuous blow down is continuous removal of constant stream from boiler, as the name says. Intermittent Blow down is operated based on the requirement. Whenever drastic increase in concentrations of pH Silica, Phosphate, Conductivity or TDS this is used so that the fresh feed water comes in and reduces the concentrations. The removal of hot water from the boiler reduces its efficiency. So automatic blow down control based on TDS and/or Conductivity will help to optimize the blow down water requirement. Apart from that Flash steam Recovery will also help to extract the energy from the blow down as low pressure steam.

### Leaks

Combustion air leak increases the load on the combustion Air fan driver as the volumetric flow requirement goes high. Leaks Pre heated combustion air path results also in heat loss through the leaky air. Flue gas leaks also causes heat energy loss and also pollutes the ambient air.  False air ingression in negative pressure regions results in dilution of hot air and increases the fuel requirement. Internal and

External corrosion possibilities are to be periodically inspected and corrective action is to be taken to avoid reduction in boiler efficiency. Ultra sonic leak detectors are available in market which greatly helps to identify the leaks especially in low pressure regions. Steam leaks in the boiler system also dampen the energy efficiency.

### Stack Losses

The flue gas temperature at the stack must be as low as possible, so that it is possible to recover the heat and use it in preheating applications. Scaling in the heat transfer area may result in High temperature at the stack flue gas. So the temperature profile across the boiler sections is to be compared with the design and if wide deviations persist, shutdown is to be taken for cleaning to improve heat transfer. The limitation in decreasing the stack temperature is the cold end corrosion due to sulfur dew point. During the design stage itself low sulfur fuel has to be selected so that maximum heat can be recovered from the flue gas coming out of the boiler. If the low sulfur content fuel is not available, we need to compromise on the efficiency.

*World's tallest chimney 419.7 m in GRES-2 in Ekibastuz, Kazakhstan (Image Courtesy: Wikipedia)*

### Economizer & Air Preheaters

Economizers are used in boilers for preheating the boiler feed water with the help of flue gases coming out of the boiler. Combustion Air pre heater is used for waste heat recovery from flue gases before letting them to atmosphere. This pre heater has to be installed with a bypass on the air side for bypassing the part of the air during low load and start up to maintain the temperature of flue gas at the stack.

### Excess Air Control:

Excess Air is required for complete combustion of fuel in boilers. The range of excess air requirement depends on the fuel type used. It is necessary to keep the excess air at optimum level to reduce heat required to preheat the excess air to flue gas temperature. Apart from that Thermal NOX formation is

favorable at high temperature and high excess air conditions. Portable and/or online Oxygen Analyser helps to keep the excess air in the required level during normal operations. During sudden load changes excess air has to be controlled with care otherwise it is detrimental to the efficiency of the boiler.

### Radiation and Convection Losses:

Insulation boiler surfaces and steam piping has to be inspected for damage and replacement has to be done on a regular basis. The boiler surface loses its heat to the surrounding environment which is relatively cool. And this heat loss is very high during the higher wind velocity.

### Scale, Soot Formation:

We discussed already about scaling in reason for High stack temperature of boiler. Due to improper treatment systems scaling may occur inside water tubes in water tube boiler. Soot formation in Coal and Fuel oil fired boilers will cause scale formation and reduces the effective heat transfer area in a fire tube boilers. Physical and Chemical cleaning methods to be adopted to restore the heat transfer during the shutdown of the boilers. During normal operation effective soot blowing operation is to be carried out to remove the soot's from the surfaces, which influences the boiler efficiency to a great extent.

### Fuel Quality:

Loss of Heat due to Moisture & Ash content in the fuel will decrease the boiler efficiency. The heat required for evaporating the moisture and bringing it to the flue gas temperature goes vain. Therefore moisture in fuel and also in combustion air has to be monitored and controlled carefully. The increase in sulfur concentration increases the dew point and therefore heat cannot be recovered by bringing the stack temperature below the dew point. Ash content in the fuel also decreases boiler energy efficiency. Loss due to unburnt bottom ash and fly ash is unrecoverable part of the energy.

### Incomplete Combustion:

Incomplete combustion results in CO emission which pollutes the environment and also decreases the efficiency. In Coal fired boilers particle size is an important parameter to be controlled. Too fine particles increases the grinding mill power consumption and too coarse particles results in incomplete combustion and unburnt losses will raise. Particle size is optimized taking care of the two. In Fuel oil fired boilers proper atomization by steam or air is very important for better combustion efficiency.

### VFD for Pump and Fan Motor:

Older fashion of controlling the combustion air and flue gas was with the help of dampers. Similarly Boiler Feed Water flow is controlled with the help of control valves. Operation of damper or control valve provides additional pressure drop which in turn is energy loss. So modern boilers are equipped with Variable Frequency Drive (VFD) for Combustion Air Fan, Flue Gas Fan and Boiler Feed Water Pump motors. This helps to keep the damper or control valve in a full open condition which offers less pressure drop and saves considerable amount of energy. For Steam Turbines speed governor is installed and looped with the control system for varying the speed of the turbine according to the air and water requirement.

**Source: http://www.chemicalengineeringsite.com/improving-boiler-efficiency/401**