



Class :3rd stage

Subject: Thermodynamics

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Chemical engineering and petroleum industries

(Thermodynamic Lab3)

Experiment No.3

Calculate the efficiency of the boiler steam

اعداد:

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Number of experiments: Three

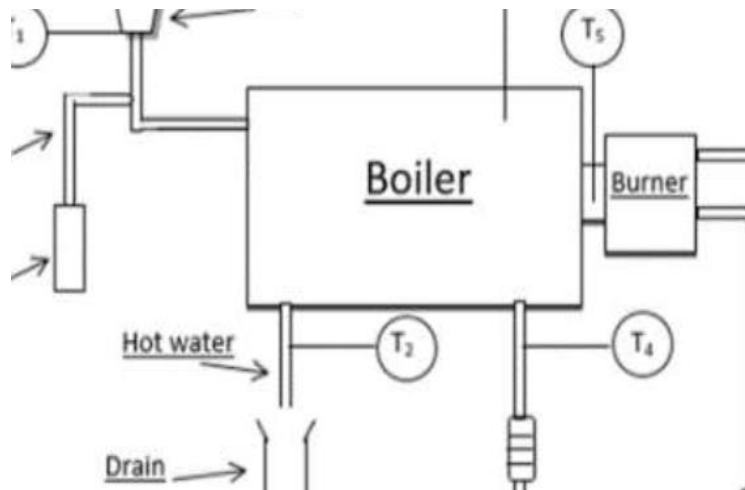
Name of Experiment: Calculate the efficiency of the boiler steam

Purpose of Experiment:

- 1- Identify parts of boilers
- 2- Study the characteristics of the boiler
- 3- Calculation of the efficiency of the boiler and the factors affecting the efficiency of the boiler

Equipment:

Figure below shows an overall description diagram for the equipment used: boiler, along with the auxiliary units. The diagram shows that a burner is attached prior to the boiler inlet, and it is equipped with a temperature sensor. At the boiler exit, the flue gas goes directly to the stack; a probe is attached to analyses the exhaust gases concentrations. Water is circulated to control the heat inside the boiler.





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Where:

T1= Flue Gas Temperature (°C)

T2= Water Outlet Temperature (°C)

T3= Jacket Temperature (°C)

T4= Water Inlet Temperature (°C)

T5= Air and Gas Inlet Temperature (°C)

Theory:

A boiler can be defined as the equipment that can be used to produce steam through boiling the water. Scientifically, boilers are defined as a device that converts the energy stored in the fuel as a chemical energy into heat energy (hot water). In some types of boilers, technically steam is produced as a result of Thermodynamic of heat energy of hot gases to water when the operation involved no firing. Boilers have been used for more than 150 years. Comparing to today, boilers have been developed significantly in the following aspects: size, variety, reliability, complexity and flexibility.

Recently, boilers usage extended to include some developing countries such as china and India as a result of fast industrialization. There are several types of boilers and it can be classified according to (water, fire) streams and circulations, type of fuel used, (temperature and pressure) applied, and steam conditions.

Modified boilers are found to be capable to have thermal efficiency in the range of 80% to 90% depending on the fuel and required amount of access air, which can be useful to limit the flame temperature, to prevent milting boiler tubes. The flue gas temperature is usually higher than the flame temperature and it is regularly used to preheat the inlet air by having the inlet air entering through it prior to using it, and that is to raise the thermal efficiency of the boiler. However, as any thermodynamic system heat loss can be happening about (% 1.5 - %2.5).

The economic gas fired horizontal boiler type was used in this experiment to raise the temperature of the water, by converting the chemical energy in the fuel to the heat energy in the heated water.



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Procedure:

The air and natural gas were injected to the burner via a series of pipelines and at regular flow rates, the combustion of the fuel and air were occurred after the igniting. Then, the water was started to flow into the boiler through a series of pipelines at steady flow rate and room temperature. Inside the boiler's tank, the water temperature started to increase gradually. The water pipe and the heat of combustion inside the tank were in direct contact. The hot water from the boiler was rejected through a pipe to drain, and the flue gas was released to outside the unit through the stack. During the boiler operation, Kane 940 analyser was used to measure the concentrations of CO₂, CO and NO_x in the flue gas via a probe. The probe was attached to the stack and the gas samples were sent to gas sampling and conditioning unit before the analyzer.

Gas sampling and conditioning unit, was to protect the analyzer from harmful effects that can be caused by: corrosion, moisture, high pressure, high temperature, and organizing the flow. Furthermore, there were five K-type thermocouples connected to the boiler, where used to measure the temperature of the (inlet and outlet water, flue gas, jacket and gas & air inlet). Then, the measured temperatures were displayed in digital screen (experimental Rig diagram).

Discussion:

- 1- What is the definition of the boiler and what are its uses and purpose?
- 2- Discuss the use of water in the boiler instead of other liquids?
- 3- What are the type of boiler and what kind of fuel is used?
- 4- What factors increase boiler efficiency?
- 5- What are the factors that reduce and influence the efficiency of the boiler?