

Review paper on Small workable condenser and economizer

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ABSTRACT

The economizer system is a method of improving energy efficiency through the operating method, which introduces outdoor Water through dampers when the outdoor Water temperature or enthalpy is lower than that of the indoor Water. The set values used for economizer control include the mixed Water temperature and high and low limits. The set values are presented as fixed values in the relevant standards and are controlled to be fixed during actual operation, which may lead to issues such as indoor discomfort, poor indoor air quality, and energy wastage. (1) Condensing boilers represent now the most advanced technology in boilers field. Currently, their operation is almost entirely based on natural gas. (2)

Keywords:- air-side economizer; optimal control; prediction model. Condensing boiler, fuels, combustion, efficiency

1. INTRODUCTION

Overview of Economizer System

An economizer is a system that reduces the amount of cooling energy needed by introducing outdoor air when it is sufficient for cooling, and economizers can be classified into passive and active systems. For instance, a passive system is used to prevent incident heat from being implemented in the design stage of a building so that cooling loads are not generated [8,9]. In contrast, an active system is any mechanical system that reduces the cooling energy or the operating time of a cooling system when cooling a data center or any other facility when the outdoor temperature is sufficiently low. Economizers in active systems can be divided into water-side economizers and air-side economizers. A water-side economizer utilizes cold air to cool the circulating cooling water of an external cooling tower.

Overview of Condenser System

Condensing technology currently offers the highest level of performance in boilers field. The idea of this technology is the condensation of the vapors of water contained in the flue and recovery of the latent heat. Thus, efficiency may increase with 10 to 12% in the case of the gas-fired condensing boilers compared with gas-fired conventional boilers [1, 2]. The yield depends on the return water temperature (the lower the temperature, the higher

1.1 Objective The objectives of the work are:

- To a small workable model of a condenser and economizer for educational purpose.
- To demonstrate the recovery of waste heat from exhaust steam and flue gases.
- To study the working principle of a condenser in converting steam into water.
- To study the working principle of an economizer in preheating boiler feed water.
- To understand the importance of heat recovery in improving boiler efficiency.
- To reduce fuel consumption by utilizing waste heat energy.
- To develop a low-cost, safe, and compact model suitable for laboratory demonstration.

1.2 Problem Statement

In conventional boiler systems, a large amount of heat energy is lost through exhaust steam and flue gases. This wastage of thermal energy reduces the overall efficiency of the boiler and increases fuel consumption. In educational laboratories, full-scale boiler accessories like condenser and economizer are not easily available due to high cost, large size, and safety issues. As a result, students find it difficult to understand the practical working and importance of these components.

Therefore, there is a need to design and fabricate a small, low-cost, safe, and workable model of a condenser and economizer that can demonstrate the recovery of waste heat. The model should clearly show how exhaust steam

is condensed into water in a condenser and how waste heat is used to preheat feed water in an economizer. This project aims to improve understanding of heat recovery, energy conservation, and boiler efficiency in a simple and practical manner.

2. LITERATURE REVIEW

In the combustion chamber of the boiler, fossil fuels are burned and the heat generated is transferred to the water by hot flue gas. Flue gas destroys a significant amount of energy because all the heat produced by the burning fuel cannot be transferred to the boiler in water or steam. Because the temperature of the flue gas release a boiler typically ranges from 150 to 250 °C, about 10-30% of the heat energy is lost through it [1]. Other major heat losses from boilers include convection heat transfer, radiation, blow-down, fly ash and bottom ash losses. In order to operate the boiler plant at maximum efficiency, it is necessary to identify the main source of energy wastage and recover the wasted energy [2]. The efficiency of the boiler is that the ratio of the net amount of heat that's absorbed by the generated steam to the net amount of heat that's supplied to the boiler. This will even be determined by subtracting net heat loss from the boiler from the net amount of heat supplied to the boiler [3]. Therefore, so as to enhance the efficiency of the boiler, it's necessary to scale back the quantity of heat being wasted from the boiler by optimizing some parameters like extra air, fuel flow rate, steam demand, some other parameter A typical heat balance in a boiler [4] .

The literature survey has been done to explore various works that has been done in the field of condenser cooling and also in the utilization of condensed water from the traditional air [5].

3. MECHANICAL DESIGN

Economizer

The exhaust gases that are leaving the Boiler contain both sensible heat and latent heat. Sensitive heat is the amount of heat needed to raise the temperature of water under constant pressure without changing the liquid state, while Latent heat is required to change Liquid state to the Vapour state at constant temperature and pressure.

The exhaust from the boilers is usually within the temperature range of 150°C 250°C, so there is an enormous amount

of losses from the boiler if any heat recovery devices aren't installed after it.

After producing steam, the flue gas exits the system but flue gas remains some amount of heat energy. A boiler economizer is a device that uses the remaining energy of flue gas to heat the inlet water to the boiler. The recovered heat can be utilized to preheat boiler feed water, combustion air, or some other applications. The amount of heat recovered totally depends on the temperature of the flue gas and also the temperature of the fluid to be heated. In the boiler, an economizer usually has a heat exchanger designed to exchange heat with fluid, usually water. And also help reduce the cost of operation by saving fuel. Economizers also increasing the efficiency of the boiler will save you a lot of operating costs and eventually extend the life of your boiler system.(4).

Air cooled condenser

air cooled condenser (ACC) is a direct heat type heat exchanger in which steam enters and is condensed to liquid inside air-cooled finned tubes. There is no direct contact between the refrigerant and the cooling fluid i.e. the ambient air. The heat of refrigerant is transferred to the surrounding cold air through the walls of the tube. The rate of heat dissipation is increased by the usage of a fan as it increases the velocity of ambient air surrounding the tube of the condenser. The condensing temperature depends on the air dry bulb temperature. Air cooled condensers are more popular for residential or domestic usage as their cooling capacity is not dependent on water availability. In addition to this they are a more cost effective option as their installation is comparatively cheaper than water cooled condensers. Their maintenance cost is also less than that of a water cooled condenser. The air cooled condenser has some limitations. The length of the air cooled condenser is large and requires large space to fit in. They are less efficient than water cooled condensers and also tend to produce noise when operated. Efficiency and power usage is always a concern in case of air cooled condensers. This topic deals with the various modifications done in air cooled refrigeration systems to enhance efficiency and reduce power consumption (5).

Safety

Pressure Safety, Temperature Safety, Electrical Safety, Leakage Prevention, Operational Safety

4. METHODOLOGY

The efficiency in steam boilers is calculated by two methods, Direct Method (Input-Output method) and Indirect Method (Heat Loss Method) [20]. The Direct Method is assumed by measuring through instrumentation and the calculated data obtained will be utilized to calculate the fuel-to-steam efficiency [21-23]. The Indirect Method can be measured by considering the temporal losses totally. Therefore, the values obtained can be used to

calculate the heat balance efficiency [10,24,25]. The main benefit of this method is that the errors in measurement do not make a major change in efficiency [3].

5.CONSTRUCTION AND WORKING

Construction

1. / Steam Generator (Heat Source)

- Pressure cooker
- Water tank / boiler drum
- Generates steam for the system



Figure 1 Pressure Cooker

2. Condenser Unit

- Condenser tubes (copper / aluminum / stainless steel)
- Cooling water inlet and outlet
- Steam inlet and condensate outlet
- Condensate collection tank

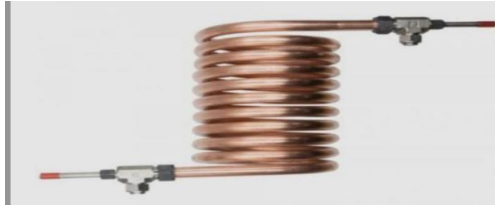


Figure 2 Condenser Coil

3. Economizer Unit

- Economizer coil or tubes
- Feed water inlet and outlet
- Support Frame (chimney)



Figure 3 Evaporator Coil

4. Water Circulation System

- Feed water tank
- Water pump
- Flexible pipes / hoses



Figure 5 Bucket.



Figure 6 Water Pump

5. Piping & Fittings

- Copper / PVC / GI pipes
- Elbows, tees, reducers
- Non-return valve (NRV)



Figure 7 Pipes

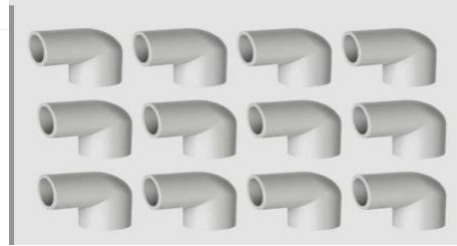


Figure 8 Elbows

6. Measuring Instruments

- Pressure gauge
- Temperature sensors / thermometer



Figure 9 Pressure Gauge



Figure 10 Temperature Sensor

Working

Step 1: Water Tank to Economizer

- Cold water is stored in the water tank.
- Water from the tank flows to the economizer through a pipe.
- The flow is controlled by a valve or small pump.

Step 2: Heating of Water in Economizer

- Hot exhaust gases / hot air from the pressure cooker (boiler) side pass over the economizer tubes.
- Waste heat from these gases is transferred to the water.
- Water gets preheated before entering the boiler.

Step 3: Economizer to Pressure Cooker (Boiler)

- Preheated water from the economizer enters the pressure cooker.
- The pressure cooker works as a boiler.
- Because water is already hot, less heat is required.

Step 4: Steam Generation in Pressure Cooker

- Water is further heated using an electric heater or gas stove.
- Water converts into high-temperature steam.
- Steam flows out through a steam outlet pipe.

Step 5: Steam to Condenser

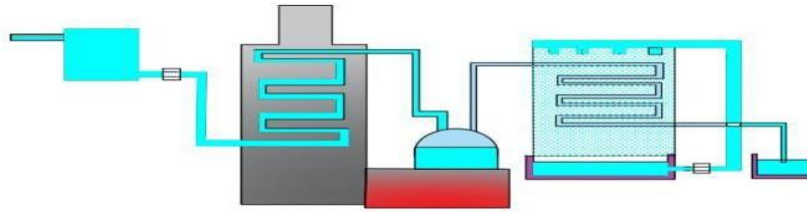
- Steam enters the condenser.
- Cold cooling water circulates around the condenser tubes.
- Heat from steam is removed.

Step 6: Condensation Process

- Steam loses heat and condenses into water.
- This water is called condensate.

Step 7: Condensate to Water Tank

- Condensed water flows back into the water tank.
- This water is reused for the next cycle.



6.RESULT

The project successfully demonstrated the working of an economizer and condenser in a closed cycle system. The economizer effectively preheated the feed water using waste heat from exhaust gassed to preheating, the time required to generate steam was reduced. Fuel / electrical energy consumption decreased, showing improvement in system efficiency. The condenser efficiently converted steam into water, enabling reuse of water. wastage was minimized by returning condensate to the water tank. Overall thermal efficiency of the system increased. The project proved that waste heat recovery is possible even in small-scale systems. model worked safely and smoothly under designed pressure and temperature limits.

7.CONCLUSION

In this regard, a comprehensive review is presented for the waste heat recovery from exhaust gases. It was investigated that, one of the dominant method of waste heat recovery using an economizer. The economizer is used to reduce total energy consumption by creating additional heat sources. High-temperature flue gases leaving the boiler are entered into economizer due to this prevents high-temperature flue gases are coming in contact with the environment. Also, an economizer device would reduce the impact on the environment by reducing emission which may very helpful to control global warming. Therefore this comprehensive review of waste heat recovery of flue gases using economizer is very helpful to improve boiler efficiency in an industrial area[4]

8.REFERENCE

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