Class :3rd stage

Subject: Thermodynamics

م.م زهراء عبد الاله هادي

م.م ايلاف جاسم محان

م.م حسن علي شمخي

مهندس احمد عباس محمد

Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College Chemical engineering and petroleum industries

(Thermodynamic Lab3)

Experiment No. 8

Heat Exchangers

اعداد:

م.م زهراء عبد الاله هادي

م.م ايلاف جاسم محان

م.م حسن علي شمخي

مهندس احمد عباس محمد

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م.م ايلاف جاسم محان

م.م حسن علي شمخي

مهندس احمد عباس محمد

Number of Experiment: Eight
Name of Experiment: Heat Exchangers
Purpose of Experiment:
-Classify and describe heat exchanger based on the external fluid used, based on the external fluid flow and based on constructional aspects.
-Explain the effect of cooling water mass flow rate on the state of leaving steam
-estimating heat transfer coefficients on external fluid and internal fluid side

Theory:

A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact. In heat exchangers, there are usually no external heat and work interactions. Typical applications involve heating or cooling of a fluid stream of concern and evaporation or condensation of single- or multi component fluid streams. In other applications, the objective may be to recover or reject heat, or sterilize, pasteurize, fractionate, distill, concentrate, crystallize, or control a process fluid. In a few heat exchangers, the fluids exchanging heat are in direct contact. In most heat exchangers, heat transfer between fluids takes place through a separating wall or into and out of a wall in a transient manner.

1) Condenser:

Condenser is a heat exchanger, the purpose of the condenser in any thermal cycle is to accept the hot gas from the compressor or turbine and cool it. Heat removed process may occur in three regions, first the superheat and then the latent heat, so that the refrigerant may leave the condenser as a saturated or a sub-cooled liquid at a lower level of the condenser, depending upon the temperature of the cooling medium and design of the condenser. In nearly all cases, the cooling medium will be either air or water.

2) Heat Exchanger Classifications:

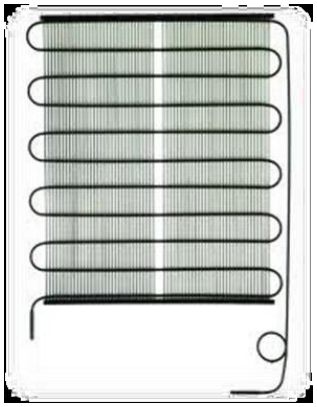
The common forms of condensers may be classified on the basis of the cooling medium as:

(A) Air Cooled Condenser
(B) Water Cooled Condenser, and
(C) Evaporative Condenser (air and water cooled).

A) Air Cooled Condenser:

As the name implies, in air-cooled condensers air is the cooling medium, the hot fluid rejects heat to air that flowing over the condenser. The flow of the liquefied fluid will be assisted by gravity, so the fluid inlet will be at the top of the condenser and the outlet at the bottom. The air-cooled condensers find applications in domestic, commercial, industrial refrigerating, chilling, freezing, and air-conditioning systems with a common capacity of less than tons to 120 tons. Air-cooled condensers must, of course, be used on land transport systems. They will also be used in desert areas where the supply of cooling water is unreliable air-cooled condensers can be further classified into natural convection type or forced convection type.

1) Natural Convection: In this type, heat transfer from the condenser is by induced natural convection and radiation. Since the flow rate of air is small and the radiation heat transfer is also not very high, As a result a relatively **large condensing surface is required to reject a given amount of heat**. Hence these condensers are used for small capacity refrigeration systems like household refrigerators and freezers .The natural convection type condensers are either plate surface type Fig(7-19-A) , finned tube type or wire and tube type. the common design is wire and tube type Fig(7-19-B), thin wires are welded to the serpentine tube coil. The wires act like fins for increased heat transfer area.



2) Forced convection Air cooled condenser: In this type of condensers, the air will circulated over the condenser surface by using fan or blower Fig(2). These condensers normally use fins on air-side for good heat transfer. The fins can be either plate type or annular type. Forced convection type condensers are commonly used in window air conditioners, water coolers and packaged air conditioning plants.

B) Water Cooled Condenser:

In a water-cooled condenser, water is used as cooling medium, to remove heat from the refrigerant. Water is often the re circulating water from the cooling tower. It also could be from a lake, river, or well near the refrigeration plant. When the river or lake water is used as the cooling water, an effective water filter system will be used to prevent fouling of condenser tubes and blocking of water passages by the impurities. Cooling water treatment is often required to prevent the growth of living organisms and also prevent condenser pipes metals from corrosion. Water cooled condenser is used with refrigerant capacity from 3 to 35000 kW.

The use of water from river, lake, or ground is it cannot be re circulated to use as cooling water again. There for cooling tower is used to cool the water that leaves the condenser ,cooling tower always in used associated to refrigeration system that operate with water cooled condenser .

There are three types of water-cooled condensers which are widely used for air conditioning and refrigeration purposes these are double tube condensers, shell and coil and shell and tube condenser.

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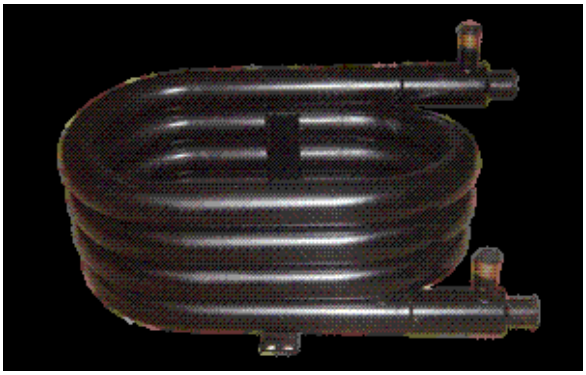

Larger sizes of water cooled condenser require closer packing of the tubes to minimize the overall size, and the general form is shell and tube Fig (4)&(5), this is the most common type of condenser used in systems from 2 TR up to 100 TR. In these condensers the refrigerant flow through the space that formed between shell and baffles turns while water flows through the tubes in single to four passes, the presence of baffles turns the flow around creating some turbulence thereby increasing the heat transfer. Baffles also prevent the short-circuiting of the fluid flowing in the shell. The coldest water contacts the liquid refrigerant so that some sub cooling can also be obtained. Further the refrigerant also rejects heat to the surroundings from the shell. The condensed refrigerant collects at the bottom of the shell then drained from the bottom to the receiver. The shell also acts as a receiver. This construction is a very adaptable mechanical design materials can be selected for the refrigerant, but all mild steel is common for fresh water, with cupronickel or aluminum brass tubes for salt

3) Shell and coil condenser:

These condensers are used in systems up to 50 TR capacity. The water flows through multiple coils, which may have fins to increase the heat transfer coefficient. The refrigerant flows through the shell Fig (6). In smaller capacity condensers, refrigerant flows through coils while water flows through the shell. When water flows through the coils, cleaning is done by circulating suitable chemicals through the coils.

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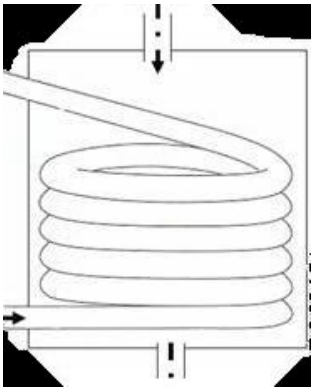

Discussion:

1. Compare between the shell and tube and shell and coil type of heat exchanger.
2. Rearrange the type of heat exchanger according to capacity
3. Show with drawing the effect of cooling water mass flow rate on exit state of hot water
4. Calculate the effectiveness of heat exchanger.
5. By using EES show the error in calculation between experimental and theoretical calculation.