EXPERIMRNT 11: To compare overall heat transfer coefficient for Parallel and Counter flow in a Double Pipe Heat Exchanger.

Introduction

Heat Exchanger consists of copper pipe, two connecting tees and a return head and a return bend. The packing glands support inner pipe within the outer pipe. This exchanger can be very easily fabricated in any pipe fitting shop as it consists of standard parts and it provides inexpensive heat transfer surface. In this exchanger, one of the fluid flows through the annular space created between two concentric pipes. It is usually employed for decreasing the temperature of hot fluid with the help of cold fluid.

These exchangers are usually assembled in effective lengths of 12,15 or 20 ft. The distance in each leg over which the heat transfer occurs is termed as the effective length. The major disadvantages of double pipe heat exchanger are:

Small heat transfer surface in larger floor space as compared to other type (e.g. shell and tube heat exchanger)

1. Dismantling requires longer time.
2. Maximum leakage points.

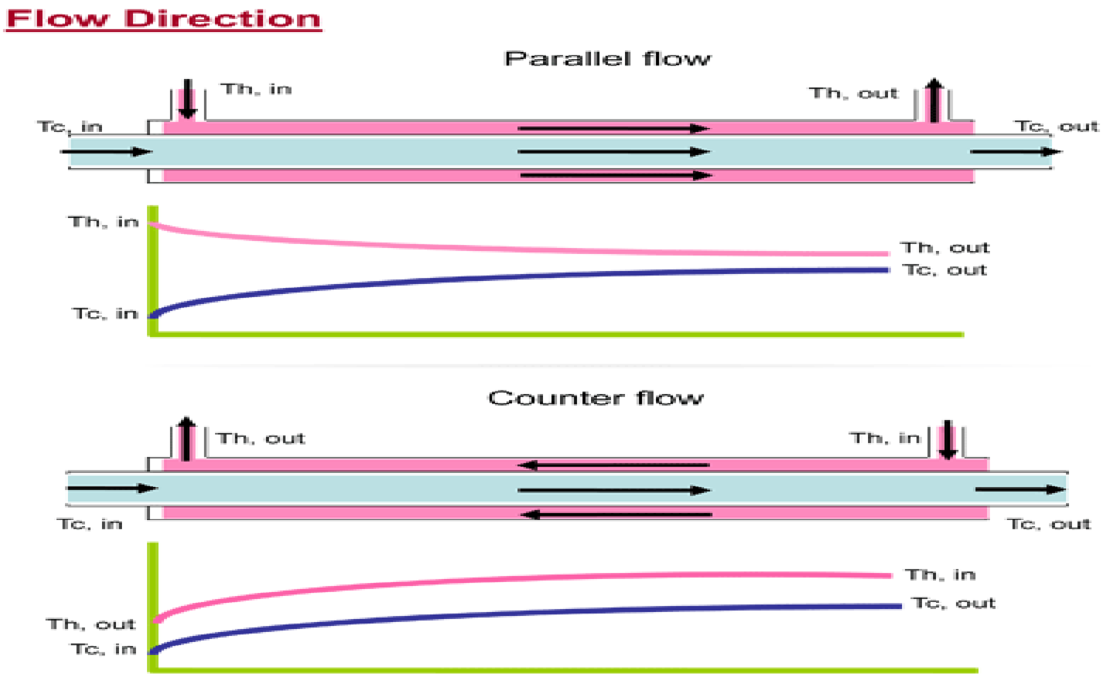
Apart from this, double pipe heat exchanger is very attractive where the total heat transfer surface required is small, 100 to 150 ft^2 or less.

Double pipe heat exchanger can be divided into major classes depending on the direction of the flow of hot and cold streams on either side of the tube wall:

1. Parallel Flow Heat Exchanger:
2. Counter Flow Heat Exchanger:

Parallel Flow Heat Exchanger

In this type of heat exchanger the hot and cold fluids flow in the same direction, hence the name parallel flow. Such an arrangement is shown schematically in figure 2(a) and (b). In a parallel flow exchanger, the temperature difference between the hot and cold fluids keep on decreasing from inlet to exit. Many devices such as water heaters, oil heaters and coolers, etc. belong to this class.



Counter Flow Heat Exchanger

In this case, as schematically shown in the two fluids flow through the exchanger in opposite directions hence the name counter flow. The temperature distribution in a counter flow exchanger is shown in figure . It can be seen that the temperature difference between the two fluids remain more nearly constant as compared to the parallel flow type. Counter flow heat exchangers are the most favourable devices for heating and cooling of fluids because, for a given surface area, these exchangers give the maximum heat transfer rate.

Procedure

1. Fill the hot water tank with about 40 liter of clean tap water.
2. Switch on the immersion type heater (3 kW) provided in the hot water tank and heat the water to the desired temperature (about 60-70 °C). Intermittently switch ON the pump with bypass line valve fully open and supply valve fully closed to ensure through mixing of water in the tank to ensure uniform temperature.
3. After achieving the desired temperature of water in the hot water tank, switch ON the pump (0.5 HP) and allow the hot water to flow through shell side and adjust the flow

rate to the desired value using the valve for about five minutes. Recycle the exit of the hot water to the hot water tank.

4. Operate the alternate valves out of four valves provided on the control panel in such a manner so that the heat exchanger operate in co-current flow mode.
5. Start the cold water supply on the shell side and adjust the flowrate to the desired value. Now place the outlet of both shell and tube side in to the drain line.
6. Monitor the hot water inlet temperature and maintain it at the constant value by switching the heater either on/ off with the help of thermostat provided on the control panel of the tank.

   (Make sure during the test period Hot Water Tank should not be emptied totally and the heater must not be exposed to air if the Heater is ON, otherwise it will be damaged).
7. Observe the inlet and outlet temperature of both cold and hot water streams and note down them after they achieve steady state.
8. Also note down the flow rates of hot water and cold water with the help of rota meters.
9. Repeat the above procedure either by changing the flow rates or by changing the inlet temperature of the hot water.
10. Alter the heat exchanger from co-current flow mode to counter-current flow mode and repeat the experiment.

Instrument image

Observation Table

Parallel Flow Run:

Hot Water Side			Cold Water Side		
Flow Rate m_h (lpm)	T_1 (°C)	T_2 (°C)	Flow Rate m_c (lpm)	T_3 (°C)	T_4 (°C)

Counter Flow Run:

Hot Water Side			Cold Water Side		
Flow Rate m_h (lpm)	T_1 (°C)	T_2 (°C)	Flow Rate m_c (lpm)	T_5 (°C)	T_6 (°C)

Calculations

For Parallel flow run:

Flow rate of hot water in kg/ s m_H =

Heat Transferred by the Hot Water to the Cold Water Q_H =

Flow rate of cold water in kg/ s m_C=

Heat Gained by the Cold Water from the Hot Water Q_C =

$Q = (Q_H + Q_C) / 2$ =

Area for the Heat Transfer, $A = \Pi * d_o * L$

where, d_o = Outer Diameter of Inner Pipe,=0.025 m

L = Effective Total Length of Double Pipe Heat Exchanger=0.950 m

LMTD =

$U_0 = Q / (A * LMTD)$

For Counter flow run:

Flow rate of hot water in kg/ s m_H =

Heat Transferred by the Hot Water to the Cold Water Q_H =

Flow rate of cold water in kg/ s m_C=

Heat Gained by the Cold Water from the Hot Water Q_C =

$Q = (Q_H + Q_C) / 2 =$

Area for the Heat Transfer, $A = \Pi * d_o * L$

where, d_o = Outer Diameter of Inner Pipe,=0.025 m

L = Effective Total Length of Double Pipe Heat Exchanger=0.950 m

LMTD =

$U_0 = Q / (A * LMTD)$

Conclusion

Sr. No.	PARALLEL FLOW RUN	COUNTER FLOW RUN
	Practical U w/ m^2 °C	Practical U w/ m^2 °C

Marks Obtained **Sign of Faculty**