CFD Analysis of Heat Exchanger

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Abstract— There is a need to transfer heat from a thermodynamic system in most of the applications. So the heat exchangers play an important role and many attempts were done to increase their efficiency. The efficiency of a thermodynamic system containing heat exchanger mainly depends on its ability to transfer heat. The efficiency can be improved by providing fins which increase the heat transfer capacity of the system. There is various cross sections of fins used to improve the efficiency of the system. Here we have decided to use a continuous fins and analyse its efficiency. This can be expanded to using various cross sections in continuous fins.
Key words: CFD, Heat Exchanger

I. INTRODUCTION

They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air.

II. HEAT EXCHANGER

A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall to prevent mixing or they may be in direct contact.

Heat exchangers are devices that facilitate the exchange of heat between two fluids that are at different temperatures while keeping them from mixing with each other. Heat exchangers are commonly used in practice in a wide range of applications, from heating and air-conditioning systems in a household, to chemical processing and power production in large plants. Heat exchangers differ from mixing chambers in that they do not allow the two fluids involved to mix. In a car radiator, for example, heat is transferred from the hot water flowing through the radiator tubes to the air flowing through the closely spaced thin plates outside attached to the tubes.

Heat transfer in a heat exchanger usually involves convection in each fluid and conduction through the wall separating the two fluids.

III. TYPES OF HEAT EXCHANGERS

Different heat transfer applications require different types of hardware and different configurations of heat transfer equipment. The attempt to match the heat transfer hardware to the heat transfer requirements within the specified constraints has resulted in numerous types of innovative heat exchanger designs. The simplest type of heat exchanger consists of two concentric pipes of different diameters, called the double-pipe heat exchanger. One fluid in a double-pipe heat exchanger flows through the smaller pipe while the other fluid flows through the annular space between the two pipes.

Two types of flow arrangement are possible in a double-pipe heat exchanger: in parallel flow, both the hot and cold fluids enter the heat exchanger at the same end and move in the same direction. In counter flow, on the other hand, the hot and cold fluids enter the heat exchanger at opposite ends and flow in opposite directions.

Two General types of Heat Exchangers:

- Parallel Flow Heat Exchanger
- Counter Flow Heat Exchanger

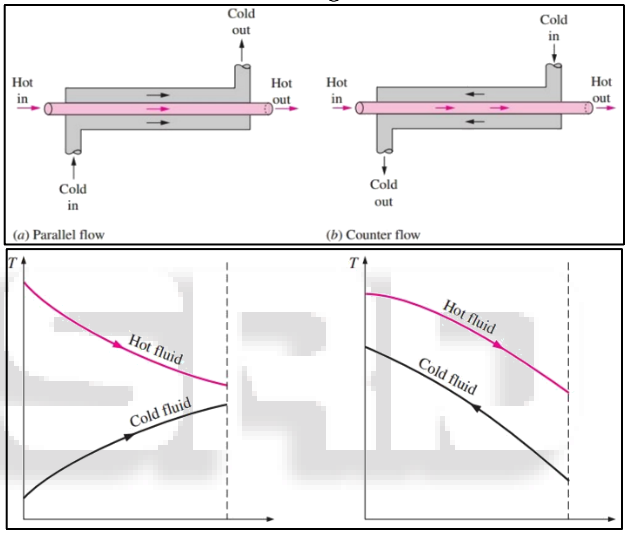

Fig. 1.1: Hot and Cold Fluid, Graphical Representations

A heat exchanger typically involves two flowing fluids separated by a solid wall. Heat is first transferred from the hot fluid to the wall by convection, through the wall by conduction, and from the wall to the cold fluid again by convection. Any radiation effects are usually included in the convection heat transfer coefficients. The thermal resistance network associated with this heat transfer process involves two convection and one conduction resistances, as shown in Figure below.

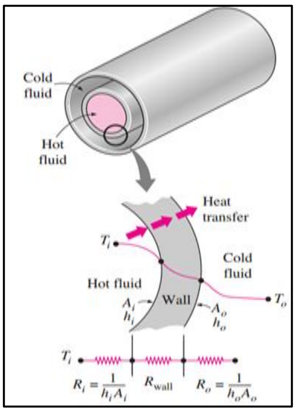

Fig. 1.2: Thermal Resistance Network Associated with Heat Transfer in a Double-Pipe Heat Exchanger

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IV. SHELL & TUBE HEAT EXCHANGER

Shell and tube heat exchangers consist of a series of tubes. One set of these tubes contains the fluid that must be either heated or cooled. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required.

A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned, etc. Shell and tube heat exchangers are typically used for high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260 °C).

This is because the shell and tube heat exchangers are robust due to their shape. Several thermal design features must be considered when designing the tubes in the shell and tube heat exchangers:

Tube diameter: Using a small tube diameter makes the heat exchanger both economical and compact. However, it is more likely for the heat exchanger to foul up faster and the small size makes mechanical cleaning of the fouling difficult. To prevail over the fouling and cleaning problems, larger tube diameters can be used. Thus to determine the tube diameter, the available space, cost and the fouling nature of the fluids must be considered

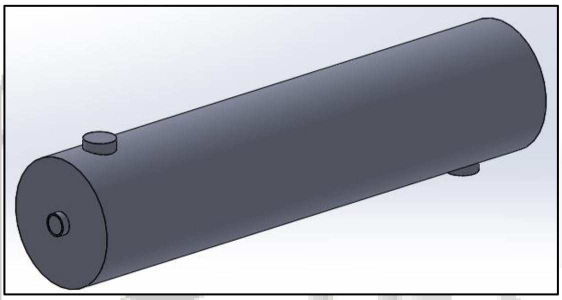
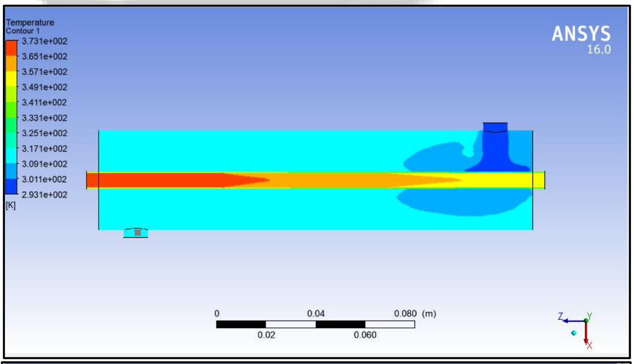
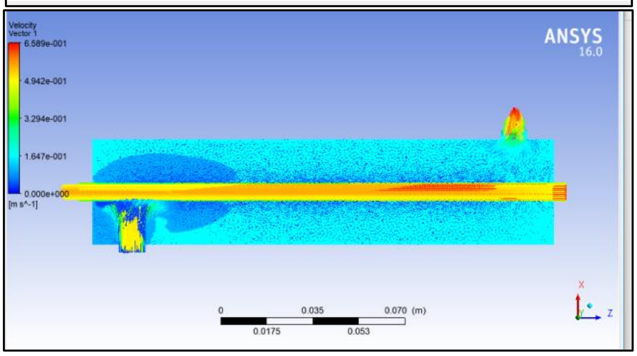


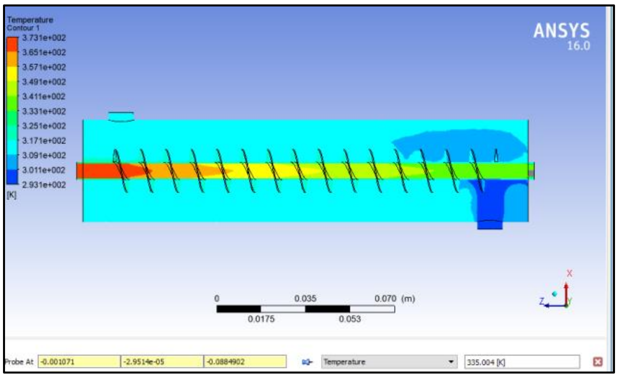
Fig. 1.3: Shell & Tube Heat Exchanger in Solid Model

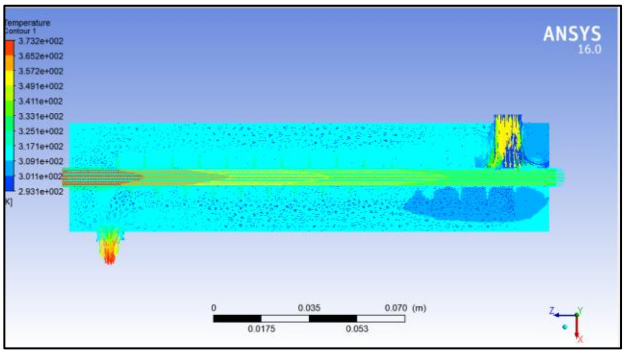
A. Shell & Tube Heat Exchanger





B. Spiral Finned Tube Heat Exchanger





V. RESULTS

Observation of Heat transfer on both cases:

without fin	With Fin	
Water Inlet Temp (K):	373	373
Water Outlet Temp (K):	354	335

Thus the observed heat transfer in Finned Heat Exchanger is very much higher than Without Finned Heat exchanger.

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