

A Comprehensive Study On Heat Exchanger

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INTRODUCTION

An apparatus used to transfer heat between two or more fluids or between a fluid and a solid surface is called a heat exchanger. Heat exchangers are extensively employed in numerous sectors and uses where effective and efficient heat transmission is required.

The movement of thermal energy from one fluid (the hot fluid) to another (the cool fluid) without the fluids mixing is the fundamental idea behind a heat exchanger. Heat exchangers are crucial parts of many industrial processes, including electricity generation, chemical processing, air conditioning, heating, cooling, and refrigeration.

Basic Principle:

Heat exchangers work on the principle of heat transfer from a hot fluid to a cooler fluid through a solid wall. The fluids can be liquids, gases, or a combination of both.

Basic Modal of Heat Exchanger :

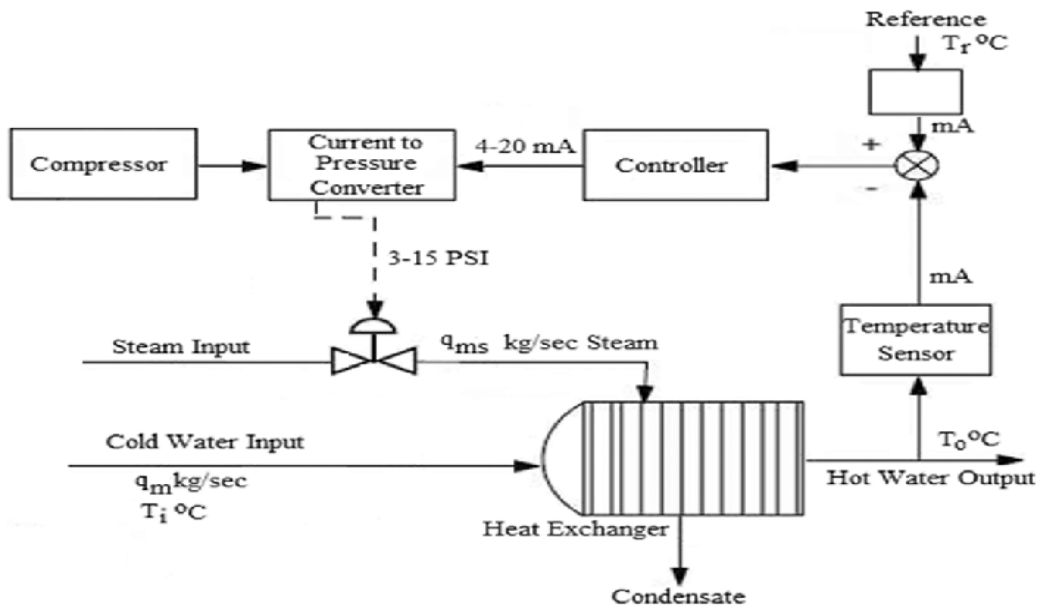


fig. - Basic Model of Heat Exchanger

Heat Transfer Modes :

Conduction: Heat transfer through solids or stationary fluids due to molecular collisions.

Convection: Heat transfer between a solid surface and a moving fluid.

Radiation: Heat transfer through electromagnetic waves.

Types of Heat Exchangers :

- 1. Shell and Tube Heat Exchangers :** This type consists of a shell (outer vessel) with multiple tubes running through it. One fluid flows through the tubes, while the other flows over the tubes inside the shell. This design allows for efficient heat transfer due to the large surface area available for exchange.
- 2. Plate Heat Exchangers :** Plate heat exchangers use a series of metal plates to transfer heat between fluids. The plates have large surface areas and are arranged in such a way that the hot and cold fluids flow alternately between them. This design maximizes heat transfer efficiency while minimizing the space required.
- 3. Finned Tube Heat Exchangers :** Finned tube heat exchangers have tubes with extended surfaces (fins) attached to them. These fins increase the surface area available for heat transfer, enhancing the efficiency of the heat exchanger.
- 4. Double Pipe Heat Exchangers :** This type consists of two concentric pipes, with one fluid flowing through the inner pipe and the other flowing through the annular space between the inner and outer pipes. Double pipe heat exchangers are simple in design and are often used in applications with low heat transfer requirements.
- 5. Plate-Fin Heat Exchangers :** Plate-fin heat exchangers use layers of flat plates with fins to increase the surface area available for heat transfer. These heat exchangers are compact and lightweight, making them suitable for applications where space is limited.

Heat Exchanger Design Parameters

Heat Transfer Area : The surface area across which heat is transferred between the fluids.

Overall Heat Transfer Coefficient (U) : Represents the overall efficiency of the heat exchanger in transferring heat between the fluids.

Flow arrangement : Determines how the hot and cold fluids flow through the heat exchanger (parallel flow, counter flow or cross flow).

Effectiveness and NTU Method

- The effectiveness of a heat exchanger is a measure of how effectively it transfers heat between the two fluids.

- The Number of Transfer Units (NTU) method is commonly used to analyze and design heat exchangers. It relates the heat transfer rate to the heat capacity rates of the fluids and the heat exchanger configuration.

Log Mean Temperature Difference (LMTD)

The logarithmic mean temperature difference is used to determine the temperature driving force for heat transfer in a heat exchanger with fluid streams at different temperatures.

Performance Evaluation:

Heat exchanger performance is evaluated based on parameters such as efficiency, pressure drop, fouling resistance, and material compatibility.

Applications:

Heat exchangers are used in a wide range of applications, including:

- HVAC systems for heating and cooling buildings.
- Refrigeration systems.
- Power plants for generating electricity.
- Chemical processing industries for heat transfer in various processes.
- Automotive industry for engine cooling and air conditioning

CONCLUSION

Heat exchangers are essential components of many industrial systems and processes because they save operating costs, increase energy efficiency, and maintain ideal temperatures. They are available in a range of designs and combinations to satisfy the demands of certain applications.