SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF FOOD TECHNOLOGY

HEAT EXCHANGE

INTRODUCTION

- Heat exchangers are devices that facilitate the exchange of heat between two fluids that are at different temperatures without the fluids coming into contact.
- Heat is transferred from the hot fluid to the cold fluid.
- Heat exchangers are classified according to heat transfer process, type of construction and flow arrangement as follows.

HEAT TRANSFER PROCESS

Direct contact heat exchangers

- These classes of exchangers do not have a physical barrier between the hot and the cold fluids.
- Direct mixing of the fluids takes place which results in simultaneous heat and mass transfer.
- This setup is only employed when the mixing of fluids does not pose problems, or is actually required. For example: cooling tower.

Regenerative Exchangers

- Heat is alternately stored and removed from a heat surface in a regenerative exchanger.
- Called the matrix of the generator, the heat transfer surface is moved into and out of the fixed hot and cold fluid streams or, the cold and the hot currents is switched into and out of it as the case may be.
- These two types are called rotary and fixed regenerative matrix exchangers respectively.

Recuperators

- It is one of the most vital types of heat exchanger.
- There is a clear demarcating physical barrier between the hot and the cold fluids all along their flow.
- It is perfect for cases where one cannot afford to mix the fluids.
- Evaporators of an ice plant and automobile radiators are examples of this type of exchanger.

DESIGN AND CONSTRUCTION

Shell and heat tube exchangers

- If larger flows are involved, a shell and tube exchangers is used, which is the most important type of exchanger in use in the process industries.
- In these exchangers the flows are continuous. Many tubes in parallel are used where one fluid flows inside these tubes.

Even though there are no strict conditions on this the following points are taken into consideration normally.

i. The corrosive fluid shall pass through the tube side as the replacement of tubes is easier and cheaper than shell side
ii. The toxic, hazardous fluid shall pass through tube side. Because in case of any leakage it won't get exposed to atmosphere.

Plate and frame heat exchanger

- This exchanger consists of a series of thin plates normal to the direction of flow of the fluids.
- The plates provide a large surface area for heat exchange and are, at some places, more convenient than the shell and heat tube exchanger primarily because of its unique shape.
- This has a major advantage over a conventional heat exchanger in that the fluids are exposed to a much larger surface area because the fluids spread out over the plates.

Spiral heat exchangers

- This exchanger is formed by spiraling two parallel flat sheets to form a spiral consisting of two flow channels.
- The fluids flow through these channels and because of the shape, get a lot of surface area for heat transfer.
- The fluids generally flow in a counter current fashion in a spiral heat exchanger.

Double-pipe Heat Exchanger

- It consists of two concentric tubes with one fluid flowing in the inner tube and the other fluid flowing in the annular space between the two pipes.
- The fluids can be in concurrent or countercurrent flow.
- The exchangers can be made from a pair of single lengths of pipe with fittings at the ends or from a number of pairs interconnected in series. These can be used for small flow rates.

Cross flow Heat Exchanger

- The fluids move in cross flow (perpendicular to each other) with one fluid flowing in the tubes and the other fluid flowing over the tubes in the transverse direction.
- The fluid inside the tubes is considered to be unmixed since it is mixed it can move about freely between the tubes and there will be a tendency for the gas temperature to equalize in the direction of normal to the flow .There are two configurations of cross flow exchangers:

i. Finned with both fluids unmixed

ii. Unfinned with one fluid mixed and the other unmixed

FLOW ARRANGEMENTS

Heat exchangers are classified by their flow arrangements. There are three basic types of heat exchangers

1) Parallel Flow
2) Counter Current Flow
3) Cross Flow

Parallel flow Heat exchangers

- where the fluids move in the same direction are referred to as parallel flow.
- In Parallel flow heat exchangers, the outlet temperature of the "cold" fluid can never exceed the outlet temperature of the "hot" fluid.
- The exchanger is performing at its best when the outlet temperatures are equal.

Counter flow Exchangers

- where fluids move in the opposite direction are referred to as counter flow.
- Counter flow heat exchangers are inherently more efficient than parallel flow heat exchangers because they create a more uniform temperature difference between the fluids, over the entire length of the fluid path.

Cross flow

- In cross flow exchangers, the hot and cold fluids move perpendicular to each other.
- This is often a convenient way to physically locate the inlet and outlet ports in a small package, however, it is less thermally efficient than a purely counter flow design.
- Many actual heat exchangers are a mixture of cross flow and counter flow due to space constraints that force the flow paths to wind back and forth.

HEAT EXCHANGER ANALYSIS

- Overall Heat Transfer Coefficient
- LMTD
- Effectiveness of heat exchangers

1.Overall heat transfer coefficient

Under steady operation, the mass flow rate of each fluid stream flowing through a heat exchanger remains constant.

2. Log-mean temperature difference (LMTD)

- Log-Mean Temperature Difference is used to relate the total heat transfer rate to inlet and outlet fluid temperatures.
- It determines the temperature driving force for heat transfer in flow systems. The LMTD is a logarithmic average of the temperature difference between the hot and cold streams at each end of the exchanger. The larger the LMTD, the more heat is transferred.

3. The effectiveness-NTU method

A heat exchanger effectiveness, is defined in terms of the actual heat transfer rate, q, and the maximum heat transfer rate, qmax, that would be obtained with a heat exchanger of infinite area.

THANK YOU