MGNewell
We Make It Work Better.




Heat Exchanger Overview

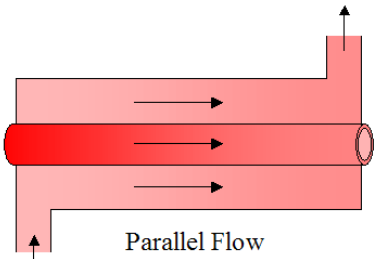
Heat exchangers allow control over the dynamics of heat transfer between fluids. They are used in widespread applications, such as solar heating, pool heating, domestic water heating, radiant floor heating, food processing, marine applications, general industrial process control, and more. The basics of heat transfer involve the second law of thermodynamics, which basically states that two thermodynamic systems, when allowed to interact, will move towards a thermodynamic equilibrium. In other words, when hot and cold substances are brought into contact with one another, the hot substance will cool and the cool substance will heat up, resulting in a median temperature.

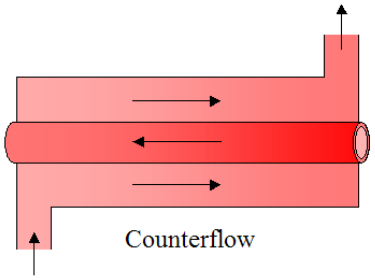
The study of heat transfer is important. It involves understanding your process, selecting the correct type of heat exchanger for the process and then optimizing the process. By controlling the thermal processing properties, it allows a producer to create certain product qualities, such as:

- Functionality
  - Preservation or retarded spoilage
  - Enzyme deactivation
  - Viscosity
- Appearance
  - Particulate identity
  - Color
  - Texture
- Sensory
  - Taste
  - Smell
  - Mouth feel

Basic Heat Exchanger Principles

A heat exchanger works by allowing two liquids of differing thermodynamic equilibria to interact, bringing about thermal transfer. In order to engender this interaction, a heat exchanger is designed according to one of three principle classifications regarding flow direction.





Parallel-flow heat exchangers involve fluid flowing in the same direction, in a parallel configuration. Counter-flow heat exchangers are constructed to allow liquid to flow in opposite directions. In both configurations, the design is such that the surface area of the wall separating the two liquids allows maximum surface area between the liquids, which contributes to the most efficient transfer of heat between them.

Under comparable conditions, more heat is transferred in a counter-flow arrangement than in a parallel flow arrangement. Counter-flow features a more uniform temperature difference which produces a more uniform rate of

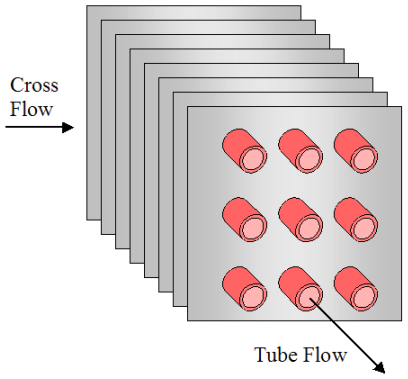
Greensboro Division / Corporate Headquarters
301 Citation Court
Greensboro, NC 27409
Phone: 336.393.0100 / 800.334.0231
Fax: 336.393.0140

Louisville Division
4400 Bishop Lane, Suite 112
Louisville, KY 40218
Phone: 502.459.7475 / 800.459.7475
Fax: 502.459.7633

Nashville Division
334 Free Hill Road, Suite B
Hendersonville, TN 37075
Phone: 615.822.3030 / 855.749.4820
Fax: 615.822.3031

www.mgnewell.com sales@mgnewell.com espanol@mgnewell.com

heat transfer throughout the heat exchanger. Parallel flow is advantageous when two fluids are required to be brought to nearly the same temperature.



The third type of flow involves a cross-flow in which flow moves across tubes rather than along their length. This type of flow typically offers better heat transfer than either parallel or counter-flow.

Types of Heat Exchangers

There are many different designs and layouts for heat exchangers, but in sanitary processing, shell and tube are the most common, followed by plate-and-frame and scrape-surface heat exchangers.

Plate-and-Frame HEX	Recommended for thin, low viscosity fluids, no particulates, $
Shell-and-Tube HEX	Recommended for thin to semi-viscous products with or without particulates; can be used for high pressure applications, $$
Scrape Surface HEX	Recommended for viscous (>1000 cps) products or products that are difficult to process, $$$

Shell-and-Tube Heat Exchanger

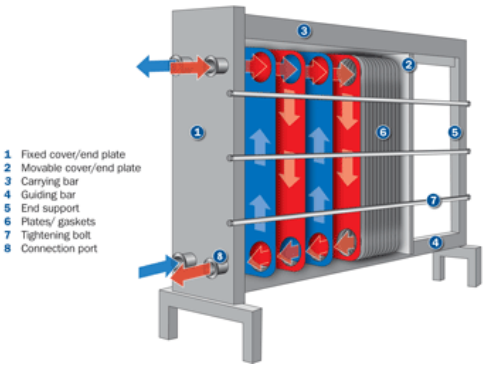
Shell and tube heat exchangers are comprised of multiple tubes through which liquid flows. The tubes are divided into two sets: the first set contains the liquid to be heated or cooled. The second set contains the liquid responsible for triggering the heat exchange, and either removes heat from the first set of tubes by absorbing and transmitting heat away—in essence, cooling the liquid—or warms the set by transmitting its own heat to the liquid inside.

These tubes can vary in tube diameter, thickness, length, corrugation, layout, and other physical characteristics. For instance, the smaller the tube diameter, the faster the heat transfer can take place and the more compact the unit can be; however, the thin diameter can also lead to malfunction, such as flow interruption. Tube heat exchangers can be designed to hold high pressure, high temperature thermal exchanges. When designing this type of exchanger, care must be taken in determining the correct tube wall thickness as well as tube diameter, to allow optimum heat exchange. In terms of flow, shell and tube heat exchangers can assume any of three flow path patterns.

Plate-and-Frame Heat Exchanger

Plate heat exchangers consist of thin plates joined together, with a small amount of space between each plate, typically maintained by a small rubber gasket. Multiple flat plates can be stacked one on top of the other in order to form a hermetically sealed volume into which fluid may be pumped. The plates have indentations and corrugations to encourage more turbulent flow across them and to make thinner films of product to promote better heat transfer.

The surface area is large, and the corners of each rectangular plate feature an opening through which fluid can flow between plates, extracting heat from the plates as it flows. The fluid channels themselves alternate hot and cold fluids, meaning that heat exchangers can effectively cool as well as heat fluid—they are often used in refrigeration applications. The large surface area allows for maximum contact between the liquids providing effective and efficient heat transfer. It is not uncommon for plate-and-frame heat exchangers to have overall heat transfer coefficients three to four times those found in shell-and-tube heat exchangers.



Advantages

- Good heat exchange, turbulent flow due to plate profile, very narrow flow area between the plates, reduced fouling due to turbulence and high velocity.
- Flow direction can be easily and frequently changed at design stage
- Lower space requirement; compact design
- Easy maintenance and cleaning

Disadvantages

- Potential for leakage - Although plate and frame heat exchangers are designed to allow the plates and the gaskets between them to be firmly clamped together, there is still a greater potential for leakage than with shell and tube heat exchangers.
- Higher pressure drop - The narrow passageways for fluid flow, which lead to a high overall heat transfer coefficient, also lead to a higher pressure drop, and thus a higher cost for pumping, than shell and tube heat exchangers.

Our next paper will highlight the features and benefits of scrape surface heat exchangers.