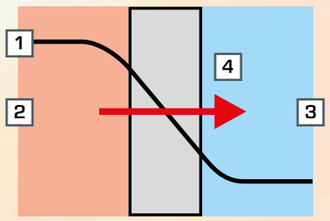
Basic Knowledge
Heat Exchangers

Heat transfer

Essentially the role of heat exchangers is to transfer the heat of a flowing material to another flowing material with a lower starting temperature. The materials can be gaseous or liquid. The temperature difference between the two media as the driving differential is essential for heat transfer.

The entire transferred heat flux is directly dependent on the transference surface. This is why different wall geometries (e.g. fins) are used in order to increase the transference surface area.

Heat transfer is divided into three stages: Heat transfer from the warmer medium to the wall, heat conduction through the wall and heat transfer from the wall to the colder medium.

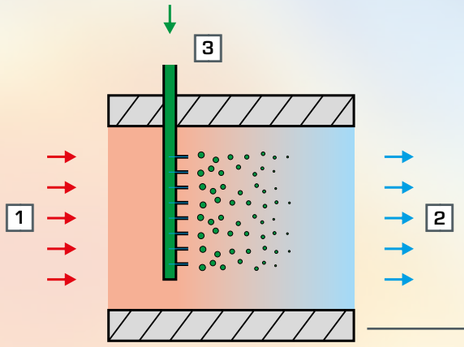


1 temperature progression
2 hot medium
3 cold medium
4 resulting heat flux

The heat transfer from the medium to the wall or from the wall to the medium is dependent upon the material type, the flow velocity and the aggregate states of the media, amongst other things. The heat conduction on the wall depends on the wall thickness and the wall material.

Type of contact between the media involved

If water is injected into a production process for cooling, this is known as direct heat transfer. There is no separation of the coolant and the product. The direct injection of water is used for example in the steel industry for intercooling or in wet cooling towers in the power station sector.



1 hot process gas
2 cooled process gas
3 injection of liquid (usually water)

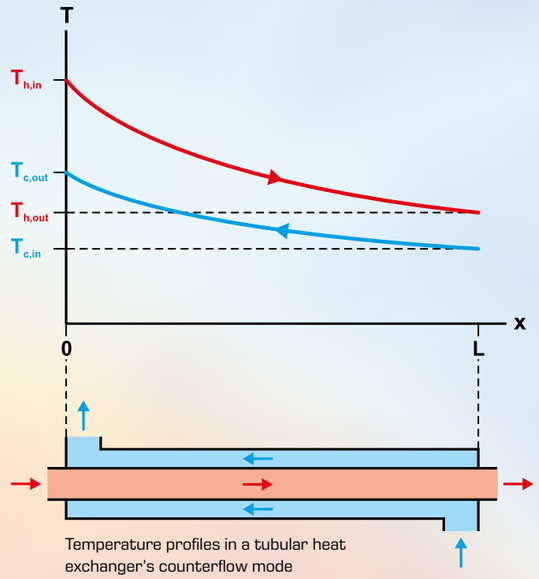
In contrast to direct heat transfer, the transfer of heat in spatially separated media is known as indirect transfer. The two materials are separated by a heat-permeable wall. The most well-known heat exchanger with indirect heat transfer is the domestic radiator.

Semi-indirect heat transfer is a special case which is used especially for heat storage. This mixed form is achieved by usage separated by time. During the day, heat storage is charged by a solar thermal system and during the night the thermal energy is discharged to heat rooms or as hot water.

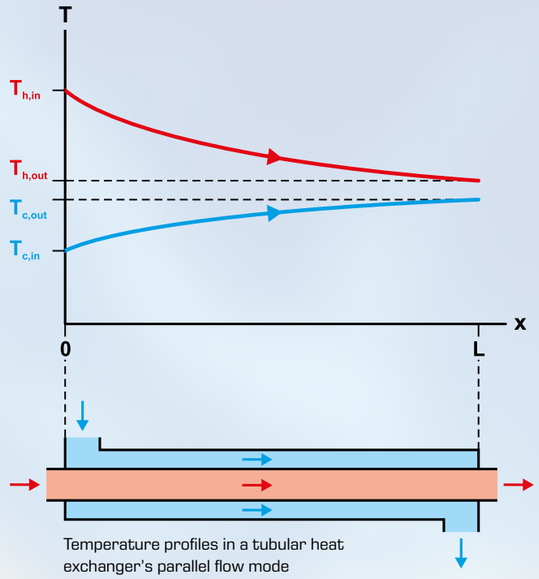
Flow conditions

The possible flow conditions of indirect heat exchangers are counterflow, parallel flow, cross flow or combinations thereof. One example of a combination is cross counter flow, which is commonly used in shell and tube heat exchangers. If the space available is limited, plate heat exchangers are often used. These are operated in counterflow.

This is not possible when operating the heat exchanger in parallel flow. The maximum outlet temperature of the cold side can be equal to the outlet temperature of the hot side. The media flow next to each other in parallel.



Temperature profiles in a tubular heat exchanger's counterflow mode



Temperature profiles in a tubular heat exchanger's parallel flow mode

In counterflow mode, the cold medium exits at the input of the hot medium. If the heat exchanger is well designed, it is possible to achieve a higher outlet temperature on the cold side than on the hot side.

The third variant is cross flow, which is used in particular for the precise temperature control of a temperature-sensitive product.

In order to use the advantages of all flow conditions, combinations of the basic forms are common. For example, a multiple-channel shell and tube heat exchanger can be used for quick and safe temperature control of large quantities of aggressive chemicals.