

## Heat Exchangers

Heat exchangers are common components in many everyday devices. Car engines, refrigerators, air conditioners, central heating boilers and radiators all contain heat exchangers. Their purpose is to transfer heat from a hot liquid or gas to a colder one.

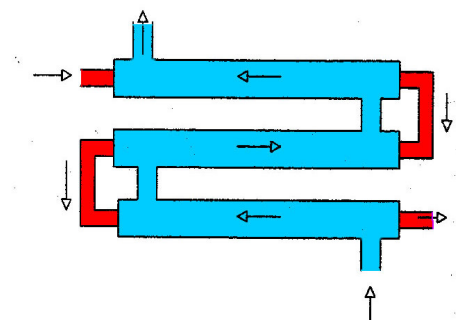
In industry, steam is often used for heating and cold water for cooling. A variety of heat exchangers have been designed to suit the range of heating or cooling applications.

The animation shows a "shell and tube" heat exchanger. When operating to heat up a liquid, hot water or steam will be pumped through the tank. This comes into contact with the pipes passing through the tank which contain the liquid that is to be heated. The arrangement of pipes gives a large surface area to conduct heat from the steam into the liquid inside the pipes.

The same arrangement can be used to cool a liquid passing through the pipes. In this case, cold water is pumped through the tank to carry away the heat from the liquid inside the pipes.

The tubes allow a large surface area for heat to be transferred. To improve the exchange of heat, the fluids flow in opposite directions. Baffles can direct the flow of fluid inside the tank to improve heat exchange however this design can be prone to damage due to the expansion and contraction of the fixed tubes.

Another type of heat exchanger has a single tube which is bent into an S-shape. Once again, the fluids flow in opposite directions to improve the heat transfer.



An example of a heat exchanger.

Cooling water (blue) enters at the bottom and flows in a jacket around the pipe containing the hot water (red) which enters at the top.

A hot jacket could be used to heat up a cooler liquid flowing in the pipe.

### Classroom contexts

These questions may provoke some discussion, or suggest further activities, within the classroom. Scroll down below the curriculum links for some suggested answers.

- Where are heat exchangers found in the home or car?
- What materials would be the best to make a heat exchanger.
- What materials are the best heat insulators?
- How are domestic heating radiators designed to be good heat exchangers?

## Links to the Primary Science National Curriculum

### Key stage 2

Sc3 - 1b  
(Materials)                      That some materials are better thermal insulators than others.

Sc3 - 2c  
(Materials)                      That temperature is a measure of how hot or cold things are.

#### ***Where are heat exchangers found in the home or car?***

The most obvious examples are car radiators and heating radiators. Both have large, flat surfaces to increase the area in contact with the air. Car radiators have many pipes and fins to increase the surface area even further. The car radiator works to cool the water passing through it while the heating radiator uses warm water inside to heat air in the room.

#### ***What materials would be the best to make a heat exchanger.***

The best heat exchangers will be made out of materials that conduct heat efficiently. These are usually metals. There will be other issues, such as strength and cost, which will decide on the type of metal. Copper is an excellent conductor of heat but it is expensive and so heating radiators are made out of steel. Expensive cooking pans will have a copper bottom to conduct the heat evenly to the food.

#### ***What materials are the best heat insulators?***

The Space Shuttle has ceramic tiles on its surface to act as a heat shield and prevent it burning up during re-entry into the earth's atmosphere. More common insulators are polystyrene, cotton wool and bubble-wrap.

#### ***How are domestic heating radiators designed to be good heat exchangers?***

Radiators have a large surface area and are thin. Apart from standing neatly against a wall, this shape provides a large warm surface that is in contact with the air in the room. Some radiators may have more than one section and fins to increase the area even more.