BSRIA

Heat Recovery Systems

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Plate heat exchanger

Thermal wheel

Run-around coil

Heat pipe heat exchanger

Air-source heat pump

A new guidance document from BSRIA

Heat recovery

Benefits of heat recovery

Heat recovery can be used in a range of building services applications. By utilising heat that would otherwise be wasted, energy consumption can be reduced. In some applications the use of heat recovery can result in a requirement for smaller capacity heating and cooling equipment.

The benefits of heat recovery should be considered in conjunction with the heat recovery equipment capital and installation costs, cost of any increased fan or pump power (resulting from increased pressure drops relating to the heat recovery equipment), and ongoing maintenance requirements.

Air-to-air heat recovery

Buildings that are mechanically ventilated have the potential to recover some of the heat that would otherwise be rejected by exhaust air. In practice, heat in the exhaust air is transferred to the fresh incoming air. Where an air-based air-conditioning system is used, exhaust air can be used to cool incoming air when the exhaust air temperature is lower than the external air temperature. This is sometimes known as recovering coolth.

The cost-effectiveness of air-to-air heat recovery will improve as the temperature difference between the outside and inside air widens, and as the volume of air supplied or exhausted from the building rises.

Although it is generally more cost-effective to install heat recovery at the same time as the ventilation system, retrofitting of heat recovery to existing systems can also be cost-effective.

A range of air-to-air heat recovery techniques are available:

- Plate heat-exchanger
- Thermal wheel
- Run-around coil
- Heat pipe heat exchanger
- Air-source heat pumps
- Closed water-loop heat pumps

Plate heat-exchanger

A plate heat-exchanger consists of a framework supporting a number of thin plates spaced apart with air passages between them. The plates are normally of metal providing only sensible heat transfer, but can be made of other substances, including treated paper or polymeric membrane which would allow latent heat transfer as well. The plates may either have flat surfaces or corrugated or finned surfaces and a typical plate spacing is between 2 mm and 12 mm.

The airflow arrangements can be parallel, counter and cross flow. Each has a theoretical maximum efficiency with counter flow providing the best. In practice, to allow for a compact arrangement, cross flow types are most numerous.

An advantage of this type of exchanger is that a wide range of plate surface types, combinations, finishes and plate spacings is available to suit many applications. Plate heat-exchangers are relatively simple devices with no moving parts. Most manufacturers offer their heat exchangers in modular form so that the appropriate number of modules may be selected to suit different air flow rates.

Advantages include:

- No moving parts, except for control of the heat recovery rate and operation of the de-frost bypass dampers (if fitted).
- Little or no possibility of cross-contamination of air streams (airtight construction is required).
- Plate material (including protective surface coating) and plate spacings can be selected to suit a wide range of applications.
- Easily cleaned where the exchanger can be freely withdrawn from the duct.
- Some media types permit latent heat transfers by using a permeable membrane.

Disadvantages include:

- Static pressure differences between fresh air and exhaust air streams is limited, depending on construction.
- A bypass may be needed to avoid over-heating fresh air in summer and to reduce the power when recovery is not needed.
- Care in filtration is required to avoid fouling of surfaces.

Thermal wheel

A thermal wheel (also known as a rotary regenerator) consists of a matrix in the shape of a wheel located inside the adjacent fresh air and exhaust air ducts.

The wheel rotates slowly at about 8 to 15 rev min. As it rotates, so the matrix material in the airstream absorbs heat from the warmer air stream and releases the heat again on re-entering the cooler air stream, which flows through the wheel in the opposite direction. The rotation of the wheel allows for a continuous transfer of heat from one air stream to the other due to the heat storage capacity of the matrix medium.

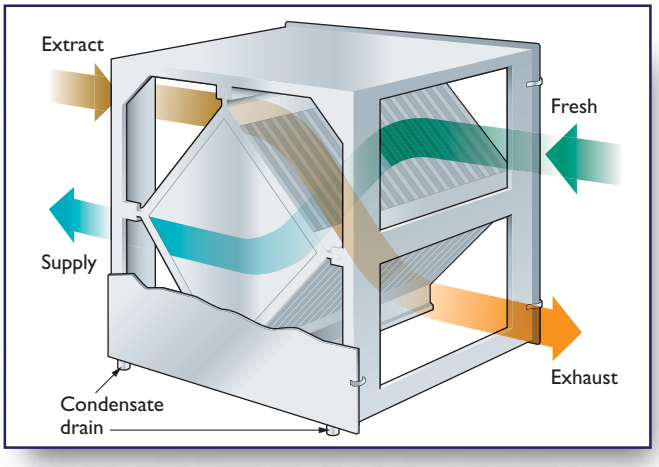
The thermal capacity of the matrix is important and this may conflict with its resistance to flow and tendency to clog. Non-metallic matrices may use a desiccant coating to achieve latent heat transfer, which significantly improves their effective heat capacity.

Advantages include:

- Some types of thermal wheels can transfer latent as well as sensible heat.
- Relatively high heat-transfer efficiency, compared to other types of air-to-air heat recovery devices, should be better than 70% for high quality units.
- The energy consumption of the electric motor rotating the wheel is very low compared to heat recovery savings.
- Matrix material and density can suit a wide range of applications.
- Can be used for either heating and cooling applications.

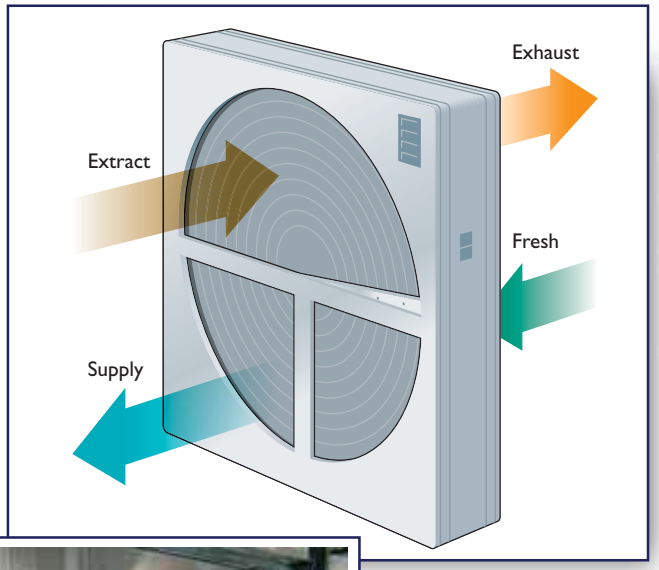
Disadvantages include:

- Regular air filter maintenance and replacement is essential because the wheel matrix is difficult to clean, especially in larger units.
- Static pressure in the fresh air stream must be higher than that in the exhaust air stream to limit cross-contamination and for successful operation of the purge unit (where fitted).
- The wheel occupies a relatively large space in the plant room.
- The large ratio of surface area to volume of matrix material makes this type of heat exchanger particularly susceptible to corrosion (depending on the material used).
- Internal leakage can be an issue but should be limited to less than 5% in high quality units.



Source: Norwegian Building Research Institute

An example of an air handling unit with a cross-flow plate heat-exchanger. This is mounted in the path of both air streams and transfers heat between them. A run-around coil heat recovery system works in a similar manner but without a change in the direction of the air stream.



Above: Schematic of a thermal wheel.

Left: An example of a thermal wheel.