

How to implement heat recovery in refrigeration

Recovering waste heat produced by the refrigeration process can save energy and cut costs.

Industrial and commercial companies of all sizes and in all sectors use refrigeration plant to reduce the temperature of buildings. The food industry also uses refrigeration in the production and storage of food and drink.

Heat recovery equipment can be fitted to existing plant, or companies can specify new plant with heat recovery already integrated. In both cases, the technology allows waste heat to be re-used for space heating or hot water.

The business case

The cost depends on size, but even on some small units, companies could recoup their investment in less than five years. For a 200kW chiller, heat recovery equipment would cost around £10,000 installed. Assuming 3,000 hours' operating a year and current gas prices, the heat recovered could add up to a saving of £5,400 – giving a payback in less than two years.

A new 150kW capacity chiller with full heat recovery would be around £26,000 installed, but operating on the same number of hours as above, could save £13,500 and give a payback in around two years.

The technology

The refrigeration process includes a heat rejection stage to cool the refrigerant for re-use in the cycle. The heat is given up at the condenser, and it's here that there is an opportunity to recover and re-use that heat.

This guide applies to refrigeration systems that use compressors for increasing the refrigeration effect rather than to absorption chillers. Whether you can have high or low grade heat depends on the type of installation and the refrigerant used. See *Figure 1*.

High grade heat recovery

High grade heat comes from 'de-superheating' the refrigerant between the compressor and the condenser. This heat can be between 60°C and 90°C.

A heat exchanger (the de-superheater) is installed, with the refrigerant on one side and the fluid to be heated on the other. Not only does this de-superheat the refrigerant, it reduces the cooling water or air needed by the condenser.

The size of the de-superheater is generally designed to meet hot water demand. If demand varies, though, a storage vessel can be used. See *Figure 2*.

Figure 1 A typical water-cooled refrigeration system. Small systems tend to have air-cooled condensers.

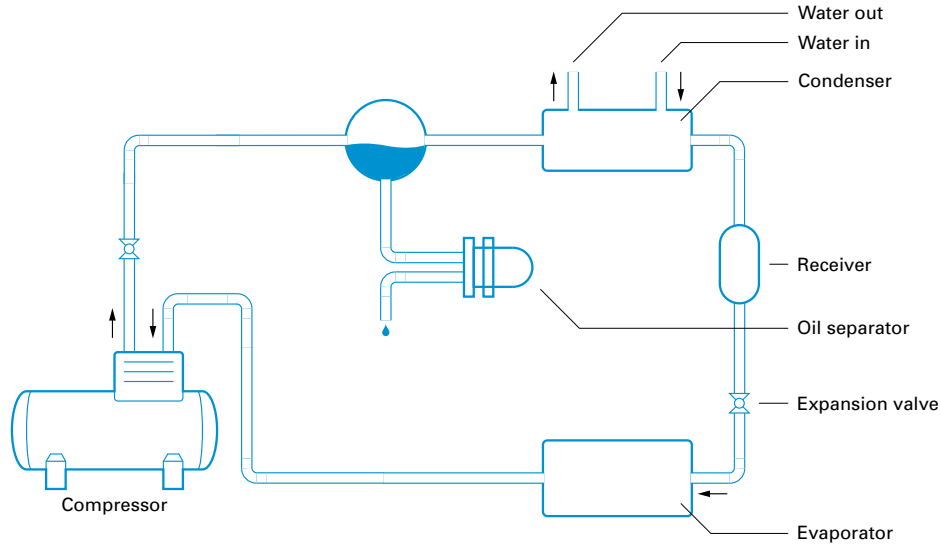


Figure 2 High grade heat recovery

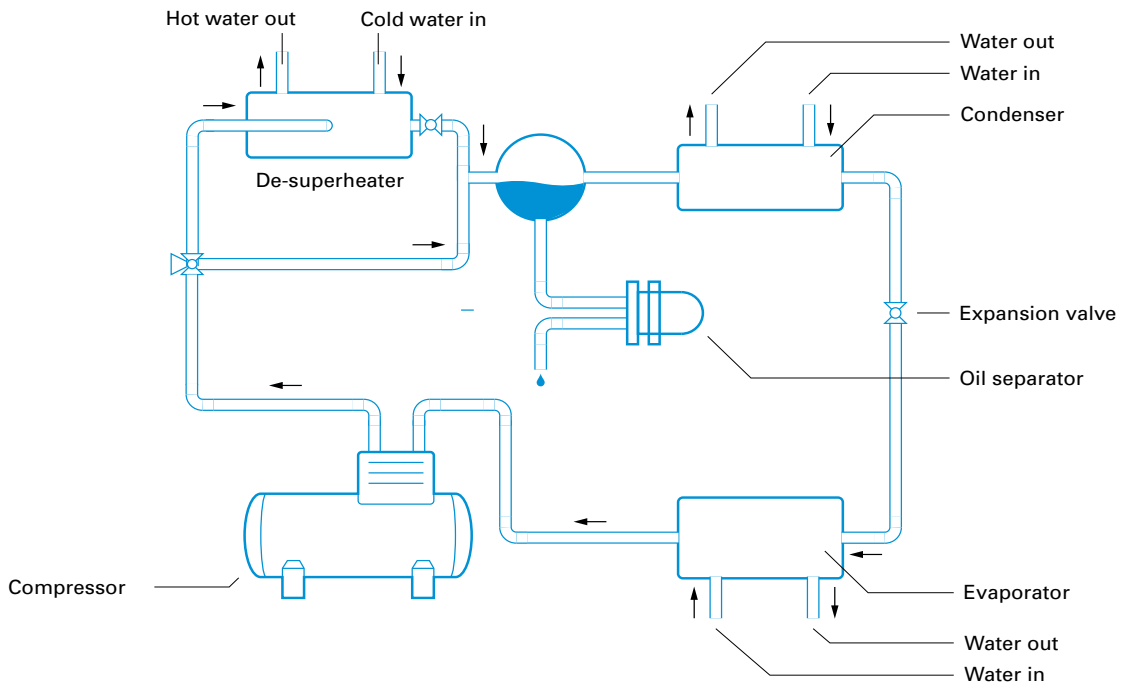
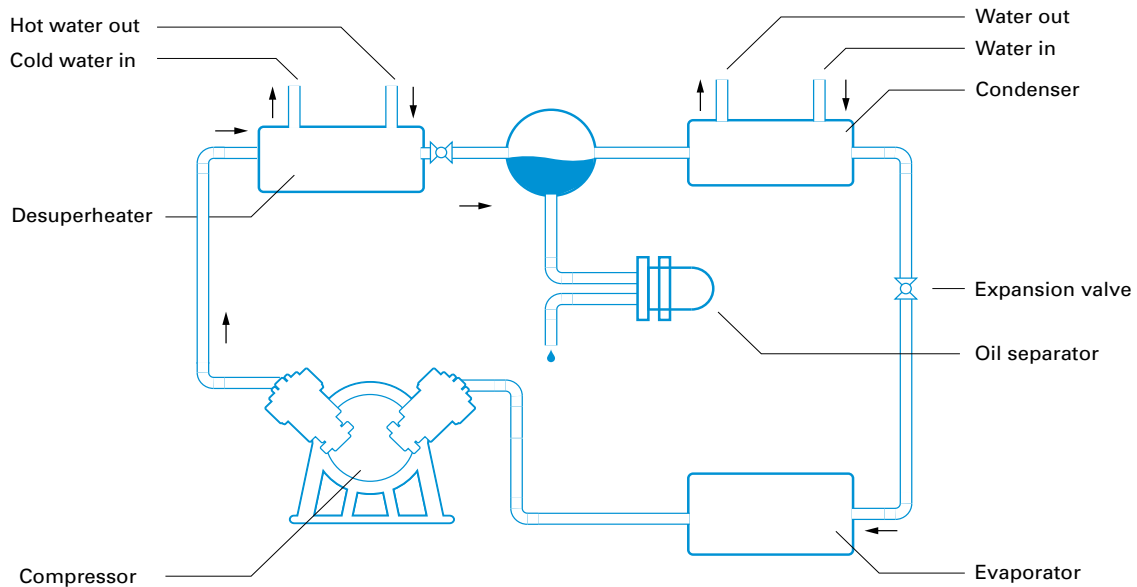


Figure 3 Low grade heat recovery

Low grade heat recovery

Low grade heat comes from the refrigerant being condensed. In the UK, this gives a temperature of between 20°C and 40°C.

At higher temperatures, heat is easier to recover and use, but it's only possible to recover between 5% and 10% of the total heat being rejected by a system.

If plant uses air-cooled condensing, the air from the condenser can be ducted to where it's needed.

The warm water produced by water-cooled condensers can be recovered too, with a heat pump to raise the temperature to a more useful level if required.

Applications

Heat recovery from air-cooled condensers is most often used to supplement space heating in neighbouring buildings. Heat recovered from a water-cooled system or a de-superheater has wider applications, including:

- process plant where demand for hot water is high, such as in steam boiler water pre-heating
- food processing plants where, for example large amounts of hot water are needed for washing down
- buildings that need air conditioning and hot water, such as swimming pools and hospitals.

Heat recovery can be applied to most sizes of plant, from small 'split' units for a room to units of more than 1,000kW used in food storage. When fitting heat recovery equipment to existing refrigeration plant, the amount recovered can be up to 30% of the cooling capacity, but isn't really viable below a compressor electrical load of 30kW. In new units, close to 100% of the waste heat can be recovered.

Specification Checklist

Actions	Comments
Identify a possible use for the heat.	
Identify the required temperature for the heat.	
If this is an existing installation, calculate or measure the heat available.	Consider using an expert or contractor to help work this out.
If this is a new installation, check with the supplier about the heat available.	
Is the heat recoverable less or equal to the heat needed?	If it's more than needed, then the design should be based on the maximum heat demand for the proposed use rather than the heat available.
Is the heat from the refrigeration plant generated at the same time as the heat is required?	If not, consider some form of storage tank.
If this is existing plant, can the system be modified to allow for a heat exchanger?	Pipework will need to be broken to install a de-superheater.
Check your contractor has the training and experience to work with refrigerants.	
Check that the proposed installation doesn't affect the main functions of the refrigeration plant.	The design of the heat recovery system for existing plants shouldn't allow higher operating temperatures. Consider using a consultant to check the design.

Commissioning checklist

Commissioning new plant or modifying existing equipment leads to changes in the refrigerant charge. New plant may come already charged or may need charging on site. Refrigerant in existing plant will need to be charged after modification. This should only be carried out by a competent contractor with the necessary training and certification.

- If the unit isn't charged with refrigerant, carry out a pressure test to ensure there are no leaks
- Evacuate any gas used for the pressure tests
- Charge the units with the correct amount of refrigerant
- Check the rotation of all electrical drives
- Check that all pipes are insulated
- Operate each item of plant separately
- Ensure that both the heat recovery plant and the plant using the heat are switched on
- Check operation against the design to ensure it meets its specifications.

Common problems

For efficient operation and to maximise energy savings, check that:

- the heat demand is switched on so that heat recovery can take place
- the control system for space heating is set up to respond to the replacement heat source, or the building may get too hot
- heat exchanger surfaces are clean for optimum heat transfer
- pipe insulation is intact
- filters in air recovery systems are not blocked.

Finding a supplier

Heat recovery is supported by the Government's Enhanced Capital Allowance Scheme. A list of approved equipment can be found at www.eca.gov.uk

The Institute of Refrigeration can supply a list of competent contractors.

Institute of Refrigeration

020 8647 7033

www.ior.org.uk