How to add adiabatic cooling to your refrigeration plant

Fitting adiabatic cooling to your air-cooled refrigeration plant will improve its efficiency and save you both energy and money.

Adiabatic cooling involves spraying water into the air supply of an air-cooled condenser to pre-cool the air. Cooler air increases the effective capacity of the condenser, which reduces the work required of the refrigeration compressor. This means that your system will consume less energy, saving you money. You'll make most of your savings during warm weather – adiabatic cooling is usually turned off when it's cold.

The business case

The cost of installing an adiabatic cooling system depends on the size of the condenser. As a general rule you're likely to recoup your investment within two years. An added advantage is that the reduced load on the compressor lengthens its lifespan and cuts maintenance costs. However, the system does consume water, so you'll have to take into account increased water costs.

A 300kW chiller will cost around £2,000 to install.

Based on 1,500 operating hours per year, it will save you around £1,400 a year, giving a payback period of 1.4 years.

The technology

When water is introduced into the air flowing onto an air-cooled refrigeration condenser, it can evaporate, increasing the humidity and lowering the air temperature. Cooler air temperatures increase the effective heat rejection capacity of the condenser, lowering the condensing temperature and improving the system efficiency. Adiabatic cooling is only applicable to air-cooled refrigeration systems.

Adiabatic cooling technology relies on the difference between the ambient air dry bulb temperature and the wet bulb temperature. In summer, this differential is high, so the air can absorb more moisture. *Figure 1* demonstrates the varying heat differential at different times of year.

Figure 1 *Dry and wet bulb temperatures at different times of the year.*

Month	Maximum dry bulb °C	Maximum wet bulb °C	Average dry bulb °C	Average wet bulb °C
January	9	6	5	4
April	17	7.5	9	6
July	32	22.5	17.5	14
October	22	16	12	10

Adiabatic cooling can be achieved in different ways, but most systems include the following components.

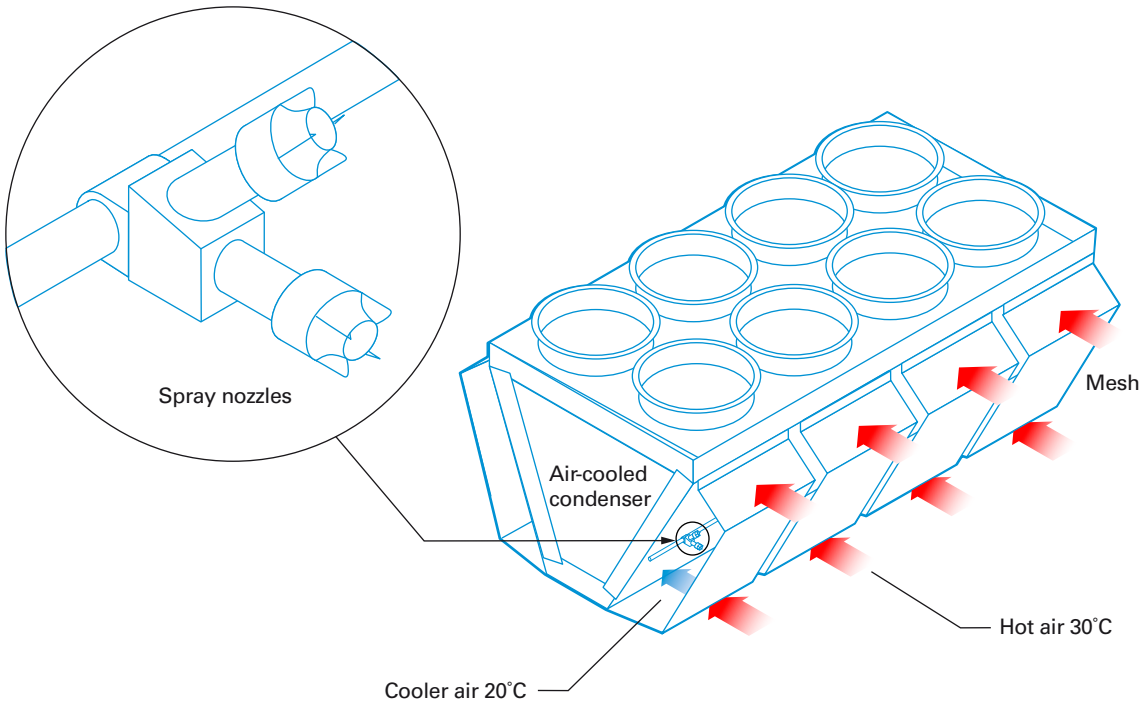
- A water supply system that intermittently sprays water into the air flowing onto the condenser. You can use a mains water supply, but if the water pressure is low you may need a pump.
- A non-metallic mesh fitted across the air flow onto the condenser. The water is sprayed onto this to keep it wet. The surface area of the mesh needs to be as large as possible to make the system effective in lowering the air temperature.
- A control system to make sure that water is only sprayed when needed and in the correct quantity. Water can be controlled either by a sensor measuring the temperature of the incoming air, or the refrigeration system condensing pressure.

As an adiabatic cooling system is designed to be a total loss system there should be little risk of Legionella contamination. Unlike wet cooling towers or evaporative condensers, all the water sprayed is evaporated, with no re-circulation of excess water, which avoids the conditions for bacterial growth. However, it is advisable to carry out a risk assessment and care should be taken in the design of the water pipework to avoid volumes of standing water. Some systems incorporate an ultra violet lamp to eliminate Legionella and other health risks.

To prevent corrosion problems, you should fit non-metallic sprays and make sure that water is not sprayed directly onto the condenser coil. If you are using meshes, these should also be non-metallic and be fitted externally so that they can be replaced without removing refrigerant from the system.

Figure 2 shows a typical adiabatic cooling installation. This design allows the user to reduce the dry bulb temperature, improving the effective capacity of the condenser.

***Figure 2** A typical adiabatic cooling installation*



Applications

Any type of air-cooled refrigeration system can benefit from adiabatic cooling. You can install it on:

- cold store systems
- retail central plant systems split air conditioning units
- rooftop chillers
- hospitals
- hotels
- process plants.

It can be used to increase cooling capacity, if your heat load has increased but your existing unit is below the required capacity.

***Figure 3** Points to consider*

Considerations	Comments
Is the condensing system air-cooled?	If not, then adiabatic cooling is not an option.
What is the rating of the condensers?	Ask your supplier.
What is the mains water pressure at the site?	If gauge pressure is below 2 bar, you may need a pump.
What is the water quality at the site?	A filter should be installed in the incoming water supply. If your water is hard, ask your supplier if any additional treatment is needed.
How will the Legionella risk be minimised?	Discuss with your supplier the precautions needed during the design and operation of the system.
How will the corrosion risk be minimised?	Discuss with your supplier whether there is an increased corrosion risk associated with the adiabatic cooling system and any precautions that will be taken to minimise this risk.
Are the condenser surfaces clean?	Make sure they are clean before any installation.
How will the water sprays be controlled?	Ambient temperature or condenser pressure? Discuss this with the equipment supplier to decide the best option.

Commissioning checklist

Once the system is installed, the water spray settings will depend on your operating conditions and the ambient air temperatures. You're likely to follow the following steps:

- If you're using mesh grids, make sure they are securely fastened to the condensing unit and check they match the design drawings.
- If you're using mains water directly, check the pressure.
- If a pump is being used, make sure it is rotating in the right direction.
- Make sure that the sprays are correctly aligned with the surface of the grid or condenser face and are not spraying water directly onto the coil.
- Start the refrigeration system. Once the system has reached normal operating conditions, switch on the water system. A water meter will help you set the best flow rate. Measure the air temperature before and after the water sprays to check that the system is producing the results expected.

Common problems

For efficient operation, you need to check that:

- Filters in the water supply aren't blocked. This is particularly important in hard water areas.
- Spray nozzles aren't blocked. This can happen in hard water areas, or if the water isn't adequately filtered.
- Spray nozzles haven't become loose because of vibration.
- The area around the condensers is free of any obstructions so air can flow freely.
- If you're using a mesh, it isn't blocked by leaves or other debris. Always clean the area before starting the plant.
- There is no standing water left in the system when it is inactive, for example during winter. When the system is switched off or on standby, the water pipes should be self-draining.

You can avoid most of the problems above through regular inspection, cleaning and maintenance. Although there's a cost attached to extra maintenance, it's offset by the fact that you're less likely to have plant capacity problems (requiring technical assistance) during hot weather.

In the past, adiabatic cooling systems have sometimes been installed with water spraying directly onto the condenser fins. This can corrode the fins, which can lead to serious degradation of the condenser within two years. Always direct the water sprays away from the condenser fins.

Finding a supplier

You will probably need a specialist to help you select and install an effective adiabatic cooling system. The Institute of Refrigeration, British Refrigeration Association and the Heating and Ventilating Contractors' Association have lists of approved refrigeration and air conditioning equipment suppliers.

Institute of Refrigeration

020 8647 7033
www.ior.org.uk

British Refrigeration Association (BRA)

0118 940 3416
www.feta.co.uk

Heating and Ventilating Contractors' Association (HVCA)

0207 313 49006
www.hvca.org.uk

See the Carbon Trust website at www.carbontrust.co.uk for further information to help you make your refrigeration more energy efficient.