

How to implement adiabatic cooling for refrigeration plant

Adiabatic cooling is the process of spraying water into the air supply of an air-cooled refrigeration condenser to pre-cool the air and so improve its efficiency. When sprayed into the air stream, the water evaporates and increases the humidity in the air. The heat that is used in evaporating the water is removed from the air stream, resulting in the air temperature being lowered, and the condenser having to work less to condense the air.

The technology

The system has three major components:

1

A non-metallic mesh fitted across the air path to the air-cooled condenser.

2

A water supply system, which intermittently sprays water onto the mesh to ensure that it is always saturated.

- If the water pressure is low, a pumping system may be required. If not, water direct from the mains can be used.

Note that for the spray system to operate efficiently, the mains pressure must be above 1.5 barg.

3

A controller to ensure the water is controlled and only used when required to cool the air. The control of the amount of water added is critical and as it is a total loss system, i.e. all the water is evaporated by the air flow, legionella precautions should not be needed. The systems can be applied across the whole range of refrigeration and air conditioning plant.

The control of the water spray can be either from:

- A sensor measuring the temperature of the incoming air.
- The compressor head pressure.

The use of non-metallic sprays and mesh ensures that there are no corrosion problems resulting from the mixing of water with the equipment. Any damage to the meshes can be replaced without the need to remove refrigerant from the system. The surface area of the mesh needs to be maximised to allow the water to be effective in lowering the air temperature.

The adiabatic cooling technology relies on the difference between the ambient air dry bulb temperature and the wet bulb temperature. During the summer months, this differential is high. The wet bulb temperature is lower in the summer, as the amount of moisture in the air is less. This allows more cooling of the air, as it can absorb more moisture. The more moisture it can absorb, the more heat is removed from the air and hence a lower air temperature results. The following table shows the difference between the dry and wet bulb temperatures at different times of the year.

In short, in warmer periods, the potential savings are the greatest.

Figure 1 below shows a typical installation of adiabatic cooling; it shows the potential of reducing the dry bulb temperature, which is the driving force for improving the cooling rate of the refrigerant.

Application

The applications for this type of technology are across the whole range of air-cooled refrigeration systems. It can be used for:

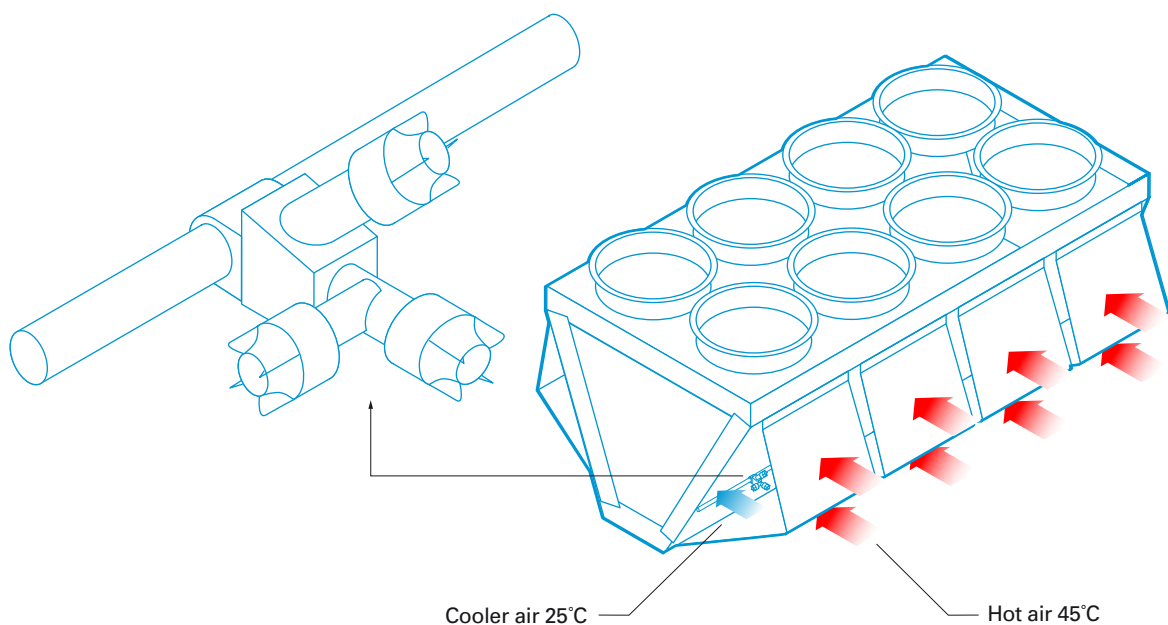
- Cold store systems.
- Split air-conditioning units.
- Roof top chillers.
- Increasing cooling capacity, where the heat load has increased, but the existing unit is below the required capacity.
- Hospitals.
- Hotels.
- Process plants.

The design rating of the condensers will decide the size of the adiabatic cooling to be installed.

Table 1 Dry and wet bulb temperatures at different times of the year

Month	Max Dry Bulb °C	Max Wet Bulb °C	Ave. Dry Bulb °C	Ave. 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

Figure 1 Typical installation of adiabatic cooling



Specification checklist

The check list below will allow a specification to be prepared for the potential installation of an adiabatic cooling system.

Commissioning procedure

The settings for the water spray system will depend upon the operating conditions and the ambient air temperatures, but as a general rule the following should be observed:

- Ensure that the mesh grids are securely fastened to the condensing unit.
- Check the mesh grids are as per the design drawings.
- If mains water is to be used, check the pressure.
- Ensure that the sprays are correctly aligned with the surface of the grid.
- If a pump is being used, ensure that it is rotating in the correct direction.
- Start the refrigeration system.
- Once the system has reached the operating conditions, switch on the water system
 - The installation of a water meter will help in optimising the flow rate.
- Measure the air temperatures before the mesh and after the water spray to ensure that the design conditions are being met.

Common Problems

The main problems will come from the following areas:

- Water pressure is not above 1.5 barg so that the system cannot be commissioned.
- Any filters in the water supply are blocked.
- The spray nozzles may become blocked, if the water filtration is not adequate.
- Spray nozzles become loose due to vibration.
- The area around the condensers needs to be free from any obstructions to allow a free flow of air to evaporate the water from the meshes.
- Leaves or other debris can block the mesh, so the area should be cleaned before starting the plant.

Table 2 Specification checklist

Item No.	Parameter	Comments
1	Is the condensing system air cooled?	
2	What is the rating of the condensers?	Contact supplier if not known.
3	What is the mains water pressure at the site?	If below 1.5 barg, a pump will be needed.
4	Are the condensers surfaces clean?	Ensure they are cleaned before any installation.
5	How are the water sprays to be controlled?	Ambient temperature or condenser pressure? Discuss with the equipment supplier to determine the optimum strategy.

Finding a supplier

The Institute of Refrigeration and the HVAC Association have lists of approved suppliers for refrigeration and air conditioning manufactures and suppliers. These can be contacted at the following:

Institute of Refrigeration

020 8647 7033

www.ior.org.uk

Heating and Ventilating Contractors Association

020 7313 4900

www.hvca.org.uk

The business case

The cost of installing an adiabatic cooling system is governed by the size of the air-cooled condenser. The savings therefore will also depend upon the size, but as a 'rule of thumb', a simple payback of less than two years is achievable. There is an added advantage that cannot be quantified, in that the reduced load on the compressor will increase its operational life and reduce maintenance costs. The capital cost of a typical installation for 300kW chiller would be £2,000 and the savings are estimated at £2,000 per annum, giving a simple payback of 1 year. The payback will depend upon the operating hours; this example is based upon 1,500 hours per year.