High Temperature Cooling

High temperature cooling is cooling of a product or place that is initially above 10°C and normally below ambient temperatures. This form of chilling provides cooling used for air conditioning applications and some industrial cooling systems as well as high temperature cooling chillers for process cooling. Although the ultimate aim may be to cool a room to 17°C, the chiller plant may have to provide a refrigerant temperature of 8-10°C to do this, due to the many heat exchange circuits in between the refrigerant gasses and the final air to be cooled.

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Types of High Temperature Refrigeration Systems

The main types of high temperature refrigeration systems used in Ireland are:

- **Single Stage Vapour Compressor**
  The single stage vapour compression refrigeration cycles are powered by an electric compressor. These compressors may vary as shown below. These types of systems normally use either a rotary or screw compressor or a reciprocating compressor. The rotary compressors are normally more efficient than the reciprocating when running at 100% output but can be inefficient depending on the design, at loads less then 70% of the full output. Such a system can provide 5 times more cooling than energy input.

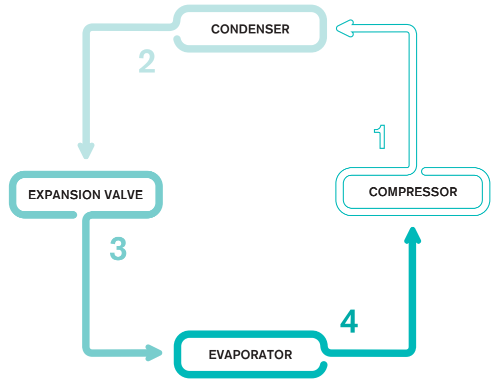
- **Desiccant Cooling Systems**
  These are non mechanical systems that cool air by passing it over a film of water. During evaporation the water takes sensible heat from the air, reducing its temperature by up to 5°C, while adding some moisture and humidity.

  It can be a cheap way to get cooling in the summer. The higher the difference between dry and wet bulb temperatures, the better the cooling effect. This type of system is fairly new in Ireland.

- **Absorption Chillers**
  These use chemical cooling cycles rather than compressors. Absorption chillers are usually powered by waste heat from another production process. They can provide cold water to 8°C and above. The higher the temperature of the waste heat source the better the overall efficiency.

Mechanical Chillers Process Flow Diagram

VAPOR COMPRESSION
REFRIGERATION CYCLE



The steps of the high temperature cooling cycle are

- **1-2:** Compressor of low pressure refrigerant gas using mechanical electrically driven compressor to a higher pressure and a temperature above ambient.
- **2-3:** The heat that the gasses absorb in the evaporator is released in the condenser by either blowing air over the refrigerant gasses or by letting water flow around the tubes containing the gasses. The high pressure refrigerant gasses are allowed to expand to a lower pressure.
- **4-1:** The lower pressure refrigerant gasses are allowed to flow in a metered fashion into the evaporator – which is in contact with the medium that needs to be cooled. Here the gasses absorb heat and in doing so cool the product or place.

High Temperature Cooling Energy Saving Opportunities

- Improved unit COP. The measured performance of a chiller is defined by the “Coefficient of Performance” or “COP”. Improvements to the operating performance of the chiller will improve the overall COP.
- Replace Chiller with different unit. It is important that the type of chiller is matched to the chilled water installation. Significant energy savings may be achieved by replacement of the existing chiller with a more appropriate or updated unit with a better COP and hence lower energy consumption.
- Improved match to load profile. Different types of chillers operate more efficiently at different loads, thus to optimise energy efficiency the load profile of the installation should be matched to the most appropriate chiller type.
- Replacement of CFC unit. CFCs are being replaced by more environmental friendly products which may additionally improve the overall energy efficiency of the installation.
- Electronic Expansion Valves. Use electronic expansion valves to help reduce condensing pressures and increase evaporating temperatures.
- Use free cooling if possible. Use well water or cooling tower water if available.
- Reduced maintenance cost for new unit. Installing a new chiller will inevitably reduce the maintenance cost of the chiller for a number of years.
- Reduced overall operating costs from change of fuel source. Whilst most chillers use electrical power, it is possible to use gas absorption chillers, which under certain circumstances can be more economic.
- Alter chiller sequencing controls. Automatic controls for chillers can be complex, chillers may have several steps of operation and where there is more than one chiller the range of operation may be significant. Correct adjustment of the chiller controls sequencing will be important to the efficient operation of the system.
- Introduce variable speed operation. The use of variable speed motor drives for chilled water circulation pump sets can significantly improve the energy efficiency of the installation, although care should be taken in the design of systems using variable speed pump sets.
- Cooling tower fans. Cooling tower fans can be variable speed controlled to reduce power consumption.
- Condenser water. Condenser water can be utilised for heat reclaim for the heating of domestic hot water or space heating.
- Chiller compressor. There are different types of chiller compressors available on the market. Depending on the size and type of installation will determine the most efficient type of compressor to be used.
- Replace cooling towers. Existing cooling towers may be inefficient in their operation. Energy savings can be made by replacing them with new units.
- Adjust chilled water set points to match demand requirements. The chilled water control system set points can be adjusted to better suit the load demand, thereby achieving improved energy efficiencies.
- Adjust condenser water set points to match demand requirements. The condenser water control system set points can be adjusted to better suit the load demand, thereby achieving improved energy efficiencies.
- Decentralise chilled water production. Centralised chiller installations may include extensive pipework giving rise to high pipe losses. Greater energy efficiency may be achieved using a number of smaller chillers located nearer to the cooling loads.
- Centralise chilled water production. Where there are a number of smaller chillers which are relatively close, and depending on the load profile, it is possible that greater energy efficiency is possible using a single centralised chiller unit. Reductions in maintenance costs can then be achieved.
- Reduced circulation volume. Due to changes and alterations to the chilled water installation, it is possible that a greater amount of chilled water is being circulated around the building then is necessary to meet the peak cooling load. Re-balancing of the system will enable the volume flow rate to be reduced accordingly.
- Pump/pump motor replacement. In some cases the pump installed may have a duty that is too high for the actual installation. By reducing the pump capacity to suit the load, energy saving and greater pump life can be achieved.

- Reduce hours of circulation. Many systems operate longer than required. By reducing the operating hours of the circulation pump, this will also reduce the energy consumption.
- Improve pipe insulation. If the pipe insulation is in a bad state of repair or is not of sufficient thickness, it will be beneficial to replace the insulation, reducing the energy wasted.
- Improve valve insulation. Over time the insulation around valves will break down, particularly where valve boxes are used. By replacing this insulation with a more flexible type, losses from the valves will be reduced.
- Reduce pipe length. Every metre of chilled water pipe within a structure accounts for energy consumption. Pump capacity as well as pipework energy losses are associated with the length of the pipe run. It may be possible to redirect pipework such that pipework lengths are reduced.
- Replace pump/pump motor/drive. Equipment which is close to the end of its serviceable lifespan is unlikely to operate efficiently. By replacing the equipment overall efficiencies will be greater, and energy savings and maintenance cost reductions will be made.
- Unit Efficiency. The configuration of existing equipment may be such that it is operating inefficiently. By making small adjustments to the equipment operation, energy savings will be possible.
- Matching to load. In many cases the equipment installed has a duty that is necessarily high for the installation. By reducing the equipment capacity to match the load, unit efficiency will be improved allowing energy savings and greater equipment lifespan. When installing any plant item it is important that it is sized to match the demand.

ESB Independent Energy has considerable expertise in the efficient utilisation of High Temperature Cooling Systems. If you require further information please contact your Customer Relationship Manager or ESBIE Head Office at 00 353 1 8628300.