

SORPTION REFRIGERATION - ADSORPTION SYSTEMS

Description of technology

Sorption refrigeration technologies such as absorption and/or adsorption are thermally driven systems, in which the conventional mechanical compressor of the common vapour compression cycle is replaced by a 'thermal compressor' and a sorbent. The sorbent can be either solid in the case of adsorption systems or liquid for absorption systems. When the sorbent is heated, it desorbs the refrigerant vapour at the condenser pressure. The vapour is then liquefied in the condenser, flows through an expansion valve and enters the evaporator. When the sorbent is cooled, it reabsorbs vapour and thus maintains low pressure in the evaporator. The liquefied refrigerant in the evaporator absorbs heat from the refrigerated space and vaporises, producing the cooling effect.

Adsorption refrigeration unlike absorption and vapour compression systems, is an inherently cyclical process and multiple adsorbent beds are necessary to provide approximately continuous capacity. Adsorption systems inherently require large heat transfer surfaces to transfer heat to and from the adsorbent materials which automatically makes cost an issue. High efficiency systems require that heat of adsorption be recovered to provide part of the heat needed to regenerate the adsorbent. These regenerative cycles consequently need multiples of two-bed heat exchangers and complex heat transfer loops and controls to recover and use waste heat as the heat exchangers cycle between adsorbing and desorbing refrigerant.

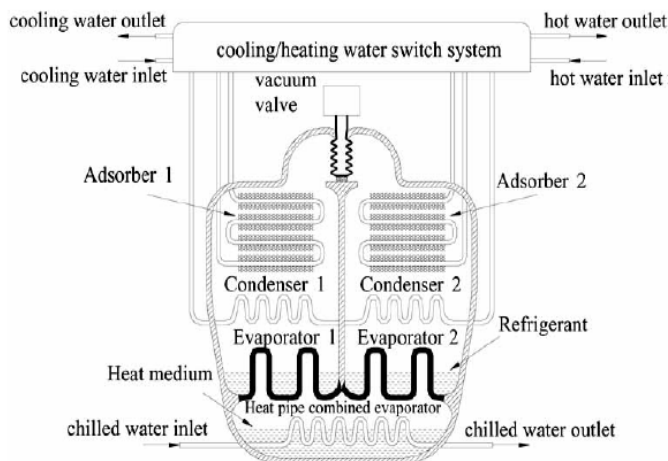


Figure Error! No text of specified style in document.. Schematic diagram of silica gel-water adsorption chiller. Xia, et al (2005).

State of Development

Adsorption systems for air conditioning applications are already commercially available from a small number of manufacturers. "MYCOM", Mayekawa Mfg. Co., Ltd. are producing Silica-gel/water adsorption chiller (ADREF-models) with ranges between 35 and 350 kW for use in the air-conditioning industry. NISHIYODO KUCHOUKI CO. LTD, produce Silica-Gel/Water adsorption chillers (ADCM models) with capacities between 70 kW and 1300 kW capable of being driven by low grade heat 50 – 90 °C and able to give COPs of over 0.7. Research and development is also underway to produce systems for refrigeration applications. Research prototypes for refrigeration temperatures down to – 25 °C are currently in operation

or under development.

Applications in the food sector

Applications in the food sector will be primarily in areas where waste heat is available to drive the adsorption system. Such applications can be found in food factories and transport refrigeration. Other possible application is in tri-generation where adsorption systems can be used in conjunction with combined heat and power systems to provide refrigeration. Such an application is currently under consideration in the UK by a major food retailer. The intended use is for air conditioning and sub-cooling of refrigerant liquid of the multi-compressor refrigeration packs.

Barriers to uptake of the technology

The main barriers to uptake of adsorption refrigeration technology:

- in their current state of development systems are bulky and of higher cost compared to competing vapour absorption systems
- only two manufacturers of commercial products and distribution channels are not well established

- application range of commercial products is currently limited to temperatures above 0 °C.
- unavailability of packaged equipment off the shelf for application in the food sector
- insufficient experience and performance data from commercial applications to provide confidence in the application of the technology.

Key drivers to encourage uptake

The main drivers to encourage uptake of the technology in the food sector are:

- successful demonstration of the benefits of the technology in applications where there is sufficient waste heat or in tri-generation systems.
- rising energy costs that could encourage the more effective utilisation of waste heat and better thermal integration of processes in food manufacturing and retail facilities.

Research and development needs

To increase the attractiveness and application of adsorption systems, research and development is required to:

- increase efficiency and reduce size and cost of systems through heat and mass transfer enhancement.
- develop systems for low temperature applications below 0 °C. This will require further development of working pairs (fluid and bed).