MANTECH Publications
Journal of Product Design, Quality Engineering & Technology
Volume 2, Issue 3, September-December 2017

Solar Cooling In Building

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Abstract

The solar cooling technologies applied in construction. There are three cooling technologies: absorption, adsorption and DEC –Desiccant Evaporative Cooling applied coupled with solar systems. What the stress is placed on are cooling systems of a high installed capacity of several hundred kW. Large scale solar cooling systems are not used in Poland. However, modern public buildings, especially offices with huge glazed facades very often require more energy for cooling than space heating. Solar cooling seems to be prospective technology to reduce energy consumption used by traditional air conditioning units. The development of renewable energy is on the rise worldwide because of the growing demand on energy, high oil prices, and concerns of environmental impacts. In recent years, progress on solar-powered air conditioning has increased as nowadays, air conditioning system is almost a must in every building if we want to have a good indoor comfort inside the building. Therefore, this type of system focuses in the design and construction of a direct current (DC) air conditioning system integrated with photovoltaic (PV) system which consists of PV panels, solar charger, inverter and batteries. The air conditioning system can be operated on solar and can be used in non-electrified areas. As we all known, solar energy is cost effective, renewable and environmentally friendly.

Keywords: *High energy consumption, Peak load demand, solar assisted air conditioning System solar energy, absorption chiller, evacuated tube solar collector*

INTRODUCTION

The demand of air conditioning is increasing due to the effect of climate change and global warming. If we still rely on the conventional electric air conditioning but electricity is generated from fossil fuels, the greenhouse gas emission would continuously worsen global warming, in turn the demand of air conditioning would be further increasing. In subtropical cities, air conditioning is a standard provision for buildings. However, air conditioning would commonly take up half of building electricity consumption.

The actual performance of the system will be studied based on operational view and commercial Introduction and background It is important to mention that using solar energy in combination with active heating and cooling is not an alternative to energy efficiency measures and passive systems, which make use of environmental heat sources and heat sinks, respectively. In contrast, application of active solar cooling technology should always go hand in hand with energy efficiency measures and a holistic overall design of the building and the solar assisted heating, ventilation and air conditioning system will lead to an optimal solution in terms of energy balance and cost. The introduction defines the different technical principles to convert solar energy into useful cooling and gives a brief overview on the most important thermally driven cooling technologies available on the market. Also the main arguments are summarized, which provide the motivation for the application of Solar Air-Conditioning and Refrigeration technology.

LARGE SOLAR COOLING SYSTEMS

1. Absorption systems

Solar absorption refrigeration systems perform a typical absorption refrigeration cycle. Solar radiation is its energy source. Due to the fact that absorption systems require a minimum temperature of 80°C evacuated tube collectors (ETC) are usually used. However, to improve the efficiency of the whole system solar concentrating collectors can be applied.

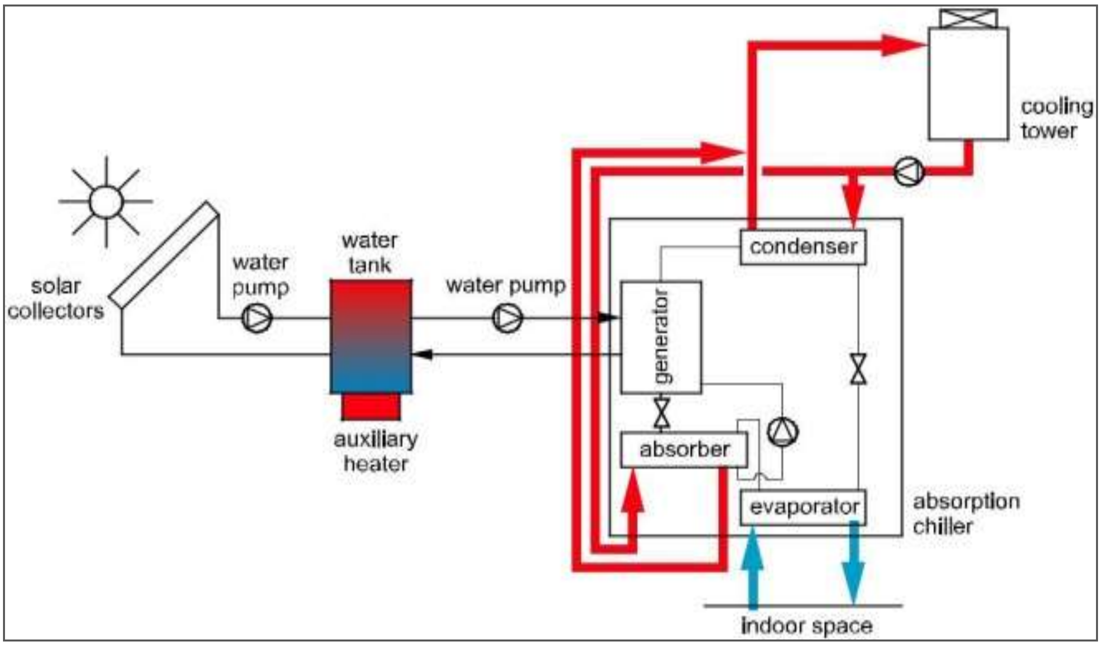

Fig.1: Solar Absorption systems

Absorption cooling is most frequently used to air condition large commercial buildings. Absorption chillers can be teamed with electric chillers in "hybrid" central plants to provide cooling at the lowest energy costs. In this case, the absorption chillers are used during the summer to avoid high electric demand charges, and the electric chillers are used during the winter when they are more economical. Because absorption chillers can make use of waste heat, they can essentially provide free cooling in certain facilities.

Absorption cooling systems can most easily be incorporated into new construction, though they can also be used as replacements for conventional electric chillers. A good time to consider absorption cooling is when an old electric chiller is due for replacement.

Absorption chillers can be direct-fired or indirect-fired, and they can be single-effect or double-effect (explanation of these differences is beyond the scope of this discussion). Double-effect absorption cycles capture some internal heat to provide part of the energy required in the generator to create the high-pressure refrigerant vapor. Using the heat of absorption reduces the steam or natural gas requirements and boosts system efficiency.

2. Adsorption systems

Adsorption refrigeration systems powered by solar energy operate in such a way that the secondary fluid supplies energy alternately to one adsorber, then to another Fig. of Solar absorption refrigeration. The refrigerant released from the bed during this process flows through a condenser, expansion valve and evaporator generating cooling power. Heat from the condenser is transferred to the cooling tower. Depending on the type of working pairs (solid and fluid) a different temperature of solar working fluid is required to thermally drive the adsorption cycle. If solar irradiation is high, it is possible to use even flat plate solar collectors working at a temperature of 80–90°C. See figure: 2

3. Desiccant Evaporative Cooling (DEC)

Solar solid desiccant cooling system consists of the following elements: two air ducts, two fans, a heat wheel, a desiccant wheel, two evaporative coolers (humidifiers) and a heater. The heater is driven by solar energy. The principle of work lies in the fact that fresh air is dried by removing the heat from this fresh air to heat up the air going out of a building. Subsequently, the fresh air is cooled in the rotary heat exchanger and then cooled by humidification. The drier the inlet air becomes, the more cooled down this air can become during the humidification process. See figure: 3

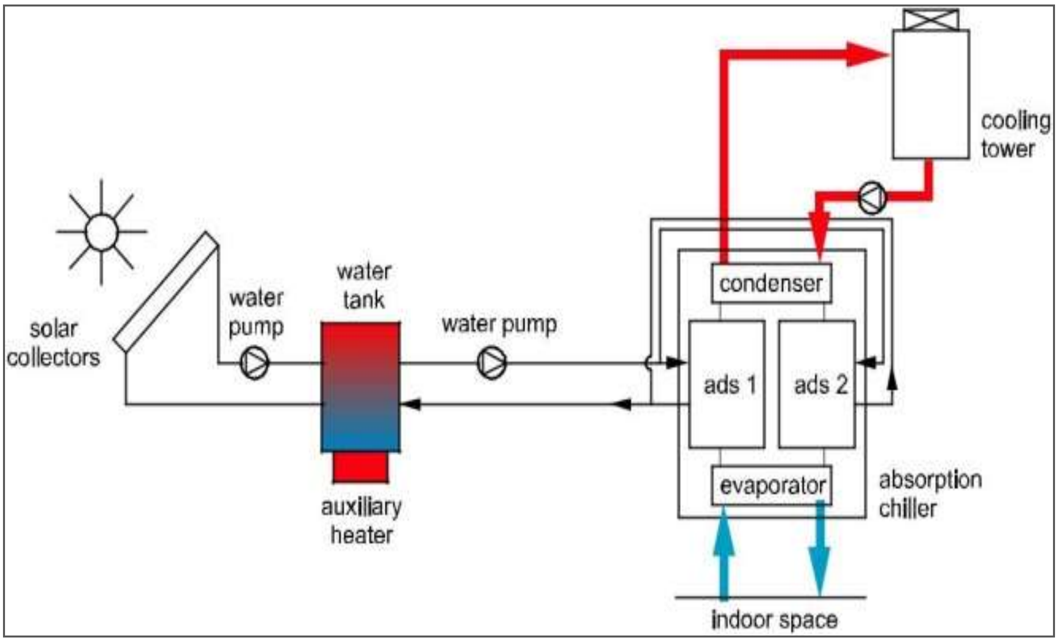

Fig.2: Solar adsorption refrigeration

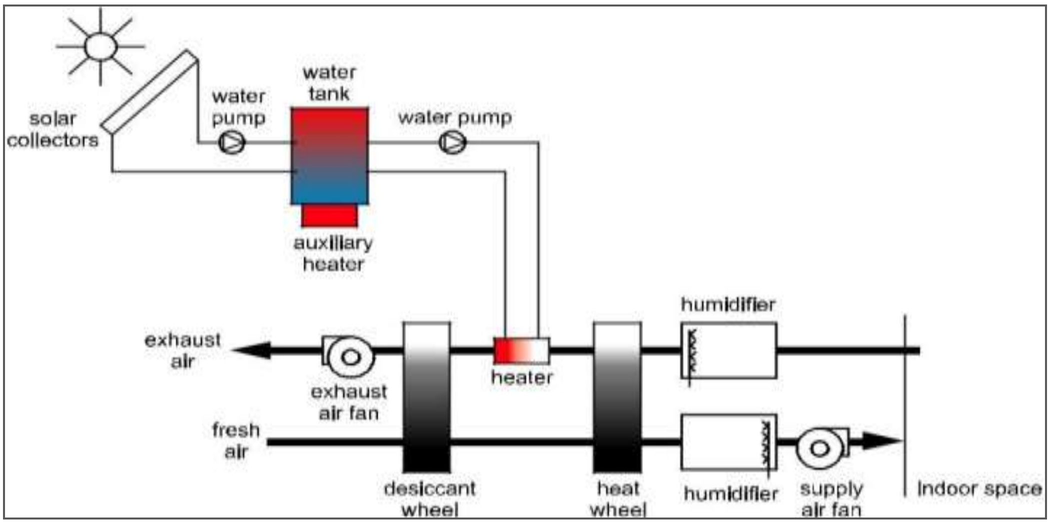

Fig.6: Solar solid desiccant cooling

The total number of large solar DEC installations in the world is 22 (19 of which are in Europe). Among these DEC installations only 7 systems use a liquid regenerator (DEC liquid). These DEC systems are predominantly operational in hot humid countries. Their cooling capacity is usually much lower than in the case of adsorption and especially absorption technologies.

PRESENT STATE OF SOLAR COOLING SYSTEMS APPLICATION

In 2011, about 750 solar cooling systems of different capacities were installed worldwide, including small capacity systems (< 20 kW). In 2012, 159 new solar cooling systems were installed around the world. In last six years the number of large solar cooling systems has doubled. At the same time, the total capacity of cooling systems has increased from 9.3 MW to 17.6 MW. case In terms of systems with a cooling capacity above 20 kW there are three dominating technologies: absorption, adsorption and DEC. Table 1 presents the different categories of sorption processes (columns: “Abs”, “Ads”, “DECs” and “DECl” refer to given technologies) with the nominal thermal cooling capacities of the installations in different world regions in 2012. Closed cycles using absorption or adsorption are indicated by “Abs” or “Ads”, whereas desiccant evaporative cooling systems with an open cycle are indicated by “DECs” when a solid sorption material, for example, in a sorption rotor is used. When a liquid sorption material is applied the system is referred to as “DECl”. The list counts 159 installed large-scale solar cooling systems, where 128 installations are located in Europe, 9 in Asia (China, Japan, Singapore, Israel, Armenia), and 10 in America (USA, Mexico), 2 in Africa and 1 Australia.

APPLICATIONS

1) The solar cooling system is used in hospitals for the comfort condition of patients.

2) It is also used for precision work in laboratory such as CNC machine.

3) Maintaining appropriate temperature for bloods and various health samples in medical.

4) In hotels it can be used for comfort conditions of customers; it is also used for preservations of food and beverages.

5) It is also used in precise measurement system, quality control room in industries.
6) Water chiller can run by this system, so it can use for cool drinking water.

ACKNOWLEDGMENT

It is pleasant endeavor to present seminar report on “**Solar Cooling In Building**”. I avail this opportunity to express my deep sense of gratitude and whole hearted thanks to my guide **Prof. V.S. Ghorade** of STC, SERT, Shegaon. for substantial guidance and cooperation in the seminar work. He has provided all the facilities whenever I need and mostly for his gracious encouragement, advice and guidance to make this seminar a success.

CONCLUSIONS

According to the National Renewable Energy Laboratory (NREL) (in USA) twenty years ago, most solar cooling systems, of the absorption or desiccant types, were designed to handle 30–60% of all cooling requirements, with the remainder supplied by a backup heat source such as natural gas. Currently, most of the new systems are designed to meet the cooling demand for the entire building, although in many cases backup heat sources do exist.

As mentioned earlier, solar cooling is not being implemented in Poland. However, modern public buildings, especially offices with huge glazed facades frequently require more energy for cooling than for space heating. Solar cooling seems, therefore, to be prospective technology. Its application should reduce the consumption of traditional fossil fuels as traditional air conditioning units largely use electricity produced by coal fired plants.

Furthermore, the solar cooling system does not involve a simple traditional installation located in the HVAC center or boiler room inside a building. BIST – Building Integrated Solar Thermal – systems are increasingly popular in different types of modern low-energy buildings, both public and private. All aspects of BIST systems are being considered by the COST Action TU1205 "Building Integration of Solar Thermal Systems (BISTS)".

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