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Criticality of Reducing Shaft Work & Pressure Level During Evaporation As Well As Condensation In Refrigeration & Cooling System by Using Solar Sorption Refrigeration Methods

Shubham Sharma[1] . Shalab Sharma[2]

[1]CSIR-Central Leather Research Institute, Regional Centre for Extension & Development, Leather complex, Kapurthala road, Jalandhar city, Punjab state, India.
[2] DAV University, Jalandhar, Punjab, India.

ABSTRACT
In the modern era, there is increase in the demand of air cooling and refrigeration system which put a huge load on the present energy resources present on the earth. The energy resources available with us are not able to cope with the present need. This short review paper focuses on the utilization of Solar Energy as an alternative to meet our demands for increasing refrigeration and cooling systems. A comparison is made between traditional method and modern solar cooling technologies which can fulfill our energy needs in future.

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Introduction

Energy is life line of modern world. The demand for cooling is increasing day by day both in developed and developing countries. So there is ever increasing demand of energy resources, especially in the developing countries. Only the Solar energy, which is present in abundant form, can cope with the energy requirements. The daily solar energy which the earth receives is equivalent to 50,000 billion oil barrels [1]. This thing has attracted the researchers & has opened innumerable options of using solar energy as alternative source of energy. Moreover the Solar Energy is easily available, eco friendly & renewable source of energy. In case of air cooling & refrigeration purposes, Solar cooling system can be used which will cut the energy requirements. Solar cooling system will be beneficial in hotter areas as plenty of sunlight is available there. This method uses Vapor Absorption/Adsorption System in which use of compressor is eliminated to create two pressure levels in the system [2]. The two pressure levels are that of Evaporation and Condensation of Refrigerant. The work required is relatively large because of compression of vapor which undergoes large changes in Specific Volume. Thus if means are available for raising pressure of refrigerant from evaporative pressure to condenser pressure without much changing its volume it is possible to reduce shaft-work. The same thing is done in Vapor sorption techniques.

Traditional refrigeration system

In case of Traditional refrigeration system (Fig. 1), a compressor, a condenser, a thermal expansion valve (also called a throttle valve or metering device), and an evaporator are used. Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapor is then in the thermodynamic state known as a superheated vapor and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air. That hot vapor is routed through a condenser where it is cooled and condensed into a liquid by flowing through a coil or tubes with cool water or cool air flowing across the coil or tubes. This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away by either the water or the air. The electric power is to be supplied to compressor for its working.

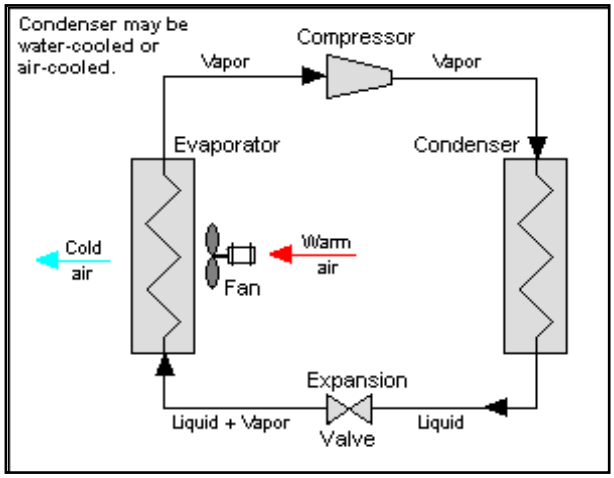

Figure 1: Traditional Vapor Compression Refrigeration system [2]

Application of solar energy in cooling

There are various numerous applications of utilizing Solar Energy in cooling system that are [4-6]: The use of solar energy can be made by elimination of the energy supplied to the compressor. In order to increase the pressure of refrigerant vapor, it is dissolved in an inert liquid at the

Corresponding Author: Shubham Sharma, Tel: +91 7009239473
Email: shubham543sharma@gmail.com
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same pressure as the evaporator and solution thus formed is pumped to a condenser pressure. The liquid which is practically incompressible and undergoes practically no change in specific volume require very little work for raising its pressure. After raising the pressure the refrigerant is separated from the solution by heating. This heat is provided with the help of Solar Energy. The various methods of using solar heat energy are:- a) Solar Absorption Refrigeration System. b) Solar Adsorption Refrigeration System.

Solar Absorption Refrigeration System

In this system (Fig. 2) the absorber receives the refrigerant in vapor form and creates a rich mixture. The pump is used to forward this mixture to the generator (which is also known as disorber) which consume a small amount of power only [7]. In the generator the refrigerator & absorber got separated with the help of heat supplied to it [8]. The generator receives the heat from the solar apparatus in which the solar radiations are absorbed in solar collector which gives heat to the working fluid that moves through pipes in the collector. The fluid in pipes passes its heat to the generator. The high pressure & temperature refrigerator then passes through condenser & rest of the procedure is same as that of traditional VCRS. With the help of pressure relief valve the weaker solution return back to absorber through Heat Exchanger. Heat Exchanger improves the COP of the system upto 60%. [1]. The required temperature for operation of absorption chillers is generally more than 70^0 C with COP ranging between 0.6 & 0.8. [9].

Properties of an Ideal "Refrigerant-Absorbent Combination" [10-11].

1. The refrigerant should have high affinity for absorber at low temperature and less affinity at high temperature.
2. Mixture should have low freezing point.
3. There should be large difference in the boiling points of refrigerants and the absorbent.

Types of absorbent-refrigerant pairs [12](Table 1)

1. Lithium Bromide (Absorbent) & Water (Refrigerant)
2. Ammonia (Refrigerant) & Water (Absorbent).

Ammonia-Water combination is widely used as it posses most desirable properties.

Adsorption refrigeration system

Adsorption is the adhesion of gas, liquid or a dissolved solid to surface which creates a thin adsorbent layer on the surface of the adsorbent [13]. In adsorption type of refrigeration system (Fig. 3) the refrigerator is adsorbed on the surface of some suitable adsorbent such as silica gel & zeolite [14]. The apparatus consists of evaporator, condenser & generator (in which adsorbent is present).

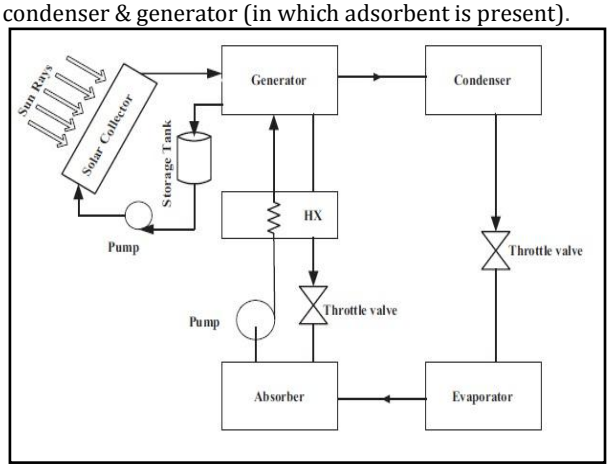

Figure 2: Absorption Refrigeration system

The vaporized refrigerant is adsorbed in the pores of the adsorbent in the reaction chamber (or generator). The adsorption process takes place in following steps:

1. In the first step refrigerant vapors which are adsorbed on the adsorber are desorbed using heating coils [15]. The heat obtained is from solar energy using suitable apparatus. This results in increase in the temperature & pressure of refrigerant which then moves to the condenser. So the refrigerant is compressed in the similar way as that by mechanical compressor [16].
2. In the second step Condensation take place as in traditional process where Vapor changes to liquid with the help of cooling coils.
3. In next step the adsorber is cooled by the cooling coils to maintain its pressure below the condenser pressure (or equivalent to pressure of refrigerant vapors) & also at low temperature [17]. There is also decrease in the pressure of refrigerant vapors in the expansion valve as in Traditional VCRS [18].
4. In the last step low pressure refrigerant vapors from evaporator are adsorbed by the adsorbent (which is maintained at low temperature with the help of cooling coils).

The main advantage of an Adsorption type Refrigeration is its wide range from 50°C-500°C. There is no need of an electric pump or Generator to be installed in this type. Moreover there is no corrosion problem in this system. Also, the amount of Refrigerant cycled in relation to the amount of an Absorbent is larger [20].

Table 1: Different types of Absorbent-Refrigerant pairs with their advantages & disadvantages

Absorbent-refrigerant pair	Advantages	Disadvantages
Lithium Bromide & water	1. Comparatively Higher COP. 2. Large Latent Heat of Vapourisation. 3. Lower Operating Pressures	1. Corrosive so inhibitor like Lithium Chromate is to be used for metal parts. 2. Comparatively Expensive. 3. Evaportor operates above 0^0C.
Ammonia & Water	1. Evaporator operates below 0^0 C.	1. Hydrogen is to be used to maintain pressure in the evaporator. 2. Ammonia is toxic & dangerous for human health.

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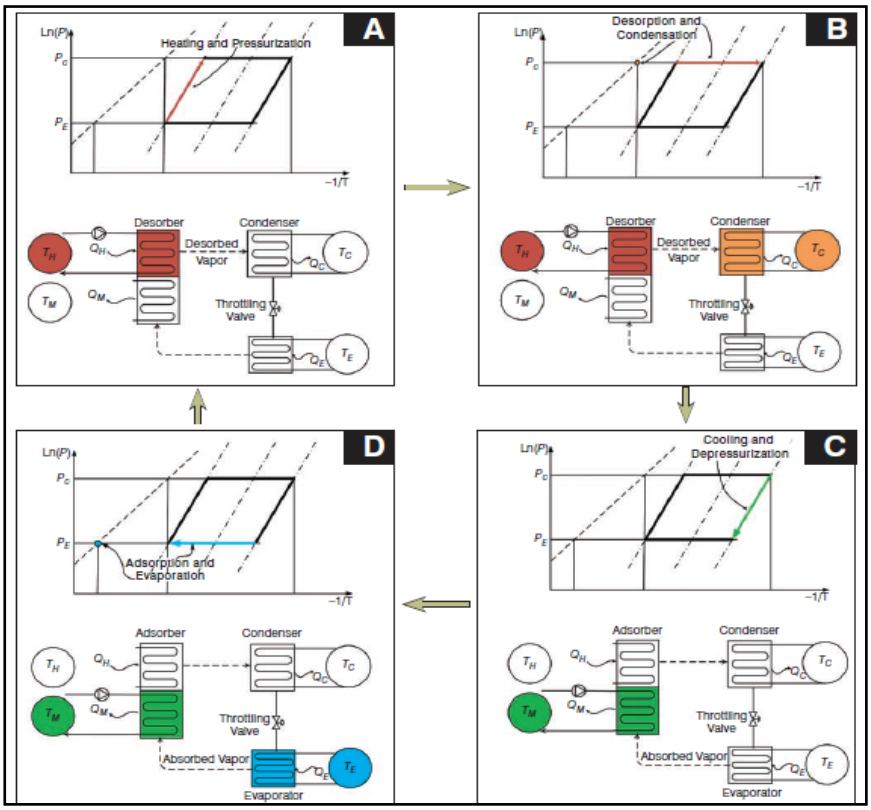

Figure 3: Adsorption refrigeration system [5]

Conclusions

This paper intends to show the utilization of Renewable energy resource i.e. Solar energy in cooling as well as refrigeration system in order to meet energy requirements. Further this paper also reflects on various methods of utilizing Solar thermal energy by combining Solar Absorption Refrigeration system & Solar Adsorption Refrigeration system for easily separation of Refrigerant vapor from the solution. This review paper mainly focus on vapor Sorption Refrigeration system, in which two pressure levels during evaporation & condensation was completely eliminated by raising the pressure of vapor refrigerant from evaporator pressure to condenser pressure without much increase in specific volume. Thus, with the use of this solar thermal energy in refrigeration and cooling system shaft power, need of external power source was reduced to large extent. Moreover there are large numbers of advantages of utilizing solar thermal energy i.e. freely abundantly available in nature, eco-friendly, meeting the future energy demands, can be renewed again and again etc.

References

1. V Mittal, KS Kasana, NS Thakur, The study of Solar Absorption Air-Conditioning systems, Journal of Energy in Southern Africa, 2005, 16(4), 59-66.
2. R.T. Saudagar, P.R. Ingole, T.R. Mohod, A.M. Choube, A review of emerging technologies for solar air conditioner, International Journal of Innovative Research in Science, Engineering & Technology, 2013, 2(6), 2356-2359.
3. The open source Wikipedia (Wiki Vapor Compression Refrigeration system).
4. Lim Chin Haw, Kamaruzzaman Sopian, Yusof Sulaiman, An overview of Solar Assisted Air-Conditioning system application in small office buildings in Malaysia, Proceedings of the 4th IASME/WSEAS International Conference on Energy & Environment (EE'09), 244-251.
5. Khaled S. Al Qdah, Performance of Solar Powered Air-conditioning system under AlMadinah Almunawwarah Climatic conditions, Smart Grid & Renewable Energy, 2015, 6, 209-219.
6. Samiksha Rathore, Prakash Kumar Sen, Gopal Sahu, An Overview of Solar Assist Air Condition System in office at summer days, International Journal of Scientific Research Engineering & Technology, 2015, 4(10), 1004-1007.
7. Salman Tamseel, Shah Alam, Analysis of Solar-Powered D.C. Air-Conditioning System, International Journal of Scientific and Research Publications, 2016, 6(4), 461-463.
8. Tatenda J Bvumbe, Freddie L Inambao, Performance of an Autonomous Solar Powered Absorption Air Conditioning System, Journal of Energy in Southern Africa, 2015, 26(1), 106-112.
9. Edlas Khor Jiunn Hao, Ali Ghaffarian Hoseini, Solar vs Conventional Air-Conditioning Systems: Review of LIMKOKWING University Campus, Cyberjaya, Malaysia, Journal of Creative Sustainable Architecture & Built Environment, 2012, 2, 23-32.
10. Vinod Sehrawat, Tarun Gupta, Raj Kumar, Review of different Technologies in the Solar Absorption Air-Conditioning systems, Proceedings of National Conference on Trends and Advances in Mechanical Engineering, Oct 19-20, 2012, 153-161.
11. Jhalak Raj Adhikari, Bivek Baral, Ram Lama, Badri Aryal, Roshan Khadka, Design and Analysis of Solar Absorption Air-Cooling system for an office building, Rentech Symposium Compendium, 2012, 2, 23-29.
12. Ali Al-karaghouli, National Renewable Energy Laboratory, USA Oman ECO-House Workshop, Oc10.

13. Z.F. Li, K. Sumathy, Technology development in the Solar absorption air-conditioning systems, Renewable and Sustainable Energy Reviews, 2000, 4, 267-293.
14. Zakaria Jusoh, Wan Mohd Faizai Wan Mahmood, Mohd Radzi Abu Mansor, Performance of Solar-Assisted Absorption Cycle Air Conditioning System, Jurnal Teknologi (Sciences & Engineering), 2016, 78:11, 121-126.
15. Ravi Gugulothu, Kishan Banothu, A review of Solar Powered Air Conditioning System, Procedia Earth and Planetary Science, 2015, 11, 361-367.
16. Amitkumar Gupta, Shubham Choudhary, Abhinish Thakur, Kaushik Roy, A review on Solar Powered Air-Conditioning System, International Research Journal of Engineering & Technology,2016, 03(04), 2314-2318.
17. Wameedh Mohammed Mezher, Adel Ahmed Awadh, Ahmed Abed Mohammed, Solar Powered Air-Conditioning using Absorption Refrigeration technique, Journal of Engineering, 2014, 20(10), 47-59.
18. D.N. Noor, A. Arshad, Z. Azran, H. Ibrahim, F. Basrawi, A review on recent development of solar absorption and vapour compression based hybrid air conditioning with low temperature storage, MATEC Web of Conferences, 2016, 38,1-9.
19. Kai Wang, New opportunities for Solar air Refrigeration system, ASHRAE Journal, 2011, 14-24.
20. I.Daut, M. Adzrie, M. Irwanto, P. Ibrahim, M. Fitra, Solar Powered Air Conditioning System, TerraGreen 13 International Conference Energy Proceedia, 2013, 36, 444-453.