FABRICATION OF SOLAR BASED ZEOLITE VAPOUR ABSORPTION REFRIGERATION SYSTEM

A Suresh[1], K Veeranjaneyulu[2] ,K Bullibabu[3]
[1]Asistant professor, Department of Mechanical Engineering, Anurag Engineering college,kodad,Telangana
[2]Asistant professor, Department of Mechanical Engineering, Anurag Engineering college,kodad,Telangana & Research scholar at KLEF.
[3]Asistant professor, Department of Mechanical Engineering, Anurag Engineering college,kodad,Telangana & Research scholar at KLEF.

Abstract: In this paper mainly discussed about the objective of solar absorption vapour refrigeration system is to design and study an environment friendly vapour absorption refrigeration system of unit capacity using zeolite and water as the working fluids. The system is designed and tested for various operating conditions using hot water as heat source. In this system, performance of the fabricated system is outlined with respect to various operating conditions related to heat source, condenser, absorber and evaporator temperatures. The basic idea of this system is derived from the solar heating panel. It will improve the efficiency of refrigeration system. Also the solar potential is at maximum in the summer.

IndexTerms –Refrigeration system, zeolite, water.

I. Introduction

About 10 to 20% of the electric power produced worldwide is consumed in cooling applications including air-conditioning and refrigeration applications. This highlights the fact that an energy efficient cooling is very important. Many adsorption cycles have been proposed and investigated by researchers. The integration of solar energy to power these cycles are also reviewed. It is concluded that solar adsorption cooling systems are the most promising technology in solar cooling applications with respect to low cost, the moderate coefficient of performance, ease of manufacture and low maintenance. The major challenge facing the researchers now is a better enhancement of heat and mass transfer in the system in favor of higher performance. In general, solar adsorption systems are not yet in the stage of world-wide commercialization but it is expected it will have a potential market with further development. Refrigeration is a term used to describe a process which maintains a process space or material at a temperature less than the ambient temperature. To accomplish this, heat must be transferred from the materials to be cooled into a lower temperature substance referred to as a refrigerant. With advancement in science and technology, the role and function of refrigeration and its application have steadily become indispensable to the existence of the modern society.The concept of using solar energy for powering a refrigerator appeared forty years ago with a prototype using a liquid sorption cycle, Sumathy (1999). The use of sorption processes to produce refrigeration has been extensively studied in the last twenty years as a technological alternative to vapour compression systems. Solar-powered refrigeration can also use solid sorption, with either a chemical reaction, or adsorption. Several theoretical and experimental studies demonstrated that sorption refrigeration systems especially those using solid-gas heat cycles are well adapted to simple technology applications. They can operate without moving parts and with low grade heat from different sources such as residual heat or solar energy. The main two technologies concerning the solid – gas sorption concept are the adsorption and the chemical reaction, including metal hydrides. The similarities and differences between these systems as well as the advantages and disadvantages of each one are extensively described by Meunier. (1998) Solar powered refrigeration and air conditioning have been very attractive during the last twenty years, since the availability of sunshine and the need for refrigeration both reach maximum levels in the same season. One of the most effective forms of solar refrigeration is in the production of ice, as ice can accumulate much latent heat, thus the size of the ice-maker can be made small. Solid adsorption refrigeration makes use of the unique features of certain adsorbent refrigerant pairs to complete refrigeration cycles for cooling or heat pump purposes. Zeolite and activated carbon were used as adsorbents in many systems. Based on his studies Ing. (2004) recommended that Solid adsorption pair of Zeolite and water is best to produce refrigerating effect while activated carbon and methanol can serve as a suitable pair for a solar powered, solid adsorption ice-maker.

II. WORKING PRINCIPLE OF ZEOLITE REFRIGERATION SYSTEM

The adsorption cycle is best understood with reference to the p-T-x (pressure temperature concentration) diagram. An ideal cycle is presented in the during diagram (LnP vs. $-1/T$). This process proceeds in an evacuated (airless) environment as shown in fig 1.1.the attraction of water by the Zeolite is so forceful that the internal pressure drops dramatically. The remaining water in an attached vessel evaporates, cools down and freezes immediately due to the heat of evaporation. The resulting ice can be used for cooling and air conditioning while the simultaneously produced heat of adsorption within the Zeolite tank can be utilized for heating. If a valve is included between the two vessels, the heat or cold production can be interrupted for any periods without loss of energy.

The first phase of this process proceeds up to the point when the Zeolite is saturated with water. The reverse process is initiated by heating the Zeolite at high temperatures in the second phase fig 1.2. The adsorbed water molecules are forced to evaporate (desorption). Condensation takes place in the water tank (condenser). The sequence of adsorption/desorption processes is completely reversible and can be repeated indefinitely.

Fig: 1.1 Adsorption phase of a Zeolite system

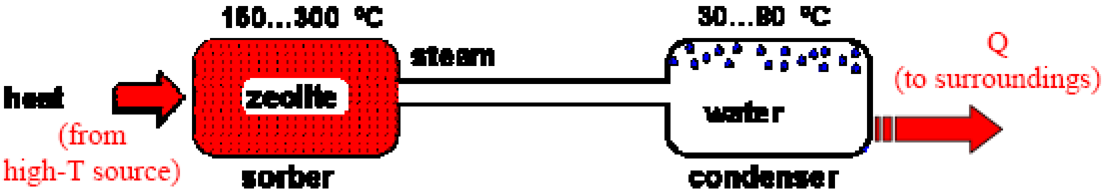

Fig: 1.2 Desorption phase of a Zeolite system

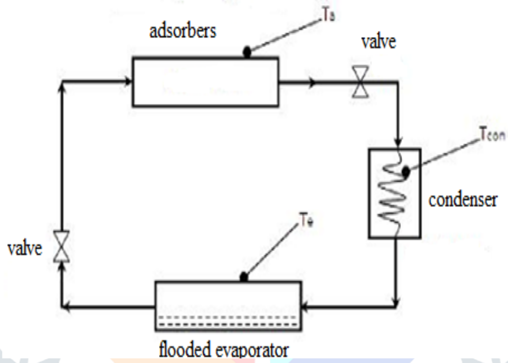

Fig: 1.3 Schematic diagram of the simple adsorption refrigerator

III. WORKING PRINCIPLE SOLAR ZEOLITE VAPOUR ABSORPTION SYSTEM

Water tank is filled with water inside the tank water pump is placed when we supply the electricity to the pump it run, it transfer the water from water tank to the solar collector.

This pressurized water is flow in the tube of the copper coil on the frame when water is circulated in the inside the tube it absorber the heat from the sun cool water gets heated. these warm water is circulated in the absorber tank here this hot water transfer the heat to the absorber tank water (zeolite water) after heat change these water again supplied to the water tank.

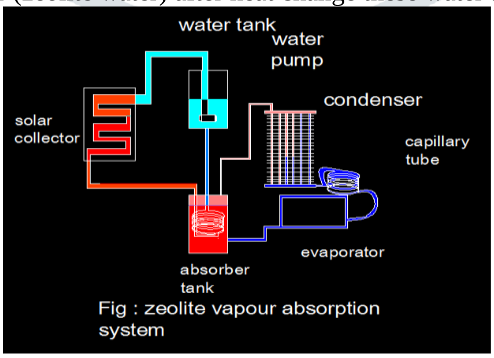

Fig: 1.4 Basic line diagram of solar zeolite vapour absorption system

In absorber zeolite water is heated due to the solar collector coil. At this time zeolite water is produced the vapour this vapour is flow in the condenser tube, in this condenser vapour is cooled in to liquid due to natural air heat exchange processes after that liquied is passed in the exapansion device where reduce the pressure and temperature this liquied is circulated on the evaporator coil where it absorber the heat it became vapour this vapour again supplied to the absorber tank.

IV. RESULTS AND DISCUSSION

The experimental determination of the adsorption refrigeration using synthetic Zeolite A and water pair has been presented in this report. Basically, Adsorption cycle is intermittent because cold production is not continuous: cold production proceeds only during part of the cycle. When all the energy required for heating the absorbers is supplied by the heat source, the cycle is termed single effect cycle. Typically for domestic refrigeration conditions, the coefficient of performance (COP) for single effect adsorption cycle lies around 0.3-0.4. A minimum of two absorbers is required to obtain a continuous cooling effect (when the first absorber is in the adsorption phase, the second absorber is in desorption phase). These absorbers will sequentially execute the adsorption-desorption process. Thus here, a new device has been made which two same kinds of structures have connected by a pipe and a valve. The one device acts as an air conditioner and other gives hot water in cold temperature. Analysis of A Zeolite-Water Solar Adsorption Refrigerator was done where water was replaced by palm oil. A 3D solid model was prepared on Pro-E while a Graphical User Interface (GUI) was prepared on MATLAB to allow the user to get a predefined input screen to have the desired output by changing various factors. It is found that the idea of sequentially executing the adsorption- desorption processes can be done by this device in a useful and effective manner.

These systems are environmentally friendly

- They can use heat rather than electricity as the primary energy source.
- No moving parts
- No solution pumps
- Silent and easy to maintain
- Satisfy the Montreal protocol on ozone layer depletion and Kyoto protocol on global warming
- Solar energy - Renewable, abundant, cheap, pollution free

Large energy saving potential

- Higher reliability
- Zeolite- Water pair has highest driving temperature
- Zeolite- nonpoisonous, non-flammable, naturally available
- Ease of manufacture
- Low maintenance
- Moderate COP
- Low cost
- Minimum looses

CONCLUSION

Everywhere in our world refrigeration is a major energy user. In poor areas "off guide" refrigerators is actually an important need. Both of these consideration point the way toward refrigeration using renewable energy as part of a sustainable way of life. The objective of this project is to develop a suitable grade of Zeolite as the absorber (considered as a chemical compressor), design, construct and test a Zeolite water solar powered refrigerator with water as the working fluid, The solar refrigerator to be designed must be simple, cost effective, affordable and reliable, with locally available materials was achieved. Lowest collector temperature recorded was 11.9^{o}C and the highest was 57.2^{o}C which indicated. We fell way below the desorption temperature for Zeolite and the lowest evaporator temperature recorded was 16^{o}C. With slight corrections in the Refrigerator the second test yielded better results. An evaporator temperature as low as 9^{o}C was recorded on one of the test days.

REFERENCES

1. N.O.Omisaniya et.al, "performance of zeolite-water adsorption refrigeration", advances in applied science research (2012), 6.3737-3745.
2. Mohand Berdja et.al, "design and realization of a solar adsorption refrigeration machine powered by solar energy", energy procedia 48(2014) 1226-1235.
3. Shu Xua a* et.al, "experiment on new adsorption bed about adsorption refrigeration driven by solar energy", energy procedia 14(2012) 1542-1547.
4 http://fc.uni.edu.pe/mhorn/ISES2003%20(solar%20refrigeration).pdf
5. Siegfried kreussler et.al "experiments on solar adsorption refrigeration using zeolite and water" applied science 15(2014) 441-452.
6. Xiangbo song, Ming li and Yuan Dai et.al, "effect of desorption parameters on performance of solar water bath solid adsorption ice making system", applied thermal engineering 89(2015) 316-322.
7. Activated alumina & molecular sieves axens http.www.axens. Net. Aderemi B.O (2004) Preliminary studies on synthesis of Zeolite from local clay.
8. Nigeria journal of scientific research 4(2) :7-12 Alghoul, M.A. Sulaiman M. Y., Azmi, B.Z. and 9. Abdul.Wahab, M. (2007). Advances on multipurpose solar adsorption systems for domestic refrigeration and water heating.
9. Applied Thermal Engineering Journal, ISSN: 1359-4311, 27 (5-6), pp. 813-822 Andreas E. S, Warecks G, Derewinski and M. Lercher J. A. (1989) Adsorption of water on ZSM5 Zeolites American Chemical society Journal Phys. Chem pp 4837-4843 Anyanwu E. E . refrigeration system.

11. Brooks M and Harms T (1994). Design, construction and testing of parabolic trough solar concentrators for developing countries. Energy conversion management vol 35 No.7, pp. 569-573
12.Critoph,R.E. (1988). Limitations of adsorption cycles for solar cooling. Solar Energy,41(1), 23- 31.
13.Critoph R.E. (1999) Rapid cycling solar/biomass powered adsorption refrigerant system Renewable energy 16 pg 673-678
14. Fundamentals of Zeolite/water Technology (2007) pp1-2. http//www.zeo-techde/ htm/e/e-grund/.htm..
15. Jordan R. C, Gayle B. P (1962). Refrigeration and air Conditioning, prentice Hall Inc Englewood cliffs.
16. Joa˜o Pires and M. Brotas de Carvalho Water adsorption in aluminium pillared clays and zeolites www. Google.com
17. Assisted Regeneration of Zeolite. International Journal of Chemical ReactorEngineering: Vol. 5: A117
18. Reynolds A.J. (1974): Turbulent flows in Engineering, John Wiley and sons