Studies on Effect of Process Variables on Hybrid Solar Assisted Adsorption Refrigeration System

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Abstract— The solar adsorption system is one of the best cooling method of refrigeration system, in this solar adsorption refrigeration system we are using water as a refrigerant and silica gel as an Adsorbent. The aim of this project is to provide the cooling effect with an easily available materials like water and silica gel with a less power by avoiding the electrical heater by replacement of solar water heater. In this project we are using solar energy is the main power supply to heat the water, the water is free of cost in a nature and easily available. Another material we are using in this project that is "Silica gel" as an adsorbent. The silica gel is holds the cooling effect up to the long time.

Keywords: Adsorption; Adsorbent; Refrigerant; Hybrid; Ambient

I. INTRODUCTION

The heat transfer of solar adsorption system is poor compare to other refrigeration system. Second and the most mutual problem come upon in every solar system is the conservational conditions in summer and winter.

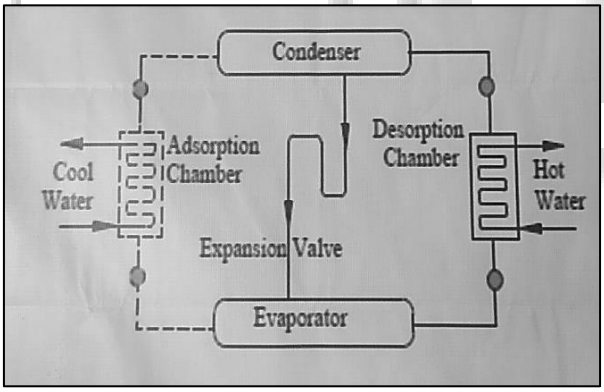


Fig. 1.1: Schematic of Adsorption Syste
Experimental Setup

In summer we can get good amount of heat in the morning but limited amount of cooling in the night. In winter the problem is exactly opposite [1]. The universal survival of solar energy, the greenhouse effect coefficient of solar refrigeration and the ozone depletion potential are zero.

What's more, due to the change of solar radiation with time and the conservation circulation of solar radiation are exceedingly consistent with air acclimatizing demand, solar refrigeration has been widely studied. Adsorption refrigeration can effectively use solar energy, industrial waste heat and other low-grade heat source and has no moving parts, low noise, long life and other advantages. So, solar adsorption refrigeration has been broadly troubled [2].

The adsorption refrigeration cycle is two sources two sinks thermodynamic cycle, which operates using three temperature levels (evaporation, ambient and regeneration temperatures). Two of these temperatures drive the thermal compressor "Reactors" that replaces the mechanical compressor in vapour compression refrigeration cycle (Demir et al, 2009) as shown in Figures 1.1 and 1.2. The cycle also operates between two Pressures (Pe and Pc) Nd two refrigerant/adsorbent concentration levels.

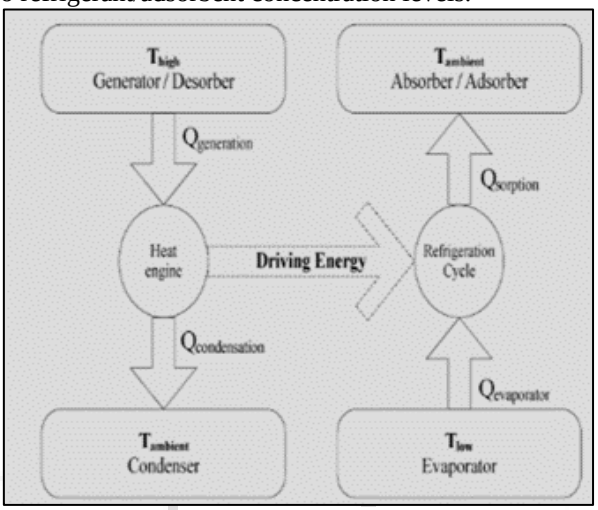


Fig. 1.1: Sorption thermodynamic cycle

In process 1-2 (as shown in Figure 2) the adsorbent bed of high concentration level is heated up by means of high temperature source ($T_{generation}$) to desorb the refrigerant which results in increasing the adsorbent bed pressure from low pressure level (Pe) to high weight level (Pc).

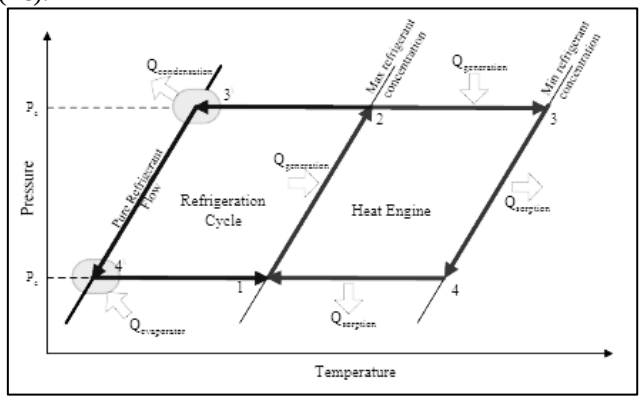


Fig. 1.2: Sorption cycle.

During process 2-3 the adsorbent bed is heated up using the same temperature level ($T_{generation}$) and connected to the condenser (2-3`) to allow the desorbed refrigerant to be condensed and passed back to the evaporator (3`-4`).

The adsorbent bed reactor of low concentration level (3) is cooled down using intermediate temperature level ($T_{ambient}$) and reducing the reactor pressure from high pressure level (Pc) to low pressure level (Pe) during process (3-4).

The adsorbent bed of low concentration level and low pressure is then cooled (4-1) while being connected to the evaporator and adsorbing the refrigerant vapour to achieve the cooling effect at the evaporative temperature ($T_{evaporation}$) by means of evaporation (4`-1) [3].

II. OBJECTIVES

1) To find the solar radiation.
2) Effect of refrigerant flowchart routine of adsorption system.
3) Compare with the vapour solidity refrigerant system.
4) The main aim of this project is to design and fabricate the Single bed silica gel/ water adsorption cooling systems and to study the various means of educational the concert of Single bed silica gel / water adsorption cooling systems.
5) Review of various Condenser, Evaporator and Absorber/disrober designs.

III. MATERIALS AND METHODOLOGY

A. *Materials.*

1) Centrifugal pump

Fig. 3.1: Centrifugal pump

In this project the centrifugal pump is used for to supply the hot water as well as cold water in to the adsorption chamber, the centrifugal pump is worked as a heat ex-changer. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor.

2) Evaporator

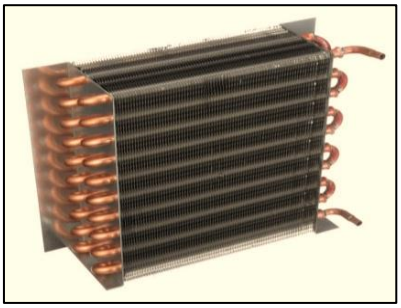


Fig. 3.2: Evaporator.

Evaporator is an important component together with other major components in a refrigeration system such as compressor, condenser and expansion device. The reason for refrigeration is to remove heat from air, water or other substance. It is here that the liquid refrigerant is expanded and evaporated. It acts as a heat exchanger that transfers heat from the substance being cooled to a boiling temperature.

3) Condenser

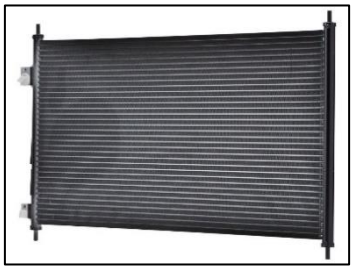


Fig. 3.3: Condenser

In systems involving heat transfer, a condenser is a device or unit used to condense a gaseous substance into a liquid state through cooling. In so doing, the latent heat is released by the substance and transferred to the neighboring atmosphere

4) Expansion Valve

Fig. 3.4: Expansion valve.

Expansion valve is a component in refrigeration and air conditioning systems that controls the amount of refrigerant released into the evaporator thereby keeping superheat, that is, the difference between the current refrigerant temperature at the evaporator outlet and its saturation temperature at the current pressure.

5) Vacuum Pressure Gauge

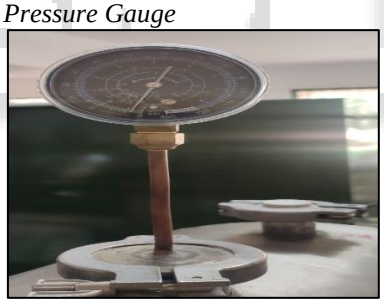


Fig. 3.5: Vacuum Pressure Gauge.

A vacuum gauge is a pressure gauge used to measure pressures lower than the ambient atmospheric pressure, which is set as the zero point, in negative values (e.g.: −15 pig or −760 mmHg equals total vacuum).

6) Hybrid Solar Water Heater

Fig. 3.8: Hybrid Solar Water Heater.

A hybrid system combines solar panels with solar water heaters to enhance energy making and make the most of every sun ray that comes its way. They developed

a hybrid system, which includes solar panels and heat pipes, not only using the sun to produce energy but also to heat up water.

B. Selection of working pair

The selection of working fluid of adsorbent-Refrigerant plays an important role in the system operation. Different pairs of adsorbents- Refrigerant gives different working temperatures and it affects the rate of heat transfer [4].

1) Water (Refrigerant).

Fig. 3.6: Water.

A chiller that uses water as its refrigerant has been launched in the UK, after being deployed for a series of applications in Germany. Organizations such as Siemens and BT have been early adopters of the natural refrigerant-based chiller, which was introduced at the end of 2014 by German constructor Efficient Energy.

2) Silica Gel (Adsorbent)

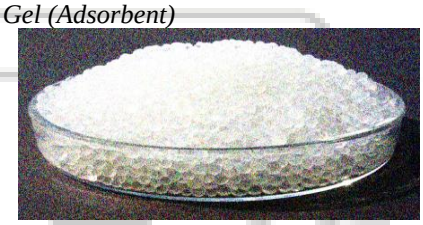
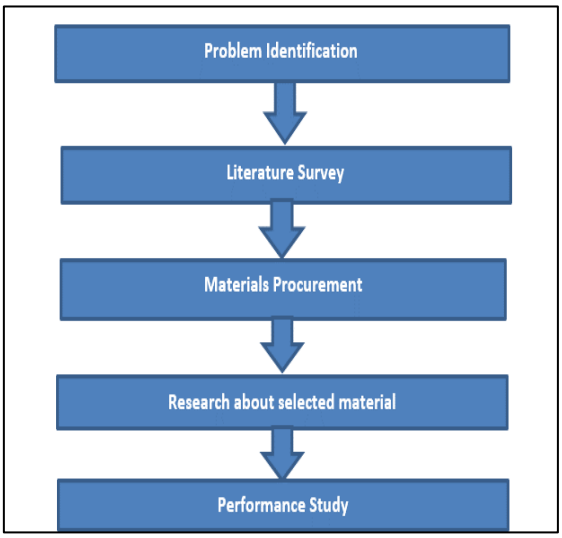


Fig. 3.7: Silica gel

In the present work, an experimental study of a modified adsorption refrigeration unit is obtained. Silica gel and water are used as a working pair in the adsorption refrigeration unit. Hot air is used for silica gel regeneration.

C. Methodology.



IV. Working Model of Hybrid Solar Adsorption System.

Fig. 4.1: Working Model of Hybrid Solar Adsorption System

V. Result and Discussion

Sl. No	Quantity Of water in ml	T_{he} In ^0C	T_{hough} In ^0C	T_{GIF} In ^0C	T_{og} In ^0C	Q_A KW	Q_R KW	COP
1.	150	85.3	76	35.2	24.05	0.584	0.7002	1.1989
2.	200	85.3	77.2	36.4	24.2	0. 6782	1.0216	1.5063
3.	250	85.3	78.4	36.8	24	0.577	1.0718	1.8575

A. For 150ml

1) Q_A= Quantity Of water in ml*4.187(G_{et}-G_o) KW
   Q_A=0.015*4.187(85.3-76) = 0.584 KW
2) Q_R= Quantity Of water in ml*4.187(T_{he}- T_{hough}) KW
   Q_R = 0.015*4.187(35.2-24.05) =0.7002 KW
3) COP=Q_R /Q_A
   COP = 1.23516/0.60711=1.1989

VI. Conclusion

1) The adsorption refrigeration technology has not been carrying out in mass production level yet.
2) Adsorption refrigeration systems have a lot of advantages making them more and more inexpensive when compared to unadventurous vapour compression refrigeration systems.
3) The two-stage solar assisted adsorption refrigeration system has been developed for incapacitating intermittency of the single bed system

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