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Experimental Analysis of solar operated water cooler with vapour Adsorption system

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Abstract:

The sun is a magnificent energy source for us. It is clean and harmless comes to the earth for free and it can be used as it is. The devices need to gather its energy is simple, quiet and non-polluting. The availability of sunshine and the need of refrigeration both reach maximum levels in the summer season. Solar adsorption refrigeration is an option to gain on the drawbacks of the conventional cooling system like peak electricity load and ozone layer depletion. The adsorption refrigeration is mainly based on the evaporation and condensation of a refrigerant mixed with adsorption. Researcher have found that the SAR system has its drawback such as low heat transfer performance, low specific cooling power, low COP and adsorption working pair is vital and is the main component. From Literature survey it is found that no one can work on composite adsorbent, so selecting composite adsorbent as 25% activated carbon & 75% silica gel and water as a refrigerant. The solar adsorption refrigerator gives some advantages to the refrigeration world by using solar energy and zero running cost of the system. The results showed that with activated carbon & silica gel the solar coefficient of performance obtained is comparatively at higher side than the conventional SAR.

Key words: Adsorption, Adsorbent, Refrigerants, and Solar adsorption refrigeration (SAR), COPs & COPc.

I. INTRODUCTION

Sunlight based vitality, similar to all other sustainable power sources, is exceptionally protected and ecologically well disposed [1]. The normal sunlight based power gotten on the Earth's surface is 1.2×10^{17} W. This implies the vitality supply from the Sun hitting the Earth in a hour can meet the aggregate vitality utilization on Earth for an entire year [3]. Researchers evaluate that daylight can give 10,000 times the measure of vitality expected to satisfy mankind's ebb and flow vitality needs [1]. Power era and the heightening expenses of petroleum derivatives in the course of the most recent couple of years, have constrained governments and building bodies to reconsider the entire way to deal with building plan and control. The oil emergencies of the 1970s invigorated concentrated research gone for lessening vitality costs, an unnatural weather change and ozone consumption (Floridesa 2002). Worldwide vitality utilization is set to increment to 60% by the year 2020 (Melford, 2003). India has more potential for delivering vitality from the sun than anyplace on Earth. However the landmass represents just a little rate of the world's sunlight based vitality yield. What India creates by method for sun based power is delivered for the most part in one nation, In Indian nations; country homes are remote and scattered. These homes are

exorbitant and frequently unfeasible to interface with the network. India, as a mainland, has colossal sunlight based vitality abilities because of the closeness of the vast majority of its landmass to the equator. At that scope, a large portion of India has 325 days of solid daylight per annum. The potential for the advancement of sun powered vitality as an option ought to be inspected. In spite of the fact that India by and by creates under 1% of the world's aggregate power from atomic sources, its development in atomic era has been the world's quickest since the mid-1980. Moreover, regardless of the possibility that the impacts of contamination brought on by extricating, refining and consuming oil are overlooked, India's evaluated oil stores of 60 billion barrels are deficient to supply the whole populace of the mainland over the long haul. In this way, despite the fact that sun powered vitality is as yet experiencing advancement to diminish costs, the request is there. India has remained for all intents and purposes clear of any modern contamination. The utilization of sunlight based power in these locales would strengthen the last specified perspective and also start a specific asset blast [19]. In India, most sunlight based vitality could be created in the deserts, which are being underutilized. In forsake areas the sun thrashes pitilessly amid the day and warms the ground to colossal temperatures. At that point around evening time

this warmth is transmitted once more into the environment. As it were, it is totally squandered. This waste should be halted and the immense measures of vitality that the sun bars down should be abused. This examination researches the utilization of sun oriented adsorption cooling as a methods for taking advantage of sun powered vitality. Unique consideration is given to the working pair for cooling, the sun oriented gatherer, the condenser and evaporator. The examination likewise prompts the plan, development and assessment of an adsorption cooler for cost adequacy.

II. LITERATURE REVIEW:

Y. Sing Chan and S. W. Ricky Lee [1] in the paper A. El Fadar et.al [1] clarified in paper entitled "Investigation of another sunlight based adsorption fridge controlled by explanatory by an illustrative trough gatherer" that for a given authority setup, there exists an ideal measurement of the reactor (ideal sweep). He additionally clarified that the ideal execution of the framework is COPs=0.18 when the outer sweep of the adsorber and opening width of the outcomes gotten in this work ,demonstrates a promising execution and his work demonstrates that the PTC is a helpful part for development of the sun based adsorption refrigeration framework. This framework is more effective and lighter when combined with warmth pipe and proposed a novel sun powered adsorptive cooling framework with 5-30 kg of actuated carbon and its execution was tried for the warmth source temperatures of 70-170°C and fined that COP expands first with increment in adsorbent mass and after that the COP diminishes.

Ahmed N. Shmroukh et.al [2] clarified in paper entitled "Adsorption Refrigeration Working Pairs: the State-of-the –art in the application" that an Adsorption refrigeration working pair is an indispensable and is the primary segment in the adsorption refrigeration machine. Subsequently the advancement key is laying on the adsorption combine that prompts the change of the adsorption refrigeration machine. This review the best in class in the utilization of the adsorption refrigeration working sets in both established and current adsorption sets are introduced, analyzed and condensed. IT is found that the most extreme adsorption limit with regards to the established working sets was 0.259kg/kg for actuated carbon/methanol and that for working sets was 2kg/kg for maxsorb III/R-134a. The review inferred that, the exhibitions of the adsorption working sets of adsorption cooling frameworks are still need assist examinations and also creating adsorption sets having higher sorption limit with low or no effect on ecological, to construct minimized, proficient,

dependable and long life execution adsorption chillier. Likewise future inquires about should be centered around outlining the adsorption framework that give proficient warming and cooling to the adsorbent materials through conveying the adsorbent material over warmth exchanger surface, to permit great warmth and mass exchange between the adsorbent and the refrigerant.

Ahmed Al-Mogbel et.al [3] clarified in paper entitled "The Potential of Solar Adsorption Air-Conditioning in Saudi Arabia: A Simulation Study" that sun oriented adsorption cooling can give a way to extensively lessen the power required for aerating and cooling in Saudi Arabia. Be that as it may, right now accessible adsorption chillers are not advanced for the high encompassing temperatures experienced in many very populated areas, for example, Riyadh. In this manner, the reproduced execution of the chillers was altogether more awful than under ostensible working conditions and evaporative recooling must be utilized keeping in mind the end goal to acquire an essential preferred standpoint over vapor pressure cooling. So as to limit water utilization and enhance the general framework proficiency, it is prescribed to concentrate the utilization of cross breed coolers and novel adsorption frameworks adjusted to high warmth dismissal temperatures.

Ashok Kumar Rajput et.al [4] clarified in paper entitled "Utility Base Estimated Solar Radiation at Destination Pune, Maharashtra, India" that Entire Solar radiation at Pune, Maharashtra, India longitude 74.15° (74° 9' east), scope 18.6° (18° 36' north) depends the variety of Direct, Global and Diffuse segment of sun oriented radiation consistently. Diffuse sunlight based radiation quantitatively insightful is high amid the stormy season (June, July , August and September). Evaluated sun based radiation it is watch that sun oriented vitality can be used productively during the time except for stormy season. In the paper examines the month to month midpoints of sun sparkle hour and month to month variety of whole sun powered radiation are assessed.

B. A. Shah [5] clarified in paper entitled "Survey of Adsorption Refrigeration Technologies" that Classical vapor-pressure advancements have achieved a critical condition of development up to now with wide use for this innovation in the nourishment retail and sustenance generation segments. the adsorption refrigeration framework has its downsides, for example, low mass and warmth exchange execution, low coefficient of execution (COP) and low

particular cooling power. Other than the straightforward irregular cycle and keeping in mind the end goal to give unfaltering refrigeration and enhance the execution of adsorption refrigeration framework. Some propelled cycles have been proposed and explored, for example, the multi-bed cycles, the warm wave cycle, the constrained convection cycle, the warmth and mass recuperation in light of various adsorbent informal lodging control techniques, warm pipe innovations half breed.

B. U. XianBiao et.al [6] cleared up in paper entitled "Availability of composite adsorbent with unrivaled of warmth and mass trade" that the mass trade is redesigned by means of carbon. Hu et.al [7] clarified in paper entitled "Sun based Adsorption Refrigeration-An Alternative/Auxiliary Way for Thermal Storage for Air Conditioning" that his R&D works done demonstrates that the sunlight based fueled strong adsorption refrigeration innovation is exceptionally encouraging and has the considerable potential to valuable to the earth through its application in ice stockpiling aerating and cooling frameworks. Coordinating the sunlight based ice making limit into the framework to share a few (if not all) ice making burden would have critical condition advantage and spare clients advance dollars. We trust that the refrigeration and cooling specialists ought to have a worry for the earth and accordingly ought to take a dynamic enthusiasm for the work we are attempted.

Ghassan M. Tashtoush et.al [8] clarified in paper entitled "Trial Study of a Solar Adsorption Refrigeration Unit, Factorial Analysis" A trial study was performed on an adsorption refrigeration unit fueled by a sun oriented vitality and furnished with three distinct sorts of initiated carbon (1: Coconut, 2: Palm seeds, 3: Charcoal. The temperatures of the bed of each adsorber and the relating fridge temperature for both the adsorption and desorption cycles separately were recorded and contemplated as a reaction. At that point a factorial examination was done considering the sort of enacted carbon and the circumstances interim as elements. The outcomes demonstrated that coconut have the most astounding bed temperature amid the day cycle with a mean of 77.5° C and the least mean temperature amid the night cycle with a mean of 12.9 °C. Moreover, it was found from the investigation that the coconut shell initiated carbon has the most elevated coefficient of execution of 0.25.

III. OBJECTIVES OF THE STUDY

1. To spare power in water cooling by trial setup of Adsorption refrigeration framework.
2. To lessen the impact of an Earth-wide temperature boost and ozone layer consumption by utilizing this framework.
3. To outline, create and assess a sun based fueled Adsorption Refrigeration framework with composite adsorbent.
4. To survey the cooling limit of the framework.
5. To survey the sunlight based coefficient of execution of the framework.

IV. STRATEGY

The proposed work can be separated into taking after strides:-

1. Information mining identified with SAR framework.
2. Planning of the cooling bureau.
3. Planning of the evaporator.
4. Planning of the sun powered authority
5. Planning of the condenser.
6. Creation of the exploratory device.
7. Exploratory method
8. Test results and examination.
9. Examination of execution and qualities of SAR framework with local fridge.

V. METHODOLOGY

The proposed work can be divided into following steps:-

1. Data mining related to SAR system.
2. Designing of the cooling cabinet.
3. Designing of the evaporator.
4. Designing of the solar collector
5. Designing of the condenser.
6. Fabrication of the experimental apparatus.
7. Experimental procedure
8. Test results and analysis.
9. Comparison of performance and characteristics of SAR system with domestic refrigerator.

VI. CONCLUDING REMARK FROM LITERATURE REVIEW

The literature review examined the extensive published data on solar powered adsorption refrigeration system. That have looked the data after going through the detailed study of literature paper following points are to be noted.

- As the mass of adsorbent increases the COP increases and then decreases.
- The high bed temperature may cause damaged to silica gel packing.
- For producing 4kg of ice the bed area must be 0.75 m².
- The adsorption refrigeration systems have low COP compare to VCC.
- The cost of the solar powered adsorption refrigeration system is high.
- For perfect running the sunny day is required.
- For desorption of pair at least 80°C is required.
- The natural cooling of condenser is sufficient for adsorption refrigeration system.
- This adsorption refrigeration system is clean and green source of energy for refrigeration.
- By using fins in condenser the COP is increases.
- Valve arrangement is necessary to operate the solar powered adsorption refrigeration system.
- The solar powered refrigeration system is intermittent. For continuous Cooling at Least two adsorber bed is required.

VII. EXPERIMENTAL METHOD AND PROCEDURE

Introduction

In this chapter, a test rig was constructed and field-tested. Results were recorded, analyzed and evaluated.

Building of the Experimental Apparatus

Resources

We conducted the research, designed the fridge, created drawings for the components and fabricated all fridge components in the Mechanical Engineering workshop, at Pune University of Technology. Vijay chemicals in Pune supplied the adsorber containing the silica gel. Perspex glass was supplied by Arihant glass works, in Pune. Energylite insulator was supplied by Anross Insulation cc, Pune. Sorbsil silica gel & activated carbon was supplied by Vijay chemicals, Pune.

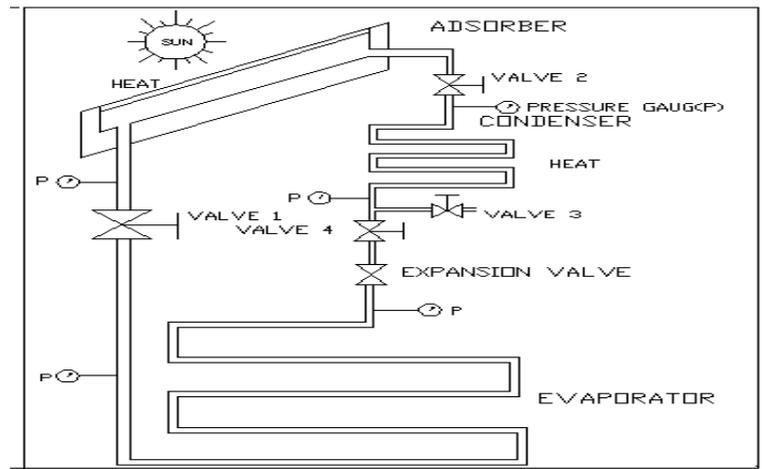


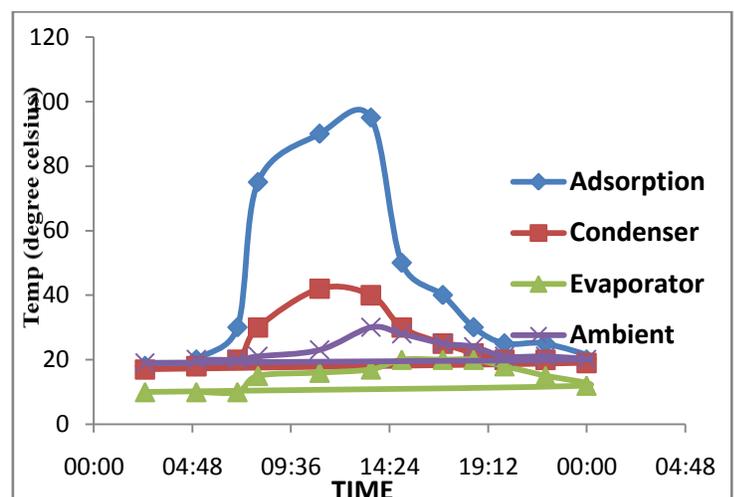
Figure 4.1: Experimental set up

VIII. RESULTS AND DISCUSSION

Analysis of Time versus temperature

Table : Variation in Temperature w.r.to Time

Time	Temp			
	Adsorption	Condenser	Evaporator	Ambient
5:00	20	18	8	20
7:00	30	20	10	20
8:00	75	30	15	21
11:00	90	42	16	23
13:30	95	40	17	30
15:00	50	30	20	28
17:00	40	25	20	25
18:30	30	22	20	24
20:00	25	20	18	21
22:00	25	20	15	21
24:00	20	19	12	20
2:30	18	17	10	19



In figure 5.1, condensation started at 11 a.m. The condenser maintained a temperature of 30°C above ambient temperature. Ambient temperatures during the activated carbon & silica gel generation period ranged over 28 to 33°C, and the condenser tube temperature increased with ambient temperature. Condensation occurred at an average temperature of 35°C.

IX. CONCLUSIONS AND FUTURE SCOPE

In this exposition work a strategy to investigate the sunlight based controlled adsorption refrigeration framework with composite adsorbent is exhibited. Amid this work taking after conclusions are found,

- i. A sun based fueled adsorption-cooling ice chest utilizing initiated carbon and silica gel-water vapor match was outlined, created and assessed.
- ii. The Solar coefficient of execution of 0.058 and the cooling coefficient of execution is 0.83 acquired for 10 liters of water load was somewhat low. The low authority productivity and valuable coefficient of execution are characteristic of the wasteful aspects in both the gatherer and the evaporator.
- iii. The low sunlight based coefficient of execution of 0.058 is brought on via air spilling into the framework, the incapability of actuated carbon and silica gel adsorption ability, sun based light and the surrounding temperature.
- iv. During the experimentation no power is required to run the any segments of the framework.
- v. As water is utilized as a refrigerant and water having a dangerous atmospheric deviation potential and ozone layer consumption potential is zero. So SAR framework is ecological inviting.

X. FUTURE SCOPE AND RECOMMENDATIONSS

1. This system can be used as a water chiller for house hold application in summer time and as a water heater in a winter time.
2. As system cost is high so someone can work for optimization cost of SAR system.
3. The adsorber-cooling period was long and could be shortened by increasing the rate of convectional cooling at night, for example, blowing cold air at the adsorber by using solar electric fans.
4. The COP was very low, improvement on the design of the adsorber and silica gel packing is suggested as this affect the performance of the system.

5. Air leaks were the major problem for this present study. With the unavailability of proper resources, this was expected. Vacuum tightness is very expensive and only experts with proper equipment are able to maintain it. It is recommended that future studies on solar adsorption cooling be funded adequately.
6. The mass of the components was high. Less dense and lighter construction materials, such as aluminium, could improve the efficiency.
7. The cycle for the adsorption cooling was intermittent, hence cooling only during the day. Further investigations are necessary to improve on making the adsorption cycle continuous and using controllers for automatic operation.

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