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A REVIEW ON SOLAR POWERED AIR CONDITIONING SYSTEM

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Abstract
The increasing demand for natural resources like fuel and coal has led to a need for efficient energy sources like solar energy. This study of solar air conditioning systems designed to promote environmental sustainability using PV solar cells and a single-phase DC motor. The absorption system converts low-pressure vapour into high-pressure vapour, which is then used in a refrigeration cycle. The process involves absorbing low-pressure vapour into a suitable absorbing liquid, converting sunlight energy into electricity. The absorption process involves a compressor, a pump, and heat to release the absorbed vapour. Both cycles can be demonstrated in a refrigeration system using the same techniques for changing low-pressure vapour into high-pressure vapour and cooling effect is produced to maintain the ambient temperature.

Key words: PV solar cells, Single phase DC motor, Solar Energy, low pressure vapour, high pressure vapour, Refrigeration

I. Introduction

Climate change and global warming are increasing the demand for air conditioning, which accounts for 50% of a building's electrical use. Traditional electric air conditioning, powered by fossil fuels, leads to increased greenhouse gas emissions. Solar energy, a renewable source, is becoming more appealing due to rising gas and power prices. Absorption cooling is a popular thermally powered technology worldwide, offering easy construction, capacity management, reliability, quiet operation, long lifespan, and less energy consumption. Solar energy is a promising option for subtropical nations due to its renewable nature and low energy consumption. This project aims to create and improve a standard air conditioner that can run on PV technology, replacing electricity with solar energy. The design and operation of the air conditioning and solar system, consisting of a PV system, have been studied to determine the viability of using solar energy. The goal of this paper is to design and build a direct current air conditioning system, explaining its components, features, benefits, and drawbacks. The system's performance will be investigated based on operational views and commercial applications.

II. Literature

I. Dauta et, al., [1] proposed " Solar Powered Air Conditioning System", The Renewable energy development accelerates due to rising oil costs, global energy demand, and environmental concerns. Solar-powered air conditioning systems are essential for indoor conditions, offering a cost-effective, renewable, and ecologically beneficial solute.

A.K.Jairath et, al.,[2] say's "Utilizing Solar Energy for Room Air Conditioning System", Research project analyzes solar air-conditioning system architecture, specifications, and operation for Indian environment, addressing electricity usage and diverse operational conditions.

Ravinder Goyal, et, al., [3] discussed the study presents a solar air conditioning system using PV solar cells and a single-phase DC motor for environmental sustainability. The absorption system converts low-pressure vapour to high-pressure vapour, which is then fed to a condenser, expansion valve, and evaporator. This system is like refrigeration systems, utilizing the same mechanisms for converting low-pressure vapour to high-pressure vapour.

A Nazar Ali et, al., [4]. Say's the working of a brushless DC motor in a solar-powered air conditioner adjusts output based on room size and shape, with BLDC motors outperforming others. Solar energy is renewable and sustainable, allowing for room-specific output adjustments is done.
Ali Mohammed Abdoulha Massoud, et, al., [5]. Discussed The project aims to develop a solar power air cooling system for SHIATS University campus using photovoltaic (PV) technology. This low-power, renewable option offers optimal cooling efficiency and is suitable for various climate changes for operating systems and maintaining the ambient room temperature for comfortable environment.
Mohammad Azim Rasuli, et, al., [6] say's Afghanistan's solar energy production is growing rapidly due to affordability and sustainability concerns. Businesses are exploring solar air conditioning systems to address air pollution, climate change, and depleted natural energy reserves. This essay evaluates the feasibility of sustainable, economical, and environmentally friendly solutions.
Jayant Sagar, et, al., [7] proposed Currently, solar cells are used in automobile air conditioning systems to produce electricity, which powers a compressor and electric motor. The system has MPPT for multi-point tracking and is built for maximum power. This ground-breaking solar-powered system provides a healthy replacement for the present ones without sacrificing performance or harming the environment.
Ashok Kumar Yadav, et, al., [8] say's Air conditioning is a major global energy consumer, causing energy shortages in countries like China. Solar systems, like the Peltier effect, can reduce power use and eliminate CFC, HCFC, or HFC refrigerants. Innovative cooling products can save money on power bills and reduce greenhouse gas emissions for the sake of environment.
R. Naskar, et, al., [9] discussed Air conditioners have become increasingly important in residential and business settings, with solar-powered systems becoming increasingly popular. This paper discusses the design and construction of a DC air conditioning system integrated with a photovoltaic (PV) system, which includes PV panels, a solar charger, an inverter, and batteries. Solar energy is cost-effective, renewable, and environmentally friendly, making it a viable option for non-electrified areas.
Rushi prasad Watpade, et, al., [10] proposed This study examines solar-powered air coolers for both domestic and commercial use. An investigation is conducted using a cross-over direct evaporative cooler and wet, strong honeycomb paper that includes packing material. To create a comfortable indoor atmosphere in arid places, the system is anticipated to function as both a humidifier and a cooling system for producing cooling effect for our comfort by reducing the power bill.
J. Aman, et, al., [11] say's Solar-powered absorption chillers have potential for residential air-conditioning, but their efficiency is lower on small scales. A study found that the absorber, generator, and condenser have the most exergy loss, with generators and condensers experiencing less. The evaporator is less susceptible to temperature increase for producing cooling effect.
Rishabh Maheshwari, et, al., [12] proposed Air conditioners in passenger cars are essential for comfort and temperature regulation, but they consume energy, affecting fuel efficiency. Green energy sources like solar power and engine compressor detachment can improve fuel economy and reduce emissions.
Shahed M Farajat, et, al., [13] discussed. Jordan's budget relies heavily on foreign energy imports, with increasing power demand due to population expansion, refugees, and improved citizen lifestyle. This research analyzes cooling load demand for Mutah University's engineering building and explores renewable energy options like photovoltaic systems. The building's cooling load is 560 kW, with a 224-kW required electrical power. PV systems offer a 40% lower cost and a 5-year payback period.
Sami Ahbab Chowdhury, et, al., [14] say's This paper compares solar-powered air conditioning systems in Bangladesh, highlighting their environmental benefits and cost-effectiveness. It compares solar systems with conventional AC units, highlighting their advantages and disadvantages for Bangladesh's economic decision-making.

Khaled.S, et, al., [15] proposed Solar-powered air conditioning is popular in Saudi Arabia, particularly in holy locations like AlMadinah AlMunawwarah. This article examines the design and performance of solar-powered air conditioning systems, integrating a photovoltaic (PV) system with PV panels, charger, inverter, and batteries. The cooling load was calculated, and the PV system was built based on it. The performance coefficient ranged from 2.16 to 4.22, indicating compatibility with traditional system knowledge in producing cooling effect for maintaining room temperature.
Asmeeta Jagdev, et, al., [16] discussed Solar energy-based cooling systems could be more productive and cost-effective for commercial, residential, and modern structures. As the world faces a growing population and economies, the demand for energy is expected to double. The enterprise is testing a sunlight-based forced air system in Vijayawada's climatic conditions. The system uses a PV grid structure, solar panels, battery-inverter system, climate control system, and outdoor and internal temperatures.
Juwari Purwo Sutikno, et, al., [17] say's This study simulates an air conditioning system using solar energy and a single effect absorption refrigeration method. The coefficient of performance (COP) for absorbent-refrigerant variables is analyzed, and COP values are compared. Solar air conditioning saves 98.85% more energy than commercial air conditioning, with LiNO3-NH3 as the working fluid achieving the highest COP value of LINO3-NH3 for using it as refrigerants.
Aniket Anil Mhatre, et, al., [18] proposed the demand for high oil and renewable energy is increasing, with solar air conditioning becoming increasingly popular for indoor comfort. This research focuses on a photovoltaic system (PV) air conditioning system, which can be used in non-electrical regions. The primary justification for using solar energy is its affordability, sustainability, and environmental beingness. The study aims to develop a sustainable and affordable solution for indoor comfort.
M. G. Mousa, et, al., [19], say's this study explores the use of thermoelectric elements and a PV panel to reverse heat flow in a room wall. Theoretical devices form junctions, causing heat to flow from one end to the other, resulting in varying temperatures in different seasons. This method allows for system integration without relying on other electricity sources and allows cooling and heating in the absence of sunlight. Additionally, extra power can be used for other purposes.
Y.V.Vankov et, al., [20], Energy saving is crucial worldwide due to increased fuel consumption, environmental pollution, and negative effects on the ozone layer. In Iraq, demand for central air conditioning systems and high-electric capacity home air conditioners has increased due to desertification, high temperatures, air pollution, and population growth. A renewable energy system using solar collectors integrates with air conditioning systems, increasing efficiency, and reducing electricity.
Rogério G. Oliveira et, al., [21] discussed absorption refrigeration is a heat-driven system that uses natural refrigerants like methanol, ammonia, and water without contributing to ozone layer depletion. This type of refrigeration operates in closed or open cycles, with a constant refrigerant mass. It is primarily used in solar-powered icemakers, with a typical solar coefficient of performance between 0.10 and 0.15. The most common types of sorption systems are LiBr-water absorption chillers and ammonia-water refrigerators. Recent developments on composite solid sorbents may make solid sorption machines cheaper and more competitive than liquid vapor absorption machines. Double-stage adsorption chillers can be powered with hot water at temperatures of at least 55°C, while single-stage chillers require heating sources from 65°C. The coefficient of performance for these machines typically ranges from 0.2 to 0.6, with some commercially produced machines reaching 0.7.
Akiyoshi Sakoda et, al., [22] proposed the solar-powered adsorption cooling system experiments were conducted using small-scale apparatuses, using silica-gel and water vapor combinations. A simple model was proposed to interpret experimental results quantitatively. The model successfully interpreted heat and mass transfer in continuous adsorption-regeneration experiments. The contribution of regeneration temperature of adsorbents to cooling performance was quantitatively clarified using the adsorption equilibrium relation.

Ghaith Yahay Abusaibaa et, al., [23] say's this study evaluates the feasibility of using solar-assisted Single Effect Absorption Chillers (SEAC) in Najaf, Iraq. The proposed system uses 105,6kW SEAC powered by Evacuated Tube Collectors. TRNSYS simulation optimizes system parameters, resulting in a solar cooling model suitable for service buildings. The solar absorption cycle reduces annual electricity consumption by 77% in Najaf, Iraq. Additionally, solar energy can benefit governments by reducing CO2 emissions, with solar evacuated tube thermal energy reducing energy usage by 70.33 tons of CO2 in Tehran and 68.88 tons of CO2 in work periods annually. Mohamed. A et, al., [24] proposed this paper presents a solar photovoltaic (SPV)-powered vapour compression refrigeration system for potato storage under various operating conditions. The system includes a PV panel, lead acid battery, 1 kW inverter, and 0.18 TR (tons refrigeration) vapour compression system. The cold storage structure is 2.50 m3 and an evaporatively cooled storage structure is used for curing. The average daily SPV energy output and energy consumption are 5.65 and 4.115 kWh, respectively. The total cost of curing and storing 1.0 kg of potatoes in a 2.5 m3 cold store using a subsidized PV system is Rs. 9.02, compared to Rs. 7.66 and 14.63 for the same system operated by grid electricity and petrol-kerosene generators the pollution is also decreased. Waleed Momani et, al., [25] discussed in this paper analyzes solar air-conditioning systems for automobiles, comparing traditional and solar systems. Results show that solar AC systems reduce fuel consumption and require only one photovoltaic panel for optimal performance. Emna Aridhi, et, al., [26] proposed recent studies optimize air-conditioning efficiency using solar energy, designing advanced plants like absorption, adsorption, and desiccant. They discuss energy intake, cost reduction, and pollution rates, particularly in rural regions. A comparison is made between solar and traditional AC systems for better conditions of working of the AC. Salman Ajib et, al., [27] say's this chapter discusses solar cooling technologies for thermal and photovoltaic applications, highlighting advantages, challenges, and feasibility analysis. It emphasizes research needed to reduce costs and improve performance and provides information for decision-makers to select the appropriate technology for specific applications. References and investigation results.

Simson Pinto et, al., [28] proposed this paper investigates a solar-powered battery-free refrigerator for cold storage and transportation of vaccines and foods. The 150-liter system uses solar panels for electricity and a cold thermal storage bank to provide cooling at night. The refrigerator operates on a 20:80 volume solution of propylene glycol and water, with a cooling time of 3½ hours when powered by PV panels. This solar refrigerator is ideal for domestic and small business applications, providing low temperature storage for vaccines and food during transportation.

Gaurav w et, al., [29] discussed rising pollution and global warming cause increased demand for fresh, cool environments. Air conditioning systems, coolers, and refrigeration systems are essential in cities and developed areas. However, power shortages and high costs lead to power cuts in developed areas and rural areas. Solar energy is introduced to address these issues, aiming to provide sustainable energy systems that efficiently serve large latent loads and improve indoor air quality. This energy is stored in batteries and used to run the mechanism, reducing costs, and improving. Rifky et, al., [30] proposed the car cabin cooling system works during operation and is powered by solar energy. This study combines solar cells, thermoelectric, and cooling systems to achieve maximum heat absorption and minimum temperature in the car cabin. Solar and thermoelectric cells are placed on the car's cabin, with a heatsink attached to the cold side of the thermoelectric. Solar cells convert solar energy into electrical energy, and the thermoelectric cooling system absorbs surrounding heat, reducing the cooling room temperature. The results show a coefficient of performance (CoP) of 0.042 for the cold room and a minimum temperature of 25.60°C. Sajena Basheer A L et, al., [31] Say's solar energy is gaining popularity, making a significant impact on daily life. This paper proposes a solar-powered BLDC-fed air-cooling system, which includes Maximum Power Point Tracking (MPPT) and a modified perturb and observe (P&O) MPPT algorithm. The system consists of power conversion stages, including a DC-DC boost converter, a

Brushless DC motor, and a scalar-controlled Voltage Source Inverter (VSI). The system is designed to perform well even under dynamic conditions and is evaluated using MATLAB/Simulink platform. Dr. M K Murthi et, al., [32] discussed Air-conditioners control temperature, humidity, and air quality in rooms. Climate change and global warming increase demand, making them essential in subtropical cities. To reduce electricity consumption, a cost-effective solar air conditioner is designed to make air conditioning more affordable. This design aims to make air conditioning more affordable. Amit A. Patil et, al., [33] say's Air-cooling methods like evaporative coolers, air conditioning, fans, and dehumidifiers require electricity, which contributes to global warming. However, these systems are often not suitable for villages due to longer power cuts and high costs. Solar power systems are considered a sustainable solution, offering better indoor air quality and efficient ventilation. Solar-powered coolers store solar energy in a battery, which is connected to a solar power source. This converted energy is used to run a centrifugal fan, which absorbs hot air through cooling pads. This technology is cost-effective and suitable for various residential applications, making it an attractive. Amina Bindh Fathima et, al., [34] proposed as atmospheric temperature rises, better cooling and energy systems are needed. In automobiles, maintaining ambient temperature inside the cabin is crucial. A system uses solar power extracted from a solar panel and a separate storage space to control the temperature. TEG modules, powered by solar energy, sense the cabin's temperature, and operate. Naman Kamble et, al., [35] say's the increasing need for relaxation in hot and humid environments has led to the increasing use of air conditioning and refrigeration systems. However, these systems are not suitable for villages due to power outages and high production costs. Photovoltaic systems offer a sustainable alternative, as solar cooling improves indoor air quality and humidity control. The project aims to test a solar-powered air cooler with refrigerated cabins for residential applications. Giovanni Brumana1 et, al., [36] proposed the paper evaluates a tertiary sector building in three locations and compares four solar cooling systems: two thermals (Li-Br absorption and adsorption chillers), a desiccant evaporative cooling system, and a photovoltaic-coupled compression chiller. The results show that the absorption chiller system meets cooling demand regardless of location, while the Desiccant Evaporative Cooling system is affected by ambient conditions. Electric solar cooling is the most efficient and cost-effective solution and usable for better room conditions Lin Zheng, Wei Zhang et, al., [37] say's a study in Chengdu, China, evaluated the efficiency of solar powered air conditioning systems with microencapsulated phase change material (MEPCM) cooling storage systems. The results showed that transient thermal efficiency decreased with temperature difference, and the system's energy saving rate reached 30.5%. The study aims to improve the study of solar powered air conditioning systems and their application in daily life style. Shiva Motamedi et, al., [38] proposed this paper investigates the economic feasibility of a solar-powered adsorption cooling system. It is mathematically formulated and optimized for a single-family house cooling load using particle swarm optimization. The system is suitable for small-scale applications and has a higher cost per 1 kW of cooling capacity. The environmental benefit of the system is calculated, showing that the optimum solution is 13% more cost-efficient than the base design. The extra cost can be justified through CO2 capture cost is effective than others. Nwasuka Nnamdi Cyprian et, al., [39] discussed this research comparing a solar hybrid air-conditioning system with conventional split-unit systems, focusing on room temperature. Results show that the solar hybrid system has lower room temperature values compared to the conventional system. Hybrid air conditioners offer significant energy savings and reduce demand. The study compares the performance of the solar hybrid system with the split units to develop analytical solutions for heat transfer in boundary layer flow and heat transfer. Ishaka M. Shuaibu et, al., [40] proposed a solar-powered evaporative cooler, using locally available materials like galvanized iron, wooden strips, and a low-power submersible water pump, is designed and constructed for easy use in hot and dry areas. The system includes a humidity and temperature control unit, consuming only 0.054kWh for 6 hours. This technology is cost-effective and suitable for residential applications in areas with power outages or no grid extension.

III. Conclusion

To accomplish space cooling, the system design must take both air conditioners and PV systems into account. Both the PV system and the air conditioning system require knowledge of several factors. An important feature of photovoltaics is the electrical equivalent, the characteristic curve, and the factors that impact the output of PV cells. In terms of the air conditioning, it is important to first estimate the cooling capacity since this will provide a general notion of how to design and build the system with adequate electrical energy provided to it. The stability and efficiency of the system for more environmentally friendly solutions to the world's energy demands will be improved.

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