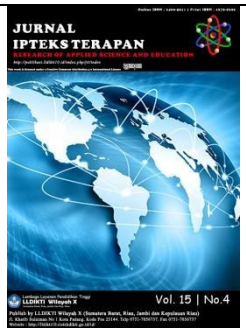

Vol. 17 No. 3 2023

EXPERIMENTAL STUDY OF HYBRID SOLAR AIR CONDITIONING SYSTEM IN WEST SUMATERA

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Submit :
03/05/2023

Accept :
22/09/2023

Publish :
23/09/2023

Abstract

Due to the near-universal presence of air conditioning systems in Indonesian buildings, the development of solar-powered air conditioning units has accelerated recently. The tropical country of Indonesia benefits from year-round sunlight. In this study, a photovoltaic (PV) system that includes a battery, a photovoltaic system composed of PV panels, a solar charger, a DC power controller/inverter, and a battery is combined with a solar-powered air conditioning system to analyze its design and performance. In locations without electricity, this air conditioning technology is usable. Obtaining approximately 1 ton of refrigeration (3.52 kW) through the first step of this research's cooling load calculation for the space to be conditioned. An estimated photovoltaic (PV) system that includes all the required connections has been constructed based on this cooling load. Temperature measurements at crucial cycle locations, including the compressor's inlet and outlet as well as the evaporator and condenser, have been made using a data logging system. All day long, measurements were made of the system's input power and coefficient of performance (COP) under Indonesia's climate. The results are compared to the performance of traditional systems and the coefficient of performance for the system ranges from 2.9 to 8.5. for the system and these results are compared with the performance of conventional systems.

Keywords: Solar Energy, Photovoltaic, Air Conditioning, environmentally friendly, Hybrid

http://publikasi.lldikti10.id/index.php/jit DOI : https://doi.org/10.22216/jit.v17i3.2222 PAGE : 689-695

ISSN : 1979-9292 / 2460-5611
JIT is Sinta 3 Journal (https://sinta3.kemdikbud.go.id/journals/profile/2143) accredited by the Ministry of Research & Technology, Republic of Indonesia

JURNAL IPTEKS TERAPAN
Research of Applied Science and Education V17.i3 (689-695)

ISSN : 1979-9292

E-ISSN : 2460-5611

INTRODUCTION

In order to produce a comfortable environment, a room must have air conditioning (AC). An air conditioner (AC) is used to provide cool, comfortable air in a conditioned space. The development of air conditioners (AC) throughout the current globalization age has a bearing on the requirement for greater electrical energy consumption. In workplaces, mosques, hotels, stores, and even individuals' homes. Due to their use for up to 24 hours, air conditioning units (AC) require electric motors with very high electrical energy consumption. One way to lessen negative environmental effects is to save energy by using alternative energy. Introduce this alternative energy into daily life in order to increase awareness of its potential to lessen negative environmental effects. Solar, wind, micro hydro, ocean waves, and tides are examples of renewable energy sources with variable availability that are currently underdeveloped. Peanus, A.D., et al [1].

Research on an ecologically friendly, energy-efficient air conditioner that employs solar energy as a source of thermal energy rather than refrigerant as its operating fluid. When compared to gas compression air conditioning systems, this method can save up to 80% of the energy required to cool indoor spaces in buildings [2].

In Saudi Arabia, where the summertime outside temperature often exceeds 42°C, air conditioning systems are almost a need in every building. As a result, solar-powered air conditioning has advanced more recently. Because AlMadinah AlMunawwarah is one of the most revered holy sites in the world, this study looks at the design and functionality of a solar-powered air conditioning system coupled with a photovoltaic (PV) system made up of PV panels, a solar charger, an inverter, and a battery. Although the cost of electricity in these places is very high, this air conditioning system can be employed in non-electric areas close to Al Madinah [3].

The primary goal of the study is to develop and build a photovoltaic (PV) system that combines a battery with PV panels, a solar charger, an inverter, and direct current (DC) air conditioning. The air conditioning unit can be utilized in places without electricity and can be powered by solar energy. Solar energy is a low-cost, renewable, and eco-friendly energy source, as is often known [4].

In simulation research, single-effect absorption refrigeration is used to simulate an air conditioning system. The coefficient of performance (COP) for each absorber-refrigerant variable is examined, and the efficacy of each absorber-refrigerant variable is compared. By comparing solar air cooling to commercial air conditioning, the simulation findings show that solar air conditioning can save 98.85% of the energy used in the latter. In addition, according to the COP calculation, the solar conditioning system using LiNO3-NH3 as the working fluid, which is composed of 55% refrigerant and 45% absorbent, achieves the maximum COP value [5].

METHOD

In recent years, using solar panels as a power source has gained enormous popularity. The potential for solar energy is so great in Indonesia that the country's

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ISSN : 1979-9292

E-ISSN : 2460-5611

government declared that solar, biomass, and water power facilities will account for the majority of the country's electricity production by the year 2050. Solar panel components are important to the development of PLTS. The issue with solar panels is that as their temperature rises, their efficiency drops, necessitating the use of cooling media. This study used a cooling box, several solar panels, and a 12 V LED light load to conduct studies on the impact of air conditioning on panel surface temperature. According to experimental findings, air cooling media with a speed of 5 m/s can boost output power and electrical efficiency by 7–10% and 0.3%, respectively, while lowering panel temperature by 21%. The temperature of the panel surface decreases with increasing air velocity used for cooling. The output power and electrical efficiency of the solar panel are inversely correlated with the panel surface temperature [6].

A test to see if utilizing cooling and mirror-reflected light may boost solar cells' output power. The findings demonstrated that adding mirrors enhanced the current and output power of solar cells but decreased open circuit voltage and maximum power voltage due to heat. Cooling increases the open circuit voltage and maximum power voltage, which raises output power [7].

This study tries to paint a clear image of how effective solar panels are as an alternative energy source when compared to using generators to power electrical equipment. The solar panel utilized in this study has a 100 WP capacity, while the battery used to store the energy it produces has a 12 V, 70 Ah capacity. The solar panel's output continues to be in the form of direct voltage electrical energy. An inverter is required to change the direct voltage produced by the solar panel into the alternating voltage needed by the majority of currently used electrical equipment. The inverter employed in this study has a 2000 watt capability as a 12 volt DC to 220 volt AC voltage converter, which will then be used as an electrical energy source for electrical equipment such blenders and electric lights [8]. A common solar technique is thermal photovoltaic technology (PVT), which combines solar thermal and photovoltaic (PV) technology. Solar energy is transformed into heat and electricity using this method. In comparison to solar and photovoltaic systems, PVT has a better efficiency for converting solar energy. As the system's operational temperature rises, the efficiency of PV cells also declines. As a result, the PV cells are cooled by the solar system that is coupled to them, which also improves the PVT system's total efficiency. Researchers studying cutting-edge energy technologies are now looking closely at PVP because of its domestic consumption suitability, compact construction, and long-term cost reductions. The performance analysis of PVP water collectors is described in this review together with earlier work in the field. Summary of PVP water collector performance findings. In terms of energy and exergy efficiency, PVP water collectors fall between 28.5% and 85% and 6.8% and 14%, respectively [9].

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RESULT AND DISCUSSION

One part of the solar power generation system is the solar charge controller, which acts as a current regulator for both the incoming current from the solar panels and the outgoing/used load current.
Energy conservation and the use of renewable resources have become crucial requirements due to the rising demand for power and energy. In the near future, solar energy will be the main and only source of energy. Therefore, highly effective and energy-efficient solar-powered machinery and applications will soon become a necessity. All solar power systems utilizing batteries require a solar charge controller, which has been examined and contrasted in this study. This controller uses maximum power point tracking (MPPT) and pulse width modulation (PWM). Its function is to control the flow of power from the solar panel to the battery. PWM and MPPT are features found in the majority of contemporary charge controllers. These charge controllers are made so that the solar battery can be promptly recharged and not drained, ensuring a longer battery life [10]. The findings in the field of controller creation and analysis for solar power plant charging are presented. A plan for a solar installation with its application is suggested, along with a description of the solar panel charge controller (SP). A polycrystalline silicon (SB) solar battery's maximum power point (MPP) is computed. It is suggested to use Pascal software for charge controller research and analysis, which can be used to several kinds of SPs, including perovskite panels. It has been demonstrated that the type of controller that tracks the MPP has better characteristics since it offers a higher charge [11].

In the research, a solar PV charge controller with innovative technology that includes a series and shunt charge controller is shown. Due to its characteristics, shunt charge controller with series charge and discharge is chosen for lead acid battery. In order to minimize switching losses, the author uses MOSFETs for switching. The proposed charge controller was created using MATLAB, and the charge and discharge processes of the created charge controller were confirmed. In addition, the created charge controller has been kept below the SOC limit taking into account the efficient battery maintenance, allowing for a higher extension of battery life. Additionally, a comparison of several charge controllers has been made, and it has been demonstrated that the performance of the suggested charge controller is enhanced and requires fewer switches, hence lowering the cost of the system. It can be used to reduce the energy crisis in rural areas to a manageable level [12].

The usage of non-conventional energy to satisfy the expanding energy needs is reaching a tipping point in the majority of nations worldwide. Solar energy has demonstrated its value and promise in India's energy sector on a large scale. It is also unrestricted and free. In order to create a voltage-driven, yet potent, inverter circuit that converts solar-charged 12 V DC signals to single phase 220 V AC, this article focuses on a straightforward, hygienic, and affordable design. Power MOSFETs are used as switching components. A revolution in the idea of

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solar farming in India has been sparked by the introduction of monocrystalline solar panels, the most efficient solar panel to date. In India's energy-scarce rural areas, where home power supply is frequently disrupted or nonexistent, this design, which can be charged by solar energy and dramatically reduces carbon emissions, is a boon [15].

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The system is installed with technical assistance as shown in Figure 1, which illustrates the Testing Scheme of Refrigeration Machine Using Solar Energy, after material selection for PV panels, batteries, charge controllers, and inverters, then using suitable construction, cabinets to protect the system, and frame for panels designed at an ideal tilt angle. In Langsa City in the Aceh Province, Indonesia's Universitas Samudra (UNSAM) is one of the country's newest state institutions. Increasing capacity through the construction of new facilities is one of the goals of UNSAM's development strategy, which aims to provide access to higher education for high school graduates in the province. It is merely an effort to fulfill UNSAM's purpose, which is to become a green campus, that the plan to build green buildings inside the campus complex. On the campus of UNSAM, there are nine buildings with a combined roof area of 11,232 m2, all of which are physically appropriate for solar photovoltaic installations. Over the course of a year, Langsa City experiences an average of 7,860 hours of sunlight. Around 5.0 to 6.5 kWh/m2/day of insulation are used on average each year at this site. In this study, the UNSAM campus solar PV system's economic viability is the main topic of discussion. It was determined that it would cost Rp 1,990 per kWh to produce electricity that would be advantageous to the economy. According to the analysis's findings [16], the location of the building and the PV installation's direction have a significant impact on the economic potential of installing a PV system.

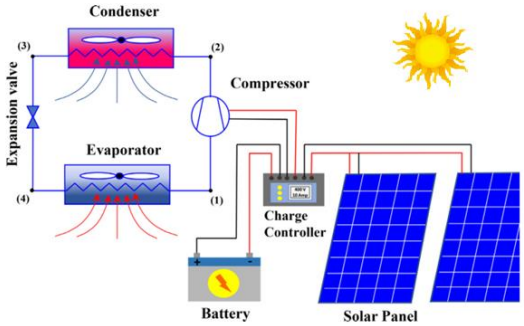

Figure 1. Testing Scheme of Solar Air

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Conditioning Using Solar Energy

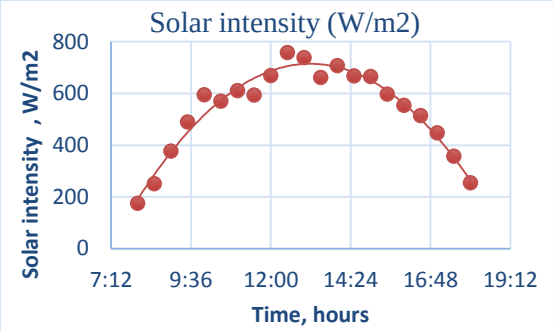

Figure 2. Solar intensity values versus time

Electric current and voltage generated by solar panels are directly inversely correlated, meaning that when voltage falls, so does the current. As shown in Figure 3.3, this is affected by the amount of solar energy that solar panels are able to collect.

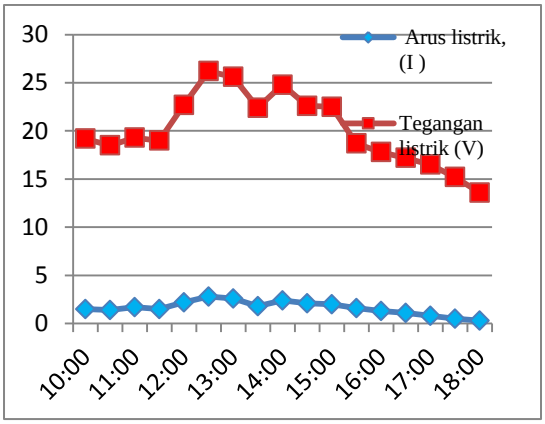

Figure 2. Voltage value of the solar panel against time

within Figure 2 The decline in COP and EER values against the test time can be attributed to a reduction in the amount of heat the evaporator is able to absorb. The test room has a low temperature due to the value decline. When the test was first started, the COP value was 8.5, the EER value was 28.7, and the test room temperature was 28 °C; however, by the time it was finished, the COP value was 2.9 and the EER value was 9.7 at a room temperature of 22 °C.

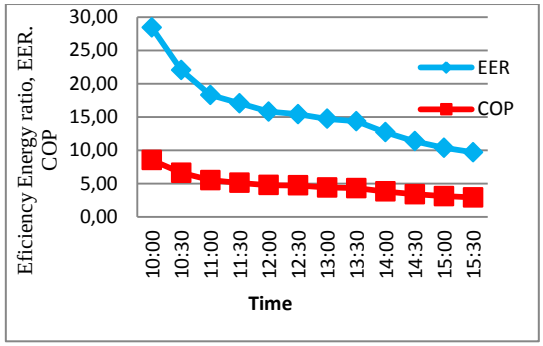

Figure 3. Efficiency Energy ratio, EER and COP

Due to a reduction in the amount of heat absorbed by the evaporator, the COP value as a function of test duration in 3 is decreasing. The room's temperature is low due to the value decline. In contrast, at the end of the test, the COP value was 2.9 at a conditioned room temperature of 22 OC, down from 8.5 at the start of the test when the room was cooled to 28 OC.

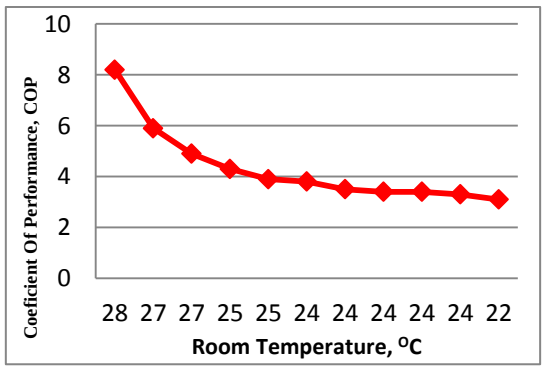

Figure 4. Coeficient Of Performance, COP with Room Temperature

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CONCLUSION

In this study, a solar-powered air conditioning system that is combined with a photovoltaic (PV) system is designed, built, and tested to see how well it performs in Indonesia's environment. This concept offers a way to lower electricity use all year long and can be effectively employed in off-grid locations without electricity. It was created using two alternative approaches, but one was chosen over the other because of the permitted voltage range and simple connection. The COP for the system was discovered to be comparable to that of the traditional system as well, but due to time-dependent sunshine and sunny weather during the day, it was highly challenging to maintain the performance of the system components over the course of the testing period.

The use of solar energy, particularly in urban areas, seems to be a worthwhile option to decrease conventional fuel consumption because of the usage of refrigeration machines as the level of demand for air conditioning is predicted to increase.

Alternatives to traditional air conditioners include solar air cooling systems. Electrical equivalents, characteristic curves, and variables affecting PV cell output are a few aspects that need to be understood in order to be used to both PV systems and air conditioning systems.

In addition to offering energy savings to end users, solar energy as a power source can lower the peak energy demand and boost the utilization of renewable energy.

ACKNOWLEDGEMENTS

In accordance with the penelitian tracking procedure No.12/LPPM-Penelitian/Hatta/ III-2023, the author extends a heartfelt thank you to the Lembaga Penelitian and Pengabdian on behalf of the University of Bung Hatta community.

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