CHAPTER 1
INTRODUCTION

1.1 Backgrounnd

In human life, energy plays a very important role. With the evolution of the times and the advancement of industrial technology, the need for energy is also increasing. One of the energies that plays an important role in human life is electricity. Today's use of fossil-based power plants, coupled with environmental issues, is demanding that humans find a way out of the threat of future energy crises. If we don't want the consequences, we have to accept that slowly we must begin to switch to clean and environmentally friendly electricity.

One way out of a future electricity crisis is to use photovoltaic (PV) or solar power plants (PLTS). Photovoltaic is a power plant that uses solar energy to make it cleaner, less polluting, environmentally friendly, and potentially abundant [1].

Solar cells are made of semiconductor material, and if the material gets photon energy, the electrons will get rid of atomic bonds and become free-moving electrons so that there is a current voltage in the same direction [2].

One of the factors that can affect the performance of solar panels in addition to solar radiation and the environmental conditions around the panel is temperature. In real-world field conditions, the solar panel will receive heat derived from solar radiation, thus causing the temperature on the panel to rise above the optimal temperature values recommended on the data sheet issued by the manufacturer, and this condition causes the performance and efficiency of the solar cell to fall drastically. Any increase in the temperature of the solar panel by 1 °C from 25 °C will result in a reduction in the output power generated in the range of 0.4-0.5%. [3-5]. The increase in the temperature of solar cells can also lead to a drop in the output voltage of solar panels to 0.22 V/°C [6–7].

A variety of research has been done to address this temperature problem, and various cooling techniques have been proposed to improve efficiency on PV, such as cooling systems using water [8–10] and also air using fans [11–12]. Techniques like neural networks were performed by Ibtisan A. Hasan and Mohammed J. Mohammed [13–14]. They conducted experiments by developing three methods of artificial neural networks, namely NARX, NAR, and nonlinear output input, to predict the temperature of PV panels based on MSE, and in the final stage, using the intelligent PID-Cuckoo search controls used to keep the temperature of solar panels within acceptable limits. Then another research method of fuzzy logic was used to regulate actuators such as water pumps and also wind fans when running the process of temperature reduction on solar panels [15–17], and the efficiency of PV can be significantly increased by using the MPPT hydride cooling system based on neuro-fuzzy [18–19].

Although the approach uses intelligent control systems such as neural networks, Fuzzie Logic, PID-PSO, P ID-Fuzzy, and Neuro-Fuszy show good performance in raising the efficiencies of solar panels and lowering and keeping the temperature of solar panels to the permissible limits, it still requires more development, especially paying attention to the efficience generated by solar panels and also taking into account the energy produced by the water pump used for the solar panel cooling process. Therefore, this time the author's research will conduct a test of the solar system cooling panel with media and using water controls to implement the intelligence system inside it.

In this study, a solar panel cooling system will be designed using water media with a new concept that continues previous research [20] and will be optimized using intelligent control systems, taking into account several parameters such as solar radiation, the temperature of the solar panel, and also the electricity generated by the water pump. The aim of this research is to obtain optimal temperature values on solar panels so that the efficiency generated by the panels can be increased and to keep an eye on the energy produced by the water pumps used for the cooling process of the panels.

1.2 Problems Statement

According to the information, the temperature of the solar panels greatly affects the efficiency generated, even when given a cooling system. As for the problem in this thesis, it is as follows:

1. How can solar panels achieve maximum output power by using a cooling system?
2. How the performance of the cooling system on solar panels can be improved by implementing the intelligent control system (fuzzy logic) can improve the output power generated?
3. How can the testing method of the intelligent control system on the solar panel cooling system be optimized with changes in sunlight conditions and temperature?

4. How can the intelligent control system method maximize the power use of the water pump, which is the main actuator in the cooling system, so that the efficiency value of the solar panel can be achieved optimally?

1.3 Objectives

When formulated from the issues raised, the purpose of writing this thesis is as follows:

1. Make a solar panel cooling system with a flowing water medium.
2. Understand, analyze, and evaluate the impact of the application of Fuzzy Logic intelligent control systems on solar panel cooling systems on the output power of solar panels.
3. Understand, analyze, and evaluate the impact resulting from the application of intelligent control systems on solar panel cooling systems based on the original values of sun radiation and temperature obtained by direct testing in real conditions.
4. Understand, analyze, and evaluate the impact resulting from the application of intelligent control systems on solar panel cooling systems based on the original values of the pump power obtained with live testing in real conditions.

1.4 Hypotheses

Most of the research focuses only on the output power output of the solar panels when given the cooling system and does not take into account the energy generated by the actuator used to stone its cooling process, so the efficiency produced by the solar panel is still a dirty efficiency.

In this research, it is proposed to apply the fuzzy logic method to fluid-based cooling systems so that it can be a solution for achieving the best working temperature on solar panels and also the power efficiency of the pump used for the cooling system.

1.5 Research Methodology

The steps of the research methodology are as follows:

1. Literary studies

   In the literature study, the latest research on the development of intelligent control systems and also cooling systems on solar panels published in the form of books, journals, papers, and proceedings is gathered to identify the problem. The problem formula and the purpose of the research are set to confirm the hypothesis in the process of identifying the problem.
2. System design

   At this stage, a test system design will be built that will be carried out in real conditions, equipped with components that can store all test data in real time. The data obtained will

be modeled using Simulink software with the addition of a fuzzy logic control method. And a testing system with fuzzy logic control will also be built, which will be carried out in real-world conditions.

3. Testing

   At this stage, the test is carried out using a microcontroller that has fuzzy logic control embedded in it. Then, the test is carried out by comparing two solar panels with different treatments, where one solar panel does not use a cooling system and the other uses a water-based cooling system that is controlled by the control. fuzzy logic.

4. Analysis and interpretation

   After a simulation is done on the software and real direct testing, the simulation results that have been processed will be analyzed. The analysis will be done by looking at the graph of the comparison of the maximum power point achieved by the solar panel system with and without coolant. The analysis would also be done by seeing the results of the power output generated by solar panels using input data of solar radiation values and also the temperature of the panel in real conditions for a day, so we would get the average value of power to determine the value of efficiency generated.

5. Conclusion

   At this stage, the results of the analysis and interpretation can be concluded based on the simulation and direct testing, as well as suggestions for improvement to improve further research.

1.6 Problem Limitation

The limitations of this research are as follows:

1. The simulation runs on the MATLAB/SIMULINK R2021a software with simulated fuzzy logic based on Fuzzy Logic Designer toolbox.
2. Fuzzy logic modeling in Simulink software uses the Mamdani inference method, and the defuzzification process uses the centroid method.
3. Parameters of the control system used for the input of solar radiation and the temperature of the solar panel, then for the output of the DC water pump.
4. The cooling system for the solar panels used in this research is a cooling system with a convection principle based on flowing water. The research carried out is a development of research previously carried out by researchers in the Power Electronics and Electromagnetic Machines Research Group, Conversion Research Center, and Energy Conservation, National Research and Innovation Agency.