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Air-Conditioning Unit Harvesting Energy Using DC Generator

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Abstract: The usage of air-conditioning unit in the residential building has increased rapidly in the recent decades. There are waste energies that released from the operation of air-conditioning unit. The main objectives of this paper are to investigate the potential energy from the air-conditioning system, create methods for energy harvest from waste energy and to verify its performance and effectiveness. The scopes will focus on designing a suitable energy harvester on the 1 HP air- conditioner using DC generator. The result presented consist of the DC generator output and it shows that DC generator is able to generate voltage during the starting of the air-conditioning unit operation. his project will help in bringing a new concept of power generation using waste energy.

Keywords: Waste energy, DC Generator, Air- conditioner.

1. Introduction

Most of the countries currently experiencing rapid urbanization and population growth are in the developing world. Nowadays, the usage of air-conditioning at the residential building has become a tremendous increase over the last few decades. The majority of the towns in Southeast Asia experience hot-humid climate all the year [1].

An air-conditioner makes your home cooler, by drawing heat energy out of the house and transferring that heat to the compressor located at the outdoors of the building, and then the air is replacing with the cooler air back to your home. The compressor is the heart of the cooling cycle. The cycle will begin where the compressor draws cool gas which is low-pressure refrigerant gas from the indoors [2]. The motor-driven compressor's sole function is to squeeze the refrigerant, raising its

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temperature and pressure. So, the high-pressure gas will exits through the compressor as hot gas. There are several potentials in generating new energy from the air-conditioning unit's operation such as heat, wind and also the movement itself.

In [3], potential sources of waste energy found in an air-conditioning condenser unit and the method that has been used is called vibration and airflow-driven energy harvesting using piezoelectric devices. Besides, a Peltier device has been developed in [4] to harvest heat from the condensing unit and convert it to electricity. The result shows that 1.61 V were collected from the split unit air-conditioner after 30 minutes of operation. There are many researchers proved that heat from compressor can be harvested to generate power for future implementations [5]-[7]. From previous studies, it shows that energy harvesting from air-conditioning units are possible and this paper will explain on how DC generator is used in generating electricity from the mechanical movement of compressor fan.

2. Materials and Methods

A DC generator is an electrical machine which at a specific voltage and frequency transforms the mechanical power from a primary mover into a DC electrical power [8]. Main component of the project will be the DC generator, battery and the compressor unit.

2.1 Main Components

The main components for this project are shown in Figure 1 where the DC generator is attached to the fan of compressor and battery is connected directly to the DC generator. The DC generator or dynamo usually used in smaller application such as homemade wind turbines. A coupling is used to connect shaft of generator and shaft of compressor fan. A fan is driven by a motor directly. The function of the fan is to blow air over the coils in order to cool and release heat to the air outside. So the fan will activate when the process in compressor is running. A battery is a container consisting of one or more cells in which chemical energy is converted to electrical energy and used as a source of backup power. Battery are connected to the terminal of DC generator.

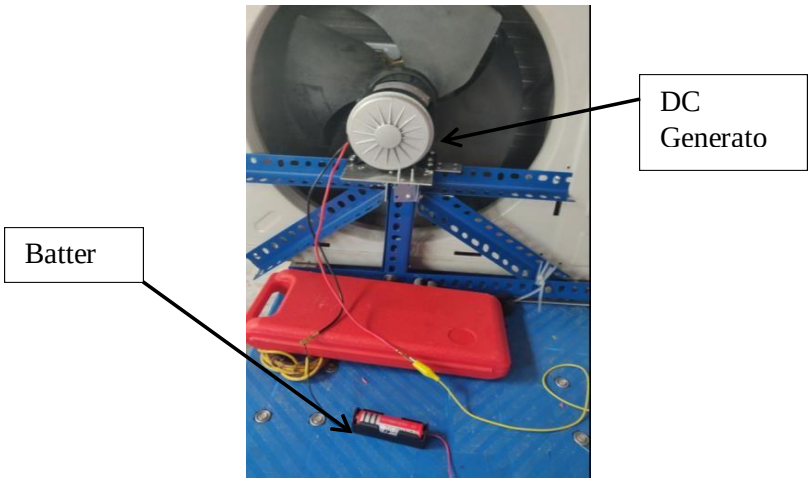

Figure 1: DC Generator and Battery

Figure 2 illustrates the flow of the project where source is coming from the air- conditioner's compressor. The mechanical source is used by the DC generator that connected to the fan of the compressor. The electricity power will be generated and the fan blows air inside the compressor. The generator's rotor spins and create electricity to charge the battery.

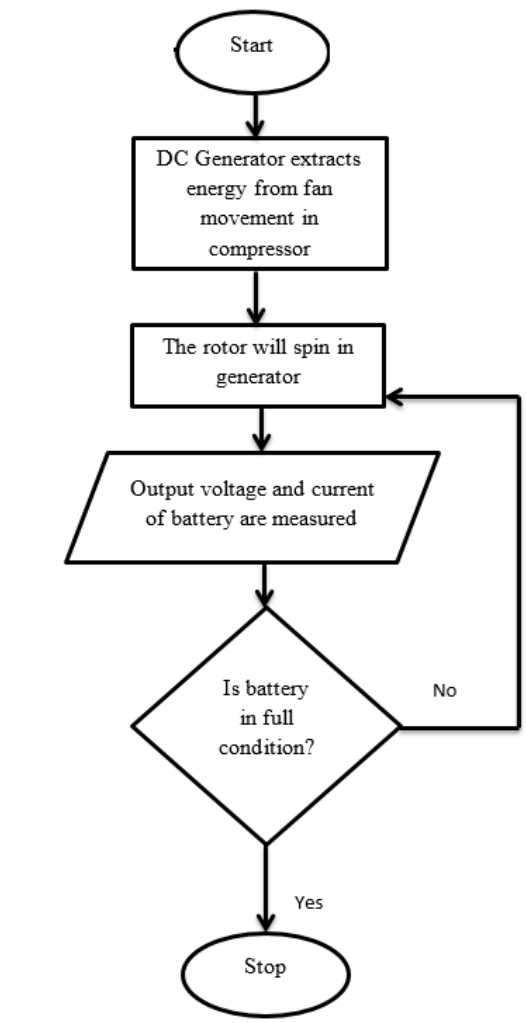

Figure 2: Flowchart of the Project

2.1 Prototype of DC Generator

The suitable place of DC generator to the fan of compressor is shown in Figure 3. A coupling is used to connect the shaft of generator and also the shaft of fan. A fan is driven by a motor directly and the function of the fan is to blow air over the coils in order to cool and release heat to the air outside. The fan will activate when the process in compressor is start. Angle Steel is used to hold the generator and was attached in front of air-conditioner's compressor. During this process, problems that related to mechanical functionality happened when the compressor start to operate. The angle bar that holds the generator is shaking and will disrupt the system outdoor unit. To counter this problem, each part of the angle bar was tightened to the body of the compressor by using screws.

Figure 3: Angle Steel used to hold the Generator

Besides that, another problem that occur was related to the connection itself. When the generator shaft and fan are connected, the connection loose. When the fan was rotated the generator shaft does not moving following the fan. However, the problem is solved by tightening the connections of generator and fan by using U holder lock as shown in Figure 4.

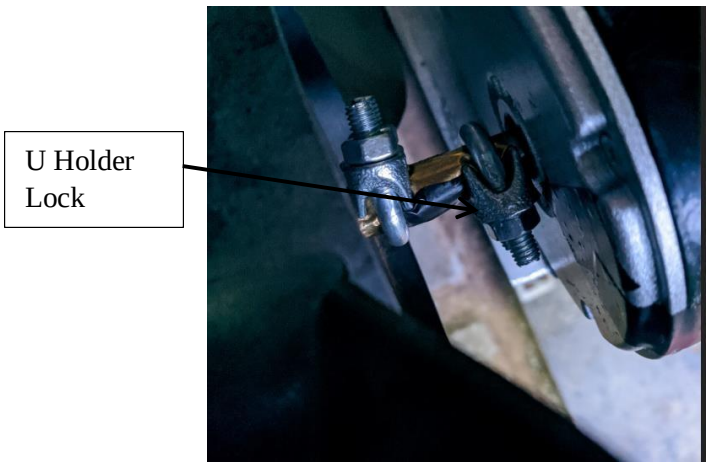

Figure 4: Tightening the Connection using U Holder Lock

3. Results and Discussion

This section will discussed the results of the project. Figure 5 shows the prototype of a 1 HP air-conditioner that is selected to be tested and analyzed in order to show its suitability for this project implementation. This testing used a 3.7 V battery and the air-conditioning unit will be operated for 30 minutes.

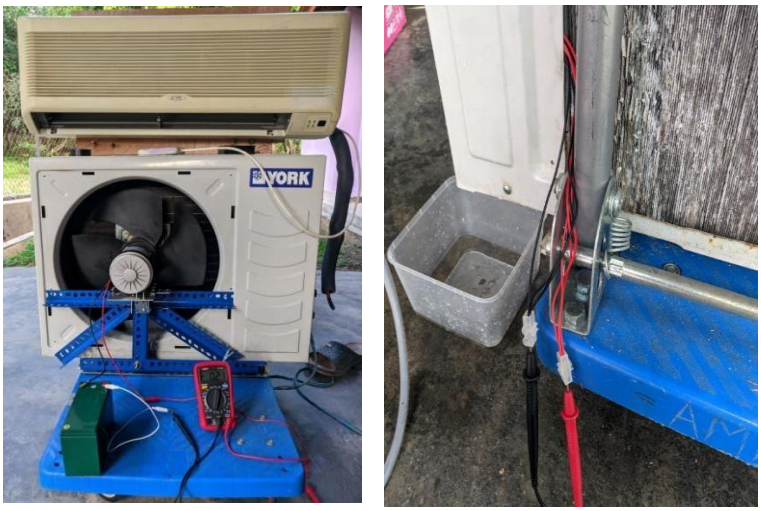

Figure 5: Prototype of a 1 HP air-conditioner a) The Front Design of Compressor b) Behind the Compressor

At the beginning stage, the battery voltage is measured using multimeter and the capacity is 2.21 V. The charging results of the battery in 30 minutes during the air-conditioning unit operations are tabulated in Table 1. During the testing period, after 25 minutes of the air-conditioning unit operations, the results are not be able to be taken anymore although the air-conditioner is ON because the fan in the outdoor unit compressor is stop. This is due to the sensor in the indoor unit detect the desired temperature or reach the temperature setting. It can be seen that the battery voltage increase from 2.21 V to 2.28 V in 25 minutes. After that, the battery can't be able to be charged due to the reason stated above.

The battery charging increased rapidly for the first 10 minutes and shown in Figure 6, but begins to slow down due to the compressor behavior in which the fan started to slow down when the temperature setting is nearly reached. The most important part, when the testing is conducted, the generator that is connected to the fan of outdoor unit system, did not cause the air- conditioning unit to trip. Also, the desired temperature and performance of air-conditioner are not interrupted and works smoothly.

In order to fully charge the battery, this system can be improved by adding another type of energy harvesting such as heat energy to generate more power. These two systems can be combined as a hybrid energy harvesting system for air-conditioning unit for future implementations.

Table 1: Results of Battery Charging in 30 Minutes

Time Taken (Minutes)	Battery Voltage (V)	Current (A)
5	2.21	0.11
10	2.24	0.11
15	2.25	0.11
20	2.27	0.12
25	2.28	0.11
30	-	-

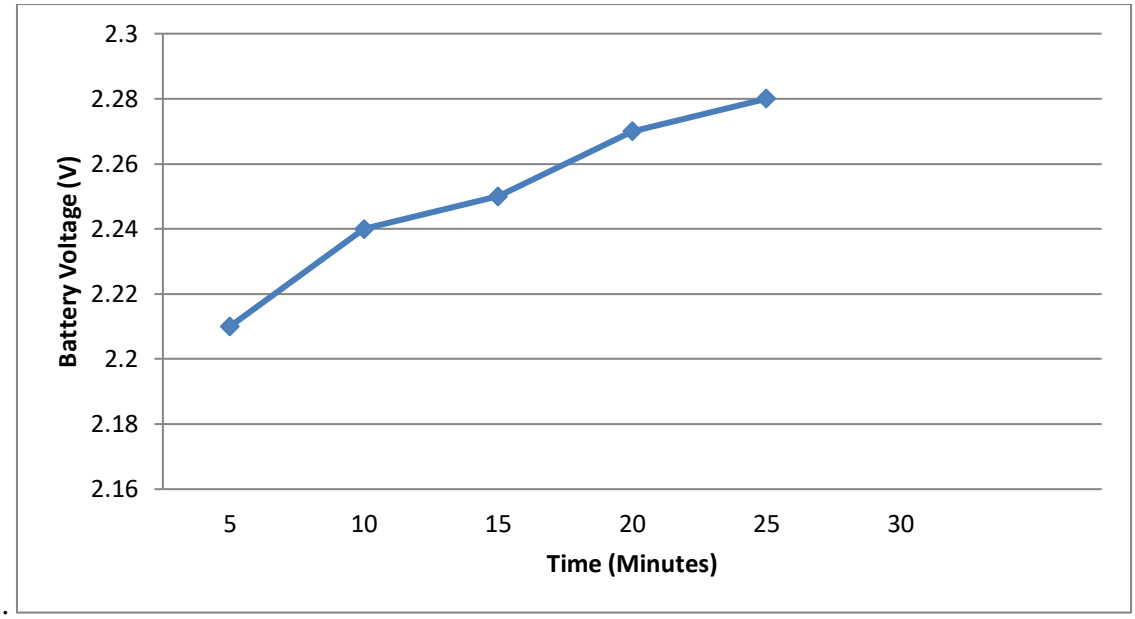

Figure 6: Battery voltages verses time

4. Conclusion

Air-conditioning unit harvesting energy using DC generator had successfully developed. The performances and the effectiveness are proved during the testing stage where it is able to charge the battery. The selection of DC generator is important due to its characteristic which used in supplying small-scale application. The results show that DC generator can produce high output voltage and current to charge the battery in a short period of times. By doing this project, it can bring a new concept of power generation using waste energy in air-conditioning unit which is the mechanical energy of the compressor's fan. For the future recommendation, this project can be added with another type of energy harvesting system such as thermoelectric generator (TEG) for heat energy of the compressor as a hybrid system.

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