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Research Article

Generation of Electrical Energy From OWC Based Wave Motion

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Abstract

Nowadays, the human population is constantly increasing. Depending on this increase, the energy need is also increasing. The fact that resources such as coal and petroleum used in electrical energy production are limited and these limited resources will be insufficient in energy production in the future have made the conversion to renewable energy a necessity.
In this study, a system has been designed to generate electrical energy with wave energy, which is one of the renewable energy sources, and its output value has been measured on a voltage basis. Wells turbine was used to increase efficiency in the system. As a result, the mechanical energy generated by the rotating turbine affected by the air pressure has been converted into electrical energy.

Keywords: Wave Energy, Oscillating Water Column, OWC, Wells Turbine, Renewable Energy

OWC Tabanlı Dalga Hareketinden Elektrik Enerjisi Üretimi

Öz

Günümüzde insan popülasyonu sürekli olarak artış göstermektedir. Bu artışa bağlı olarak, enerji ihtiyacı da artmaktadır. Elektrik enerjisi üretiminde kullanılan kömür, petrol gibi kaynaklarının sınırlı olması ve bu sınırlı kaynakların, gelecekte enerji üretiminde yetersiz kalacak olması, yenilenebilir enerjiye dönüşü bir gereklilik haline getirmiştir.
Bu çalışmada, yenilenebilir enerji kaynaklarından olan dalga enerjisi ile elektrik enerjisi üretmek için bir sistem tasarlanmış, çıkış değeri voltaj bazında ölçülmüştür. Sistemde verimliliğin artması için Wells türbini kullanılmıştır. Sonuç olarak hava basıncından etkilenerek dönen türbinin sayesinde oluşan mekanik enerji, elektrik enerjisine çevrilmiştir.

Anahtar Kelimeler: Dalga Enerjisi, Salınımlı Su Kolonu, OWC, Wells Türbini, Yenilenebilir Enerji

1. Introduction

The use of non-renewable energy sources in electrical energy production has caused people to search for electricity generation in different ways due to the damage it causes to the environment and the gradual decrease of these resources. While energy is obtained from fossil fuels such as oil, coal and natural gas, CO2 is emitted to the atmosphere. This heat-absorbing gas increases the average temperature of the world and as a result, global warming occurs, ice melts in the polar regions, climate changes occur, and climate changes negatively affect many situations such as the ecosystem, water resources, agriculture, health and sea level [1]. The continuous increase in the world population and the steady increase in energy needs have pushed humanity to renewable and less harmful energy production ways. Some of these renewable energy sources are; solar energy, wind energy, geothermal energy, hydraulic energy, wave energy. Although wind energy and solar energy are widely used, wave energy has not yet found its place and value in our world.

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1.1. Wave Energy

It is the type of energy obtained through waves formed as a result of wind and external factors. Once formed, waves travel thousands of kilometers with very little energy loss. In order to use this energy, it is necessary to make measurements that take many years and are very expensive in the area to be used. In places where these measurements cannot be made, wind measurements, which are more economical, are made, and wave energy is calculated by using the formulas that give the relation between wind and wave. From this calculated energy, the amount of electrical energy that can be obtained with the help of one or more wave turbines placed at the measurement point can be determined [2].

1.2. Oscillating Water Column

The oscillating water column is within the shoreline applications of wave energy. The basic principle here is based on the trapping of air in a chamber. With wave movements, the air in this chamber is squeezed and transmitted outwards by a pipe. Meanwhile, the turbine on the transmission path rotates and generates mechanical energy. With the return of the wave, the negative air pressure turns the turbine again and energy is produced by a second movement. Turbines rotating in the same direction in both air flows and this will increase the efficiency, and for this reason Wells turbine was used in the study. Figure 1 shows an oscillating water column.

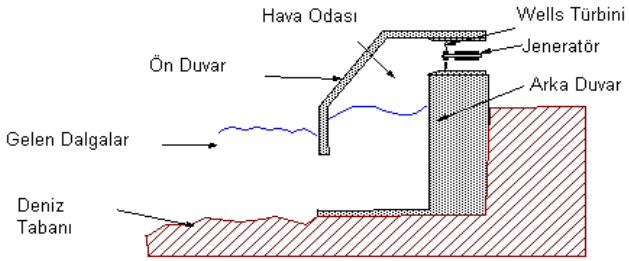

Figure 1. Oscillating Water Column System [3]

1.3. Wells Turbine

Wells turbine is an air turbine that rotates in one direction regardless of the direction of airflow. The oscillating water column was developed by Alan Arthur Wells in the late 1970s to be used in power plants [4]. The Wells turbine used in the study was obtained from the drawing in Figure 2 with a 3D printer.

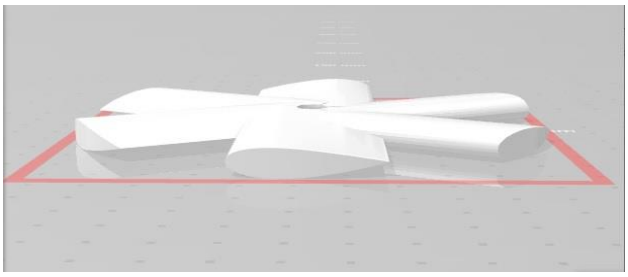

Figure 2.1. Wells Turbine side view

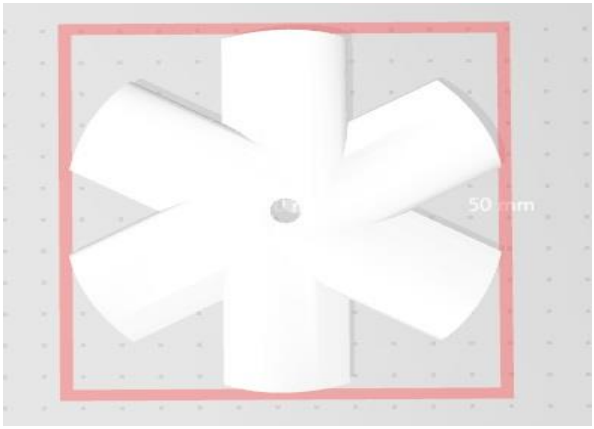

Figure 2.2. Wells Turbine view from above

2. Material and Method

2.1. Material

Materials used in the study;

- Glass reservoir where the wave will be created,
- Wells turbine
- The engine (generator) to which the turbine is connected
- Multimeter

2.1.1. Material Properties

An aquarium was used as a water reservoir in the study. The aquarium is 1-meter-long and 40 cm wide. The side and top views are as follows;

Figure 3. Side view of the glass container

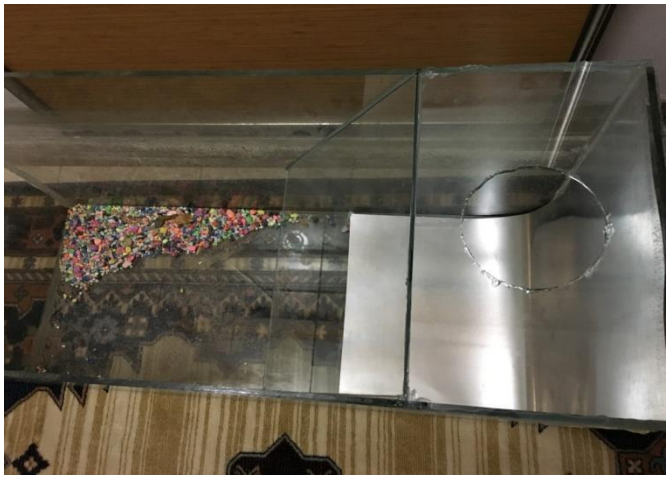

Figure 4. Top view of the glass container

To prevent the wave from losing energy by hitting the corner, a sheet metal is placed in the chamber as shown in the figure. Thus, the water coming with the wave is transferred upwards.

The diameter of the air chamber on the aquarium is 14 cm. In the later stages of the work, ventilation pipes and Wells turbine will be installed here. Wells turbine to be used in the study was obtained by 3D printing. The wing diameter is approximately 12 cm.

The 13 Volt engine generator is connected to the turbine. The shaft of the engine is fixed in the center hole of the turbine. Thus, as the turbine rotates, the generator shaft will also rotate and mechanical energy will be converted into electrical energy.

A manual method was used to create waves.

A conventional multimeter is used to measure the voltage to be obtained from the generator output. This multimeter is connected to the motor via cables.

The view of the system with the completed material is as in Figure 5.

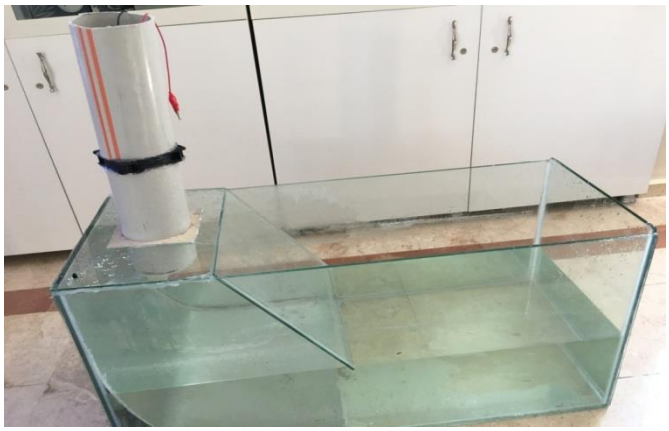

Figure 5. Completed system

2.2. Method

First, the glass reservoir was filled with approximately 0.4 m^3 of water. Then, a wave was created manually from the open side of the chamber.

The flowing action insisted of two phases. In the first phases, the formed waves started to move up in the glass chamber and the air that was compressed. As the waves formed, the compressed air became flowing out through the turbine channel. Then the rotation movement begins in one direction and the speed of the turbine increased. In the second phase, the level of the water decreased in the glass chamber. Then the air became flowing in to the chamber through the turbine channel. The turbine rotates in the same direction because of its' special design.

In the generator connected to the shaft of the rotating turbine, electrical energy was produced as a result of this mechanical movement.

3. Results and Discussion

3.1. Results

As a result of the air flow generated when the system was operated, electrical energy was generated through the Wells turbine and generator. Approximately 13.5 Volt voltage was generated at the end of 120 seconds. The V-Time graph of the produced voltage is as in Figure 6.

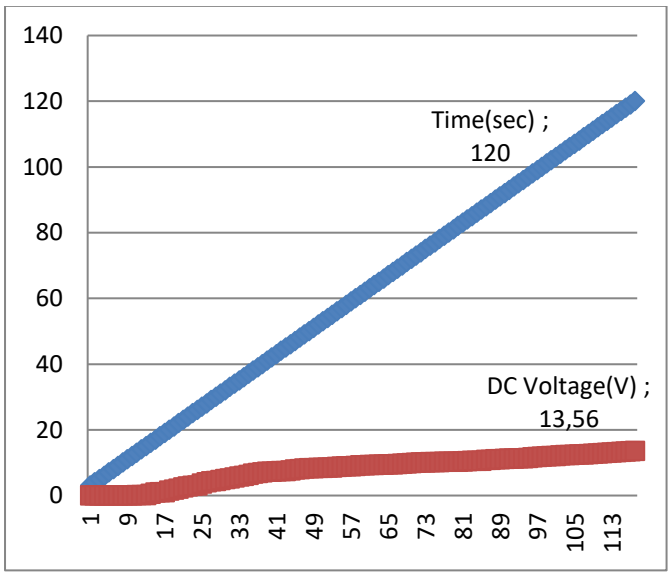

Figure 6. Voltage Produced Over Time

3.2. Discussion

In the laboratory environment, electrical energy was produced by waves created in a very small reservoir compared to the ocean and seas. The importance of using huge energy resources such as seas and oceans in our world, where the interest in renewable energy resources is increasing, has been proved with this study.

4. Conclusions and Recommendations

Thanks to the waves created in the system, there was an air compression and expansion in the air chamber. This compressed air came out with the help of pipes and then returned to the water reservoir in the same way. The Wells turbine on the road here started to rotate thanks to the air flow and accelerated within seconds. Electric energy has been started to be produced thanks to the generator connected to the turbine. Measurements were made with a multimeter connected to the generator, and the electricity generated as a result of 120 seconds was recorded as approximately 13.5 Volts.

I recommend the following items for future studies;

- The propeller and aquarium sizes to be used must be compatible with each other.

- There should be almost zero distance between the propeller blades and the chamber it is in, so that air leakage is prevented.

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