2nd Nommensen International Conference on Technology and Engineering

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PREFACE

On behalf of the 2nd Nommensen International Conference on Technology and Engineering, I would like to welcome you all speakers and participants to our campus in Medan. This city is fascinating with its culinary tourism offering tropical fruit like durian and various food and cakes that spoil our tongue. Beside its culinary tourism, the city of Medan is close to a dynamic business city with relevant past in agriculture and plantation. We hope you will have the opportunity to enjoy the food and your time while staying in this city.

This conference is the second time the NICTE series was conducted by our university. The current theme is "Sustainable Engineering, and Technology Innovation and Application." The theme is selected with the objective to bring more innovation in technology application to the current development in this city and the whole country of Indonesia. The great effort dedicated by our government to expedite the construction of massive infrastructures requires more technology innovation and application. Our contribution to this conference however small is also of valuable input to the current government effort in developing this country.

I would like to take this opprtunity to thank all the committe, speakers, authors, reviewers and participants who dedicated their effort for the successfull execution of this conference. Without your contribution, we simply could not have had this conference.

We received more than 140 submissions in this time. They came from various countries like Czech, Malaysia, Turkey and Russia in addition to those from Indonesia. We categorised the papers under seven groups, namely: Civil and Enviromental Engineering, Mechanical Engineering and Technology, Electrical Engineering, Material Sciences and Engineering, Food and Agriculture Technology, Informatic Engineering and Technologies, Medical and Health Technology. Some papers can be categorised conveniently into one of these groups. Others bring their own difficulties because they might be put under more than one group. Still, the committee has done a great job to send your paper to the right reviewer. All papers regardless of their standing or initial classification, were available for general discussion at the task force meeting.

We are fortunate to have five distinguished keynote speakers at the moment. They are David Herak from CULS, Badorul Abu Bakar from USM Malaysia, Shyh Leh Chen from CCU Taiwan, Katsumi Suzuki from Shizuoka University Japan and Himsar Ambarita from USU Indonesia. David Herak is currently doing extensive work in biofuels and renewable energy. Badorul Abu Bakar interest is concrete technology and brick structures. Shyh Leh Chen has filed for a patent on active magnetic bearings. Katsumi Suzuki is leading research work on plant production and environmental agriculture. Himsar Ambarita currently leads a research centre focusing on sustainable energy and biomaterial. I would like to give thanks to the five of you for the interesting keynote speech at this conference.

Finally I hope that all participants enjoy a successfull conference, make a lot of new contacts, engage in fruitful discussions and have a pleasant stay in Medan.

Richard AM. Napitupulu
2nd NICTE CHAIRMAN

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The use of DC water pumps on solar-based vacuum desalination system

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The use of DC water pumps on solar-based vacuum desalination system

Eko Yohanes Setyawan[1*], Mochtar Asroni[1], Soeparno Djiwo[1], Asroful Anam[1], Richard A. M. Napitupulu[2], Parulian Siagian[2]

[1]Mechanical Engineering, Faculty of Engineering, National Institute of Technology Malang, jl. Bendungan Sigura-gura No.2 Malang 65152, Indonesia
[2]Mechanical Engineering, Universitas HKBP Nommensen, Medan, Indonesia

[*]Email: yohanes@lecturer.itn.ac.id

Abstract. Speed up in vacuum desalination system means many things that are in desperate need of development especially energy transfer. Therefore, in this experiment, a pump is used to transfer the energy from the solar collector into the evaporator including the forced convection heat transfer. The water fluid inside the solar collector is heated by sunlight and then pumped into the evaporator to evaporate seawater. It is done to support the performance of the condenser which turns steam into clean water. It is reported that pump performance for a total head loss value is 2.67 m and for pump head is 2.82 m. By generating pump axle power of 28.73 W, thus the resulted motor power was 33.03 W. With total existing energy for 13 MJ/m^2 the electric current generated by solar cell during experiment is 2.6 A in average from 08.00 A.M until 16.00 P.M with speed water average of 3.1 m/s. It is due to the effect of the sun intensity if the sun intensity is high speed of the pump is also high since it uses a photovoltaic 100 WP therefore it affects the electric current received by the pump.

1. Introduction

Water is a major necessity for human beings. The rapid development of population growth and many rainwater absorption areas that make up residential areas will surely lead to fresh water scarcity. Furthermore, with the increase of industrial area without considering the environmental impact of the production, henceforth, there are many water sources that have been contaminated by the industrial activities in question.

Thus, it takes such a developmental technology to answer the problems that will arise in the future. One of the technology which can be developed is desalination technology that, by principle, is a way to get clean water through the process of distilling the sea water. The general principle of desalination work is that sea water is heated to evaporate, and then the resulting vapor is condensed back and accommodated in a separate shelter.

Desalination is widely adopted in the Middle East, Arab Countries, North America, Asia, Europe, Africa, Central America, South America and Australia to meet the needs of fresh water and water treatment. Nearly 10000 tons of oil is needed each year to produce 1000 m^3 / day of fresh water [1]. The salt concentrate discharged out of the desalination system also poses a serious threat to the life of seawater [2]. The most commonly used desalination systems are Multi Stage Flash (MSF), Multi-Effect Distillation (MED), Vapor Compression (VC), Reverse Osmosis (RO) and Electro-Dialysis (ED) [3]. Conventional desalination systems operated using fossil fuels also contribute greenhouse gas emissions or GHG (Green House Gas). This has prompted researchers to look for alternative ways to power systems with renewable energy.

Renewable energy used by the desalination process is generally in the form of solar, wind, and geothermal energy. Among the three, 57% desalination systems are supplied with solar power as renewable energy. Desalination technology using solar energy can reduce the use of fossil fuels, thereby reducing the greenhouse gas emissions that become global issues today. The sun is a promising source of renewable energy. In all the renewable energy desalination units operating in the world, almost 57% of them are powered by solar energy [4]. Solar energy can be used directly on the desalination process [5]. The solar-powered desalination system uses an integrated condenser with a flat plate solar collector and a vacuum pump developed to produce fresh water. Compared to the usual system, the experimental results show that the developed system increases the water productivity, for all water salinity due to the presence of a vacuum pump. Desalination of natural vacuum solar with low temperature to produce fresh water from seawater, the advantage of using a vacuum is to increase low temperature heat sources such as solar energy to the maximum [6,7]

Another study reported on natural vacuum solar desalination consisting of evaporators that received direct solar radiation and condenser in a shadier place. To provide better water supply, blowers are used to transfer vapor from the evaporator to the condenser [8]. Numerical and experimental methods at the laboratory scale of natural vacuum desalination units have been reported, replacing the heat of solar energy with the electrical elements used in the evaporator [9]. Recently, it has been reported the initial field tests of natural vacuum solar desalination units. In this case, electric heaters are replaced by solar collectors [10].

Of the development of vacuum desalination technology naturally, there have not been many to develop this green technology, so there were still many that needs to be developed. The development was done with several modifications such as to improve the thermal performance of the solar collector by adding a DC pump (nothing mentioned about this in results and in conclusion) to accelerate in the energy transfer from the collector to the evaporator. It was expected to be able to provide input on clean water needs globally by utilizing free solar energy. The goal was to explore a natural vacuum desalination system using solar energy.

2. Method and equipment

To perform this experimental test firstly created a whole vacuum desalination system by fully filling the seawater into the desalination system (evaporator, tube-in-tube heat exchanger and condenser). To create a vacuum system, each valve in the feeder pipe (pipe in the heat exchanger) was opened, so the seawater in the evaporator would fall due to the gravitational force through the feeding pipe, thus forming a vacuum chamber in the desalination system. With evaporator material made of 304 stainless steel cylindrical shape with cone-like top, the height and thickness of each evaporator were 80 cm, 20 cm, and 5 mm. The heat taken from the solar collector would be incorporated into the evaporator in a circulation using water fluid, hence it was to provide energy to evaporate seawater. With the help of a DC-powered electric pump generated by a photovoltaic capacity of 100 Wp. as shown in Figure 1schematic diagram and Figure 2 solar water dc pump.

Systematically the seawater inside the evaporator was heated by the heating coil with the fluid of water transferred from the solar collector with the help of the DC pump, therefore, the copper pipe was used along the test of the Solar desalination of this natural vacuum system, because the copper pipe has so excellent thermal conductivity that it can deliver heat optimally along the desalination solar system in this test. The water flowed into the copper pipe until it was full, then the DC pump would circulate the water out of the pump to the collector and it went toward the evaporator through a 5/8 inch in diameter copper tube with an overall length of 11.6 meters. Water flowed along the 5/6 inch copper pipe with the water debit which was measured its flow rate with flow meter every 10 minutes from 08:00 A.M until 16:00 P.M.

Figure 1. Desalination Experiment Tool

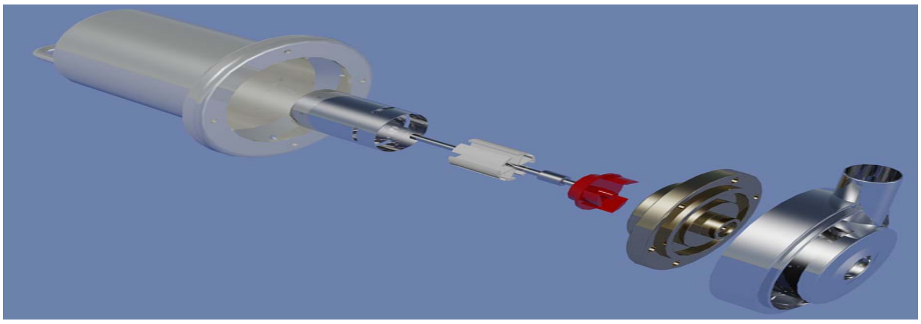

Figure 2. Solar Water DC Pump

3. Results and Discussions

The pump served as a water supply in the copper pipe which was then heated in the Solar Collector and the next it was sent to the evaporator. The pump must be able to consistently supply water in the evaporator so that the temperature of the copper pipe in the evaporator was maintained. It would enable the copper pipe inside the evaporator heat the seawater inside which would then get its moisture results. Hence, we had to use some equations to find out the pumphead that was the amount of energy required to move or flow the fluid.

$$H = Hs + HL + \Delta HP + \Delta HV \quad (1)$$

Where:

H = pump head (m)
Hs = static head(total height distance)
HL = loss head(m)
ΔHp = difference of pressure head (m)
ΔHv = head speed difference (m)

a. Head Static (*Hs*)
   The static head is the difference in the height of the water surface to be circulated by the pump through the flow meter., The magnitude of the static head was:
   $Hs = 0.15$ m

b. Pressure head difference (ΔHp)
   In this working system the water pressure entering the pump was equal to the outlet pressure; 1 atmosphere, then the pressure head difference in this system was zero.
   $\Delta Hp = 0$

c. Head seed difference (ΔHv)
   The head difference of the flow velocity was zero because of the amount of head speed on the suction side and press side was the same.
   $\Delta Hv = 0$

d. Head loss (*HL*)
   While the head loss itself consists of friction losses along the pipe and friction losses on fitting of 2.67 m obtained using the equation below:
   $$HL = Hf + He \quad (2)$$
   where:
   Hf = Head of the friction in the pipe
   He = Head friction on fitting

According to Copper Tube - NZS3501, the head of friction in the pipe of 1.11 m was figured out using the following equation:

$$Hf = F \ x \ Q1,8 \quad (3)$$

where:
Hf = Head loss friction (m / 100m)
F = Friction coefficient
Q = Equivalent Flow rate
$Q = V \ x \ c$ (4)
where:
V = flow velocity (m / s)
c = flow coefficient

To figure out the value of friction coefficient and flow coefficient can be depicted in the following table.
According to Copper Tube - NZS3501, head friction at 1.56 m fittings was figured out using the following equation:

$$He = f \ x \ [[Q / c]]^{\wedge} 2 \quad (5)$$

Where:
f = friction coefficient of fitting
Then the total head loss value was 2.67 m by adding total head friction on the pipe and total head friction fitting.

$$HL = Hf + He \quad (6)$$

From all the data that had been figured out above then the value of pump head is 2,82 m in this system with the equation below:

$$H = Hs + HL + \Delta HP + \Delta HV \quad (7)$$

a. Hydraulic Power Pump

The hydraulic power of the pump is the power put into water by the rotor or piston pump so that the water could flow.

The obtained 22.98 W Hydraulic power (in kilowatts) can be stated as follows:

$$Ph = 0.163 \times QxH \times \gamma \quad (8)$$

b. Power Shaft Pump

The pump shaft power is the power to be inserted into the pump shaft. The shaft power required to drive a pump is equal to hydraulic power plus a power loss in the pump of 28.73 W. This power was stated as follows:

$$Pp = Ph / \eta p \quad (9)$$

Description:

Ph = Hydraulic power

ηp= pump efficiency

c. Power Motor Driver

The driving force of the pump motor is the power applied to the driving force to rotate the pump shaft. The driving force of Pm must be greater than the power of the pump shaft, the excess is dependent on the motor type and the motor shaft relation. The driving force motor was figured out to be 33.03 W using the equation:

$$Pm = Ph\ (1 + A) / (\eta p.\ Hk) \quad (10)$$

The experiments were conducted from 8:00 to 16:00 on July 16th, 2017 at the Magister Mechanical Engineering building of Universitas Sumatera Utara. The blazing sunshine during the experiment is shown in figure 3. The measurement radiation curve with HOBO was below the theoretical calculation radiation curve line. These figures show that solar radiation measured was lower than the theory underlined, because theoretical calculations were based upon the clear skies alone with the absence of clouds. In fact, during the solar radiation experiments it was obstructed by clouds that were above the sky. Measurements showed that solar irradiance increased along with the time. However, after 2 pm the solar radiation dropped gradually.

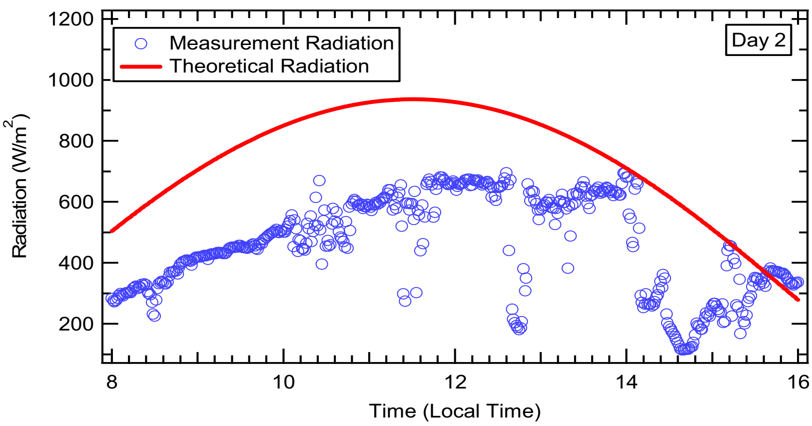

Figure 3. Theoretical radiation and radiation measurement graphs

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From the graph of theoretical radiation and radiation measurements it could be known that the amount of radiation energy coming during the test was 13 MJ/m^2. As it was known that the intensity of radiation was an important factor, because the process of desalination experiments was very influential on solar energy. The red line indicates the ideal conditions of a clear sky where the measured solar radiation is indicated by the blue circle sign and the radiation of the clear sky is indicated by the red line.

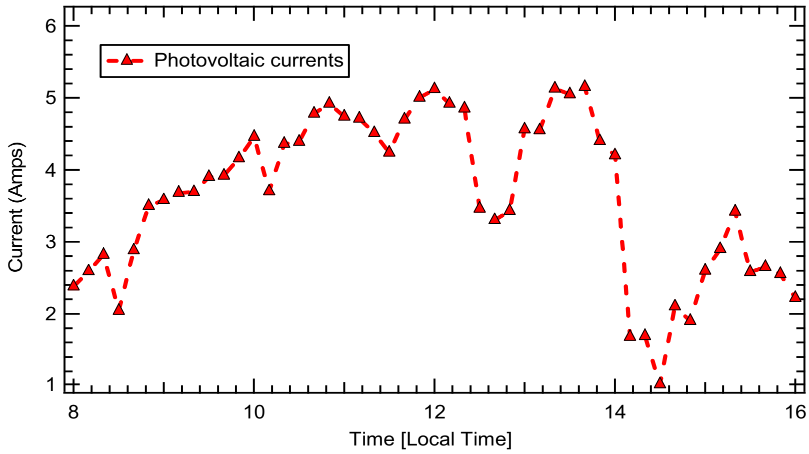

Figure 4. Photovoltaic currents with local time

In figure 4 Shows that the power going into the cell from 08.00 am will continue to increase until 12.00 noon. After 12.00 mid-day with the fluctuated amperes entering solar cells, it tends to rise despite the decrease until 14.00, it continues declining until 16.00.

The electric current generated by solar cells during the experiment was 2.6 A in average from 08.00 to 16.00 which was influenced by the coming energy that could be detected by the solar cell. The smaller the angle the greater the energy absorbed by the solar cells. Therefore, the increasing energy absorbed resulted a higher generated solar cell power especially during the sunny bright day.

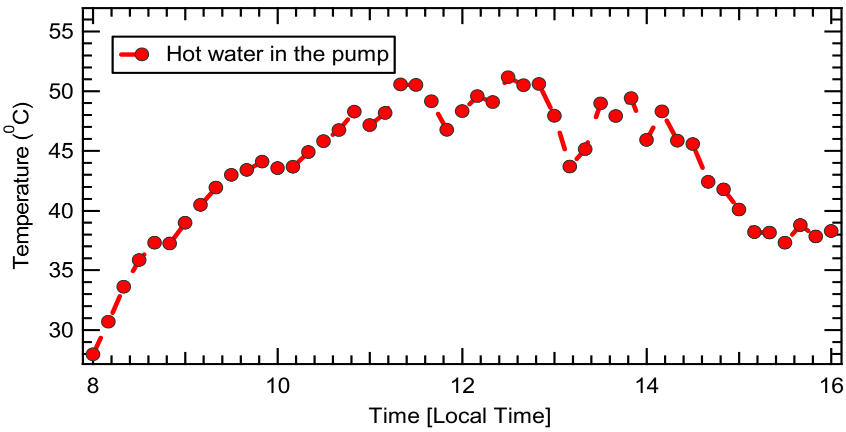

Figure 5. Graph of hot water temperature inside the pump

It shows the water temperature inside the pump after passing the evaporator. The temperature received by the pump was not so high as it had been used to heat seawater inside the evaporator during the experiment. To make a comparison between the intensity of radiation toward the increase of pump temperature which increased, in average, during the day time . This temperature was very influential on the condensation rate in the condenser, because it was an important factor in a desalination system which, in this experiment, produced 1.4 liters of water. The start of the test was in the morning at 8:00 WIB and the temperature received by the pump was not yet too high; 28^0C. It was the lowest temperature at the time of the experiment and began to creep up to the highest temperature of 510 C at 12.30. The temperature indicated that the temperature at the pump diminished tremendously after passing through the evaporator shown by the red line in Figure 5.

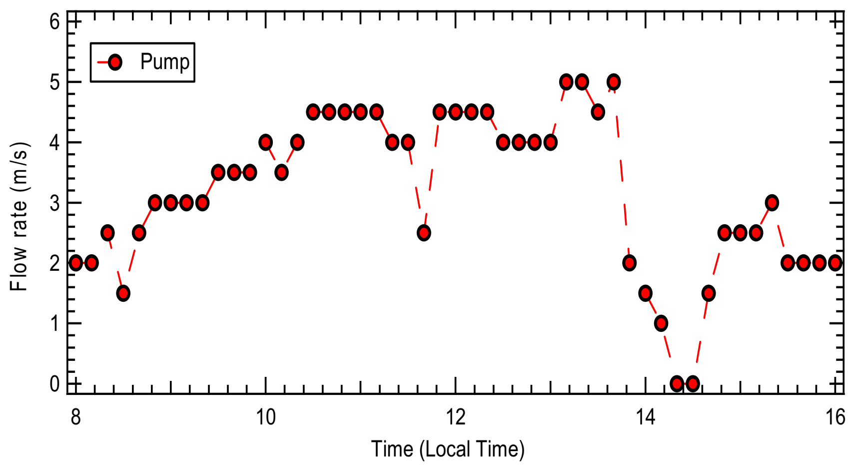

Figure 6. The pump velocity

According to the experimental results, the average water velocity was 3.1 m/s and the top speed was 5 m/s, it was due to the effect on the intensity of the sun; the higher the intensity the faster the pump. The speed of the pump affects the electric current received by the pump since it used photovoltic 100 WP.If it were desired to increase the speed of the pump, it used a larger photovoltic. As a result, it could increase the electrical current generated by photovoltic.

4. Conclusion

The entire pipe length used was 11.6 meters of 5/8 inch pipe and 14,05 meter of pipe size 1/2 inch. Then the total head of pipe friction was 1.11m by using 30 pieces of elbow and the total head friction fitting headpiece on the pipe was 1.56 m. While the total heat loss value was 2.67 m. The data showed that the heat pump was 2.82 m. The generate pump shaft power was 28.73 W. Therefore, it was known that the driving power of motor was 33.03 W. With total energy coming for 13 MJ/$m^2$the electric current generated by solar cell during experiment was 2.6 A in average, with highest temperature of 51^0 C at 12.30 WIB, once out of the evaporator, the liquid re-enters the solar collector to get the heat energy from the sun that has been absorbed by the black plate and then transfer to the evaporator again with the help of the DC pump . The average water velocity was 3.1 m/s at the top speed of 5 m/s and it was due to the effect on the intensity of the sun. If the sun intensity were high the speed of the pump was also high because it affected the electric current received by the pump as it used a photovoltic 100 WP

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