Paper No :

MSAE2018-AI004

Seawater Desalination using Embedded PV Solar Still: A Practical Approach to Fresh Water Shortage in Malaysia.

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ABSTRACT

Greenhouse Gas Effect (GHG) is known to be one of the main factors of El Nino phenomenon which significantly reduce the rainwater intensity level causing water shortage in dams. The scarcity of clean drinking water can be overcome by using conventional solar desalination method where this method can offer abundant and steady source of fresh water regardless of the weather or possible climate changes. A new technological approach of combining Solar Photovoltaic technology directly embedded to the Solar Still frame structure is presented. The integrated system provides means of producing potable water from seawater sources with increasing yield as compared to a normal solar still purification system. A sample of seawater is collected from the ocean of Port Dickson,Negeri Sembilan,Malaysia and tested at the University Putra Malaysia (UPM) PV site. Field test using embedded PV Solar Still is presented covering the element of water quality.

KEYWORDS

Desalination, Water shortage, Embedded solar still, El Nino, Tropics

Paper presented at the 2018 MSAE Conference, Serdang, Selangor D. E., Malaysia.
7 & 8 February 2018

INTRODUCTION

The availability of good portable water also affected due to frequent climate change. There is a sign show that our earth is getting warmer such as the changing of rain pattern, rising sea level, snow and ice at Antarctica begin melted slowly. As the temperature rises, our environment and climate continue to change and it will affect people and ecosystem. Recent analysis shows Malaysia has worrying signs that the temperature is getting warmer. According to Haliza Abdul Rahman, temperature changes and precipitation changes could hit Malaysia from 0.7 to 2.6 degree Celsius and -30% to 30% respectively by forecasting using a climate modelling (Rahman, 2009). Furthermore, Malaysia will experience more severe floods and longer droughts are likely to occur due to frequent rainfall in the wet season and a less rainfall in the dry season (Rahman, 2009). The trend shows that Malaysia will experience warmer temperature in the year 2050 that could rise to up to 1.5°C (Rahman 2009). Rising sea level from 15 to 95 centimeters to is expected to rises in hundred year's period and it causing a threat to residents who live near our coastal area (Rahman 2009).

MATERIALS AND METHODS

Set-up the PvWPS (Photovoltaic water purification system) and field test

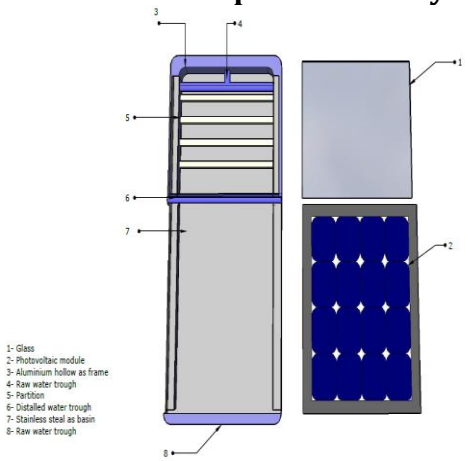

Figure 8: A photovoltaic water purification system

PvWPS (Photovoltaic water purification system) consist of glass, aluminum hollow as the frame, stainless steel as basin and stainless steel pipe is used for water flow and collect the droplets of evaporated water from glass. Field test was conducted on 28 & 29 October 2017 at University Putra Malaysia (UPM) PV pilot site from 9am to 5pm.

The main switch is configured with raspberry pi controller, pump and timer is switched on before testing. Ten liter of seawater is poured into the bucket and ready to be pumped. Timer was set to turn on hourly for a specific duration to maintain seawater flowing through PvWPS using rubber pipe. Inside the PvWPS, seawater flows into a custom-made stainless steel pipe distributing the seawater evenly. Seawater flows into partition and move down accordingly by means of gravitational force. (PvWPS is set up at tilt angle of 30° degree). The heat inside the structure evaporates the seawater where condensation occurred at the glass of the PvWPS (production of drinking water).

The evaporated water flows through rubber pipe and collected into a bottle. The remaining of seawater flows out and reuse. The weight of water is taken hourly using a weight scale. At the end of experiment, the collected water is stored for further testing.

Figure 2: PvWPS set-up at University Putra Malaysia (UPM) PV site.

Water analysis

Table 1: Type of analysis used to analyse water collected from PvWPS.

Analysis	Parameter	Method
Physicochemical analysis	pH	In situ
	Color	APHA 2120 C (2005)
	Turbidity	APHA 2130 B (2005)
	Chloride	APHA 4500 CI (2005)
	Ammonia	APHA 4500 NH3 B & C (2005)
	Hardness	APHA 2340 C (2005)
	Fluoride	APHA 4500 F D (2005)
Microbiological analysis	Total coliform	APHA 9222 B (2005)
	E.Coli	APHA 9222 D (2005)

RESULTS AND DISCUSSIONS

Table 2: Result from water samples collected from PvWPS and compared with Drinking Water Quality Standard (MOH Malaysia)

Parameter	Results	Recommended raw water quality Acceptable value (mg/litre (unless otherwise stated))	Drinking water quality standard Maximum acceptable value (mg/litre(unless otherwise stated))
pH	6.68	5.5-9.0	6.5-9.0
Total coliform	ND<1	5000 MPN/100ml	0 in 100ml
E.coli	Absent in 100ml	5000 MPN/100m	0 in 100m
Turbidity	0.23	1000 NTU	5 NTU
Color	ND<5	300 TCU	15 TCU
Chloride	29.5	250	250
Ammonia	0.35	1.5	1.5
Hardness	20.2	500	500
Fluoride	0.3	1.5	0.4-0.6

From Table 2, pH value obtained from the analysis is 6.68. This value shows that the water sample is slightly acidic. Degree of corrosion metals and disinfection efficiency could be affected by pH. The result shows that total coliform and E.coli in the water sample is not detected and absent which shows the degree of pollution. Results also confirm that the sample is safe from faecal material carrying pathogen

ISBN 978-967-16145

which could cause waterborne illness such as nausea, vomiting, and diarrhea. Furthermore, the color and turbidity is not detected which is less than 5 TCU and 0.23 respectively. These show that water is free from contaminants such as bacteria, protozoa, sewage effluent, nitrates and phosphorus. Moreover, other parameters such as ammonia, chloride, and fluoride obtained are within the recommended raw water quality and drinking water quality standard set by Ministry of Health Malaysia.

CONCLUSIONS

This study unfolds the field test for a newly developed PvWPS water purification system. The results show that water produced by PvWPS is safe to drink and will not cause any harmful effect as referred to the recommended raw water and drinking water quality standard set by Ministry of Health Malaysia.

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