Study and Design of Appropriate Sewage Methods in KMUTT Bang Khun Thian

Anatta Nunthatraithip[1], Kantasit Kongthip[1] Sukontee Suracharoenchai[1,*], Tas Yusoontorn[2], Jutharat Sunprasert[2]

[1]Darunsikkhalai Science School, King Mongkut's University of Technology Thonburi, Bangkok, 10140, Thailand
[2] Engineering and Science Classroom, King Mongkut's University of Technology Thonburi, Bangkok, 10140, Thailand

*Corresponding author. E-mail: sukontee.suracharoenchai@mail.kmutt.ac.th

ABSTRACT

The King Mongkut's University of Technology Thonburi (KMUTT), in the education service area Bang Khun Thian is located near a mangrove forest. As a result, the soil therefore becomes more salinized than usual, which also disturbs the salinity of the local water sources and causes a higher level of salinity in the wastewater in this area. This project aimed to study and design a suitable wastewater treatment method in KMUTT Bang Khun Thian to reduce water salinity until it is safe to use for watering freshwater plants. One of the desalination methods that utilizes the distillation concept is the solar still. When saltwater is placed in a container with a transparent material cover and exposed to direct sunlight, the water will heat up and vaporize. The steam produced will adhere to the covering material and condense into less saline water. Using PVC pipes to construct the prototype's rectangular, trapezoidal shape. As a result, it can reduce salinity by up to 86.24 percent. Because of the slow rate of evaporation, there is still an issue. A small amount of steam escapes from the system and sticks to the plastic where it is not needed, preventing some water droplets from falling down the gutter. The quantity of water received is, therefore, less than expected. The machine will eventually be changed to improve its suitability.

Keywords: *Wastewater, Desalination, Evaporation, Salinity*

INTRODUCTION

Wastewater is water that has been tainted in terms of quality by human intervention, and it can have a harmful impact on the surrounding ecosystem. Both odor pollution and pollution have a harmful impact on the environment. It serves as a breeding habitat for germs and disease carriers. Around 3-10 billion gallons of wastewater are discharged each year. This number has increased over the previous years. As a result, water treatment is necessary to improve the quality of wastewater before it is released into natural water sources or used for other purposes such as agriculture, livestock, and so on. However, if untreated wastewater is released, it will have a negative impact on the user's health since the water may be contaminated with heavy metals or other organic chemicals that are difficult to detect. Therefore, the

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treatment includes multiple detailed phases, including the primary treatment. In this step, wastewater is purified by removing suspended particles and macromolecules. Secondary Treatment is a treatment solution for organic matter in wastewater. Finally, the tertiary treatment is water treatment to specialized purposes like agriculture, where each step of this water treatment is expensive and time-consuming. Additionally, there is also a classification of treatment types to fit each location's wastewater.

Figure 1: Activated sludge in KMUTT Bang Khun Thian

Figure 2: Constructed wetland in KMUTT Bang Khun Thian

The wastewater treatment system used in King Mongkut's University of Technology Thonburi Bang Khun Thian makes use of activated sludge and constructed wetland. Because the institution is situated in a mangrove forest and close to the sea, the area's wastewater is highly salinized. The second treatment, constructed wetland, has the potential to decrease salinity to some extent. However, it is not feasible to use this treated water for irrigation of freshwater plants or for use in agriculture. Due to the excessive salinity and the absence of tertiary treatment at the institution. As a result, a significant amount of wastewater cannot be utilized to irrigate freshwater plants. It produces a foul odor and serves as a haven for germs around the institution. To lower the salt of the water so that it is acceptable for watering freshwater plants, the organizer aims to research and construct a suitable wastewater treatment method for King Mongkut's University of Technology Thonburi, Bang Khun Thian. This will also be able to lower the amount of water needed to irrigate those plants.

METHODOLOGY

The King Mongkut's University of Technology Thonburi Bang Khun Thain was considered to be a good fit for solar still due to its inexpensive price, simplicity of usage, and clean energy source, which is sunshine, after establishing the scope of studies and research on desalination. High TDS (Total Suspended Solids) or salty wastewater is evaporated to the top in the Solar Still using heat from the sun. The water vapor that has condensed to create droplets of water on the cover then gathers and flows down the gutter to concentrate in the Freshwater outlet.

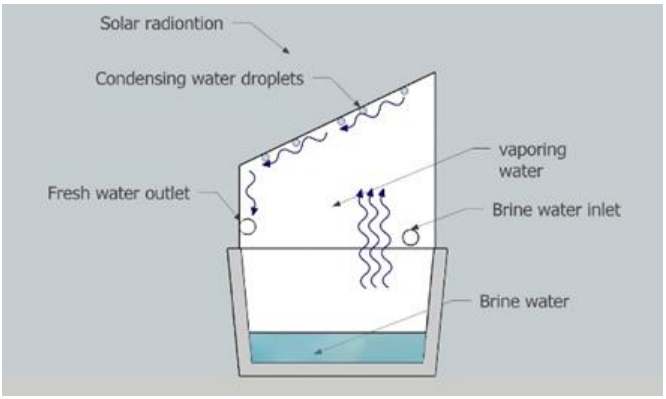


Figure 3: Mechanism of the solar still prototype

To better understand the solar still, the authors designed and built a prototype and tested its performance, with the following steps:

1. Literature review on desalination, by considering the cost, ease of usability, and energy consumption.
2. Design a solar still with the following conditions:
    a. There must be a slope to allow water droplets to flow downwards to gutter.
    b. It must be a closed system and heat conservative.
    c. It must be transparent material to allow sunlight to pass through.

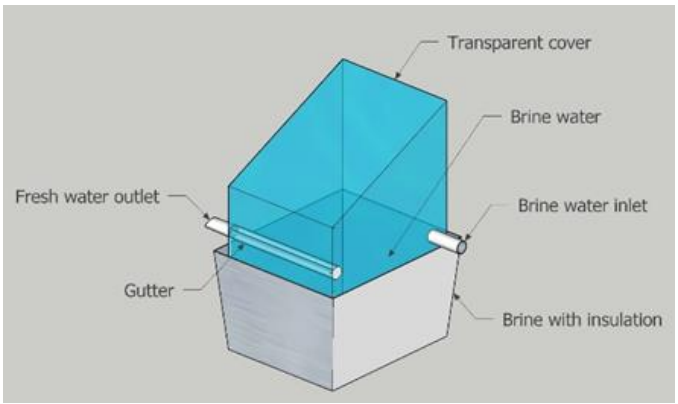


Figure 4: Trapezoid shaped solar still and its parts

3. Construct solar stills that have different surface area. Prototype 1's surface area was 805 cm^2, whereas Prototype 2's surface area was 1900 cm^2, which was 57.63% larger.

Figure 5: Construction of a solar still by using PVC pipes.

4. The desalination efficiency is evaluated by placing 2 liters of KMUTT Bang Khun Thian wastewater in Prototype 1 and Prototype 2 and placing both solar stills out in the sunlight in the same KMUTT Bang Khun Thian area for 3 days.

Figure 6: wastewater in KMUTT Bang Khun Thian

5. Observe and measure salinity with the YSI 600XL water quality sonde at the end of day 3.

Figure 7: YSI 600XL water quality sonde

6. Measure the amount of evaporated freshwater with 200 milliliters measuring cylinder every 3 hours.
7. Use the following equation to get the salinity reduction (%Salinity reduction):

$$\%Salinity\ Reduction = \frac{S_i - S_f}{S_i}$$

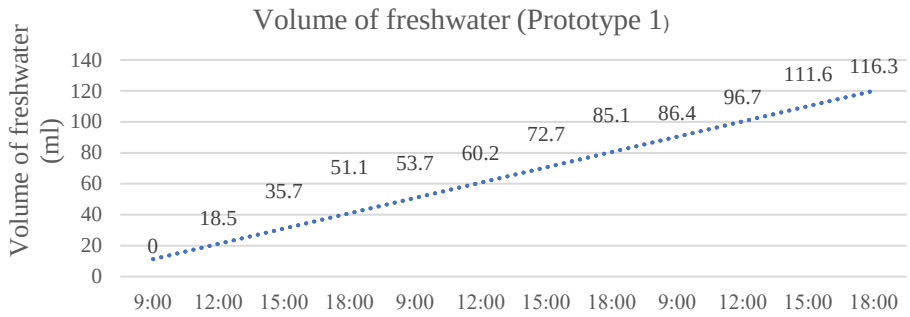
8. Use the following equation to get the freshwater production rate (ml/hr):

$$Freshwater\ production\ rate = \frac{v\ (ml)}{t\ (hr)}$$

RESULTS

From the experiment we found that after 3 days, Prototype 2 can produce 68.5 ml of freshwater more than Prototype 1. Due to its more surface area.

Line Graph 1: Volume of freshwater of Prototype 1 in 3 days



For the salinity reduction when the experiment take time for three days, Prototype 1 can reduce 86.64% of water salinity and 98.98% in Prototype 2

Line Graph 2: Volume of freshwater of Prototype 2 in 3 days

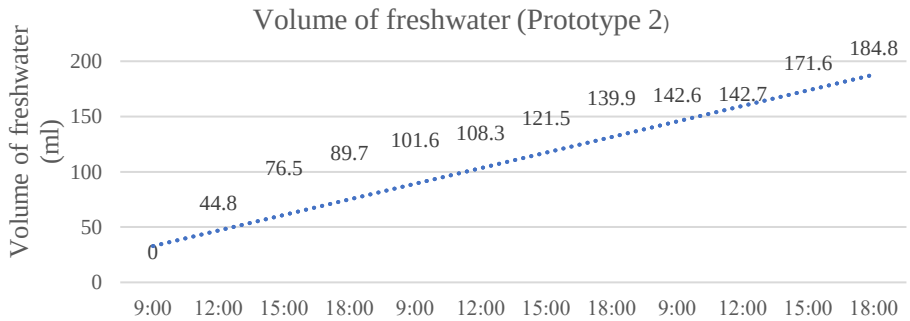


Figure 8: Prototype 1

Figure 9: Prototype 2

In terms of the efficiency of salinity reduction, Prototype 1 was able to reduce salinity by 86.24% after 3 days, but Prototype 2 was able to reduce salinity by 98.98%.

Model	Salinity (ppt)		Salinity reduction (%)
	Before desalination	After desalination	
Prototype 1	3.56	0.49	86.24
Prototype 2	2.97	0.03	98.98

DISCUSSION

The solar still method is a distillation process that involves evaporating the wastewater to the top. Although the solar still method may reduce salinity by up to 99.64%, the freshwater production rate is quite low. If it is utilized, it will not be able to obtain enough fresh water for usage. As a result, the pace of freshwater production must be increased. There are several approaches to being suitable. As a result, a strategy is employed to enhance the surface area available for evaporation since it is less expensive. It was discovered that increasing the evaporation surface area resulted in an increase in the freshwater production rate from 1.62 milliliters per hour to 2.56 milliliters per hour, an increase of 0.94 milliliters per hour that could be explained mathematically.

$$m = \frac{hA(T_{water} - T_{cover}) \times 3600}{l}$$

m = Freshwater production rate (ml/hr)
h = Convection heat-transfer coefficient (W/ m^2K)
A = Evaporating surface (m^2)
T = Temperature (K)
l = Latent heat of vaporization (J/g)

Derived from mathematical equations, the rate of freshwater production was discovered to be closely proportional to the surface area and the convection coefficient. Increasing the evaporating surface area would therefore result in more fresh water. A material modification (which modifies the convection coefficient) enhances the rate of freshwater generation.

CONCLUSIONS

A highly efficient and inexpensive, renewable energy method for reducing salinity is solar still. It has a 98.98% salinity reduction ability, nevertheless, the volume of water that evaporated was minimal. To obtain sufficient amount of clean water, it takes much more than 3 days of experiment. Additionally, solar still can only be produced in times of heat and sunlight. Otherwise, there will not be any wastewater evaporation.

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The author of this project believes that others who are interested may find it beneficial. This may be used to profit, and we hope that the initiative will contribute to the dissemination of information to individuals who are interested in future research. The organizers would want to express their heartfelt gratitude to you here.

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