**International Journal of Science and Research (IJSR)**
**ISSN: 2319-7064**
**SJIF (2019): 7.583**

# A Locally Fabricated Water Distillation Kit: A Tool for Sustaining the Interest of Students in the Learning of Physics in Africa

**[1]Ozuomba, J. O., [2*]Edebeatu, C. C., [3]Elekalachi, C. I.**

[1]Department of Physics & Industrial Physics, Imo State University Owerri, Imo State, Nigeria
[2]Department of Physics, Admiralty University of Nigeria, Delta State, Nigeria
[3]Department of Industrial Physics Anambra State University, Uli, Anambra State, Nigeria
*Corresponding Author: edebeatuchinedu[at]gmail.com +2348038715660, Okananduj[at]gmail.com

**Abstract:** ***Successful students have a continuous motivating cycle of reflection, connection, confidence and positive self-esteem. Therefore, it is imperative for an educator in an academic institution to create a positive and encouraging environment that enhances students learning and personal fulfillment. We fabricated a Roof - type Solar Water Distillation (RSWD) kit which was tested under actual environmental conditions of Urualla, an ancient town in the Eastern part of Nigeria. The system includes four major components; a rectangular wooden basin, an absorber surface, a glass roof and a condensate channel. All the components were obtained from our local environment and the RSWD was able to generate 2.3m$^3$ of distilled water within six days. This is a successful practical application of the principles of thermal absorbance, evaporation and condensation. Obviously, a successful practical experience ensures deeper understanding of the subject and sustains student interest.***

**Keywords:** Roof-type solar, water distillation kit, portable water, students' interest in physics, Urualla, Eastern Nigeria

## 1. Introduction

Physics is a core area in the faculty of Physical Sciences and it is absolutely imperative to boost the interest of African students in the learning of Physics and other related courses. Motivation is one of the most significant psychological concepts in education and can be indicted by the achievement of personal goal setting and developing an interest in the subject area [1], [2]. Motivation can easily be achieved through participation in practical courses. When students successfully carry out a practical course, it will create a continuous motivating cycle of reflection, connection, confidence and positive self - esteem [3], [4], [1. When there is a sense of victory, students will sacrifice to succeed, become energized, follow the game plan and help fellow students which all greatly sustains students learning interest and enhances the graduate's future professional status [5], [1].

Water is a renewable natural resource of the earth that is extremely essential for the survival of all organisms [6], [7]. In nature, more than 97% of water sources are brackish but portable water is not abundant [7], [8]. Therefore, controlling of water quality is of the essential issues of drinking water management [9], [10], [11], [12]. Distillation is the most widely used process for water purification [13].

Naturally, solar energy heats water in the seas and lakes, and then evaporation takes place. Water vapour condenses in the atmosphere and returns to earth as rain water. Solar distillation represents one of the oldest techniques and is still useful for the production of fresh water from briskish or saline water in many parts of the world today [14]. Among the many factors considered in the design and fabrication of a solar water distillation system are cost implication and efficiency. As a supporting technique for water purification, various types of solar stills have been developed and are being applied worldwide [15], [16] [17]. Generally, solar still system has the advantage of low operating and maintenance costs and the shortcoming of low thermal efficiencies [18].

In this research work, we designed a roof - type solar water distillation (RSWD) kit to replace the natural process of evaporation and condensation. In the RSWD system, a wooden rectangular box covered with black polyethylene absorber surface was the tank. A glass roof was designed to rest onto the water tank. Beneath the glass roof was a gutter or condensate channel for driving out distilled water. The heating and evaporation took place on the absorber surface, while condensing process took place on the roof.

## 2. Materials and Method

Figure 1 below shows the schematic diagram of a RSWD water basin whose interior has been covered with black polyethylene. The 91 cm x 56 cm rectangular water tank is 22 cm deep. The water tap is for discharging of untreated water sample should the need arise. The condensate channel was made of aluminum sheets, while the wooden frame that formed the water basin also served as thermal insulator.

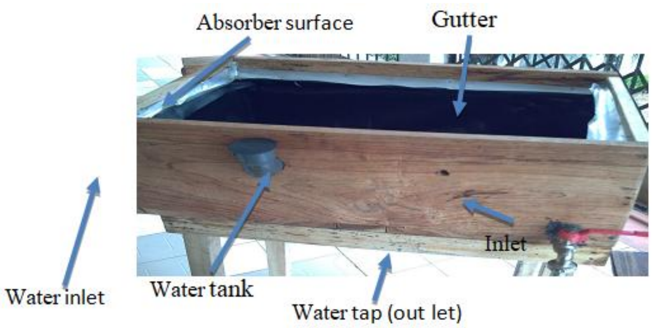


**Figure 1:** The rectangular water tank on top of wooden stand

Figure 2 shows the glass roof, outlets for distilled water and RSWD stand. Two sheets of glass, about 90.8 cm long, 61.2 cm wide and 3 mm thick were rightly placed to form the glass roof. Each of the two edges of the glass roof was covered with a triangular glass sheet of two equal sides and a base of 57.8 cm. A 2 - in - 1 chimney fast epoxy glue was used to hold glass roof in places.

Solar energy warms the absorber surface and some of the water evaporates and condenses on the glass roof. The condensate flows into the condensate channel and is taken out through a hose pipe. The volume of distilled water produced hourly by the RSWD kit is measured and recorded for six consecutive days. The water sample was obtained from Urashi River.

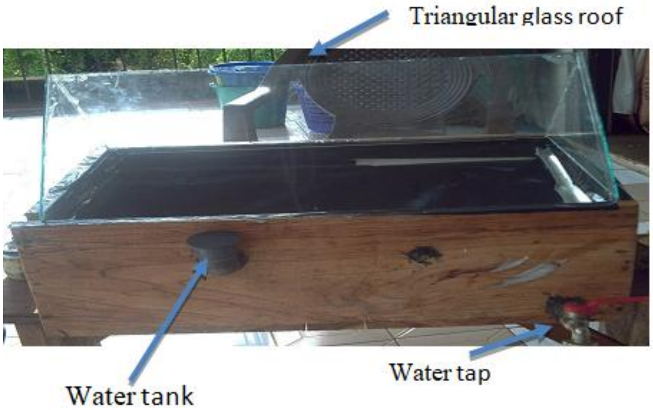


**Figure 2:** The glass roof on top of the rectangular water tank

Urashi is one the popular rivers located in the Eastern part of Nigeria with extension to the South - South region of Nigeria. Hourly measurement of volume and temperature was carried out at Uralla. The atmospheric temperature was measured using a copper / constantan thermocouple.

## 3. Results and Discussion

Characterization of the solar water distillation kit was done on January 2019 at Urualla, Imo State, Nigeria. Table 1 is the hourly volume of distilled water produced by the RSWD on day 1. The highest condensate off 78.0 ml was recorded at 5 pm local time and maximum temperature was 40.0$^{0}$C. The results obtained on the remaining five days (Tables 2 - 6) show that the RSWD still usually produces the highest volume of distilled water towards evening. A relationship exists between volume of distilled water and daily temperature. A comparable high volume of condensate usually overflows as the atmospheric temperature reduces. Also, evaporation and condensation occur overnight. Table 7 shows the relationship between the average daily temperature and total volume of distilled water collected for the day.

**Table 1**: Hourly volume and temperature measurement on day 1

| Time (hours) | Volume per Hour x $10^{-3}$($m^3$) | Atmospheric temperature ($^{0}$C) |
|---|---|---|
| 8am | 0.0 | 25.5 |
| 9am | 1.0 | 27.5 |
| 10am | 1.0 | 31.0 |
| 11am | 6.0 | 33.0 |
| 12am | 6.0 | 35.0 |
| 1pm | 19.0 | 37.0 |
| 2pm | 24.0 | 37.0 |
| 3pm | 47.0 | 38.0 |
| 4pm | 68.0 | 40.0 |
| 5pm | 78.0 | 36.5 |
| 6pm | 19.0 | 34.0 |
| 7pm | 51.0 | 32.0 |

**Table II:** Hourly volume and temperature measurement on day 2

| Time (hours) | Volume per hour x $10^{-3}$($m^3$) | Atmospheric temperature ($^{0}$C) |
|---|---|---|
| 8am | 4.0 | 28.0 |
| 9am | 2.0 | 29.0 |
| 10am | 8.0 | 31.0 |
| 11am | 4.0 | 35.5 |
| 12am | 24.0 | 34.0 |
| 1pm | 19.0 | 37.0 |
| 2pm | 42.0 | 36.0 |
| 3pm | 63.0 | 36.5 |

| | | |
|---|---|---|
| 4pm | 69.0 | 37.5 |
| 5pm | 57.0 | 35.5 |
| 6pm | 26.0 | 33.0 |
| 7pm | 24.0 | 34.0 |

**Table III**: Hourly volume and temperature measurement on day 3

| Time (hours) | Volume per hour x $10^{-3}(m^3)$ | Atmospheric temperature ($^0$C) |
|---|---|---|
| 8am | 2.0 | 26.5 |
| 9am | 4.0 | 28.0 |
| 10am | 0.5 | 30.0 |
| 11am | 0.0 | 32.0 |
| 12am | 6.5 | 32.0 |
| 1pm | 5.0 | 35.0 |
| 2pm | 38.0 | 35.0 |
| 3pm | 29.0 | 37.0 |
| 4pm | 53.0 | 36.5 |
| 5pm | 63.0 | 34.0 |
| 6pm | 28.0 | 31.5 |
| 7pm | 35.0 | 28.0 |

**Table IV:** Hourly volume and temperature measurement on day 4

| Time (hours) | Volume per hour x $10^{-3}(m^3)$ | Atmospheric temperature ($^0$C) |
|---|---|---|
| 8am | 0.5 | 26.5 |
| 9am | 2.0 | 28.0 |
| 10am | 3.5 | 29.0 |
| 11am | 1.0 | 29.0 |
| 12am | 3.0 | 32.0 |
| 1pm | 2.0 | 33.5 |
| 2pm | 33.0 | 34.0 |
| 3pm | 48.0 | 34.5 |
| 4pm | 42.0 | 33.5 |
| 5pm | 51.0 | 33.5 |
| 6pm | 20.0 | 32.0 |
| 7pm | 39.0 | 30.0 |

**Table V:** Hourly volume and temperature measurement on day 5

| Time (hours) | Volume per hour x $10^{-3}(m^3)$ | Atmospheric temperature ($^0$C) |
|---|---|---|
| 8am | 1.0 | 23.0 |
| 9am | 1.0 | 27.0 |
| 10am | 0.0 | 30.0 |
| 11am | 0.0 | 33.0 |
| 12am | 0.0 | 36.0 |
| 1pm | 18.0 | 36.0 |
| 2pm | 80.0 | 36.0 |
| 3pm | 78.0 | 39.0 |
| 4pm | 24.0 | 39.0 |
| 5pm | 32.0 | 36.5 |
| 6pm | 40.0 | 33.0 |
| 7pm | 12.0 | 32.0 |

**Table VI:** Hourly volume and temperature measurement on day 6

| Time (hours) | Volume per hour x $10^{-3}(m^3)$ | Atmospheric temperature ($^0$C) |
|---|---|---|
| 8am | 7.0 | 27.5 |
| 9am | 0.0 | 29.0 |
| 10am | 8.0 | 31.0 |
| 11am | 0.0 | 32.0 |
| 12am | 11.0 | 35.0 |
| 1pm | 32.0 | 35.3 |
| 2pm | 34.0 | 36.4 |
| 3pm | 56.0 | 37.0 |
| 4pm | 104.0 | 35.0 |
| 5pm | 51.0 | 33.0 |

| | | |
|---|---|---|
| 6pm | 26.0 | 32.0 |
| 7pm | 33.0 | 30.0 |

**Table VII:** The relationship between total volume and average temperature day 7

| Day | Total Volume x $10^{-3}$($m^3$) | Average temperature ($^0$C) |
|---|---|---|
| 1 | 385 | 33.9 |
| 2 | 429 | 33.6 |
| 3 | 298 | 31.2 |
| 4 | 282 | 32.1 |
| 5 | 365 | 33.4 |
| 6 | 471 | 32.8 |

## 4. Conclusion

A roof - type solar water distillation kit was successfully fabricated and characterized under actual environmental conditions of Urualla, an ancient town in the Eastern part of Nigeria. The system includes four major components; a rectangular wooden basin, an absorber surface, a glass roof and a condensate channel. The RSWD of surface area 0.5$m^2$ was able to produce 2.3$m^3$ of distilled water within six days. Though the quantity of water was small compared to daily need of portable water, the efficiency of the distillation kit can be increased by using larger absorber surfaces. The materials are readily available and affordable, while the cost of maintenance is almost free. Above all, there is a free source of energy. Students can money from this project by supplying distilled water to industries, homes, schools and hospitals. The success of this practical experience ensures a deeper understanding of some underlying principles of physics as a discipline and it is a motivating factor for students. Hence, the interest of students in the learning of physics and other related courses is sustained.

## References

[1] Kistnanmy, E.J. (2014). The power of extrinsic motivation in tertiary education. American Journal of Education Research, 2(6), 383 - 388.
[2] Regan, J.A. (2003). Motivating students towards self - directed learning. Nurse Education Today, 23, 593 - 599.
[3] Dearnley, C. and Matthew, H. (2007). Factors that contribute to undergraduate student success. Teaching in Higher Education. 12(3), 377 - 391.
[4] Freitas, F.A. and Leonard, L.J. (2011). Maslow's hierarchy of needs and student academic success. Teaching and Learning in nursing. 6, 9 - 14.
[5] D'Aloisio, A. ((200). Motivating students through awareness of the natural correlation between college learning and corporate work settings. College teaching. 54(2), 225 - 229.
[6] Bathusa, M.I. and Saseetharan, M.K. (2006). Statistical study of physics - chemical characterization of ground water Coimbatore south zone. Indian J. Environ. Prot., 26(6), 508 - 515.
[7] Vaishnay, M.M. and Dewangan, S. (2011). Assessment of water quality status in reference to statistical parameters in different aquifers of balco industrial area, Korba, C.G. India. Res. J. Chem. Sci., 1(9), 67 - 72.
[8] Sharma, S., Vishwakarma, R., Dixit S. and Jain, P. (2011a). Evaluation of water quality of narmda river with reference to physio - chemical parameters at Hoshangabad city, MP, India. Res. J. Chem. Sci., 1(3), 40 - 48.
[9] Trevett, A.F., Carter, R. and Tyrrel, S. (2004). Water quality deterioration: A study of household drinking water quality in rural Houndras. Int. J Environ Health Res. 14, 273 - 283.
[10] Dieter, H.H and Muckter, H. (2007). Assessment of so - called organic trace compounds in drinking water from the regulatory, health and aesthetic - quality points of view, with special consideration given to pharmaceuticals. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitssuchutz. 50, 322 - 331.
[11] Murhekar, G.H. (2006). Assessment of physio - chemical status of ground water samples in Ako city. Res. J. Chem. Sci., 1(4), 11 - 124.
[12] Sharma, S., lffat, N., Mohammad, I.A. and Safia, A. (2011b). Monitoring of physio - chemical and microbial analysis of underground water samples of district Kallar Syedan, Rawalpindi - Pakistan, Res. J. Chem. Sci., 1(8), 24 - 30.
[13] Hikmet, S.A. (2006). Mathematical modelling of an inclined solar water distillation system. Desalination, 190, 63 - 70.
[14] Adel, M.A.D. (2006). Experimental and Numerical Performance of a multi-effect condensation-evaporation solar water distillation system. Energy, 31, 2710 - 2727.
[15] Chafik, E. (2002) A new seawater desalination process using solar energy. Desalination, 15, 325 - 337.
[16] Rodrigues, L.G., Palmero-Marreroa, A.I. and Gbmez-Camachob, C. (2002). Comparison of solar thermal technologies for applications in seawater desalination. Desalination, 142, 135 - 142.
[17] Reali, M. (2006). Solar barometer distillation for seawater desalinating Part II: analysis of one - stage and two stage distillation technologies. Desalination, 190, 29 - 42.
[18] Xuyun, W., Lin, Huajian, Y. and Huanlin, C. (2009). Feasibility research of portable water publication via solar - heated hollow fibre membrane distillation system. Desalination, 247, 403 -411