



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 4, April 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

Solar Radiation Water Purifier with Submerged Pump

Santhosh Kumar N¹, Venkatesh M¹, Sivakumar S¹, Sathish Raja¹, Ayyanar Raja²

U.G Student, Department of Mechanical Engineering, Francis Xavier Engineering College, Tirunelveli,
Tamil Nadu, India.¹

Professor, Department of Mechanical Engineering, Francis Xavier Engineering College, Tirunelveli,
Tamil Nadu, India²

ABSTRACT:As per the estimates of the world health organization (WHO); by 2025, about half of the world's population shall inhabit water stressed areas. Water purification through usage of solar energy is a clean and lucrative option to ensure access to clean and safe drinking water. In most of the solar energy driven desalination systems, evaporation of water is one of the key processes. In this direction, we propose that addition of submerged pump particles into the water (owing to their enhanced thermo-physical properties and optical tenability) could significantly enhance the evaporation rate and thus the pure water yield. The results of the developed theoretical model have been compared with the experimental results in the literature, the two have been found to be in good agreement except at some submerged pump particle volume fractions.

I. INTRODUCTION

Although intermittent, solar energy is a clean and abundant renewable energy resource. In the backdrop of the improvements in the solar thermal energy harnessing technologies, it is envisaged that in years to come, it shall play a significant (and more tangible) role in host of applications ranging from cooking, water heating, air-conditioning, electricity generation and water desalination. Among these, water purification is one of the most critical applications wherein solar energy could be put to use to improve the quality of drinking water especially in rural and water stressed regions of the globe where the deployment of state of the art water purification systems is not a viable and cost effective proposition. Conventional solar desalination systems have relatively low pure water yields. Over the years, these systems have undergone various design modifications with the objective of further improving the pure water yield. In conventional solar stills, solar energy heats the water indirectly (an intervening solar selective surface first absorbs the solar energy and then transfer to the water through conduction), resulting in evaporation (and hence purification) of the water, subsequently this water in vapour form is collected with the help of condensation on to an inclined cooled surface. The present work explores the idea of enhancing the evaporation rate of water through addition of submerged pump particles. Owing to the tunable optical properties and very high convective heat transfer coefficients, the submerged pump particles can effectively absorb and subsequently transfer the absorbed solar energy to the water and hence considerably enhance the evaporation rates and the pure water yield. In other words, direct volumetric absorption by the submerged pump particle dispersion could actually enhance the evaporation rates. Recently, few researchers have shown that addition of submerged pump particles to the base fluid could actually enhance the evaporation rates but there is no theoretical model which could quantify (and hence predict) evaporation rates during volumetric heating (particularly in case of submerged pump fluids).

II. METHODOLOGY

This project being technical in nature had a unique design process and methodology. The project went through procedures of research, study of scientific theory, and practical experimentation. Simultaneously the design processes of conceptualization, human factors, product manufacturing and usage were conducted. The scope of the project was technical which meant form follows function. The construction and working was given higher priority than aesthetics. The whole project was carried out under an experienced designer working in the industry as well as guided by an internal faculty in NID. There was constant communication and interaction for valuable feedback and advice from the guides. Research was conducted regarding availability of existing technologies and new innovative ways of bringing all of them together to form one single unit. Many visits were conducted to various vendors and shops to figure out the

most economical equipment for getting pure distilled water using the solar energy. Further many experiments were conducted with hit and trial methods and further refining them to get the most efficient setup

III. EXPERIMENTAL RESULTS

Fig. 1(A) Schematic Showing The Evaporation Process When Solar Irradiance Directly Interacts With The Submerged Pumpparticle Dispersion, And (B) Spectral Reflectance (And Absorptance) Of 3M Solar Mirror Film Measured With UV-VIS-NIR Spectrophotometer (Perkinelmer Lambda 1050).



fig. 2 extinction coefficient as a function of wavelength for submerged pumpparticle dispersions (amorphous carbon submerged pumpparticles dispersed in water) at various volume fractions. the values of indices of absorption and indices of refraction for calculation of spectral extinction coefficients have been taken from Ref. [12-14]



Fig. 3 Algorithm implemented in MATLAB for finding the evaporation rate and the spatial temperature distribution.



Fig. 4 Schematic showing the spatial discretization of submerged pump particle dispersion.



Fig. 5 (a) Mass evaporated as a function of time; temperature distribution and liquid depth evolution in case of (b) submerged pumpparticle dispersion, and (c) pure water.



Fig. 6: Effect of submerged pumpparticle volume fraction on the solar weighted absorption coefficient of the submerged pumpparticle dispersion.



Fig. 7 Effect of submerged pumpparticle volume fraction on the (a) evaporation rate, and (b) the temperature change of the submerged pumpparticle dispersion.

IV. CONCLUSION

A comprehensive theoretical model has been developed to predict the evaporation rate when solar irradiance directly interacts with the submerged pumpparticle dispersion. Theoretical results indicate that addition of trace amounts ($f_v = 0.0001$) of amorphous carbon submerged pumpparticles can significantly increase the evaporation rate (~58% higher than in the case of pure water). Among the various parameters, submerged pumpparticle volume fraction and solar irradiance have been found to significantly impact the evaporation rate. It has been found that the volume fraction of submerged pumpparticles can be increased only up to a certain limit, after which the effect of increasing volume fraction does not

enhance the evaporation rate further. Furthermore, the effect of size of submerged pumpparticles has negligible effect in enhancing evaporation rate.

REFERENCES

- [1] K. Vinoth Kumar, R. Kasturi Bai, Year: 2007, "Performance study on solar still with enhanced condensation", DOI: 10.1016, PP. 51–61.
- [2] Imad A I-Hayek a, Omar O. Badran, Year: 2004, "The effect of using different designs of solar stills on water distillation", www.elsevier.com/locate/desal, DOI: 10.1016, pp. 121-127.
- [3] R. Suresh, P. Balashanmugam, Year: 2014, "Harvesting solar thermal energy through Nano fluid-based volumetric absorption systems", International Journal of Heat and Mass Transfer, DOI.org/10.1016, PP. 377–384.
- [4] Y. Assouad, Z. Lavan, Year: 1988, "Solar Desalination with Latent Heat Recovery", Journal of Solar Energy Engineering, Vol: 110, pp. 14-16.
- [5] Himanshu Tyagi, Patrick Phelan, Ravi Prasher, Year: 2009, "Predicted Efficiency of a Low-Temperature Nanofluid-Based Direct Absorption Solar Collector", Journal of Solar Energy Engineering, Vol: 131, pp. 041004/1-041004/7.



- [6] Andrej Lenert, Evelyn N Wang, Year: 2012, "Optimization of nanofluid Volumetric Receiver for Solar Thermal Energy Conversion", ELSEVIER, <http://www.elsevier.com/locate/solener>, DOI: 10.1016, pp. 253–265.
 - [7] Bong Jae Lee, Keunhan Park, Timothy Walsh, Lina Xu, Year: 2012, "Radiative Heat Transfer Analysis in Plasmonic Nanofluids for Direct Solar Thermal Absorption", Journal of Solar Energy Engineering, Vol: 134, pp. 021009/1-021009/6.
- Vikrat Khullar, Himanshu Tyag, Nathn Hordy, Todd P Otanicar, Yasitha Hewakuruppu, Poojan Modi, Robert A Taylor, Year: 2014, "Harvesting Solar Thermal Energy Through Nano fluid-based Volumetric Absorption System", International journal Of Heat and Mass Transfer, DOI: 10.1016, pp. 377-384.



**Impact Factor:
7.512**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details