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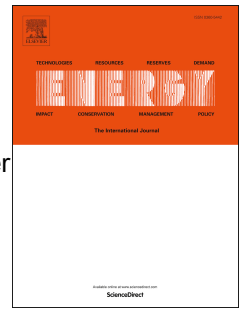

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Guo Xie, Licheng Sun, Tiantong Yan, Jiguo Tang, Jingjing Bao, Min Du

PII: S0360-5442(18)30964-2

DOI: 10.1016/j.energy.2018.05.130

Reference: EGY 12965

To appear in: *Energy*

Received Date: 30 November 2017

Revised Date: 15 May 2018

Accepted Date: 19 May 2018

Please cite this article as: Xie G, Sun L, Yan T, Tang J, Bao J, Du M, Model development and experimental verification for tubular solar still operating under vacuum condition, *Energy* (2018), doi: 10.1016/j.energy.2018.05.130.

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Model development and experimental verification for Tubular Solar Still operating under vacuum condition

Guo Xie, Licheng Sun*, Tiantong Yan, Jiguo Tang*, Jingjing Bao, Min Du

State Key Laboratory of Hydraulics and Mountain River Engineering, College of Water Resource & Hydropower, Sichuan University, Chengdu 610065, China

*Corresponding author. E-mail address: leechengsun@sohu.com (L. Sun), tangjiguo@sina.cn (J. Tang); Tel.: +86 28 85405633; Fax: +86 28 85405633.

Abstract

A theoretical and experimental study was carried out on performance of a Tubular Solar Still (TSS) under vacuum operation condition, based on which a modified model was proposed. Theoretical analysis shows that a vacuum operation pressure augments the concentration differential of humid vapour around the trough and that around the condensation surface, intensifying the diffusion and natural convection of vapour in the cavity. It is further indicated that as the operation pressure approximates the saturation pressure of the saline water, buoyancy force due to mass transfer would surpass that from thermal diffusion, and dominate vapour transportation process in the still. The proposed model for predicting the freshwater yield adopted the diffusion rule of binary mixture in the calculation of the mass transfer coefficient. It has a deviation of -3% - 11% against the current experimental results and was further verified by an independent dataset. Upon that the performance of current TSS under vacuum running condition was evaluated with the help of the model. In view of the efficiency in energy utilization, the evaluation results show that the energy utilization efficiency of the system has an increase over 80% compared with that under normal operating pressure condition.

Keywords: Dynamic energy model; Tubular Solar Still; Solar desalination; Vacuum pressure; Mass transfer

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