

Modelling of Solar Still Using Granular Activated Carbon in Matlab

MD Irfan Ali, R. Senthilkumar and R. Mahendren

Abstract— In the last years the demand for fresh water is increasing tremendously all over the world. The future demand will be very high and the fresh water resources are getting depleted at a faster rate. We need to depend on the brackish water and oceanic water resources for meeting the fresh water demand. Furthermore non-conventional energy resources are required for meeting energy demand. One best option is to use solar energy for water distillation. This paper is about the numerical analysis and modelling of a solar still and enhancing its efficiency by mixing the still water with granular activated carbon. Matlab software is used to simulate the model. Matlab code was written for calculating the various heat fluxes in the still, to determine the hourly output of still and to find the efficiency of the still. Complete numerical analysis and various characteristics graphs of still were plotted using matlab. Simulink tool box is used to simulate the model.

Keywords— Solar Desalination, Solar Still, Granular Activated Carbon(GAC), Matlab, Simulink

I. INTRODUCTION

IN the last years the worldwide amount of fresh water becomes smaller and smaller and this causes the shortage of water in different places of the world. One reason is the global warming, the growth of the population in the world and the wasteful use of fresh water. In many areas of the world there was not enough rain. A lot of animals die on water deficiency, because a lot of water holes dry up and so the animals and of course the people cannot get enough water for their daily use. A very small fraction, about 0.3%, of the available water resources is available as fresh water [1]. A drinking water shortage is expected to become one of the biggest problems facing the world. To compensate for this, desalination of saline water appears to be the best solution, since the only inexhaustible source of water is the ocean. Desalination processes consumes significant amounts of energy, and many countries in the world, particularly those suffering from severe water shortages, cannot afford the energy required for desalination. Fortunately, many of those countries lie in areas with high insolation rates. Therefore, solar desalination can be a suitable alternative, provided efficient technologies are developed to utilize the solar energy in a cost effective way.

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Solar energy can be used to produce fresh water directly in a solar still or indirectly where the thermal energy from a solar energy system is supplied to a desalination unit.

A number of efforts have been made to develop and improve the performance of solar desalination systems, particularly solar stills. The efficiency of the still is directly proportional to the inlet water temperature to still. To increase the temperature of the water inside the still, some researches [2,4] suggested coupling the still to solar collectors. The results showed an improvement in the still's performance. One of the main reasons behind the low efficiency of solar stills, which is about 30-40% [1], is the loss latent heat of condensation to the environment and the sensible heat carried away by the condensate. The use of latent heat of condensation to preheat the feed water has shown good improvement in the still's performance [5,6]. The use of latent heat of condensation of one stage to evaporate water in another stage, as in multi-effect stills, has been studied by many researchers showing very good improvement in the still's performance [7,8]. Other researchers [9,10] have investigated the concept of evaporation at low temperatures under vacuum conditions and reported good improvement in the system performance. However they used vacuum pumps which require additional energy input to the system.

This paper presents a complete numerical analysis and modelling. Matlab M-file coding is used to find the convective, radiative and evaporative heat transfer rates and the hourly distillate from the still and the efficiency of the still. Simscape tool box from Matlab simulink is used to simulate the model.

II. MATHEMATICAL MODELING

Performance of solar still based on productivity, efficiency as well as internal heat and mass transfer coefficient. Hence performance directly proportional to internal heat transfer coefficient and distillate output from solar still. Internal heat and mass transfer coefficient in the solar still based on three parameters called convection, radiation and evaporation, hence there are three heat transfer coefficient called convective heat transfer coefficient, radiative heat transfer coefficient and evaporative heat transfer coefficient.

A. Convective Heat Transfer Coefficient

Action of buoyancy force due to density difference of humid air due to temperature difference is the major reason behind the convective heat transfer coefficient in solar still.

The convective heat transfer coefficient of water surface to condensing glass cover is given by:

$$q_{conv} = h_{conv} (T_g - T_w) \quad (1)$$

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Solar Desalination Technology Anil Kumar, Om Prakash, 2019-04-23 This book presents the latest developments and advances in solar desalination technology including the concept design testing modeling economics and innovation The chapters in this volume are contributed by leading international researchers and are based on original research material The contents of this volume will be of interest to researchers professionals and policymakers alike

Trends in Mechanical and Biomedical Design Esther Titilayo Akinlabi, P. Ramkumar, M. Selvaraj, 2020-08-20 This book comprises select papers presented at the International Conference on Mechanical Engineering Design ICMechD 2019 The volume focuses on the recent trends in design research and their applications across the mechanical and biomedical domain The book covers topics like tribology design mechanism and machine design wear and surface engineering vibration and noise engineering biomechanics and biomedical engineering industrial thermodynamics and thermal engineering Case studies citing practical challenges and their solutions using appropriate techniques and modern engineering tools are also discussed Given its contents this book will prove useful to students researchers as well as practitioners

Renewable Resources and Energy Management Satyajit Chakrabarti, Arun Kumar Bar, Swati Chowdhuri, Debashis Jana, Nirban Chakraborty, Sanjoy Mondal, 2023-05-25 International Conference on Energy Management Renewable Resources has been a premium forum for presenting recent advances in renewable based energy systems smart applications of power electronic devices in modern grid systems and AI based control over energy management areas IEMRE2022 has been an excellent platform to collaborate and showcase high end research giving exposure to interact with the eminent Professors Technocrats Scientists Administrators and Students throughout the world by the latest innovations in the field of Renewable Energy and Energy Management with their applications in worldwide energy sectors IEMRE 2022 was organized by Department of EEE EE of Institute of Engineering Management Kolkata India for three days in online mode with invited lectures by outstanding speakers from all over the world on emerging areas in the field of renewable energy This book is a collection of select papers from the conference

Analysis of Solar Desalination Plant at SRM University Irfan Ali, 2012 Solar desalination using solar still is the age old technique to get fresh water from saline and brackish water The efficiency of the solar still depends on many factors The main objective of this book is to show how the output from the solar still is increased at SRM University This book presents the complete mathematical modeling of solar still and solar pond The book presents how the temperature of the feed water to solar still and basin water of the solar still can be increased to increase the efficiency The temperature of the feed water to solar still can be increased by circulating the feed water through solar pond and the basin water temperature of the still can be increased by using various photo catalysts In this work the temperature of the basin water of solar still was increased by using two different photo catalysts 1 Granular activated carbon GAC and 2 lead oxide coating PbO₂ Experiments were done by using 0.5 kg GAC and 1kg GAC with 0.5 kg PbO₂ coating on the base of the solar still The

added advantage of this book is it used MATLAB software for physical modeling of solar still Simulink toolbox was used to build a physical model of solar still

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