

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.

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 researchers [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 MODELLING

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:

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

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Modelling Of Solar Still Using Granular Activated Carbon:

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 *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 *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 *Solar Energy Update* ,1980 New and Future Developments in Catalysis Steven L Suib,2013-07-19 New and Future Developments in Catalysis is a package of seven books that compile the latest ideas concerning alternate and renewable energy sources and the role that catalysis plays in converting new renewable feedstock into biofuels and biochemicals Both homogeneous and heterogeneous catalysts and catalytic processes will be discussed in a unified and comprehensive approach There will be extensive cross referencing within all volumes The use of solar energy during various catalytic chemical processes for the production of an array of chemical products is the theme of this volume Photocatalysis is a topic of increasing importance due to its essential role in many of today s environmental and energy source problems The use of solar energy for catalytic reactions results in a carbon dioxide neutral process All photocatalytic processes and the future developments in this area are discussed including an economic analysis of the various processes Offers in depth

coverage of all catalytic topics of current interest and outlines future challenges and research areas A clear and visual description of all parameters and conditions enabling the reader to draw conclusions for a particular case Outlines the catalytic processes applicable to energy generation and design of green processes **Photochemistry** Stefano Crespi, Stefano Protti, 2021-09-20 Providing critical analysis of emerging and well established topics this book is essential reading for anyone wanting to keep up to date with the literature on photochemistry and its applications Volume 49 combines reviews on the latest advances in photochemical research with specific highlights in the field The first section includes periodical reports of the recent literature on physical and inorganic aspects including reviews of the molecules employed as dyes in art light induced reactions in cryogenic matrices photobiological systems studied by time resolved infrared spectroscopy and photophysics and photochemistry of transition metal complexes This selection is completed by reviews of the literature on solar photocatalysis for water decontamination and disinfection and for water splitting hydrogen production Coverage continues in the second part with highlighted topics from the use of aromatic carbonyls as photocatalysts and photoinitiators in synthesis photoinduced and photocatalysed decarboxylation reactions development of dye sensitized solar cells design of luminescent water soluble systems and applications of plasmonic nanoparticles This volume also includes a third section entitled SPR Lectures on Photochemistry where leading scientists in photochemistry provide examples to introduce a photochemical topic to academic readers offering precious assistance to students in this field New and Future Developments in Catalysis Detlef W. Bahnemann, Linda A. Lawton, Peter K.J. Robertson, 2013-07-19

Photon-Involving Purification of Water and Air Pierre Pichat, 2018-03-05 This book is a printed edition of the Special Issue Photon involving Purification of Water and Air that was published in Molecules **Selected Water Resources Abstracts**, 1991 **Technology Innovation in Mechanical Engineering** Prem Kumar Chaurasiya, Abhishek Singh, Tikendra Nath Verma, Upendra Rajak, 2022-04-29 This book comprises select papers presented at the conference on Technology Innovation in Mechanical Engineering TIME 2021 The book discusses the latest innovation and advanced research in the diverse field of Mechanical Engineering such as materials manufacturing processes evaluation of materials properties for the application in automotive aerospace marine locomotive and energy sectors The topics covered include advanced metal forming Energy Efficient systems Material Characterization Advanced metal forming bending welding casting techniques Composite and Polymer Manufacturing Intermetallics Future generation materials Laser Based Manufacturing High Energy Beam Processing Nano materials Smart Material Super Alloys Powder Metallurgy and Ceramic Forming Aerodynamics Biological Heat Mass Transfer Combustion Propulsion Cryogenics Fire Dynamics Refrigeration Air Conditioning Sensors and Transducers Turbulent Flows Reactive Flows Numerical Heat Transfer Phase Change Materials Micro and Nano scale Transport Multi phase Flows Nuclear Space Applications Flexible Manufacturing Technology System Non Traditional Machining processes Structural Strength and Robustness Vibration Noise Analysis and Control Tribology In

addition it discusses industrial applications and cover theoretical and analytical methods numerical simulations and experimental techniques in the area of Mechanical Engineering The book will be helpful for academics including graduate students and researchers as well as professionals interested in interdisciplinary topics in the areas of materials manufacturing and energy sectors

Proceedings of the 9th International Conference and Exhibition on Sustainable Energy and Advanced Materials Mohd Azli Salim,Najiyah Safwa Khashi'ie,Kit Wayne Chew,Chonlatee Photong,2024-06-04 This book gathers the proceedings of the 9th International Conference and Exhibition on Sustainable Energy and Advanced Materials ICE SEAM 2023 held on 14 September 2023 in Putrajaya Malaysia It focuses on a diverse range of subtopics Additive Manufacturing Advanced Materials and Processes Design and Optimization Energy Efficiency Energy Engineering and Management Modelling and Simulation Surface Engineering and Tribology Thermal and Fluids Vibration and Control The content caters to academicians researchers students practitioners working in the field of sustainable energy systems and advanced materials

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Nidal Hilal,Ahmad Fauzi Ismail,Mohamed Khayet Souhaimi,Daniel Johnson,2021-04-23 *Osmosis Engineering* provides a comprehensive overview of the state of the art surrounding osmosis based research and industrial applications The book covers the underpinning theories technology developments and commercial applications Sections discuss innovative and advanced membranes and modules for osmosis separation processes e g reverse osmosis forward osmosis pressure retarded osmosis osmotic membrane distillation different application of these osmosis separation processes for energy and water separation such as the treatment of radioactive waste oily wastewater and heavy metal removal draw solutions pretreatment technologies fouling effects the use of renewable energy driven osmotic processes computational environmental and economic studies and more Covers state of the art osmotic engineering technologies and applications Presents multidisciplinary topics in engineered osmosis including both fundamental and applied EO concepts Includes major challenges such as fouling mitigation membrane development pre treatment and energy usage

Water Resources Research Catalog ,1968 Beginning with vol 9 only new and continuing but modified projects are listed Vols 8 should be kept as a record of continuing but unchanged projects

Photodegradation of Water Pollutants Martin M. Halmann,2024-11-01 Photodegradation of Water Pollutants the only complete survey available of current photocatalytic methods for treating water pollutants covers all aspects of light stimulated detoxification Ideal for researchers and students this new book explains methods for pollution treatment that have proven more effective than conventional biodegradation Photodegradation of Water Pollutants examines advanced oxidation processes that have been successful in treating the chemical substances produced by industrial effluents and intensive agriculture These oxidation processes include irradiation

with ultraviolet or visible light the use of homogenous sensitizers such as dyes and the use of heterogeneous photocatalysts such as dispersed semiconductors In addition Photodegradation of Water Pollutants addresses the naturally occurring self cleaning of some pollutants in sunlit surface waters as well as several alternative non photochemical approaches to water treatment Available treatment options are discussed for the main groups of water pollutants including toxic inorganic ions cyanides heavy metals hydrocarbon derivatives oil spills surfactants pulp and paper wastes halocarbons organo N organo P and organo S compounds The text also contains a unique section on the economics of advanced oxidation pollution treatments **Energy: a Continuing Bibliography with Indexes** ,1982 **Energy Research Abstracts** ,1993

Modelling Of Solar Still Using Granular Activated Carbon Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has become much more apparent than ever. Its ability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Modelling Of Solar Still Using Granular Activated Carbon**," published by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound impact on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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