

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:

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

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