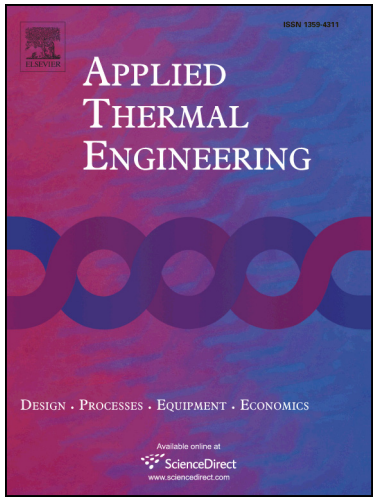

Research Paper

A comparative study of the performance of solar ponds under Middle Eastern and Mediterranean conditions with batch and continuous heat extraction

Alireza Abbassi Monjezi, A.N. Campbell

PII: S1359-4311(16)32020-8
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2017.03.086
Reference: ATE 10090

To appear in: *Applied Thermal Engineering*

Received Date: 29 September 2016
Revised Date: 17 February 2017
Accepted Date: 19 March 2017

Please cite this article as: A.A. Monjezi, A.N. Campbell, A comparative study of the performance of solar ponds under Middle Eastern and Mediterranean conditions with batch and continuous heat extraction, *Applied Thermal Engineering* (2017), doi: http://dx.doi.org/10.1016/j.applthermaleng.2017.03.086

A comparative study of the performance of solar ponds under Middle Eastern and Mediterranean conditions with batch and continuous heat extraction

Alireza Abbassi Monjezi*[1], Campbell AN*

* Department of Chemical and Process Engineering, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford GU2 7XH, UK

Abstract

This study presents a novel heat extraction method, which can be operated in batch or continuous, modes for salinity gradient solar ponds. A comparison between the performance of two solar ponds of the same size (10,000 m^2) in Adana (Turkey) and Ahvaz (Iran) is also presented. The heat extraction method entails brine removal from the non-convective zone (NCZ) as well as the heat storage zone (HSZ). The presented model incorporates the heat losses from the bottom and surface of the pond as well as the cooling effect imposed as a consequence of the replacement of extracted brine from each layer, and the supply of freshwater to the surface of the pond to maintain its inventory. The model can be employed to predict the performance of solar ponds of various dimensions for any given location. It was established that the pond modelled for Ahvaz would perform 30% better than the pond in Adana in both batch and continuous heat extraction modes, predominantly due to the higher quantities of solar energy reaching the surface of the pond and the higher air temperatures throughout the year at this location. The quantities of heat provided in the first year of operation from the ponds in Adana and Ahvaz in batch mode extraction are 2.8 x 10^6 MJ and 4.0 x 10^6 MJ, respectively. These values are approximately three times higher than those from the continuous mode of heat extraction due to the larger volume of withdrawal in the batch mode. Using the proposed heat extraction method in batch mode, 85% of the total heat is removed from the HSZ while this is just over 50% for the continuous mode indicating the better energy storage performance of the batch mode. Both heat extraction modes offer an efficient mechanism of stabilising a temperature gradient throughout the pond with the aim of insulating the HSZ for heat storage. This is carried out by designating brine removal thresholds of 70 °C, 80 °C and 90 °C within the NCZ and 95 °C in the HSZ. It is also demonstrated that the requirement for the supply of freshwater to the surface of solar ponds is significantly dependant on the wind velocity at each location and is unaffected by the mode of heat extraction.

Keywords: Solar pond model; Salinity gradient; Transient heat transfer; Heat extraction; solar thermal engineering; Renewable energy

[1] Corresponding author
Email address: a.abbassimonjezi@surrey.ac.uk (A. Abbassi Monjezi)