Available online at www.sciencedirect.com
ScienceDirect
Desalination 222 (2008) 572–578
DESALINATION
www.elsevier.com/locate/desal

Two-stage solar multi-effect humidification dehumidification desalination process plotted from pinch analysis

Shaobo Hou[a,b]

[a]*College of Engineering, Guangdong Ocean University, East Jiefang Rd. No. 40, Xiashan, Zhanjiang, Guangdong 524006, China*
[b]*School of Power and Energy, Northwestern Polytechnical University, Xi'an, Shaanxi 710072, China*
Tel. +86 759 2886705; email: sbhou@163.com

Received 20 December 2006; accepted 3 January 2007

Abstract

This paper presents a two-stage solar multi-effect humidification dehumidification desalination process plotted from pinch analysis. The sketch of two-stage solar multi-effect humidification dehumidification desalination process is given. The solar vacuated tube collector is employed in the desalination system, multi-effect humidification dehumidification desalination (HDD) process are plotted two different temperature range according to pinch technology. The higher temperature range is from 60 to 80°C, and the lower is from 30 to 60°C. The mass flow rates of dry air in the two stage desalination units are different. The pinch analysis chart is given. According to the pinch chart, the energy recover rate could get higher according to working temperature range. The research proves that the multi-effect HDD has much room to be improved.

Keywords: Solar desalination; HDD; MEH; Pinch technology

1. Introduction

Water is available in abundant quantities in nature; however, there is a shortage of potable water in some places of many countries in the world. Desalination seems to be the most suitable solution. Solar desalination is gradually emerging as a successful renewable energy source of producing fresh water. Solar multi-effect humidification (MEH) units based on the humidification–dehumidification principle are considered as the most viable among solar desalination units.

The standard desalination techniques like multi-stage flash (MSF), multi-effect (ME), vapor compression (VC) and reverse osmosis (RO) are only reliable for large capacity ranges of 100–50,000 m^3/day of fresh water production [1]. These technologies are expensive for small amounts of fresh water, and they cannot be used in locations such as islands and remote

Presented at the conference on Desalination and the Environment. Sponsored by the European Desalination Society and Center for Research and Technology Hellas (CERTH), Sani Resort, Halkidiki, Greece, April 22–25, 2007.

0011-9164/08/$– See front matter © 2008 Published by Elsevier B.V.
doi:10.1016/j.desal.2007.01.127

areas where there are limited maintenance facilities and energy supply. Additionally, the use of conventional energy sources to drive these technologies has a negative impact on the environment. Solar energy is the most important renewable source of energy in south china. Consequently, solar desalination is a suitable solution to supply some remote islands in south china with fresh water.

Solar desalination can be either direct or indirect [2]. One of the well known indirect solar desalination systems is the humidification–dehumidification distillation (HDD) process.

Bacha et al. [3] presented the new concept of the multi-effect humidification dehumidification process (MEH), the mathematical model of components of the desalination unit, including solar collector, humidifier and dehumidifier, and some simulated and experimental results such as the impact of water temperature at the evaporation tower inlet on the condensate flow rate, the air humidity, the air temperature on the outlet of the evaporation tower and the cooling water temperature of the inlet of the hot water. The obtained results are then compared against the experimental results. The good quality of distilled water obtained by this new concept favors its use for producing water for drinking and irrigation.

Nawayseh et al. [4,5] have done much research work on the multi-effect humidification–dehumidification process (MEH). These include the method of evaluating the heat and mass transfer coefficients in the humidifier, computer simulation, and so on. Their researches show that solar desalination with the humidification–dehumidification process is an efficient means of utilizing solar energy for the production of fresh water from saline or seawater.

Nafey et al. [6,7] presented a numerical and experimental investigation of a humidification–dehumidification desalination (HDD) process using solar energy at the weather conditions of Suez City, Egypt. Both tested and numerical results showed that the productivity of the system is strongly affected by the saline water temperature at the inlet to the humidifier, dehumidifier cooling water flow rate, air flow rate and solar intensity and the wind speed and ambient temperature variation have a very small effect on the system productivity.

Farid et al. [8] gave a mathematical modeling and simulation study of solar multi-effect humidification (MEH) units based on the humidification–dehumidification, which was focused on studying and analyzing the effects and performance of various components involved in the process along with the study of the effect of water feed flow rate on the desalination production.

Parekh et al. [9] provided a comprehensive technical review of solar desalination with a multi-effect cycle and indicated solar desalination based on the humidification–dehumidification cycle presents the best method of solar desalination due to overall high-energy efficiency.

Hou et al. [10] presented a method of performance optimization of solar humidification–dehumidification desalination (HDD) process using Pinch technology, and indicated that there exits an optimum mass flow rate ratio of water to dry air if given the temperature of spraying water and cooling water and that if the minimum temperature difference at pinch points are 1°C, the energy recovery rate could reach 0.75 when the spraying water temperature is 80°C and cooling water temperature is 25°C.

Xiong et al. [11] developed a comprehensive steady-state mathematical model for the multi-effect humidification–dehumidification desalination process, and it include the heat and mass balances on both sides of the desalting column, the mass transfer rate at the humidification side, and the heat transfer rate between the dehumidification side and humidification side. They also discussed the mass transfer coefficient at the humidification side and the total heat transfer coefficient between the dehumidification side and humidification side and presented the formulas to calculate them.

Download English Version:

https://daneshyari.com/en/article/627348

Download Persian Version:

https://daneshyari.com/article/627348

Daneshyari.com