بسم الله الرحمن الرحيم

شبكة المعلومـــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

﴿ قـــسـم ﴾

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد اعدت دون آية تغيرات

يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of
15 – 25c and relative humidity 20-40 %

بعض الوثائق الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصـــل

Suez Canal University
Faculty of Petroleum & Mining Engineering
Engineering Science Department

STUDY OF WATER DESALINATION BY SOLAR ENERGY USING HUMIDIFICATION - DEHUMIDIFICATION PROCESSES

A thesis
Submitted in partial fulfillment of the requirements for the degree of Master of Science in Thermal and Energy systems Engineering

BY

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APPROVAL SHEET

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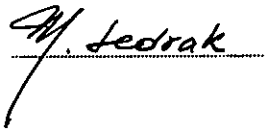
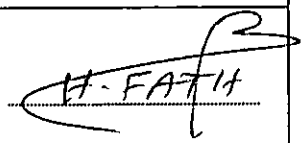
Prof. Dr. Momtaz F. Sedrak Mechanical Power Engineering Dept. Faculty of Engineering, El-Mataria Helwan University	
Assist. Prof. Dr. Hassan E. S. Fath Mechanical Power Eng. Depart. Faculty of Engineering Alexandria University	

بسم الله الرحمن الرحيم

﴿ أَوَلَمْ يَرَ الَّذِينَ كَفَرُوا أَنَّ السَّمَاوَاتِ وَالْأَرْضَ كَانَتَا رَتْقًا فَفَتَقْنَاهُمَا
وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ أَفَلَا يُؤْمِنُونَ ﴾

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*First of all, I thank **ALLAH** the merciful, for helping me to complete this work.*

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ABSTRACT

For supplying the required fresh water to an area, it has to be decided whether desalination is more economical than the transportation of fresh water from the nearest available source or not. Different desalinating technologies are currently used. Like multi stage flash, multi effect, vapor compression, reverse osmosis and solar still. Conversions of salty water into fresh water using thermal distillation processes are internationally gaining more and more importance. However using the solar energy has the objective of reducing water production cost; and environmentally friend energy source. Solar desalination using humidification-dehumidification process has many advantages; suitable for a few families or small-groups living in remote areas, the cost of produced fresh water is very low when compared with the other desalination processes. Owing to the use of below-boiling temperatures and ambient pressure, the process device can be made of available inexpensive material. Reliability can also be obtained because of the modest level of employed technology, the simplicity of design and the ability to be manufactured locally.

This work presents both theoretical and experimental study of the humidification-dehumidification desalination (HDD) process using solar energy. The main components of HDD process (The solar air heater, the solar water heater, the humidifier, the dehumidifier and the storage tank) were modeled theoretically. A computer program simulating the system was developed to obtain the best configuration of the system, which gives the highest productivity. The computation model was also utilized to study the influence of operating and weather conditions on the system productivity.

A test rig was designed and constructed for the experimental study of HDD process in outdoor testes. The main parts of the rig are a cooling tower (the humidifying equipment), an air cooler (the dehumidifying equipment), solar air heater, solar water heater and hot water storage tank. The test rig configuration consists of two closed loops. They are; the air loop and the water loop. The stream of the saline water is heated using the solar water heater and then sprayed within the cooling tower (humidifier) to humidify the air. The remaining water collected in the humidifier was lead back to the saline water storage tank in order to recirculate it again to the solar water heater and hence

the cycle was repeated. The air stream was heated using the solar air heater and then it entered into the cooling tower to be humidified. The humidified air is guided into the air cooler (dehumidifier) where moisture removal is achieved and collected to get fresh water. The exit air from the air cooler is recirculated through the solar air heater and finally into the cooling tower in order to repeats the cycle again.

The weather conditions in the test site (Suez province) throughout the day alter as the following. The total solar intensity changes from 3.1 kWh/m^2 to 7.65 kWh/m^2, the average of ambient temperature changes from 23 °C to 35 °C and the average of wind speed changes from 1.1 m/s. to 6 m/s. The test operating conditions were, flow rate of air is changed from 0.0049 kg/s to 0.0294 kg/s. The flow rate of water through the water heater is changed 0.005 kg/s to 0.06 kg/s. The flow rate of water through the air cooler is changed from 0.005 kg/s to 0.0625 kg/s. The average of inlet cooling water temperatures changed from the range of 24 °C to 33 °C.

The theoretical results were compared with those of the experimental study and other pervious investigators. From the experimental results, the main relationships between the different variables were developed.

Within the operation ranges used in the present study it was found that:

A- Theoretically

1- A good agreement is obtained between present model and other published models.
2- The water energy input to the unit has a positive effect on the unit productivity.
3- The productivity of the unit which consists of a humidifier, dehumidifier, solar air heater, solar water heater, and hot water storage tank could be increased by
   (i) 25% above the configuration without hot water storage tank.
   (ii) 67% above the configuration that consists of a humidifier, dehumidifier and solar water heater only (water open loop).
   (iii) 78% above the configuration that consists of a humidifier, dehumidifier and solar water heater only (water closed loop).
   (iv) 118% above the configuration that consists of a humidifier, dehumidifier and solar air heater only.