LARGE ACTIVE SOLAR SYSTEMS: LOAD

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Contents

Summary

To provide sufficient thermal energy from the sun large systems are necessary to collect, operate and simultaneously to store energy for extended operation during the night or on cloud covered days. To operate these systems properly and with low costs estimations of the required storage of the heat and the heat loss from the whole system are necessary. The models for estimations and calculations for large active systems are analyzed in detail.

1. Introduction

Load is the total thermal energy required to raise the temperature of solar heated fluid up to a certain degree and to maintain the achieved degree of temperature as long as needed. The load of any solar energy system is the quantity that determines the characteristics and the allowable cost of the system. Typical loads for industrial process water are of importance for desalination applications in the case where medium to low grade heat (<100°C) is needed for distillation systems, or for steam production in solar power plants. Low grade heat is provided easily from solar energy. However by increasing supply temperature the cost of per unit of solar collector increases due to higher heat losses and the decrease in the collector efficiency. For desalination purposes load profiles are constant with respect to time and for distillation purposes low grade heat is in the most cases sufficient. The estimation of thermal load is of importance for running solar desalination plants in an economic way.

2. Estimation of Thermal Load

2.1. Estimation of the Required Heat, Q_{load}

To estimate the necessary load, Q_{load}, of a system an amount of energy has to be

supplied to the system. This amount consists of three components (Duffie 1991):

(a) The energy demand, $Q_{w,}$ to increase the water temperature from the initial temperature of the central distribution system to the temperature required.
(b) The supplementary energy, Q_p, to balance the heat loss in the distribution pipe network system, and I.

(c) To balance the heat loss, Q_s, from the storage tank, if storage is used.

$$Q_{load} = Q_w + Q_p + Q_s \text{ J} \qquad (1)$$

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Bibliography and Suggestions for further study

A. Wokaun. Beyond Kyoto: The risks and how to cope. UN Framework Convention on Climate Change. Bonn, Germany, 16-25 June 2004

Al-Karaghouli A.A., Alnaser W.E. (2004), *Experimental comparative study of the performance of single and double basin solar-stills*. Appl Energy **77(3)**, pp. 317-25.

Al-Karaghouli A.A., Alnaser W.E. (2004), *Performances of single and double basin solar-stills.* Solar Energy **78(3)**, pp. 347-54.

Al-Shammiri M., Safar M(1999). Multi-effect distillation plants: state of the art. Desalination , 126:45-59.

ASHRAE (1979) American Society of Heating, Refrigerating and Air Conditioning Engineers, *Cooling and Heating Load Calculation Manual*, GRP, 158, Atlanta, GA.

ASHRAE (1989) American Society of Heating Refrigerating and Air Conditioning Engineers, Handbook - Fundamentals, Atlanta, GA.

Chafik, E., 2003. A new type of seawater desalination plants using solar energy. Desalination

Corrado Sommariva ,(2010),COURSES IN DESALINATION, Thermal Desalination

Delyannis E. (2003), *Historic background of desalination and renewable energies.* Solar Energy **75(5)**, Elsevier pp. 357-66.

Duffie J A Beckman (1991) *Solar Engineering of Thermal Processes*, Second edition. John Wiley and Sons, Inc., New York, 920 pp.

Florides G., Kalogirou S. (2004), *Ground heat exchangers – a review.* Proceedings of third international conference on heat power cycles, Larnaca, Cyprus, on CD-ROM.

García-Rodríguez L. (2003), "Renewable energy applications in desalination: state of the art", Solar Energy 75, 381-393.

García-Rodríguez, L., 2002, Seawater desalination driven by renewable energies: a review. Desalination 143: 103-113

Gregorzewski, A. and Genthner, K., High efficiency seawater distillation with heat recovery by absorption heat pumps. Proceedings of the IDA World Congress on Desalination and Water Reuse, pp. 97-113, Abu Dhabi, November 18-24, 1995.

Kalogirou S. (2003), *The potential of solar industrial process heat applications.* Appl Energy, **76**(**4**), pp. 337-61.Lysen E. (2003), *An outlook for the 21st century.* Renew Energy World, **6**(**1**), pp. 43-53.

Kalogirou S. (2004), *Solar energy collectors and applications.* Prog Energy Combust Sci, **30**(**3**), pp. 231-95

Karameldin, A. Lotfy and S. Mekhemar (2003), *The Red Sea area wind-driven mechanical vapor compression desalination system*, Desalination **153**, Elsevier pp. 47-53.

Kudish A.I., Evseev E.G., Walter G., Priebe T. (2003),*Simulation study on a solar desalination system utilizing an evaporator/condenser chamber*. Energy Convers Manage **44**(**10**), Elsevier, pp. 1653-70.

M.A. Darwish , Iain McGregor, (2005), *Five days' Intensive Course on - Thermal Desalination Processes Fundamentals and Practice*, MEDRC & Water Research Center Sultan Qaboos University, Oman

Millow B. and Zarza E., Advanced MED solar desalination plants. Configurations, costs, future – Seven years of experience at the Plataforma Solar de Almería (Spain), Desalination 108, pp. 51-58, 1996.

Müller-Holst, H., 2007. Solar Thermal Desalination using the Multiple Effec Humidification (MEH) method, Book Chapter, Solar Desalination for the 21st Century, 215–225.

Parekh S., Farid M.M., Selman R.R., Al-Hallaj S. (2003), *Solar desalination with humidification-dehumidification technique – a comprehensive technical review*. Desalination **160**, Elsevier pp. 167-86.

Sayig A.A.M. (2004), *The reality of renewable energy*. Renewable Energy, pp. 10-15.

Soteris A. Kalogirou (2005), *Seawater desalination using renewable energy sources*, Progress in Energy and Combustion Science **31**, Elsevier, pp. 242-281.

Thomson M., Infield D. (2003), *A photovoltaic-powered seawater reverse-osmosis system without batteries*. Desalination **153**(1-3), pp. 1-8

Tiwari G.N., Singh H.N., Tripathi R. (2003), *Present status of solar distillation.* Solar Energy 75(5), Elsevier, pp. 367-73.

Tzen E., Morris R. (2003), *Renewable energy sources for desalination.* Solar Energy **75**(**5**), Elsevier, pp. 375-9.

United Nations, Water for People, Water for Life – UN World Water Development Report, UNESCO Publishing, Paris, 2003.