Proceedings of the Fifth International Conference on Energy and Environment, Cairo, Egypt, 1996

THE USE OF AIR FLOW THROUGH WATER FOR WATER EVAPORATION

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ABSTRACT

In water desalination system the productivity rate is improved by increasing the rate of water evaporation either by heating the water or by forcing air to carry more vapor before condensation.

This paper describe an experimental investigation into the effect of forcing the air to flow through a hot water contained in a closed tank through a perforated end of inlet tube. When the air bubbles pass through the water, it increases the rate of vaporization. The effect of some operating parameters are investigated and the results are presented and discussed.

INTRODUCTION

Solar energy utilization for water desalination has been under investigation for many years. Many types of basin types solar still have been developed, constructed and tested for their productivity rate ref. [1,2]. The results obtained from indoor and outdoor testing of the classical basin type solar still (convection type) indicated that the maximum productivity achieved is in the order of 3.5 to 4 lit/m^2 day. Many modification have been developed

to enhance the productivity of these types of stills by improving the methods of solar energy utilization and reduces the energy loss within the still components ref. [3,4]. Another approach employed to enhance the still productivity is to use forced convection for increasing water evaporation. Ref. (5,6,7) proposed a forced convection solar desalination plants where air enters the evaporator and carries the water vapor over water surface to an external heat exchanger In some of the plants described the productivity rate achieved was in the order of 6.5 lit/m^2. day at a solar radiation of 24 MJ/m^2. and system efficiency of 62%.

The present work suggested a desalination plant which can be used for solar energy application. In this system air is forced to flow through a perforated end of a tube inside a water contained in a closed tank (evaporator). When the air bubbles through the water it will carry more vapor and increase the rate of productivity of the still.

The effect of water level inside the evaporator and water temperature on the rate of evaporation are experimentally investigated.

EXPERIMENTAL SET-UP

In order to carry out this experimental study, a test desalination plant is constructed as shown in fig. (1). The plant consists of an evaporating tank made of 6mm glass sheet of 80 x 80 x 30 Cm dimensions with metal top. A 7.5 Cm (P.V.C) pipe with 50 Cm length closed at the end and 156 holes are drilled in 6 rows each has 26 holes. The higher three rows, the diameter of the hole is 6 mm while 8 mm diameter holes are used in the bottom three rows. The pipe is immersed inside the water tank. The outlet pipe is also made of

PVC of 7.5 Cm diameter which takes the air water mixture from the evaporator.

Air flow can be measured by an standard orifice having 3.75 Cm diameter with a water. manometers. A heat exchanger is added for vapor condensation. An air blower is used to force the air to flow through the water in the evaporator. The water in the evaporator is heated by two electric heaters of, 1 KW heating Capacity. Water temperature and air temperature at the points indicated in Figure(1) are measured by thermometer having ± 0.1°C accuracy. Details of the evaporator under test are shown in Figure(2)

TEST RESULTS AND DISCUSSIONS

In this paper the results obtained from indoor tests of the evaporating tank will be presented and discussed. The effect of water level on the evaporation at constant air flow rate and constant water temperature is shown in Figure(3). The results show that the rate of evaporation is increased with the increase in the water level as the water covers all holes in the perforated pipe. As the water level is increased over 18.6 Cm for the proposed evaporator, the rate of evaporation is reduced again due to the increase in the pressure head of the water which reduce blower mass flow rate.

The variation of maximum rate of evaporation achieved from this system with water temperature at the optimum operating conditions is shown in Figure(4). The results indicate that the maximum rate of evaporation is increased as the temperature of the water is increased up to 80°C which is the maximum water temperature could be reached.

Fig (5) shows, the variation of evaporation rate and water temperature with time. The decrease in the evaporation rate and water temperature are due to the drop in the water level during evaporation. The variation in dry bulb and wet bulb temperature of the air evaporator outlet are also shown in fig.(6)

CONCLUSIONS

1- Passing air through heated water enhanced the rate of vaporization.
2- For evaporator dimensions used in this project the optimum level of water is found to be 18.6 Cm.
3- The rate of evaporation is increased with the increase in water temperature.
4- The process used in this study can be applied to enhance the productivity rate of solar stills.

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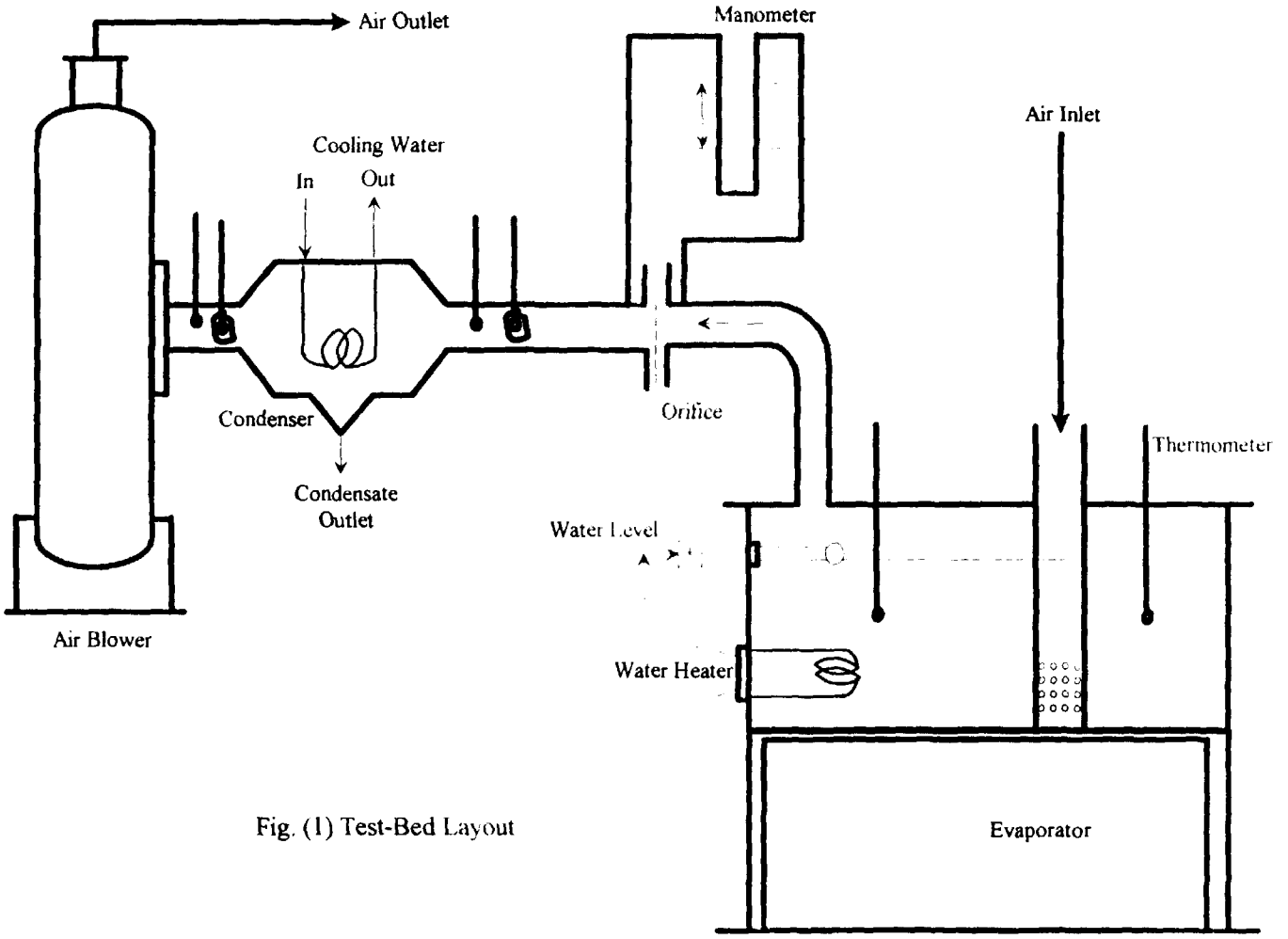

Fig. (1) Test-Bed Layout

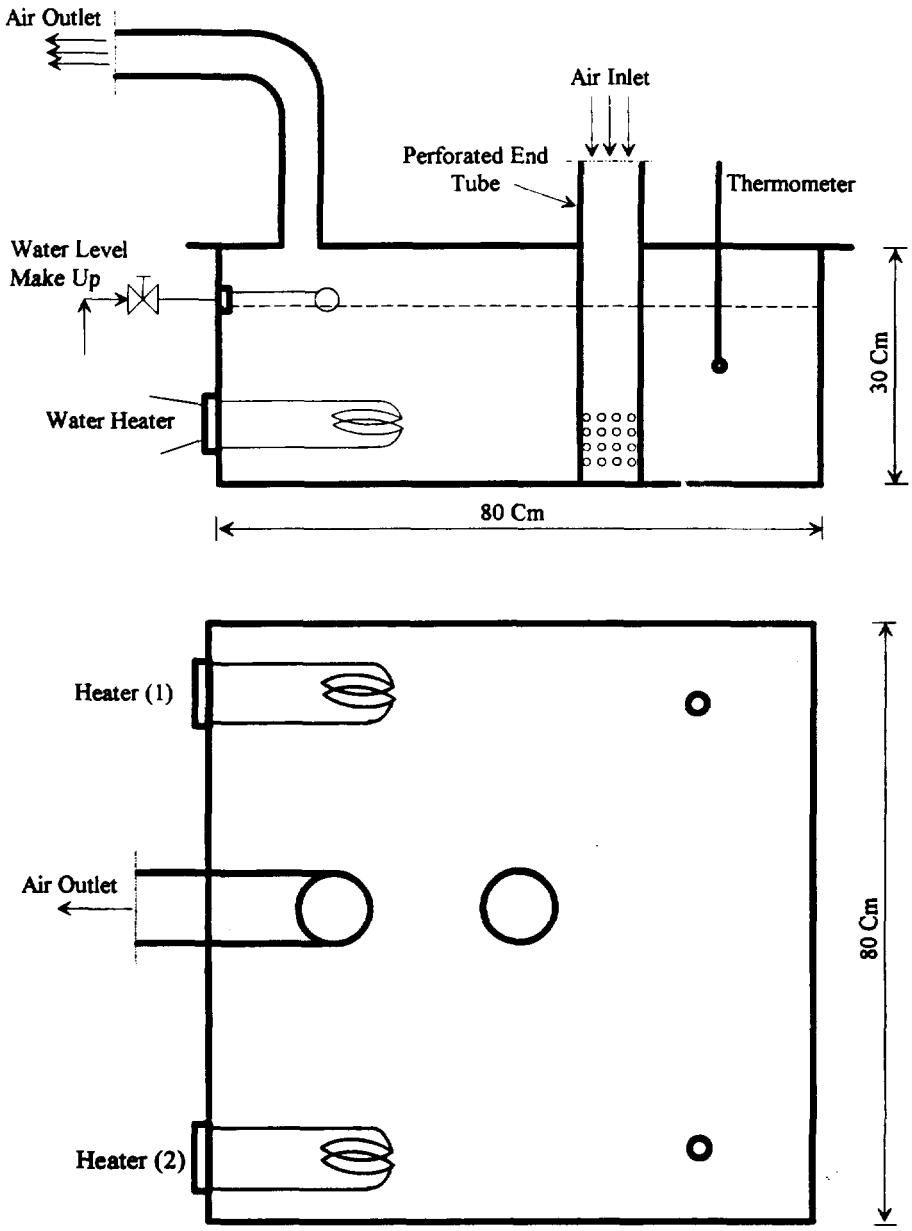

Fig. (2) Evaporator Details

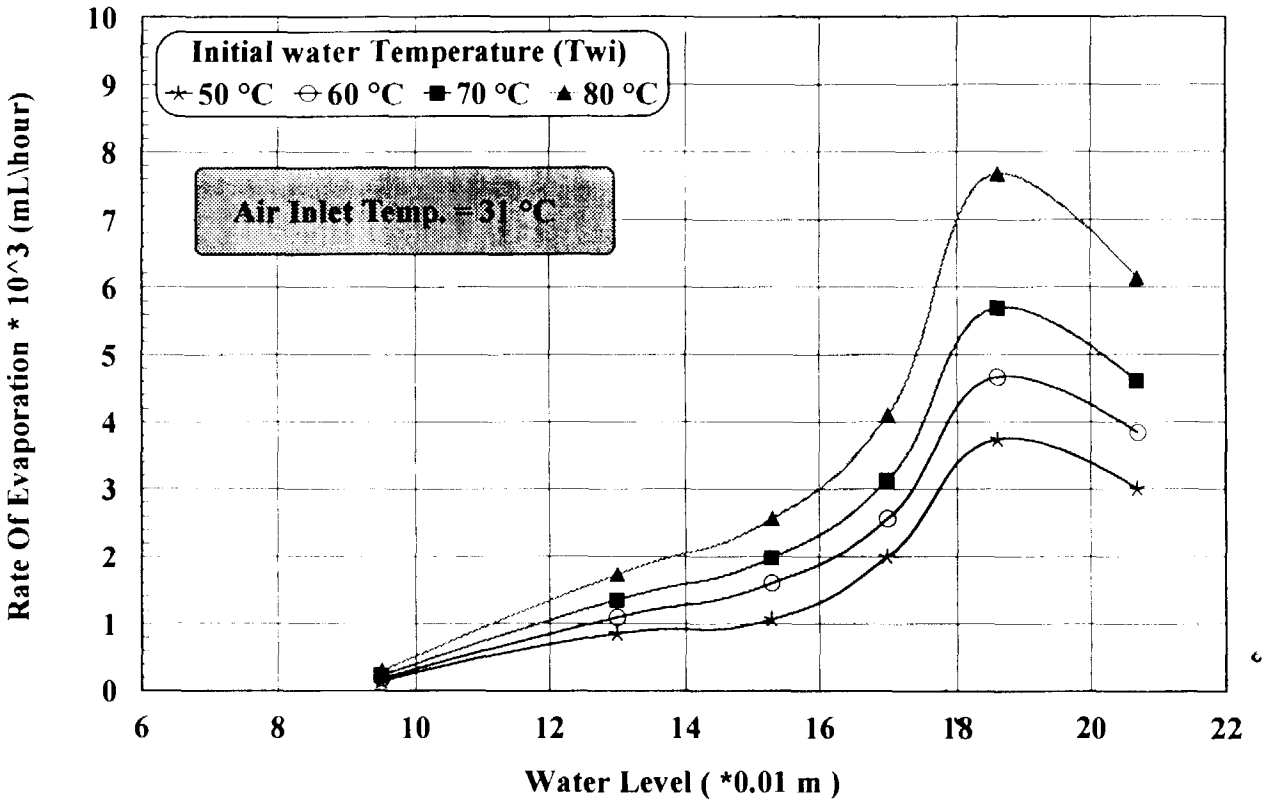

Fig.(3) Effect Of The Water Level on The Rate Of Evaporation at Constant Water Temperature and Constant Air Flow-Rate

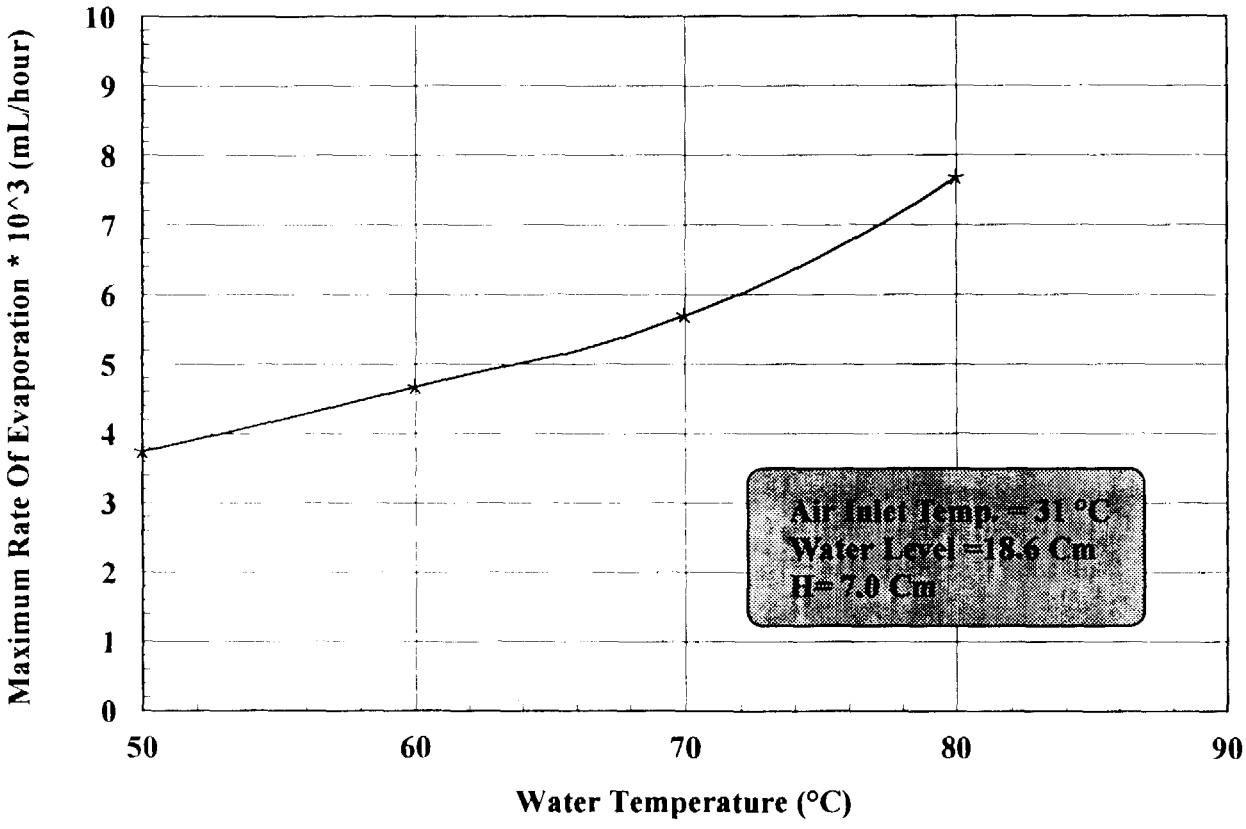

Fig.(4) Effect Of Water Temperature on The Maximum Rate of Evaporation at The Optimum Water Level (18.6 Cm)

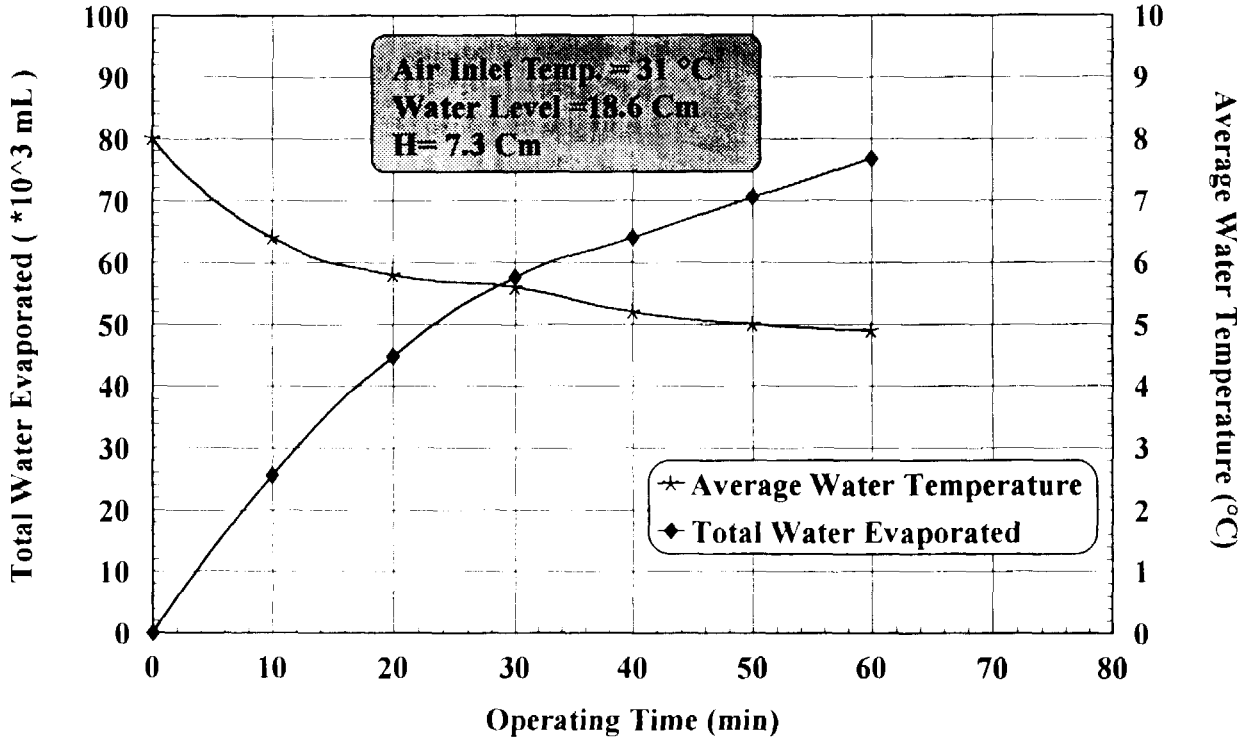

Fig.(5) Variation of Water Temperature and Total Water Evaporated with Time

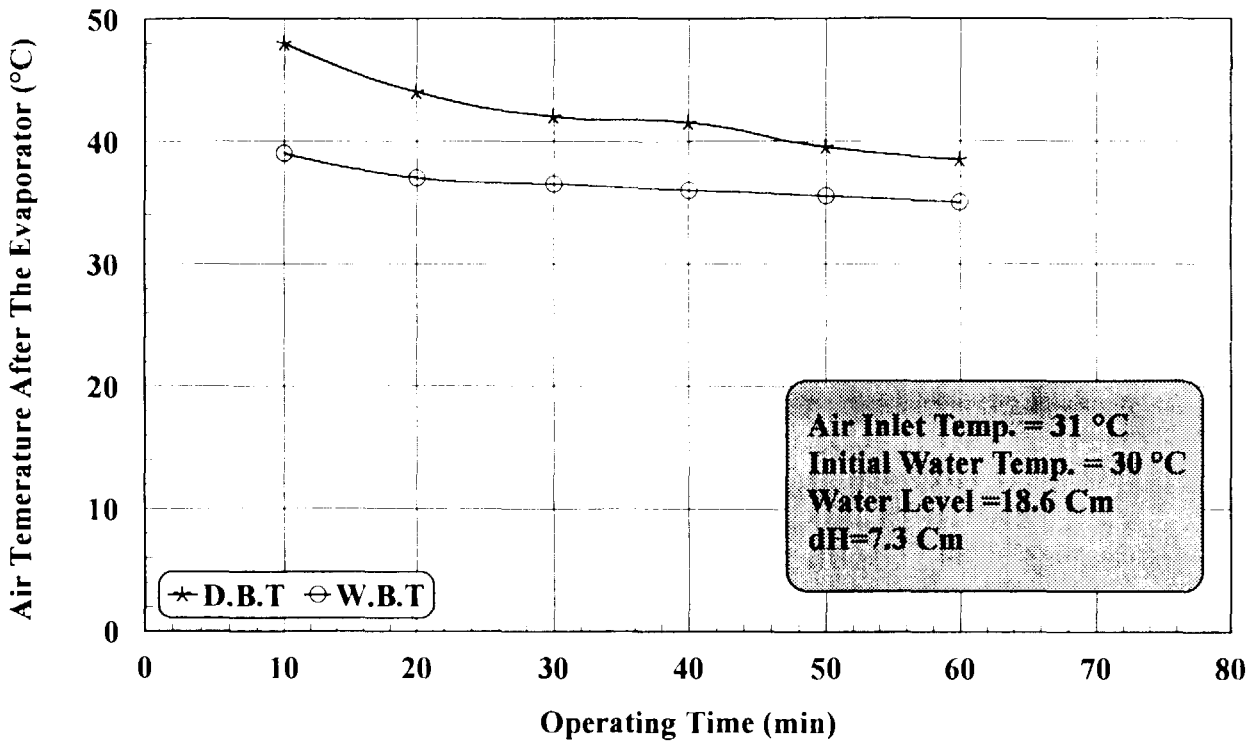

Fig.(6) Variation In Air Temperature with Time at Evaporator Outlet