ANALYSIS OF THE SOLAR STILL PRODUCTIVITY BY SIMILITUDE APPLICATIONS

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ABSTRACT

The aim of the present study is to develop mathematical analysis for common design solar still involving all ambient surrounding variables affecting its productivity and coefficient of performance. Two similar units of the solar stills were used namely: Control unit and cooled glass cover unit (cooled unit). The prediction equations for the productivity of the two studied units were reasonably accepted with coefficients of determinations ranged between 98-99%.

It was also found that the cooled unit has highest values of the productivity and coefficient of performance. The daily productivity and average coefficient of performance were 6.1655 kg/m^2, 59.52% for the cooled unit compared to 5.536 kg/m^2 and 52.19% for the control unit.

INTRODUCTION

Frich and Sommerfeld (1973) designed a wick-type collector – evaporator or distiller of a shallow depth. They reported that it has a production rate of 3.8-4.4 L/m^2.day, with an operational efficiency of about 40 to 46 %. Mostafa et. et. al. (1994) mentioned that the productivity of solar stills reaches its maximum value at an optimum cover slope. They added that the slope depends on the time of the year, the location of still, and the ambient conditions. An average slope of 20 to 25 degrees from the horizontal shows satisfactory results for a wide range of stills. Ernani (1996) studied a solar still versus solar evaporator. He concluded that, the distillation rate increases with increasing water temperature and temperature differences. Zabady (1997) mentioned that the total daily productivity decreases from 4646 to 4506, 4416 and 4323 cm^3/m^2.day with brine depth increased from 0.5 to 1.0, 1.5 and 2 cm respectively. The nocturnal production increased from 835 to 850, 900 and 912 cm^3/m^2 when brine depth increased from 0.5 to 1.0, 1.5 and 2 cm respectively. Abdel-Rahman (2009) reported that at a maximum recorded

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value of solar intensity 825 w/m^2, and the corresponding air temperature of 40.7 ^oC, the maximum and minimum solar still productivity and the corresponding transpiration rate accomplished in September were 3196, 1910 g/m^2 and 2234, 1254 g/m^2 respectively. Tayel et. al. (2009) designed and evaluated four different units of solar stills namely: control unit, preheated unit, air blowing unit and air suction unit. They studied several parameters affecting the productivity of the solar still as: brine depth, slope angle of glass cover, feeding water and covering materials. They reported that the preheating unit has the highest productivity (6030cm^3/m^2. day) with brine depth of 0.0 2 m, slope angle of 20^o.

THEORITICAL APPROACH

The first step in the similitude application is to define the most associated variables affecting the phenomena under investigation. The following are the pertinent and independent variables considered to affect the productivity of the solar still. Their units and dimensions are as follows:

NO.	Symbol	Description	Dimension	Units
1	D	Productivity of the solar still	$M\ L^{-2}\ t^{-1}$	kg/m^2.h
2	ΔP	Evaporation and condensation potential or the difference between partial pressure at glass cover temperature and water temperatur	$M\ L^{-1}\ t^{-2}$	kg m^{-1} s^{-2}
3	I_p	Solar intesity	$HL^{-2}\ t^{-1}$	W/m^2
4	Q_{ec}	Heat utilized in vaporizing water in the still	$HL^{-2}\ t^{-1}$	W/m^2
5	ΔT_{g-a}	Temperature difference between glass cover and the ambient air.	θ	^oK
6	U_L	Over all heat loss coefficient	$HL^{-2}t^{-1}\ \theta$-^{1}	W/m^2 ^oK
7	λ	Brine depth	L	m
8	ϕ	Elapsed time	t	h
9	Cos β	Glass cover tilt angle	dimensionless	

The general relationship for the productivity of the solar still as a function of the associated independent variables can be expressed as:

$D = F(\ \Delta P, I_p, Q_{ec}, \Delta T, U_L, \lambda, \phi, \text{Cos}\,\beta\ )$ …………………….(1)

According to the Buckingham Pi-theorem, the number of dimensionless and independent quantities required to express a relationship among the variables in any phenomenon is equal to the number of quantities involved , minus the number of dimensions of those quantities Murphy (1950). In the present study nine quantities with five dimensions is involved. So, four dimensionless groups can be formed. The dimensional analysis yields the following relationship for both tested units:

$$\frac{\lambda D}{\Phi \Delta p (3600)^2} = \left[A \left(\frac{Q_{ec}}{I_p} \right) + C \right] \cos\beta \qquad \text{………… …………………….(2)}$$

Where A and C are functions of $\pi 3$. The value $(3600)^2$ is used as conversion factor of Δp to kg m^{-1} h^{-2} .It is notable that $\pi 2$ represents the C.O.P of the solar still. $\pi_3 = [U_L \Delta T_{g\text{-}a}/I_P]$ represents the ratio between heat losses and solar insolation. π_1 includes Δp that represents the potential of evaporation and condensation.$\pi 4$ is a constant represents the view factor of sky, ground and surrounding with respect to cover tilt angle.

MATERIALS AND METHODS

In the present study two similar solar stills were used .The experimental part was carried out on the roof of the Agricultural Engineering Department Faculty of Agriculture Al-Azhar University Nacr City .

Solar still construction:

The solar still as shown in Fig.(1) is consists of an evaporator of four sides of galvanized iron sheet of 0.6 mm thick .The basin dimensions (evaporator) are 865x 695 mm, the still was insulated from its bottom and sides by two layers0.03m fpolyurethane and 0.016 m wood panels. The space above the basin is completely enclosed by a transparent cover tightly. The inside still base and sides are painted twice with a black paint. The outer surface of the glass cover for the cooled unit is surrounded by three sides of glass slices 30mm high, two ducts at the ends of the glass cover was made to allow cooling water to be easily collected and recycled. Saline water was distillated by the solar still and water was continuously fed.

Measuring instrumentations:

1 Thermocouples :Temperature were measured using type-K

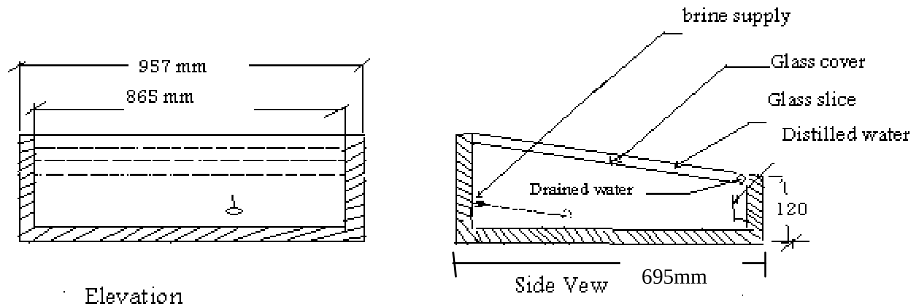


Fig.(1) Construction of the solar still (CGC unit).

thermocouples, the output device includes a large 4-digits temperature reading display and electronic circuitry, the specifications of thermocouples are manufactured inU.S.A, model 8528-40, full accuracy 18-28^{o}C and useful range 4-45 ^{o}C

2 Graduated glass bottle :(1 litter) was used to measure the amount of distilled water.

3 Solar intensity device: A black and white pyranometer was constructed and tested by Ghanem (1989) and calibrated in the solar energy department, National research center, Giza Egypt.It was used for measuring the solar intensity in W/m^2.

4 Turbo meter: A turbo meter was used for measuring the wind speed in m/s, the meter is manufactured in U.S.A of measuring rang: 0 – 44.8 m/s.

METHODS

1 Solar still energy balance

In the present work assuming steady state, the performance of the solar still can be described by energy balance that indicates conversion of the solar energy into useful energy gain, thermal losses and optical losses. The useful energy used in evaporation and condensation" $\mathbf{Q_{ec}}$ " is equal to the difference between absorbed energy " $\mathbf{Q_{abs}}$**.** "and energy losses.The thermal energy lost from the still to the surrounding by conduction, convection and infrared-radiation can be presented by the over-all heat transfer coefficient " U_L " times difference of the average value of water and steel temperature" T_{ws}" and the ambient air temperature " T_a'. :

$$Q_{ec} = Q_{abs.} - U_L \; (T_{ws} - T_a) \text{ ……………………………(3)}$$

2 Over-all heat transfer coefficient of the solar still

It is useful to develop the concept of over-all heat loss coefficient for the solar still to simplify the calculations. A thermal net work Fig.(2) was made to change the thermal loss in a similar electrical resistance around the basin to help in estimating the overall heat loss coefficient and the useful energy gain. Fig.(3) shows the equivalent thermal net work for the solar still. This method is considered the simplest one to evaluate the over-all heat loss coefficient for flat plate collectors as reported by Ria (1980) and applied by Shoukr et. al.(1986). The over-all heat transfer coefficient is the sum of top" U_T ", back " U_b "and edge " U_E "losses respectively which can be represented as:

$$U_L = U_T + U_b + U_E \text{ …………………………………………… (4)}$$

2-1 Top loss coefficient U_T

Energy losses through the top of the still is essentially a result of convection and radiation between the basin, cover plate, radiation and convection due to ambient air and sky temperatures.

2-1-1 Basin loss coefficient R_1

The convection heat losses can be evaluated according to Rai(1980) as follows:

$$hc_{w-g} = 8.84X10^{-4}\left(\left(T_w - T_g\right) + \left(\frac{P_w - P_{wg}}{265x10^3 - P_w}\right)\left(T_w + 273\right)\right)^{1/3}\left(P_w - P_{wg}\right) \text{ …….(5)}$$

$$hr_{w-g} = \frac{0.9\sigma\left(T_w{}^4 - T_g{}^4\right)}{T_w - T_g} \text{ ……………………………………..(6)}$$

Where

hc_{w-g} : is the convection heat transfer coefficient between glass cover and brine water; $W/m^2\,^oK$,

hr_{w-g} : is the radiation heat transfer coefficient between glass cover and brine water; $W/m^2\,^oK$,

T_w : is brine water temperature; ^oK,
T_g : is the glass cover temperature ^oK;
P_w : is the partial pressure of water in P_a at T_w ^oC, .
P_{wg} : is the partial pressure of water in P_a at T_g ^oC,
σ : is Stefan Boltzman 56.7x 10^{-9} $W/m^2\,{}^oK^4$.

Both partial pressures are evaluated by regressing steam table data for the partial pressure as a function of temperature at a range of 20-75 ^oC for the present study as follows:

$$\mathbf{P = 0.1483\,T^3 - 8.4081T^2 + 341.34T - 2323.3 \qquad (R^2 = 1)} \ldots\ldots\ldots (7)$$

Then, the loss resistance from the basin to the glass cover will be:

$$\mathbf{R_1 = \left(\frac{1}{hc_{w-g} + hr_{w-g}}\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

2-1-2 Glass cover loss to surrounding R_2

The resistance from the glass cover to surrounding due to the wind blowing and radiation "**hr_{g-a}**" $W/m^2\,{}^oK$ can be determined according to Duffie and Bechman(1980) as follows:

$$hr_{g-a} = \varepsilon_c\,\sigma\,(T_g^2 + T_a^2)(T_g + T_s)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Where :

ε_g : is the emittance of the glass cover;0.9 ,
T_s : is the sky absolute temperature ^oK ,
T_a : is the ambient air temperature, ^oK ,

The wind losses "**h_w**" $W/m^2\,{}^oK$ can be evaluated according to Rai(1980) :

$$h_w = 5.7 + 3.8\,V_w \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$T_s = 0.0552\,T_a^{1.5} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Then the top loss coefficient is:

$$\mathbf{U_T = \frac{1}{R_1 + R_2} = \left[\frac{1}{(hc_{w-g} + hr_{w-g})} + \frac{1}{(hc_{g\text{-}a} + h_w)}\right]^{-1}} \ldots\ldots\ldots\ldots (12)$$

2-2 Back loss coefficient U_b

The resistance to heat flow through the bottom of the steel pate is "**R_3**" which is covered by insulation can be determined as follows:

$$R_3 = L_s / k_s \quad \ldots\ldots(13)$$

Where " L_s=0.0006 m" is the thickness of the steel sheet constructing the basin and " k_s =48W/m.°K " is the thermal conductivity of that sheet.

Duffie and Beckman (1980) reported that the bottom resistance is due to insulation.

2-3 Resistance due to insulation

The energy losses through the bottom of the solar still is represented by three resistances "R_4 " ,"R_5 "and "R_6 ". R_4 and R_5 are resistances due to insulation and R_6 is due to convection and radiation to the environment. Since R_4 and R_5 >> , R_6 we may neglect R_6 in calculations of the bottom loss coefficient as reported by Rai(1980). So, back loss coefficient "U_b" for the two layers of insulation, polyurethane and plywood of thickness and thermal conductivity of 0.03 m, 0.0245 W/m.°K and 0.016m, 0.12 W/m.°K respectively, can be determined as follows:

$$U_b = \frac{1}{R_b} = \frac{1}{(L_1/K_1)+(L_2/K_2)} \quad \ldots\ldots (14)$$

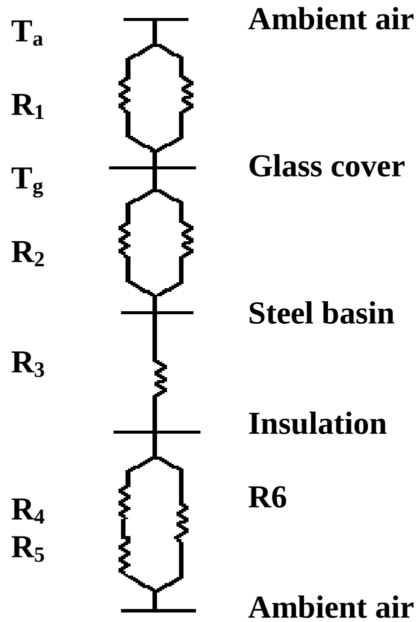


Fig.(2) Thermal net work of the still.

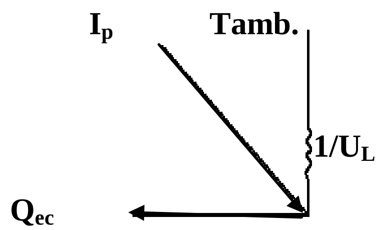


Fig.(3) Equivalent network.

2-4 Edge loss coefficient U_E

Rai (1980) reported that if the edge insulation thickness is kept equal to the bottom insulation thickness, the edge losses may be estimated by assuming one dimensional sideway heat flow around perimeter of the still. Shoukr et.al.(1986) mentioned that the evaluation of edge losses is very complicated .However, in well designed system, the edge losses should be small that it is not necessary to predict it with great accuracy.

$$U_E = (U\,A)\,edge / A_s \quad \ldots\ldots(15)$$

Where **(U A) edge** is edge loss coefficient multiplied by its area m^2 and A_s is the solar still area m^2.

3 Evaluation of heat flux by evaporation

The rate of heat flux due to vaporizing water within the solar still"**Qec** W/m^2 "can be determined according to Mostafa et.al. (1994) as follows:

$$Q_{ec} = 0.0061\left[\left(T_w - T_g\right) + \left(\frac{P_w - P_{wg}}{265x10^3 - P_w}\right)\left(T_w + 273\right)\right]^{1/3}\left(P_w - P_{wg}\right)L_{HV} \quad \ldots\ldots (16)$$

Where L_{Hv} is the latent heat of vaporization of water kJ/kg which can be evaluated by regressing steam table data for the latent heat of vaporization as a function of temperatures within the range of 20-75 ^{o}C in the present study as follows:

$$\mathbf{L_{HV} = -2.4124T+2502.9 \qquad (R^2=0.99)} \ldots\ldots (17)$$

To study the effect of glass cover temperature on the productivity and coefficient of performance of the solar still, two similar solar stills were constructed. One of them was used as a control unit and the other was cooled by spraying water three times per hour on the upper surface of the glass cover to reduce its temperature. Brine depth of 0.02 m and 20 ^{o} tilt angle of the glass cover were used as reported by Tayel et. al.(2009). Solar intensity, ambient air, glass cover, steel basin, water in the tank and cooling water temperatures were hourly recorded. Wind speed was continuously recorded and average values were used.

RESULTS AND DISCUSSIONS

3-1 Prediction equations :

In the present study Table (1) and (2) summarize calculations for and $\pi3$ for the cooled glass cover and control units. Figs.(4)and (5) showed justified relations between $\pi1$and $\pi2$ at constant tilt angle of the glass cover i.e cos α = 0.9397, constant brine depth L= 0.02m and elapsed time of one hour, for the cooled cover and control unit of the form:

$$\frac{\lambda D}{\Phi \Delta p} = \left[A\left(\frac{Q_{ec}}{I_p}\right) + C\right]\cos\beta \quad \ldots\ldots (18)$$

Where A and C parameters are functions of π_3= $[U_L \Delta T_{g-a}/I_P]$, Figs (6) shows the best fit relations, which are for the cooled unit:

$A = 2.01x\ 10^{-14}\ \pi_3+4.475x\ 10^{-15}$ $\qquad$ $(R^2=0.8)$……………..(19)

$C= 4.63x10^{-12}\pi_3+6.17x10^{-14}$ $\qquad$ $(R^2=0.98)$……..……...(20)

And for the control unit :

A =-7.72x10^{-15} π_3+1.39x10^{-13} (R^2=0.85) …………...(21)

C=1.54x10-12 π_3+1.543x10^{-16} (R^2=95) ……………...(22)

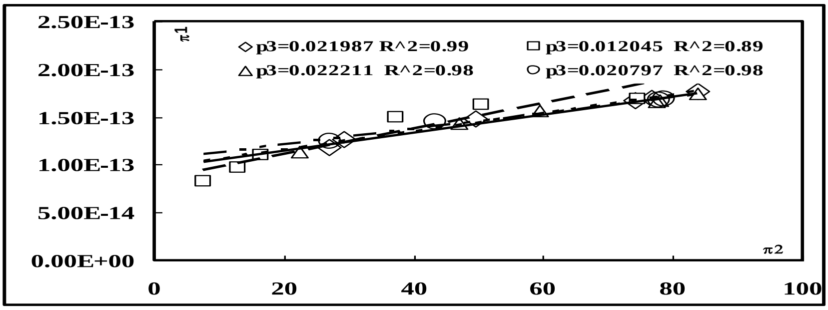


Fig.(4)Effect of π2 on π1 for the cooled unit.

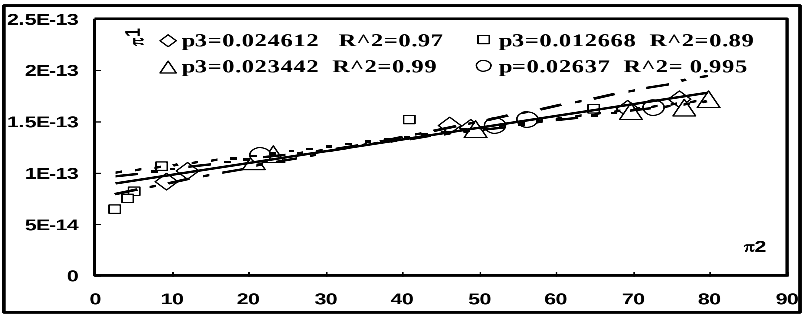


Fig.(5) Effect of π2 on π1 for the control unit.

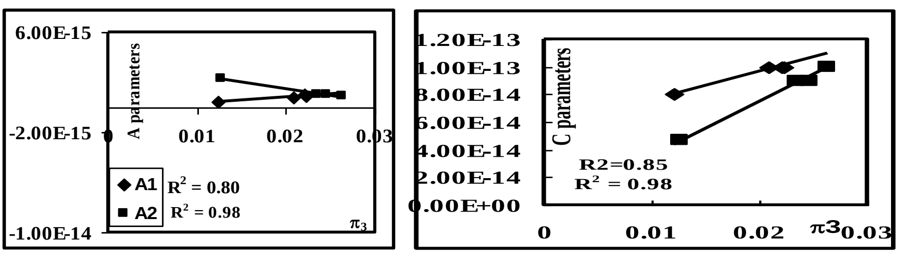


Fig (6)Evaluation of A and C parameters of the two studied units.

3-2 Productivity of the solar still

Prediction equation for determining the productivity of the cooled cover unit can be presented as follows:

$$D=\left[1.3x10^{-5}\left(\frac{Q_{ec}}{I_p}\right)\left(\frac{U_L\Delta T_{g-a}}{I_p}\right)+0.003\left(\frac{U_L\Delta T_{g-a}}{I_p}\right)+2.9x10^{-6}\left(\frac{Q_{ec}}{I_p}\right)+4x10^{-4}\right]\Delta p \quad \text{…………(23)}$$

And for the control unit:

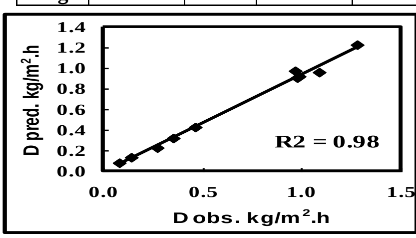
$$D=\left[-5x10^{-5}\left(\frac{Q_{ec}}{I_p}\right)\left(\frac{U_L\Delta T_{g-a}}{I_p}\right)+10^{-3}\left(\frac{U_L\Delta T_{g-a}}{I_p}\right)+9x10^{-5}\left(\frac{Q_{ec}}{I_p}\right)+10^{-7}\right]\Delta p \quad \text{……………..…(24)}$$

Table (1) Evaluation of π1, π2 and π3 for the cooled glass cover unit.

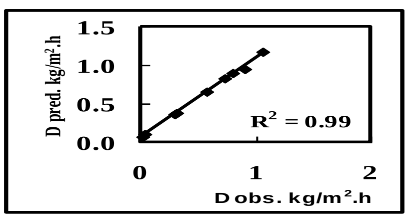
I_P	ΔT_{g-a}	Q_{ec}	ΔP_{w-g}	U_L	π1	π2	π3
W/m^2	°K	W/m^2	P_a	$W/m^2.°K$	$\lambda D/\Delta p\phi$	Q_{ec}/I_P %	$U_L \Delta T_{g-a}/I_P$
241	2.50	53.7	1074.2	1.02176	$1.14x10^{-13}$	22.27	0.0106
320	7.74	150	2399.5	0.9874	$1.44x10^{-13}$	46.95	0.0233
490	11.16	291	4244.9	0.9942	$1.57x10^{-13}$	59.48	0.0226
770	19.27	596	8421.1	0.98582	$1.67x10^{-13}$	77.44	0.0247
800	21.86	624	8835.6	0.98714	$1.67x10^{-13}$	78.01	0.027
950	24.16	796	10840	0.89467	$1.75x10^{-13}$	83.79	0.025
804	18.09	632	8838.3	0.98726	$1.69x10^{-13}$	78.66	0.0222
765	19.18	596	8454.8	0.98769	$1.67x10^{-13}$	77.97	0.0248
498	10.08	217	3440.7	0.99739	$1.44x10^{-13}$	43.50	0.0202
315	5.10	85.4	1576.9	0.98963	$1.24x10^{-13}$	27.10	0.016
Avg.						59.516	

Table (2) Evaluation of π1, π2 and π3 for the control unit.

I_P	ΔT_{g-a}	Q_{ec}	ΔP_{w-g}	U_L	π1	π2	π3
W/m^2	°K	W/m^2	P_a	$W/m^2.°K$	$\lambda D/\Delta p\phi$	Q_{ec}/I_P %	$U_L \Delta T_{g-a}/I_P$
241	1.40	49.6	1016.5	1.0222	$1.11x10^{-13}$	20.57	0.0059
320	2.55	74.2	1437.7	0.9887	$1.18x10^{-13}$	23.19	0.0079
490	15.86	243	3925.7	0.9956	$1.43x10^{-13}$	49.52	0.0322
770	24.27	536	7900.2	0.9866	$1.61x10^{-13}$	69.56	0.0311
800	27.39	612	8847.9	0.9872	$1.64x10^{-13}$	76.49	0.0338
950	28.66	757	10529	0.985	$1.72x10^{-13}$	79.69	0.0297
804	24.09	584	8490.4	0.9879	$1.63x10^{-13}$	72.69	0.0296
765	26.18	431	6765.5	0.9909	$1.51x10^{-13}$	56.35	0.0339
498	15.18	259	4128.4	0.9953	$1.45x10^{-13}$	52.05	0.0303
315	3.70	68.5	1344.5	0.99	$1.17x10^{-13}$	21.75	0.0116
Avg.						52.185	



Fig(7)Predicted and observed productivity for the cooled unit



Fig(8)Predicted and observed productivity for the control unit

The observed and predicted productivities were evaluated and correlated to each other for the two tested units, Figs.(7) and (8). Prediction equations give reliable results for the still productivity of the two studied units. The coefficients of determinations were,0.98 and 0.99 for the cooled and control units respectively.Table(3) shows that, as the solar intensity increases partial pressure potential $\mathbf{\Delta P_{w-g}}$**,** glass cover, water

Table(3) Solar intensity, ,glass cover temperature T_g, brine water temperature T_w, partial pressure potential ΔP_{w-g} and productivity for the two studied units.

Item	Cooled unit				Control			
I_P	T_g	T_w	ΔP_{w-g}	D	T_g	T_w	ΔP_{w-g}	D
W/ m^2	^oC	^oC	P_a	kg/m^2. h	^oC	^oC	P_a	kg/m^2. h
241	20.4	26	1074.2	0.0792	21.5	26.7	1016.5	0.0732
320	22.1	33	2399.5	0.2232	27.1	33.1	1437.7	0.1103
490	43	34	4244.9	0.4317	47.7	39	3925.7	0.3627
770	52	62	8421.1	0.9125	57	65.1	7900.2	0.8222
800	55.7	65	8835.6	0.9579	61.2	69	8847.9	0.9431
950	63	71.8	10840	1.2304	67.5	75	10529	1.1741
804	52.9	63.1	8838.3	0.9688	58.9	67	8490.4	0.8988
765	53	62.8	8454.8	0.9134	60	66.4	6765.5	0.6626
498	42.9	33	3440.7	0.3218	48	38.9	4128.4	0.3874
315	25	32	1576.9	0.1267	26.4	32.2	1344.5	0.1017
Avg.				6.1655				5.536

temperatures and productivity increases. The total daily productivity and average coefficient of performance were 6.1655kg/m^2, 59.52% for the cooled unit compared to 5.536 kg/m^{2}and 52.19% for the control unit. The maximum productivity , water temperature, temperature difference between water and glass cover, and partial pressure potential of 1.2304 kg/m^2.h, 71.8^{o}C, 8.8 ^{o}C, and 10840 P_a for the cooled unit compared to 1.0529 kg/m^2.h, 75 ^{o}C, 7.5 ^{o}C and 10529 P_a for the control unit.

SUMMARY AND CONCLUSION

The aim of the present study is to develop mathematical analysis for common design solar still involving all ambient surrounding variables affecting its productivity and coefficient of performance. Two similar units of the solar stills were used namely: Control unit and cooled glass cover unit (cooled unit). Similitude technique was used to develop prediction equations for these units. From the present study we can concluded that:

1- The prediction equations for the productivity of the two studied units were reasonably accepted with coefficients of determinations of 0.98 and 0.99 respectively. The predicted equations were of the form :

$$D = \left[A\left(\frac{Q_{ec}}{I_p} \right) + C \right] (\Phi \Delta p) \frac{\cos\beta}{\lambda}$$

Where D is the productivity in $kg/m^2.h$,C and A are functions of $\pi3$or $[U_L\Delta T_{g-a}/I_P]$ which are linearly justified ,ϕ time duration in hours, I_p solar intensity W/m^2, Q_{ec} the heat utilized in vaporizing water in the still W/m^2, U_L over-all heat loss coefficient in $W/m^{2o}K$, T_{g-a}, temperature difference between ambient air and glass cover ^oK, ΔP_{w-g} partial pressure potential kg $/m.s^2$, λ is a constant represents the view factor of sky, ground and surrounding with respect to cover tilt angle.

2- It was also found that the cooled unit has highest values of the productivity and coefficient of performance. The daily productivity and average coefficient of performance were 6.1655 kg/m^2, 59.52% for the cooled unit compared to 5.536 kg/m^2 and 52.19% for the control unit.

3-The maximum productivity , water temperature, temperature difference between water and glass cover, and partial pressure potential of 1.2304 $kg/m^2.h$, 71.8^{o}C, 8.8 ^{o}C, and 10840 P_a for the cooled unit compared to 1.0529 $kg/m^2.h$, 75 ^{o}C, 7.5 ^{o}C and 10529 P_a for the control unit.

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الملخص العربى

تحليل انتاجية مقطر شمسى باستخدام التحليل البعدى

***د/ طارق حسين غانم**

نظراً لندرة المياة العزبة فى بعض الأماكن الساحلية لجمهورية مصر العربية؛ يعد استخدام الطاقة الشمسية كمصدر للطاقة النظيفة والجديدة والمتجددة من افضل الطرق وأرخصها لتحلية مياة البحر. ويهدف البحث الى التوصل لنموذج رياضى يربط جميع المتغيرات المحيطة والداخلية بانتاجية مقطر شمسى ودراسة تأثير انخفاض درجةحرارة غطاؤه الشفاف ايضا على انتاجيتة واداءة . استخدم لذالك نموذ جين متشابهين تصميميا حيث تم تبريد غطاء احدهم بالماء ثلاث مرات كل ساعة ومماسبق يمكننا استخلاص الأتى:

١. حققت المعادلات التى تم التوصل اليها نتا ئج مرضية فى التنبأ بانتاجية كلا المقطرين موضع الدراسة حيث تراوح معامل الارتباط بين ٩٨% و ٩٩% وكانت صورةالمعادلات:

$$D=\left[A\left(\frac{Q_{ec}}{I_p}\right)+C\right](\Phi\,\Delta p)\frac{\cos\beta}{\lambda}$$

حيث (D)هى الانتاجية كجم/م٢. س ، (A) و (C) تمثل دوال فى المجموعة الثالثة $[U_L\Delta T_{g-a}/I_P]$، (Q_{ec}) هى الحرارة المستفاد بها فى التبخيروالتكثيف وات/م٢ ، (ϕ) الزمن بالساعة،(ΔP) هو فرق الضغط الجزئى عند درجة حرارة المحلول الملحى والغطاء الزجاجى ،(U_L) هى معامل الفقد الحرارى الكلى وات/م^2. كلفن ،(ΔT_{g-a}) هى فرق درجات الحرارة بين المحلول الملحى والغطاء الزجاجى بالكلفن ،(β) هى زاوية ميل الزجاج وهى ٢٠ ° و (λ) هى عمق المحلول فى المقطر بالمتر.

٢. قدرت الانتاجية اليومية ومعدل الآداء بـ ٦,١٦٥٥ كجم /م^2 و ٥٩,٥٢ % للمقطر المبرد مقابل ٥,٥٣٦كجم/م^2 و ٥٢,١٩% لوحدة المقارنة.

٣. حققت أعلى انتاجية عند اعلى كمية اشعاع شمسى وعندما كانت درجة حرارة الماء المالح وفرق درجة حرارة بين سطح الزجاج والماء وكذلك فرق الضغط الجزئى ١,٢٣٠٤ كجم/م٢ .س ، ٧١,٨ م° ،٨,٨ م° ، ١٠٨٤٠ بسكال للمقطر المبرد مقابل ١,١٧٤١ كجم/م٢ .س ٧٥، م° ،٧,٥ م° ، ١٠٥٢٩ بسكال لوحدة المقارنة.

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