Thermal Modeling of Pyramid Solar Still

Kuldeep H. Nayi and Kalpesh V. Modi

Abstract Solar desalination is most encouraging an alternative solution for fulfilling the requirement of clean and drinkable water in today's world of energy crises and water scarcity. Performance viability of solar desalination system is the main concern in this fast and advance world/life. Albeit, conventional solar still is cheap in cost, simple in construction, operation, and maintenance; its low productivity raises many questions on its worldwide applicability. Pyramid solar still is an innovative idea and design for the solar still that have higher productivity and many more other benefits over conventional solar still. Performance of solar still depends on operational, design and meteorological parameters. Thus, it is necessary to establish function that describe the relationship, which can be utilized for optimization of system and furthermore to anticipate viability and competitiveness of system. Therefore, thermal modeling (theoretical/mathematical model) of system plays vital role before actual implementation of system as well as after implementation for performance evaluation and improvement. In this chapter, basic fundaments of pyramid solar still with its advantages over conventional solar still are described. Further, thermal modeling (theoretical/mathematical model) is developed which can be useful to study the pyramid solar still.

Keywords Renewable energy · Solar desalination · Pyramid solar still · Thermal modeling · Performance evaluation

K. H. Nayi (✉)
Mechanical Engineering Department, Government Engineering College, Valsad, Gujarat, India
e-mail: kuldeep.nayi@gmail.com

K. V. Modi
Mechanical Engineering Department, Government Engineering College, Bhuj, Gujarat, India

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Nomenclature

English Letters

C	Specific heat in kJ/kg K
h_{fg}	Latent heat of evaporation of water in J/kg
m	Mass in kg
Q	Heat transfer rate in kW
R	Reflectivity
T	Temperature in K

Greeks

α	Absorptivity
ε	Emissivity
η	Efficiency
σ	Stefan–Boltzmann constant

Subscripts

a	Ambient air
b	Basin
c	Top Cover
cond	Conductive
conv	Convection
DW	Distillate water
evp	Evaporation
eff	Effective
i	Instantaneous
rad	Radiative
t	Total
Theo	Theoretical
w	Water

1 Introduction

Water is key element for sustain life on earth. It is also necessary for irrigation, agriculture, sanitation, energy generation, industrial production, etc. In twenty-first century, the most burning worldwide problem for humankind is shortage of available drinking water for current and future generation. One of the most adverse effects of overpopulation is depletion of natural resources. It is estimated that the per capita water availability may be reduced to 1137 billion cubic meters (BCM) by 2065 in India as compared to 1614 BCM for 2011 [1]. However, the situation can be better saved if sincere attempts are made to conserve water. On Earth, 96.5% of the planet's water is found in oceans that cannot be consume and utilize directly. Moreover, many remote areas are not accessible to ocean water. Therefore, it is necessary to find out solution to make brackish/contaminated water potable. Solar desalination is one of the most promising and sustainable solution to fight against the problem of water scarcity. Besides, the most attractive feature of solar desalination is that it uses inexhaustible and pollution free renewable solar energy for conversion from brackish/contaminated water into clean and pure drinkable. Thus, it is revolutionary for energy sectors, too. Solar still is device used for solar desalination. Conventional single basin single slope solar still is that in which saline/contaminated water is filled in basin that covered with inclined highly transparent glass or acrylic or plastic cover. Solar radiation penetrates into solar still through transparent top cover, that raises the temperature of basin saline water and saline water gets evaporated due to partial pressure. Evaporated water vapor raises up and condense at inner surface of top cover, which is at low temperature. The condensed water droplets glide down and collected by the collecting channel and drained out from solar still for end use. This condensate water is clean and hygienic [2].

In real world, advancement in innovation and technology in any system acquires priority. This concept tends to make system higher efficient, reliable eco-friendly and inexpensive. Thus, engineers and designers have recently developed the range of innovative and efficient configurations of solar still that can supply higher yield at low cost than that of conventional solar still. Figure 1 represents the various solar still configuration such as double slope solar still, multi-stage or multi-effect solar still, inverted trickle solar still, stepped solar still, weir type solar still, hemi-spherical solar still, spherical solar still, v-type solar still, pyramid solar still (triangular and square), cylindrical solar still, tubular solar still, conical solar still, etc. [3, 4]. Many attempts have been made to increase daily productivity of solar still by incorporating other auxiliary system with solar still such as solar still integrated with solar collectors, integrated with hybrid PV/T system, integrated with heat exchanger, integrated with solar pond, etc. [5, 6].

2 Pyramid Solar Still

Unlike conventional single basin single slop solar still, pyramid solar still has pyramidal top glass cover. Based on shape of that pyramid top glass cover, pyramid solar still: can be classified as shown in Fig. 2: (a) Triangular pyramid solar still and (b) square pyramid solar still.

Fig. 1 Classification of solar still based on geometry

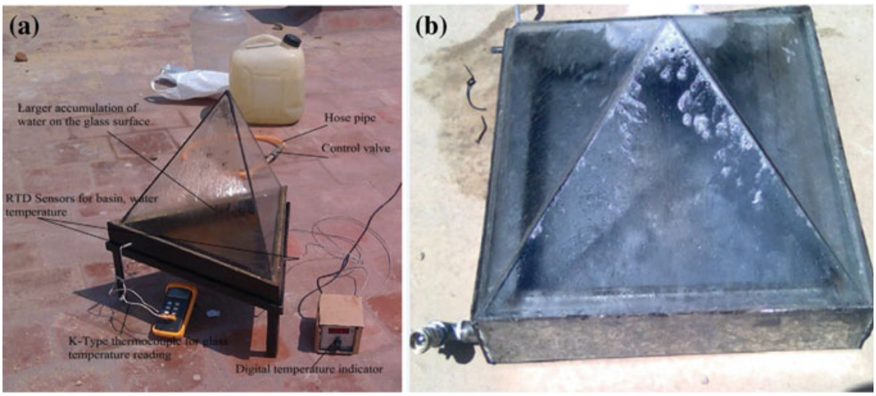

Fig. 2 **a** Triangular pyramid solar still [8] **b** Square pyramid solar still [9]

Pyramidal shaped glass cover of solar still potentially offer major several advantages over conventional (single basin single slope) solar still [7]. Conventional solar still must be placed in such a way that its inclined glass cover surface faces sun directly and tracking is required to gain maximum solar radiation throughout the day, whereas pyramid solar still can be placed irrespective of direction. The shading of side wall on saline water surface in basin is lesser in case of pyramid solar still than that of conventional solar still.

Till now very few but notable works on pyramid solar still has been reported in literature. First ever work in the pyramid solar still was reported by Hamdan et al. [10]. They have compared the performance of single, double and triple basin square pyramid solar still under the climatic condition of Amman, Jordan and achieved 44% maximum daily efficiency and 4.896 kg/m^2 daily yield from triple basin square pyramid solar still. 24% and 5.8% higher distillate water was obtained from triple basin pyramid solar still than single and double basin pyramid solar still, respectively. Fath et al. [11] have analytically compared the performance of square pyramid solar still with conventional single slope solar still. In the study, they have utilized scale-down dimension of the Great Pyramid of Giza, Egypt for construction of square pyramid solar still and compared the performance from thermal and economic point of view with conventional single slope single basin solar still. Also, many attempts have been carried out for increasing daily productivity of pyramid solar still. Kabeel [12] have attempted to increase the daily productivity of pyramid solar still with the use of concave wick surface in basin and concluded that the concave wick surface increases evaporation area that lead to enhancement in daily yield of pyramid solar still. About 4.1 l/m^2 daily average productivity with maximum instantaneous efficiency of 45% and average daily efficiency of 30% was achieved. Comparing cost of this concave wick pyramid solar still with conventional solar still, cost of liter for this pyramid solar still was 22% lower than that of conventional solar still. O Mahian and A Kianifer [13] have carried out mathematical modeling and experimental study on active and passive type square pyramid solar still. In active pyramid solar still, they obtained 4.2 l yield per day due to forced convection. At 4-cm saline water depth in basin, percentage error of 11.4% for passive solar still and 25% for active solar still was obtained between experimental and theoretical results. About 25% increment in daily yield was noted due to forced convection induced by placing small fan inside solar still in experimental study conducted by Taamneh et al. [9]. Satyamurthy et al. [8] have reported the effect of various operational parameters including mass of saline water, phase change material (PCM), saline water temperature at different depth of saline water, wind velocity over glass cover, etc. on the performance of triangular pyramid solar still. The lowest cost of distillate output of 0.031 $/liter was obtained for pyramid solar still which reveals that pyramid solar still is most promising alternative of conventional solar still [7].

3 Thermal Modeling of Square Pyramid Solar Still

Thermal/theoretical modeling of any system is the first step toward development of system. The study of theoretical model can be utilized: for selection of critical design criteria, for innovative development in system, for checking reliability and capability of system for desired purpose before actual execution of system at full scale and for performance evaluation or comparison between available alternatives. Performance of any solar still is evaluated based on its daily productivity and efficiency. Although working principle and construction of solar still is simple, its theoretical analysis is complex and based on experimental conditions. Thermal modeling of any thermal system can be carry out by two ways (i) Energy analysis based on first law of thermodynamics (first law energy efficiency) (ii) Exergy analysis based on second law of thermodynamics (second law energy efficiency). In present section, theoretical model of square pyramid solar still has been presented using energy balance equations based on first law of thermodynamics. The study involves the various heat flows occurs in system. Dunkle [14] has developed the various heat transfer correlations, which are utilized to calculate the heat transfer in solar still.

Fig. 3 illustrates the various heat transfer occured in solar still. Solar radiation enters in solar still through highly transparent top cover, where some part of it is reflected back, some is absorbed by top cover itself based on material of top cover and remaining radiation is transmitted and reaches at surface of saline water in basin. A part of solar radiation available at surface of saline water is transmitted and reaches to absorber plate of solar still, a part is reflected back towards glass cover that produces greenhouse effect inside solar still and a part is absorbed by saline water itself that raises the temperature of saline water. The solar radiation transmitted through saline water is absorbed by the absorber plate as it acts as a black surface that raises the temperature of the absorber plate. The absorber plate supplies the heat to saline water by convection and a part of heat is lost by conduction in surrounding through bottom and side of still. Saline water receives the heat from basin and solar radiation, which causes the evaporation of saline water. The evaporated water vapor rises up and condenses at the inner surface of glass cover due to the difference between saline water temperature and glass cover temperature. Thus, glass cover receives heat from evaporated water vapor that condense on it, from enclosed air and from heated water in addition to the direct absorbed solar radiation. The energy which is transferred to the cover is conducted through it and is lost to the surrounding by convection and radiation.

3.1 Energy Balance Equations

The performance of any solar still can be evaluated from its thermal model. In present section, theoretical model is developed to study the transient analysis and performance of pyramid solar still. For thermal system, theoretical model can be

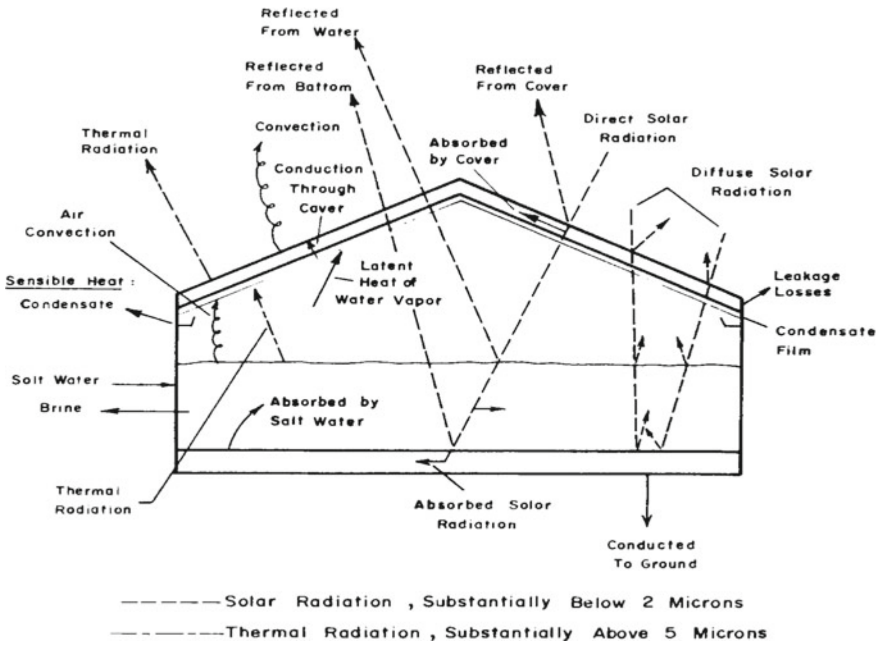

Fig. 3 Energy flow in solar still [15]

developed from energy balance equations of various component of system. Basin, saline water and glass cover are main part of conventional solar still.

The assumptions considered in theoretical models are as follows: constant saline water level is maintained in basin, no temperature gradients along the glass cover thickness and along the saline water depth, physical properties of basin material, saline water, glass cover, and insulation material are constant in operating temperature range, and vapor leakage losses are neglected.

(a) **Energy balance equation for basin:**

Solar energy absorbed by basin = Energy stored in basin + energy lost to water mass by convection + total energy lost to ambient

$$I(t)A_b\alpha_b' = m_bC_b\frac{dT_b}{dt} + Q_{conv,b-w} + Q_{loss} \quad (1)$$

where $I(t)$ is incident solar energy for solar still (W/m^2), A_b is area of basin (m^2), α_b' is fraction of solar radiation absorbed by basin material, m_bC_b is heat capacity of basin material (W/m^{2}K) and $\frac{dT_b}{dt}$ is temperature gradient with respect to time in basin.

Energy supplied to saline water from basin by convection and total energy lost to ambient is estimated using Eqs. (2) and (3), respectively.

$$Q_{\text{conv,b-w}} = h_{\text{conv,b-w}} A_{\text{b}} (T_{\text{b}} - T_{\text{w}}) \quad (2)$$

$$Q_{\text{loss}} = U_{\text{b}} A_{\text{b}} (T_{\text{b}} - T_{\text{a}}) \quad (3)$$

Overall heat loss coefficient for basin (U_{b}) represents combine effect of conductive heat loss from basin to insulation material and convective heat loss from insulation to surrounding and is estimated from Eq. (4) [16].

$$U_{\text{b}} = \left(\frac{y_{\text{ins}}}{k_{\text{ins}}} + \frac{1}{h_{\text{t,b-a}}} \right)^{-1}; h_{\text{t,b-a}} = 5.7 + 3.8\,\text{V} \quad (4)$$

where y_{ins} and k_{ins} are thickness of insulation (m) and thermal conductivity of insulation material (W/m^{2}K), respectively. $h_{\text{t,b–a}}$ is convective heat loss coefficient based on surrounding wind velocity (V in m/s).

(b) **Energy balance equation for saline water**

Solar energy absorbed by saline water + Energy received from basin by convection = Energy stored in water + Total energy lost to inner surface of glass cover

$$I(t) A_{\text{w}} \alpha'_{\text{w}} + Q_{\text{conv,b-w}} = m_{\text{w}} C_{\text{w}} \frac{\text{d}T_{\text{w}}}{\text{d}t} + Q_{\text{t,w-c}} \quad (5)$$

A_{w} is area of saline water that absorbs the solar radiation (m^2), α'_{w} is fraction of solar radiation absorbed by saline water, $m_{\text{w}} C_{\text{w}}$ is heat capacity of saline water (W/m^{2}K) and $\frac{\text{d}T_{\text{w}}}{\text{d}t}$ is temperature gradient with respect to time in saline water.

Energy lost to inner surface of glass cover from saline water is actually occur in three mode thus total energy lost to glass cover from saline water includes energy lost by conduction, by convection and by radiation.

$$\therefore Q_{\text{t,w-c}} = h_{\text{t,w-c}} A_{\text{w}} (T_{\text{w}} - T_{\text{c}}) = \left(h_{\text{conv,w-c}} + h_{\text{rad,w-c}} + h_{\text{evp,w-c}} \right) A_{\text{w}} (T_{\text{w}} - T_{\text{c}}) \quad (6)$$

In Eq. (6), convective and evaporative heat transfer coefficient between saline water and glass cover can be calculated by Eqs. (7) and (8), respectively, as suggested in Dunkle's model [14],

$$h_{\text{conv,w-c}} = 0.884 \times \left[(T_{\text{w}} - T_{\text{c}}) + \frac{(p_{\text{w}} - p_{\text{c}}).T_{\text{w}}}{268,900 - p_{\text{w}}} \right]^{\frac{1}{3}} \quad (7)$$

$$h_{\text{evp,w-c}} = 16.273 \times 10^{-3}.h_{\text{c,w-c}}.\frac{(p_{\text{w}} - p_{\text{c}})}{(T_{\text{w}} - T_{\text{c}})} \quad (8)$$

In above empirical relations, T_{w} and T_{c} are temperature of saline water and glass cover, respectively, in K. p_{w} and p_{c} are saturation vapor pressure of saline water and glass cover at respective temperature and are given by Eq. (9) [17].

$$p = e^{\left[25.317 - \frac{5144}{T}\right]} \tag{9}$$

And radiative heat transfer coefficient between saline water and glass cover is [14] …

$$h_{\text{rad,w-c}} = \varepsilon_{\text{eff}}\sigma(T_{\text{w}} + T_{\text{c}})\left(T_{\text{w}}^2 + T_{\text{c}}^2\right); \varepsilon_{\text{eff}} = \left(\frac{1}{\varepsilon_{\text{w}}} + \frac{1}{\varepsilon_{\text{c}}} - 1\right)^{-1} \tag{10}$$

(c) **Energy balance equation for Top cover:**

Solar energy absorbed by cover + Total energy received from saline water by convection, radiation and evaporation = Energy stored in cover + Total energy lost to surrounding

$$I(t)A_{\text{c}}\alpha'_{\text{c}} + Q_{\text{t,w-c}} = m_{\text{c}}C_{\text{c}}\frac{\text{d}T_{\text{c}}}{\text{d}t} + Q_{\text{t,c-a}} \tag{11}$$

A_c is area of glass cover that absorbs the solar radiation (m^2), α'_c is fraction of solar radiation absorbed by glass cover, $m_c C_c$ is heat capacity of cover material (W/m^2K) and $\frac{dT_c}{dt}$ is temperature gradient in glass cover with respect to time.

Energy lost from top cover to surrounding occurs by convection and radiation. Thus, total energy lost from cover to surrounding has main two components, viz. convective heat loss and radiative heat loss which can be estimated by Eqs. (12) and (13), respectively.

$$Q_{\text{conv,c-a}} = h_{\text{conv,c-a}}A_{\text{c}}(T_{\text{c}} - T_{\text{a}}) \tag{12}$$

$$Q_{\text{rad,c-sky}} = h_{\text{rad,c-sky}}A_{\text{c}}\left(T_{\text{c}} - T_{\text{sky}}\right); T_{\text{sky}} = T_{\text{a}} - 6 \tag{13}$$

Convective heat transfer coefficient between top cover and surrounding can be calculated as $h_{\text{conv,c–a}} = 2.8 + 3\text{ V}$ [16], and radiative heat transfer coefficient is given by Eq. (14)

$$h_{\text{rad,c-sky}} = \varepsilon_{\text{g}}\sigma\left(T_{\text{c}} + T_{\text{sky}}\right)\left(T_{\text{c}}^2 + T_{\text{sky}}^2\right) \tag{14}$$

Substituting values of different heat transfer and/or losses from Eqs. (2), (3), (6), (10), (12) and (13) in basic energy balance equations of various component of solar still, i.e., Eqs. (1), (5) and (11) and rearranging terms, one can get the governing differential equations for the various components of solar still as below,

$$\frac{\text{d}T_{\text{b}}}{\text{d}t} + \frac{A_{\text{b}}}{m_{\text{b}}C_{\text{b}}}(h_{\text{conv,b-w}} + U_{\text{b}})T_{\text{b}} = \frac{A_{\text{b}}}{m_{\text{b}}C_{\text{b}}}\left(I(t)\alpha'_{\text{b}} + h_{\text{conv,b-w}}T_{\text{w}} + U_{\text{b}}T_{\text{a}}\right) \tag{15}$$

$$\frac{\text{d}T_{\text{w}}}{\text{d}t} + \frac{A_{\text{w}}}{m_{\text{w}}C_{\text{w}}}\left(\frac{A_{\text{b}}}{A_{\text{w}}}h_{\text{conv,b-w}} + h_{\text{t,w-c}}\right)T_{\text{w}} = \frac{A_{\text{w}}}{m_{\text{w}}C_{\text{w}}}\left(I(t)\alpha'_{\text{w}} + \frac{A_{\text{b}}}{A_{\text{w}}}h_{\text{conv,b-w}}T_{\text{b}} + h_{\text{t,w-c}}T_{\text{c}}\right) \tag{16}$$

$$\frac{dT_c}{dt} + \frac{A_c}{m_c C_c}\left(\frac{A_w}{A_c} h_{t,w-c} + h_{conv,c-a} + h_{rad,c-sky}\right)$$
$$T_c = \frac{A_c}{m_c C_c}\left(I(t)\alpha_c' + \frac{A_w}{A_c C_c} h_{t,w-c} T_w + h_{conv,c-a} T_a + h_{rad,c-sky} T_{sky}\right) \quad (17)$$

Equations (15), (16) and (17) are the basic governing differential equations for solar still, viz. basin, saline water and top cover, respectively.

The solution of above governing differential equations was obtained with assumptions that the time interval is very small, values of heat transfer coefficient are constant during that small time interval and nearly steady-state condition is achieved during that small time interval.

Applying initial conditions as $T_b(t = 0) = T_{b0}, T_w(t = 0) = T_{w0}, T_c(t = 0) = T_{c0}$, the solution obtained for Eqs. (15), (16) and (17) are as below,

$$T_b = \left(\frac{f_1}{P_1}\right)\left(1 - e^{-P_1 t}\right) + T_{b0} e^{-P_1 t} \quad (18)$$

$$T_w = \left(\frac{f_2}{P_2}\right)\left(1 - e^{-P_2 t}\right) + T_{w0} e^{-P_2 t} \quad (19)$$

$$T_c = \left(\frac{f_3}{P_3}\right)\left(1 - e^{-P_3 t}\right) + T_{c0} e^{-P_3 t} \quad (20)$$

where

$$f_1 = \frac{A_b}{m_b C_b}\left(I(t)\alpha_b' + h_{conv,b-w} T_w + U_b T_a\right) \text{ and}$$
$$P_1 = \frac{A_b}{m_b C_b}\left(h_{conv,b-w} + U_b\right),$$
$$f_2 = \frac{A_w}{m_w C_w}\left(I(t)\alpha_w' + \frac{A_b}{A_w} h_{conv,b-w} T_b + h_{t,w-c} T_c\right) \text{ and}$$
$$P_2 = \frac{A_w}{m_w C_w}\left(\frac{A_b}{A_w} h_{conv,b-w} + h_{t,w-c}\right),$$
$$f_3 = \frac{A_c}{m_c C_c}\left(I(t)\alpha_c' + \frac{A_w}{A_c} h_{t,w-c} T_w + h_{conv,c-a} T_a + h_{rad,c-sky} T_{sky}\right) \text{ and}$$
$$P_3 = \frac{A_c}{m_c C_c}\left(\frac{A_w}{A_c} h_{t,w-c} + h_{conv,c-a} + h_{rad,c-sky}\right)$$

The average value of temperature for the time duration can be calculated as $\bar{T} = \frac{1}{t}\int_0^t T\,dT$, Eqs. (18), (19) and (20) can be represented as below,

$$\bar{T}_b = \left(\frac{f_1}{P_1}\right)\left(1 - \frac{1 - e^{-P_1 t}}{P_1 t}\right) + T_{b0}\left(\frac{1 - e^{-P_1 t}}{P_1 t}\right) \quad (21)$$

$$\bar{T}_w = \left(\frac{f_2}{P_2}\right)\left(1 - \frac{1 - e^{-P_2 t}}{P_2 t}\right) + T_{w0}\left(\frac{1 - e^{-P_2 t}}{P_2 t}\right) \quad (22)$$

$$\bar{T}_c = \left(\frac{f_3}{P_3}\right)\left(1 - \frac{1 - e^{-P_3 t}}{P_3 t}\right) + T_{c0}\left(\frac{1 - e^{-P_3 t}}{P_3 t}\right) \tag{23}$$

Using initial temperature (initial condition), initial value of heat transfer coefficients can be calculated. After small interval of time, temperature of various components of solar still can be calculated from Eqs. (13) to (16). Thus, the temperature of various components of solar still can be calculated by following similar procedure for the time duration of experiment.

- **Estimation of fraction of solar radiation absorbed by various component of solar still**

In energy balance equations of various component of solar still, i.e., Eqs. (1), (5) and (11), α'_b, α'_w and α'_c are fraction of solar energy absorbed by basin material, saline water and top cover material, respectively. These parameters depend on the individual absorptivity and reflectivity of material used for basin, water and top cover.

From the solar radiation available at the surface of glass cover, a part of solar radiation is reflected back based on reflectivity of cover material and then depending on its absorptivity, a part of solar radiation is absorbed by itself and remaining part of solar radiation is transmitted to saline water. Some amount of solar radiation which is transmitted to saline water from top cover is reflected from top surface of saline water, some amount is absorbed by it and remaining is transmitted to basin where basin absorbed solar radiation based on its absorptivity after reflection. Figure 4 illustrates this simple mechanism.

Thus, fraction of solar energy absorbed by top cover material, saline water and basin material are given as [18] …

$$\alpha'_c = (1 - R_c)\alpha_c \tag{24}$$

$$\alpha'_w = \alpha_w(1 - \alpha_c)(1 - R_c)(1 - R_w) \tag{25}$$

$$\alpha'_b = \alpha_b(1 - \alpha_c)(1 - R_c)(1 - R_w)(1 - \alpha_w)(1 - R_b) \tag{26}$$

3.2 *Estimation of Hourly Yield and Efficiency*

Hourly theoretical distillate output from temperature (°C) can be predicted by [19] and represented as below,

$$\begin{aligned} m_{DW|Theo} = {} & 0.012(T_w - T_c)(T_c - T_a) - 3.737 \times 10^{-3} T_w(T_c - T_a) - 5.144 \\ & \times 10^{-3} T_c(T_c - T_a) + 5.365 \times 10^{-3}(T_c - T_a)^2 + 0.212(T_c - T_a) - 3.828 \\ & \times 10^{-3} T_w(T_w - T_c) - 5.015 \times 10^{-3} T_c(T_w - T_c) + 2.997 \times 10^{-3}(T_c - T_a)^2 \\ & + 0.217(T_w - T_c) + 1.182 \times 10^{-3} T_c T_w + 1.663 \times 10^{-3} T_c^2 - 0.106 T_c \\ & - 0.065 T_w + 8352 \times 10^{-4} T_w^2 + 1.992 \end{aligned} \tag{27}$$

Instantaneous efficiency of solar still at any particular time can be estimated as [16],

$$\eta_i = \frac{m_{\mathrm{DW}} h_{\mathrm{fg}}}{I(t) A_{\mathrm{b}} \Delta t} \tag{28}$$

4 Conclusion

Thermal model for the performance evaluation of solar still especially for pyramid solar still is developed and comprehensively described in this chapter. Pyramid solar still offers extremely great points of interest over conventional single basin single slope solar still. Equation (27) is utilized to estimate distillate yield from the solar still based on theoretical temperatures of various components of solar still as described in Sect. 3.1, and these results also show the good agreement with experimental results [19]. It is clear that the theoretical distillate yield mainly depends on the temperature of main components of solar still as well as the temperature of the surrounding. Furthermore, from the various relations obtained in this chapter for

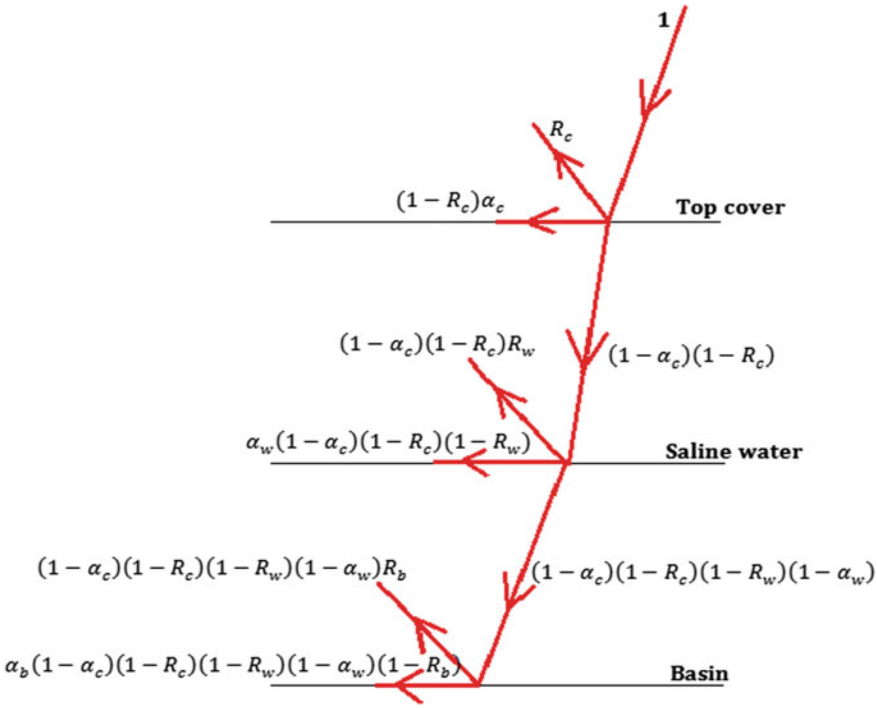

Fig. 4 Solar radiation absorbed by various solar still components

temperature estimation, temperature of solar still component (i.e. basin, saline water and glass cover) has great effect of various climatic parameters like solar radiation, wind speed, surrounding temperature, atmosphere humidity, etc.; various design and material parameters like top cover inclination angle, area and material of absorber plate and condensing cover, salinity of saline water, depth of saline water, thickness of absorber plate and top cover, thickness and material of insulation, etc. Thus, all parameters mentioned above have a significant effect on the yield of solar still so it is necessary to optimize those all parameters to achive maximum yield. Further, the daily productivity of pyramid solar still can be improved by providing some additional accessories and add-ons in a simple solar still such as wick materials, storage materials, nanoparticles, and additional solar collectors and reflectors, etc. Notwithstanding the energy analysis carried out in this chapter, second law efficiency analysis of pyramid solar still need to be developed as it identify areas required for improvement in solar still. As pyramid solar still has large advantages over conventional solar still, pyramid solar still can be thought as an alternative for conventional solar still.

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