

Experimental study on double effect solar distiller using bioactivity nanoparticles with analysis of thermo-economic and enviro-economical

Ravinder Kumar^{a,*}, Prabhat Tripathi^a, Bulbul Ongar^b, Yerkin Khidolda^b, Zakaria Mohamed Omara^c, A.S. Abdullah^{d,e}, S. Shanmugan^{f,**}

^a Department of Mechanical Engineering, Lovely Professional University, Punjab, 144411, India

^b Satbayev University, Department of Power Engineering, 22a Satpaev str., Almaty, 050013, Kazakhstan

^c Mechanical Engineering Department, Faculty of Engineering, Kafrelsheikh University, Kafrelsheikh, 33516, Egypt

^d Department of Mechanical Engineering, College of Engineering in Al-Kharj, Prince Sattam Bin Abdulaziz University, Al-Kharj, 11942, Saudi Arabia

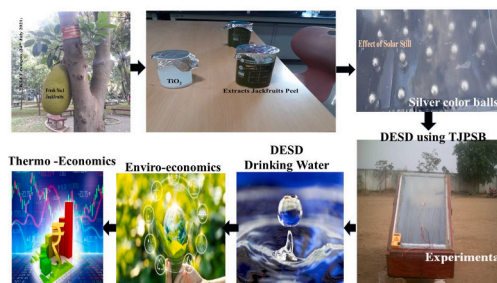
^e Mechanical Power Engineering Department, Faculty of Engineering, Tanta University, Tanta, 31521, Egypt

^f Research Centre for Solar Energy, Department of Engineering Physics, College of Engineering, Koneru Lakshmaiah Education Foundation, Green Fields, Guntur District, Vaddeswaram, Andhra Pradesh, 522502, India

HIGHLIGHTS

- DESD used TJPSB confirmed the result of 29.95% higher production for 0.3% and the Laplacian approach solution analysis.
- Improve productivity is 8.7919 L/m² per day, and efficiency is 50.55% by DESD with TJPSB (0.3%).
- The average thermo-enviro-economics analysis of DESD is 3.35 (exergy) and 4.71% (Energy).
- DESD analysis of the economics price for the portable water (per liter) appraised about 0.0726\$.

GRAPHICAL ABSTRACT



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ABSTRACT

Potable water is crucial in today's society, which is resolving the freshwater issue. In this work, the progress of direction in a basin area inner heat transmission mode with a Double Effect Solar Distiller (DESD), which is approaching the temperature mechanisms (parameters) for the Laplacian method using builds coated basin areas with a TiO₂/Jackfruit peel with silver balls (TJPSB) blend is done. To create green TiO₂ nanoparticles from eco-friendly bleaching chemicals and

* Corresponding author.

** Corresponding author.

E-mail addresses: rav.chauhan@yahoo.co.in (R. Kumar), prabhattripathi652@gmail.com (P. Tripathi), b.ongar@satbayev.university (B. Ongar), y.khidolda@satbayev.university (Y. Khidolda), zmomara@yahoo.com (Z.M. Omara), a.abdullah@psau.edu.sa (A.S. Abdullah), s.shanmugam1982@gmail.com (S. Shanmugan).

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Silver balls
Double effect solar distiller

jackfruit peel, a green nanoscale approach has been developed. The TiO_2 /Jackfruit peels (TJP) (0.1%, 0.2%, and 0.3%), along with the performance of silver color balls, are used to build and verify the DESD. The TJP materials studies were supported by the surface morphology analysis of chemical compounds with functional energy absorption additions. A typical particle magnitude of jackfruit peel has 40–60 nm, giving a zeta potential value. Images taken using a scanning electron microscope (SEM) presented an absorbent structure with 85% crystallinity in the X-ray powder diffraction (XRD) measurements. The TJPSB by the DESD outcomes as of 9.00 a.m. to 5.00 p.m. focuses on 0.1%, 0.2%, and 0.3% by layer yields of approximately 4.800 L/m^2 , 5.560 L/m^2 , then 6.120 L/m^2 , individually. More vibration basin regions that benefit from TJPSB's average productivity of 50.55% and $8.790 \text{ L/m}^2/\text{d}$ attracted to focus on 0.3% with a performance of DESD. TJPSB initially presents further manipulative applications of solar desalination process ingredients. Maximum access to the energy, exergy productivity of DESD consequences is 41% and 5.63% , individually. Based on water depth of 0.8 cm , TJPN is discovered in 20% of cases. Overall DESD efficiency is 7.35 kg m^2 per day at 12 h of 30% TJPN observation and 0.8 cm of water depth. An economic analysis of DESD was found with a cost of concentration that portable water (per liter) and assessed approximately $0.0726\$$ by reimbursement term of 14 months. The average thermo-enviro-economics analysis of DESD was found to be 3.35 (exergy), and 4.71% (Energy).

1. Introduction

The need for fresh aquatic resources across many nations is a major daily representation of the citification of living modern human existence. Several researchers showed in solar desalination in most recent decades to reduce the strength attributes that are non-renewable. The primary advantage of this study activity on solar desalination areas is the imperfect down-conservation of energy resources, which helps with the problem of water shortage. When Electricity is utilized as the best substitute for fossil fuels, the energy resource is exploited most effectively and sustainably [1]. El sheikh et al. [2] brought out a new act of solar distillates employing efficient nanoparticle techniques. Al_2O_3 nanoparticles focused at around 0.04 , 0.08 , and 0.12% were employed by Sahota et al. [3] in the double slope solar distiller basin region to produce more thermal energy. The utilization of solar distiller design was theoretically and experimentally verified using the different nanofluids (Al_2O_3 , TiO_2 , CuO) by Sahota et al. [4]. Al_2O_3 nanofluid at 46.10 (energy), 12.38% (exergy), and TiO_2 nanofluid at 43.81 (energy), 9.75% were among the materials that supported that system (exergy).

Although translucent roofed solar distiller are popular, they have drawbacks in real-world applications, including limited efficiency, warmth sufferers, an excessive vigor ingesting. Double Slope Solar Still (DSSS) connecting PCM-TES using vacuum mold-filling processes microencapsulated in an epoxy's mastic compound. To determine the impact of TES on productivity, the collected data from the traditional distiller and DSSS-TES associated. The daily average temperatures for the DSSS-TES attained are 65.2°C , 77.5°C , 82.4°C , 79.5°C , and 68.4°C for the glass cover, humid air, salt water, still basin absorber, and TES cavity, respectively. the use of 7.5 L of potable water every day, a 3-h expansion of the working period, DSSS-TES has produced more. Additionally, rates of condensation and evaporation increased by 105% along with the rise in production. The system's integration of TES has decreased heat losses, and a microencapsulated insulator has stopped PCM nanocomposite leakages. Desalinated water has not been discovered to contain any metals, microbes, or organic pollutants. Based on all-year-round activities, profit historical of 0.8 years verified. Findings and current models are in good accord. Additionally, the sensory properties met WHO requirements.

The DSSS examined, Lukmon Owolabi Afolabi et al. [5] expending PCM-TES, vacuum mold-filled processes to microencapsulate epoxy resin composite. The everyday mean temperatures at glass cover (65.2°C), moist atmosphere (77.5°C), saltwater (82.4°C), still basin absorber (79.5°C), and TES (68.4°C) are used to calculate in DSSS-TES. It was determined that the new design results in a greater production of 7.5 L per day and higher rates of condensation and evaporation along with a 105% rise in production. Sangeetha et al. [6] investigation of activated carbon nanoparticles (ACNPs) with fixed ZnO nanoparticles from *Mangifera indica* (M) and *Celostia argentea* (C) looked at various ratios of 5 , 10 , 15 , 20 , and $25 \text{ wt}\%$. Utilizing silver-colored steel balls (SBs) and the Gibbs free energy equation, which promote convective heat transfer and absorb solar radiation. The thermodynamic analysis of the samples is calculated to an entropy change. The study concluded that BPACNP-SB boosted daily efficiency by 38.73% while the DUSS improved by $14.92 \text{ L/m}^2/\text{day}$. Sangeetha et al. [7] reviewed of DSSS and improvements in effectiveness Phase Change Materials (PCMs), and Nano-Fluids (NFs) based on the thermal energy storage materials. Universal task, it focuses predictions by applying publicity creativities of the PCMF employed in DSSS. The same research team, Kabeel et al. [8], considered productivity level properties expending fan to draw vapor from the distiller to an external condenser and adding Al_2O_3 nanofluids (0.2%) to the basin. Al_2O_3 nanofluids and a fan increased the profit by 125% . Using Al_2O_3 nanofluids, PCM, and a wicking medium, Shanmugan et al. [9] investigated the impact of passive units. A material yield of $7500 \text{ ml/m}^2/\text{day}$ was the outcome. Al_2O_3 nanofluids without PCM, on the other hand, produce $4200 \text{ ml/m}^2/\text{day}$. Using absorber liners for coating materials of $\text{TiO}_2/\text{Cr}_2\text{O}_3$, Shanmugan et al. [10] have experimented to construct sessions for the yield of winter is 5.39 L/m^2 , then summer is 7.89 L/m^2 per day. In addition to significant uses nanoscience applications, Hussein [11] has explored theoretical and practical investigations related to energy systems. It is now observed as a crucial link between nanotechnology and all forms of renewable energy that are now available, allowing researchers to better understand how nanotechnology can improve renewable energy sources. Comprehensive analysis of the most current advancements through captivation solar accumulators were provided by Hussein et al. [12]. The use of nanofluid in direct absorption solar collectors were investigated in recent theoretical, numerical, and experimental works pertinent use solar collector that can significantly improve the effectiveness of

these gadgets. The impact of PCM's thermophysical properties on a double-glazing unit loaded with PCM's thermal performance was studied by Li et al. [13]. It was hypothesized that as PCM's melting temperature, specific heat capacity, latent heat, and thermal conductivity increase, so does the length of time it takes for its temperature decrement factor to increase with temperature changes. Specific heat capacity was 4460 J/(kg K) and performs better than the 2.1 W/(m K) result. Reviewing simulation research nanotechnology forms solar collector, in addition to reviewing these works. The most current developments in nanotechnology for numerous types of solar collectors has been evaluated by Hussein [14,15] using nanofluid based solar collectors that increase efficiency of these systems. The phase change material was developed by Liu et al. [16], so that its thermal performance and numerically examined optical properties could be used for the glazing construction. When the phase change material's refractive index is less than 1.95, it has been discovered that a double-glazing unit filled with it, has negligible impacts on temperature time lag, temperature decrement factor, solar transmittance, solar absorption, and reflectance. Violent materials with high extinction coefficients are not advised from a lighting usage perspective. As the absorber tube of the parabolic trough receiver, Benabderrahmane et al. [17] introduced the tube receiver with central corrugated insert. When compared to a smooth absorber, it can greatly increase heat transfer performance, raising the average Nusselt number by up to 3.7 times. Overall effectiveness increased the reduction in heat loss of 23% on average corrugated insert increases optical efficiency from 0.656 to 0.792. According to Rostami et al. [18], a new flat plate solar collector (FPSC) that utilizes elliptical pipes rather than circular ones pushed a multiwalled carbon nanotube (MWCNT) and water nanofluid (NF) to convect. Using elliptical pipes enhanced the output fluid temperature, energy efficiency, and exergy efficiency, according to the Reynolds number (Re) optimization technique. The NF (ϕ) volume percentages are 50–12,000 and 0–0.1. Highest energy efficiency is 7.1%, which is attained with a value of $\phi = 0.10\%$. Three different nanoparticles of ZnO, Al_2O_3 , and SnO_2 were coated in a concert conventional system basin area, which Elango et al. [19] examined. Al_2O_3 nanoparticles in this unit are coupled with nanoparticles other than two elements by the model's performance and harvested to a maximum amount of drinkable water. Design performance is improved by using Al_2O_3 by 29.95% as opposed to ZnO and SnO_2 elements, which each see gains of 18.63% and 12.2%, respectively. By combining a linear Fresnel solar reflector with a liquid and vapor refrigerant (R718), Ghodbane et al. [20] discovered a method for converting solar energy into thermal energy. The "COPejc" ejector air conditioning subsystem's performance value is 60.664%. The machine "STR"'s average thermal performance value reached 19.17%. The Fresnel linear concentrator's overall performance was 31.60% developed for the hemispherical solar still used recent innovations thermal performance of the system by Younis et al. [21]. CuO nanofluids developed the glassier refrigeration for solar units and investigated the outcomes of Nazari et al. [22]. They claimed that increased production of purified water (81%), energy (112.5%), and energy (80.6%) in the design.

Systems for absorption bowl solar desalination have been created by Panchal et al. [23] and doped with graphite nanoparticles and black paint to improve optical characteristics. The accompanying distiller system did not have a painted absorber plate, and water harvest was increased by 17%. Thakur et al. [24] used a mixture of CuO–ZnO nanoparticles to enhance thermal characteristics. The mass production of the CuO solar distiller was observed 2025 ml/day. The daily output of the solar distiller was 1590 ml and 1430 ml, respectively, with and without ZnO nanoparticles. Jathar et al. [25] followed in glass refrigeration thermal concert in the multi-basin system and considered properties using MgO, Al_2O_3 , TiO_2 , and the nanofluids volume, all fractions were 0.1% and 0.2%. The units produced by the distillate water increase of volume fraction by about 0.2%, developed by the volume fraction by about 0.1%. The volume fraction of 0.2% used in the system has been enhanced by the water yield of about 41.35% for MgO, Al_2O_3 is 28.42%, and TiO_2 nanofluid is 19.10%, individually and compared to a conventional system. Parsa et al. [26] acknowledged that mixing that conservative unit through an outside glass condensing with silver nanoparticles improved freshwater production. The rotatory wicking distiller using nanofluid of quantum particles was produced by Essa et al. [27]. Quantum dots enhance the heat transfer processing of distillate parts, nanofluids summarized another nano-colloidal and TiO_2 /Jackfruit peel nanocomposites by Abdulmohsen et al. [28], $\text{SiO}_2/\text{TiO}_2$ nanolayer, Mohandass Gandhi et al. [29], SiO_2 Nanoparticles/Jatropha curcas L. Rajesh Kumar et al. [30], and LaCoO_3

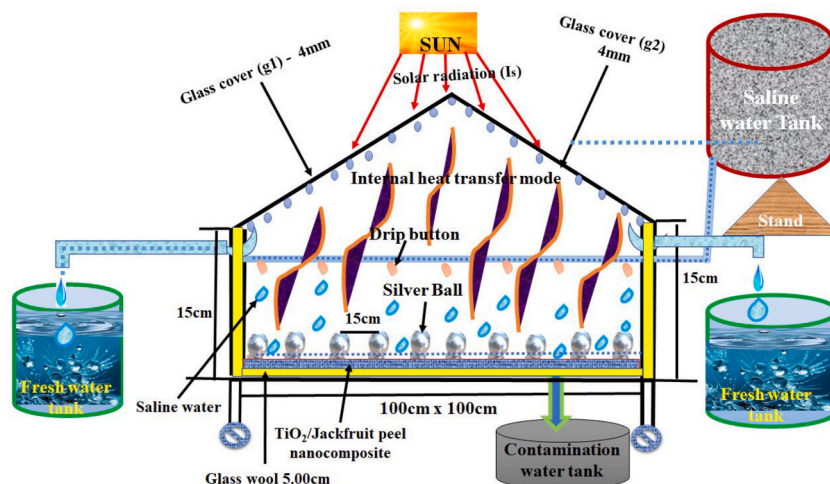


Fig. 1(a). schematic diagram for a DESD using TJPSB.

nanoparticles, Ghandourah et al. [31] were employed by the solar desalination units. It was observed that various research consequences by nanoparticles proven to augment energy performance on solar stills.

Hence, the synthesis of Jackfruit peel/TiO₂ nanoparticles (JPT) has been prepared by sol-gel self-ignition technique. The control metal types with analysis of X-Ray Diffractometer (XRD) and Scanning Electronic Microscope (SEM) are characterized by the JPT nanoparticles. The double effect solar distiller (DESD) is layered by 20 wt (TJP) with SB using the basin area and is considered and verified in the below climatical environments in the Solar energy laboratory. The Laplacian approach to the DESD has also been adopted to solve the temperature. After that, DESD is associated with and without comparing the TJPSB/dark dye. The green nanoscale production method is developed as a low-cost material and uses TJPSB to increase heat transfer. The various strength ratios of TJPSB are 0.1%, 0.2%, and 0.3% coating a DESD increases the absorbed heat transfer conditions by the system.

2. Material and methodology

2.1. Investigation on solar still arrangement

The DESD is coated in extracts of jackfruits peel/TiO₂ (JPT - 0.1%, 0.2%, and 0.3%) with a blend of the silver ball (SB), schematic and experiment arrangement is shown in Fig. 1(a) and Fig. 1(b). A modestly viable drop-by-drop saline water control has been used for the heat transfer pipe, which is connected to the greater points storage water chamber. The absorber allows the saline water via its drip button upper heat transfer pipe through drop by dropping fall down the basin area spraying daily. The silver ball is fixed inside the basin area for each distance of 15 cm. Already coated the TJPSB with an arranged silver color ball to fill the active saline water process of the DESD has absorbed more solar energy and actual temperature for evaporation of internal heat development. The new material's performance of DESD was continued mass of flow rate process. The absorb layer permeability profits of the seawater were inflamed to the basin area, which maintains that the saline water is hot of the main role of TJPSB material. The originality points of TiO₂/Jackfruit peel have been influenced with different ratios of 0.1%, 0.2%, and 0.3% mixture of the mad black dye coating absorber by the system. TJPSB of 0.3% has improved the evaporative ratio for the silver ball absorbing more sunlight. Table 1 shows the low-cost properties of accessible materials. DESD outer basin area is used for the viscosity of good yellow color glass wools thickness of 5 cm. Devices used to measure the DESD is shown in Table 2.

The temperature analysis of glass cover, basin, moist air, silver balls, and inlet saline water is measured in thermocouple wires of three K-types ($\pm 0.2\%$) for all parameters by the DESD. Sun rays are calculated by Pyranometers ($\pm 1\%$). The arrangement of the system is fixed at Vijayawada (16.5062° N, 80.6480° E) weather conditions analysis with an inclination position of 13° of the glass cover. The sensitive stability of 1000g is measured by the drinking water produced in Fig. 1(b), which assesses the TJPSB using DESD. In the summer weather environment, the roof in Koneru Lakshmaiah Education Foundation (KLEF) on May 10, 2021, was verified and measured 30 min at intermission from 6:00 to 17:00 (12 h) with operating parameters by a mechanism of DESD. The DESD is valued, with guaranteed enough water for smooth dripping flow up to the end process. The freshwater that produces an escape is observed during the experiment to confirm that valued foundational freshwater is suitable. The no leakage of a new design was monitored for the working sections and for improved thermal efficiency.

2.2. Chemical and material assemble for synthesis and characteristics

Fig. 1(c) is assembled the new number one jackfruit and collected at 3nos to each one wait of 10 kg in KLEF campus on Jul. 24, 2021. The peel, pulp, flake, and fresh ripe jackfruits were removed to separate these materials dry to all powdered mad after that good powder, which is kept at 32 °C for 8 h. Anil Scientific Company purchased TiO₂ at Vijayawada (Andhra Pradesh). Next, Vasa Scientific Company at Bangalore (Karnataka) of Acetonitriles, Formic acids, Ethylene glycol, and HPLC grade collected materials. Scientific Engineering enterprise at Hyderabad (Telangana) purchased Millipore water (ultra-pure water). Shastra Scientifics at Chennai (Tamil

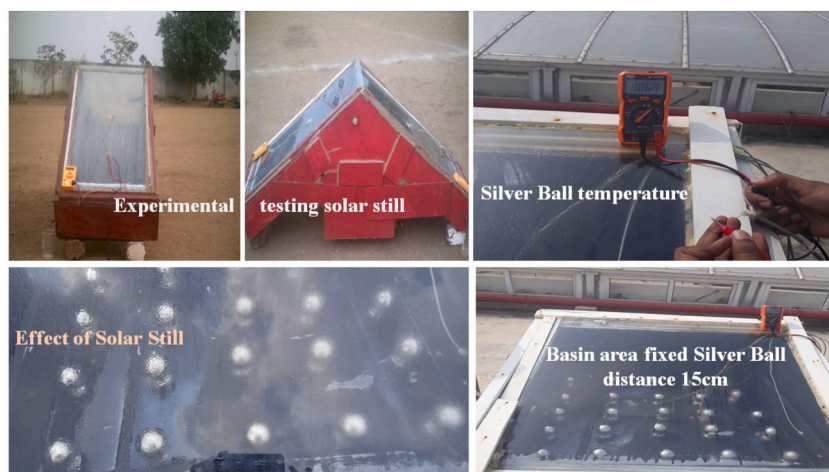


Fig. 1(b). shows experimental testing for a DESD using TJPSB.

Table 1

Using the TJPSB continuous flow rate, the DESD's focus portions can be clarified.

S. No	DESD sectors	Clarification	DESD thickness materials (mm)	Magnitudes(m)
01	Area of basins	Cu piece	01	0.90×0.80
02	Coating in JPT	Superficial part	01	0.90×0.80
03	Filling of insulations	Yellow glasswool	05	0.90×0.80
04	Basin surface of JPT	Covered	00.95	0.90×0.80
05	Glass cover area	Glass cover	04	1×1
06	Plyboard	Walls (basin indices)	02.5	0.90×0.80
07	The steel color silver ball	925 - Preciously Mine	3	100 numbers

Table 2

Devices used to measure the DESD.

Order	Tools	Standard	Measure	Choice of element	Sequence	Magnitude of accuracies
01	The pyranometer	Accuracy Ghostly pyranometer	Sunbeams	(W/m ²)	2800–00	(%) ± 1
02	Wire in thermocouple	Type in K	temperatures	(° C)	+300 to –20	(%) ± 0.2
03	Reduced climate trailer	K - 4500-NV	temperatures	(° C)	+80 to –20	°C ± 1.0
04	Concise climate follower	K - 4500-NV	Wind speeding	(m/s)	80–0.3	(%) ± 3.0 F
05	Sensor flow rates	KS - GEMS	Flow rate molcules	(l/m)	3.0–0.1	% ± 2.0

**Fig. 1(c).** Fresh No. 1 Jackfruits (3 no's to 10 kg for each) are shown in at the KLEF campus on July 24, 2021.

Nadu) bought analytical-grade chemicals. Erandwana (Pune), a dimensional diameter range of 0.5 mm, got the silver balls of 100Cr6 (ISO 3290 grades) in Fig. 1(d).

The systematically dual-purified aquatic is cleaned by a wholesome number one jackfruit peel (JP), desiccated in an air heater, and then milled after getting to jackfruit peel powder. Then, the room temperature of 31 °C is used, 5g of JP powder is taken, then a mixture of the twice purified water 40 ml after JP obtained completely filtered the Spectrum (nylon mesh). Millipore hydrophilic filter is used for 0.22 μm and covered at 10 nM for JPT with 200 ml of ionization water applied with a magnetic stringing at 3 h. Jackfruit peel extraction and TiO₂ synthesis is operated at room temperature under mixing environments for 8 h is shown in Fig. 1(e).

The new material's performance in Fig. 1(f) is analyzed by the photocatalytic degradation for the Methyl Orange (MO) smaller than heat as Xenon light absorption of JPT with a photocatalytic (0.1%, 0.2%, 0.3%) process. The absorption of the new materials was prepared by the JPT powder of 0.3g, which is dispersed at a 200 ml delay concentration of about 40 mg L⁻¹ after stirring for 120 min after achieving absorption equilibrium of dark color. U.V.–Visible agreed on an optical density to the wavelength of 465 nm. The degree of degradation for the methyl orange (A₁) absorption [32–34] has counted level as

$$\frac{(A_1 - A_f)}{A_1 \times 100.00} \quad (1)$$

Fig. 2(a) is made for the illustrations to fix the values of the XRD pattern in JPT (Phillips PW 1830 - 45 kV) by using 30 mA per Cu Ka1 radiation. The angles are formed with the diffraction of the strengths from 30° to 80°, which is measured at 3 h for the samples. They are reached for the samples at 2 h at about 27.42°, 36.10°, 41.30° and 54.33° peak data presence of JPT is acting in XRD pattern (JCPDS values as File No. 99-101-0954). The highest values are $h = 27.42^\circ$, which contests values at 110 by the JPT rutile arrangement with smooth of important in crystallographic represents the nanoparticles' structure form a particular rutile, it is not anatase or



Fig. 1(d). Silver balls 100Cr6 (ISO 3290 grades).

brookite grouping. Operational main probing heights to crystalline dimensions have been calculated in the Scherrer formula, then a range of 48 nm. The rutile and anatase formulation resulted in JPT rutile as *A. flavus* [35], a leaf extract of *C. roseus* [36], and a strong preliminary statement for temperature levels of absorption application. The sample (JTP) analysis of morphology for the scanning electron micrograph (SEM) with TiO_2 nanoparticles is combined to a stable form of fruit peel by the sphere-shaped (powder particles) from a nanoparticle exposed in Fig. 2(b) exposes spherical nanoparticles.

2.3. DESD with Laplacian approach for theoretical studies

Under the solid-states condition, energy balance equations with different mechanisms of temperature by DESD have been written and analyzed. The DESD - TJPSB is basin temperature, silver balls, water temperature, glass cover, moist air, and mass output, which will analyze. Based on the theoretical investigation, Kumar and Anand [37] and Dunkle [38] follows assumptions that TJPSB used DESD has predicated an energy balance equations resulting in a convention thought as.

- (i) The components of DESD are obvious at five temperatures and a steady state of significant time.
- (ii) Each temperature module is no gradient temperature with basin areas.
- (iii) Temperature components were written for 1st order differential equations
- (iv) The regular working process of nature is DESD

The glass covers

$$M_{gsn} \frac{dT_{gsn}}{dt} + h_{g(sn)a} A_g (T_{g(sn)} - T_a) = A_{g(sn)} \alpha_{g(sn)} I + h_{mg(sn)} (T_m - T_{g(sn)}) + h_{sbg(sn)} (T_{sb} - T_{g(sn)}) \quad (2)$$

Silver Ball of the nanofluid

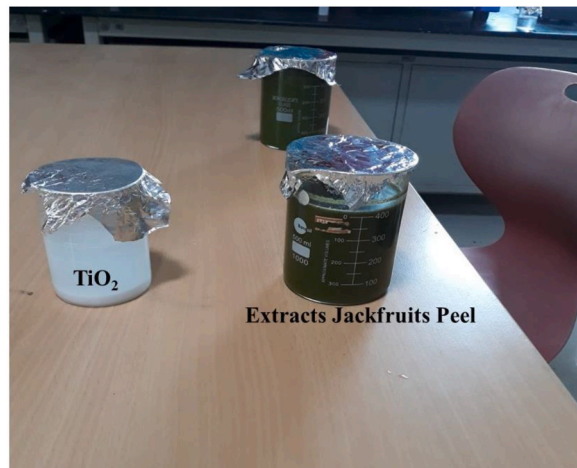


Fig. 1(e). Jackfruit peel extraction and TiO_2 synthesis.

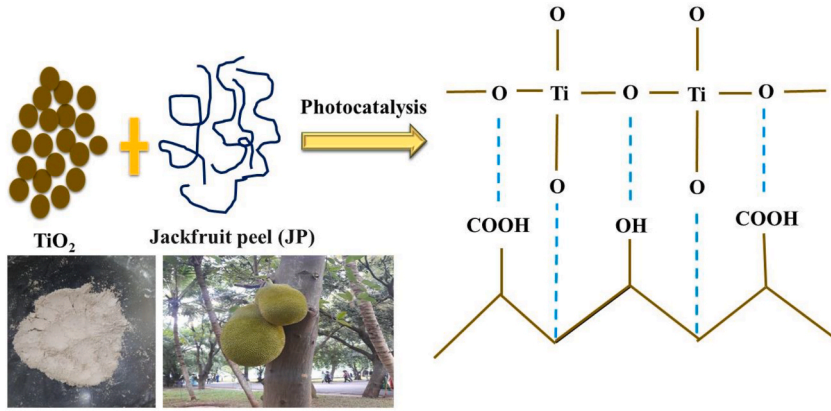


Fig. 1(f). The photocatalytic degradation of methyl orange is used to study the photocatalytic performance of TJP samples.

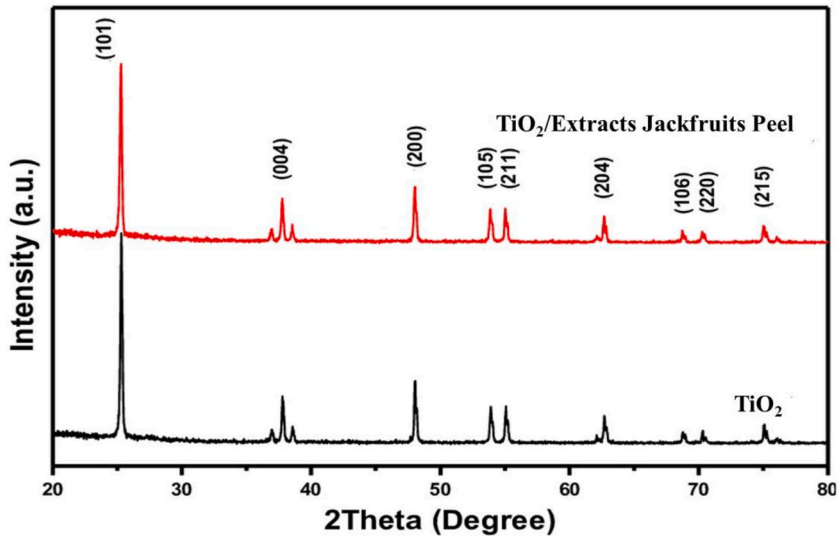


Fig. 2(a). TJP performance XRD pattern.

$$M_{sb} \frac{dT_{sb}}{dt} + h_{g(sn)sb} A_{g(sn)} (T_{g(sn)} - T_{sb}) = A_{sb} \alpha_{sb} I + h_{sbm} (T_{sb} - T_m) \quad (3)$$

Moist air

$$\frac{dT_m}{dt} + h_{mg(sn)} (T_m - T_{g(sn)}) = h_{sbm} (T_{sb} - T_m) \quad (4)$$

Basin area

$$M_{b(TJP)} \frac{dT_{b(TJP)}}{dt} + h_{b(TJP)w} A_{b(TJP)} (T_{b(TJP)} - T_w) = h_{sb(TJP)} (T_{sb} - T_{b(TJP)}) \quad (5)$$

Saline water

$$M_w \frac{dT_w}{dt} + h_{wsb} (T_w - T_{sb}) = h_{b(TJP)w} (T_{b(TJP)} - T_w) \quad (6)$$

Herewith equations (2)–(6) given rescheduled 1st order differential equations were

$$\frac{dT_{g(sn)}}{dt} + \tau T_{g(sn)} = AT_a + BT_m + CT_{sb} + A_{g(sn)} \alpha_{g(sn)} I \quad (7)$$

$$\frac{dT_{sb}}{dt} + \eta T_{sb} = DT_{g(sn)} + ET_m \quad (8)$$

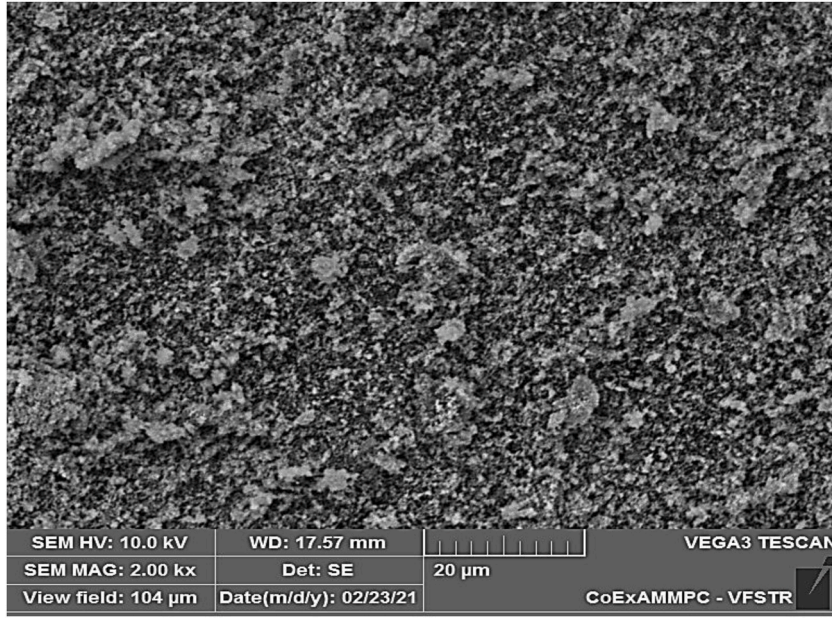


Fig. 2(b). The SEM examination of TJP samples.

$$\frac{dT_m}{dt} + \gamma T_m = FT_{sb} + GT_{g(sn)} \quad (9)$$

$$\frac{dT_{b(TJP)}}{dt} + \beta T_{b(TJP)} = HT_w + KT_{b(TJP)} \quad (10)$$

$$\frac{dT_w}{dt} + \mu T_w = PT_{sb} + QT_{b(TJP)} \quad (11)$$

where

$$\begin{aligned} \tau &= \frac{(h_{g(sn)a} A_{g(sn)} + h_{mg(sn)} + h_{sb g(sn)})}{M_{g(sn)}}; \eta = \frac{(h_{g(sn)snb} A_{g(sn)} + h_{sbm})}{M_{sb}}; \gamma = h_{mg(sn)} h_{sbm}; \beta = \frac{h_{b(TJP)w} A_{b(TJP)} + h_{b(TJP)sb}}{M_{b(TJP)}}; \mu = \frac{h_{wsb} + h_{b(TJP)w}}{M_w}; \\ A &= \frac{h_{g(sn)a} A_{g(sn)}}{M_{g(sn)}}; B = \frac{h_{mg(sn)}}{M_{g(sn)}}; C = \frac{h_{sb g(sn)}}{M_{g(sn)}}; D = \frac{-h_{g(sn)sb} A_{g(sn)}}{M_{sb}}; E = \frac{h_{sbm}}{sb}; F = h_{sbm}; G = h_{mg(sn)}; H = \frac{h_{b(TJP)w} A_{b(TJP)}}{M_{b(TJP)}}; K = \frac{h_{b(TJP)sb}}{M_{b(TJP)}}; \\ P &= \frac{h_{wsb}}{M_w}; Q = \frac{h_{b(TJP)w}}{M_w} \end{aligned}$$

From Eqs. (7)–(11), the primary requirements are $T_a = 00$, $T_{sb} = 00$, $T_{b(TJP)} = 00$, $T_m = 00$ and $T_w = 00$, and expressed as

$$T_{g(sn)} = \frac{I}{J} + \left[T_{g(sn)0} - \frac{I}{J} \right] e^{-Jt} \quad (12)$$

$$T_l = \frac{L}{M} + \left[T_{l0} - \frac{L}{M} \right] e^{-Mt} \quad (13)$$

$$T_{ai} = \frac{N}{O} + \left[T_{ai0} - \frac{N}{O} \right] e^{-Ot} \quad (14)$$

$$T_{b(TJP)} = \frac{R}{S} + \left[T_{b(TJP)0} - \frac{R}{S} \right] e^{-St} \quad (15)$$

$$T_w = \frac{U}{V} + \left[T_{w0} - \frac{U}{V} \right] e^{-Vt} \quad (16)$$

where

$$I = \tau; L = \eta; N = \gamma; R = \beta; U = \mu$$

$$J = AT_a + BT_m + CT_{sb} + A_{g(sn)}\alpha_{g(sn)}I; M = DT_{g(sn)} + ET_m; O = FT_{sb} + GT_{g(sn)}; S = HT_w + KT_{b(TJP)}; V = PT_{sb} + QT_{b(TJP)}$$

The saline water absorption solar radiation and ambient energy received by the DESD measure the in between the 10 min attractive the mechanisms. The basin area loading is based on saline water (12 kg) heat take that time of $t = 0$. Altogether, the temperature modules are approached in Laplace transform matrix equation for the initial conditions, and the Fourier transform studies of $T_{g(sn)s}$, T_{sbs} , T_{ms} , $T_{b(TJP)s}$ and T_{ws} . The time-varying temperature execution of Laplace transforms the working of DESD in initial conditions, "s," as suggested in Laplace transform matrix following as

$$\begin{bmatrix} T_{g(sn)s} \\ Q_{g(sn)s} \end{bmatrix} = \begin{pmatrix} ch\sqrt{\left(\frac{s}{t}\right)} & \frac{-1}{h_{g(sn)a}}ch\sqrt{\left(\frac{s}{t}\right)} - \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}sh\sqrt{\left(\frac{s}{t}\right)} \\ \sqrt{\left(\frac{s}{t}\right)}sh\sqrt{\left(\frac{s}{t}\right)} & \frac{1}{h_{g(sn)a}}sh\sqrt{\left(\frac{s}{t}\right)} + \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}ch\sqrt{\left(\frac{s}{t}\right)} \end{pmatrix} \begin{pmatrix} T_{g(sn)0} \\ Q_{g(sn)0} \end{pmatrix} \quad (17)$$

$$\begin{bmatrix} T_{sbs} \\ Q_{sbs} \end{bmatrix} = \begin{pmatrix} ch\sqrt{\left(\frac{s}{t}\right)} & \frac{-1}{h_{g(sn)sb}}ch\sqrt{\left(\frac{s}{t}\right)} - \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}sh\sqrt{\left(\frac{s}{t}\right)} \\ \sqrt{\left(\frac{s}{t}\right)}sh\sqrt{\left(\frac{s}{t}\right)} & \frac{1}{h_{g(sn)sb}}sh\sqrt{\left(\frac{s}{t}\right)} + \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}ch\sqrt{\left(\frac{s}{t}\right)} \end{pmatrix} \begin{pmatrix} T_{sbs0} \\ Q_{sbs0} \end{pmatrix} \quad (18)$$

$$\begin{bmatrix} T_{ms} \\ Q_{ms} \end{bmatrix} = \begin{pmatrix} ch\sqrt{\left(\frac{s}{t}\right)} & \frac{-1}{h_{mg(sn)}}ch\sqrt{\left(\frac{s}{t}\right)} - \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}sh\sqrt{\left(\frac{s}{t}\right)} \\ \sqrt{\left(\frac{s}{t}\right)}sh\sqrt{\left(\frac{s}{t}\right)} & \frac{1}{h_{mg(sn)}}sh\sqrt{\left(\frac{s}{t}\right)} + \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}ch\sqrt{\left(\frac{s}{t}\right)} \end{pmatrix} \begin{pmatrix} T_{m0} \\ Q_{m0} \end{pmatrix} \quad (19)$$

$$\begin{bmatrix} T_{b(TJP)s} \\ Q_{b(TJP)s} \end{bmatrix} = \begin{pmatrix} ch\sqrt{\left(\frac{s}{t}\right)} & \frac{-1}{h_{b(TJP)w}}ch\sqrt{\left(\frac{s}{t}\right)} - \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}sh\sqrt{\left(\frac{s}{t}\right)} \\ \sqrt{\left(\frac{s}{t}\right)}sh\sqrt{\left(\frac{s}{t}\right)} & \frac{1}{h_{b(TJP)w}}sh\sqrt{\left(\frac{s}{t}\right)} + \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}ch\sqrt{\left(\frac{s}{t}\right)} \end{pmatrix} \begin{pmatrix} T_{b(TJP)0} \\ Q_{b(TJP)0} \end{pmatrix} \quad (20)$$

$$\begin{bmatrix} T_{ws} \\ Q_{ws} \end{bmatrix} = \begin{pmatrix} ch\sqrt{\left(\frac{s}{t}\right)} & \frac{-1}{h_{wsb}}ch\sqrt{\left(\frac{s}{t}\right)} - \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}sh\sqrt{\left(\frac{s}{t}\right)} \\ \sqrt{\left(\frac{s}{t}\right)}sh\sqrt{\left(\frac{s}{t}\right)} & \frac{1}{h_{wsb}}sh\sqrt{\left(\frac{s}{t}\right)} + \frac{1}{\sqrt{\left(\frac{s}{t}\right)}}ch\sqrt{\left(\frac{s}{t}\right)} \end{pmatrix} \begin{pmatrix} T_{ws0} \\ Q_{ws0} \end{pmatrix} \quad (21)$$

Laplace transfer first matrix has been used for right-hand position calculations (17) to (21). In a double pattern (matrix), preliminary standards have been used parallel to the temperature module by DESD. The temperature movement of various components absorber plate used TJPSB have related to the separate temperature. 1st order differential equation general result is the study found time-variable values of Laplace transform as a substitute for getting the DESD. The ordinary differential equations (12)–(16) using a general solution were obtained by equations (17)–(21).

The various temperature components of DESD have been combined to find suitability as double techniques an evaporative mass transfer (m_o) has resulted in yields such as

$$m_o = \Delta t \frac{h_{ev,w}(T_w - T_{g(sn)})}{L} \quad (22)$$

Thermal efficacy (η_e) of DESD was written by cumulative yield (m_y) as

$$m_y = \sum m_o \quad (23)$$

$$\eta_e = \frac{Lm_y}{T_{JPTS} + \Delta t LA_s} \quad (24)$$

2.4. Exergy efficiency of DSESS

DSESS, the exergy input is calculated as equal to the exergy as

$$\dot{E}x_{in} = \dot{E}x_{sun} = A_s \times I(t) \times \left[1 - \frac{4}{3} \times \left(\frac{T_a + 273}{T_s} \right) + \frac{1}{3} \times \left(\frac{T_a + 273}{T_s} \right)^4 \right]$$

DSESS exergy output is

$$\dot{E}x_{evap} = A_s \times h_{ew}(T_{sw} - T_{scie}) \times \left[1 - \frac{T_a + 273}{T_{sw} + 273} \right] \quad (25)$$

2.5. Economic analysis of DSESS

DSESS analysis of economic source is involved in assessing the liquid-making price, gain-price proportion, exergo-economical, and enviro-economical investigate powerful constraint price by supplying mineral water in DESD. The lifetime analysis of DSESS has been obtained to assess the CO₂ extenuation (carbon credit produces - enviroeconomic analysis) interest rates.

2.5.1. Water production of DSESS assessment cost analysis

The freshwater yield of DSESS is an important point for reducing the cost, which necessitates showing a cost connected and scheming the cost of manufacturing at 1 L of freshwater [39]. The recent importance sequence and equivalent yearly currency expenses have used ratio to determine the Capital recovery factor. An effective costs analysis of the parameter is working to agree to the achievement through the savings in the lifetime (n) of DSESS can be written the formula [40,41]:

$$\text{Capital recovery factor} = \frac{i_{br}(1 + i_{br})^n}{(1 + i_{br})^n - 1} \quad (26)$$

Instead of annual interest rate performance, the interest rate is measured to physical return on saving accounts investments. The compounding over time is appealing, showing that when a real (%) amount is payable, an activity gives loans or some more arrears. Yearly benefit rates are estimated to a resulting effective relative as [42]:

$$i_{er} = 1 + \frac{i_{br}}{t} - 1 \quad (27)$$

The steady combination of interest rates is limited to the mathematical complex concentration formula, which is interesting annually combined an immeasurable number of times obtained by the resulting formulation parameters [42] as depends on the laws each country follows on the conditions of the lending bank.

$$i_{erc} = e^i - 1$$

DSESS is commercially operable standing take to the total cost needed by capital cost (C C₁) used for the First Annual Cost (FA C₁). The overall analysis of DSESS entries lifespan for the cost per year is gained for resulting relative [43] as.

First Annual Cost (FA C₁) = capital cost (C C₁) × CRF (28).

DSESS has been estimated by salvage value (SV₁), which is completed depreciation through the end of the unit's useful life. Annual salvage values are dependent on components for the DSESS lifetime [44] relation is.

Annual Salvage Values (ASV₁) = Salvage Value (SV₁) × Sinking Fund Factor (SFF₁).

The sinking Fund Factor (SFF₁) represents an equal annual cash flow (interest bank rate). It is calculated future ratio value (CRF) as [45]:

$$\text{Sinking Fund Factor (SFF}_1) = \frac{i_{br}}{(1 + i_{br})^n - 1} \quad (29)$$

DSESS is gained for the Annual Maintenance Cost (AM C₁), components destruction, repair, and operation as [46]:

$$\text{AM C}_1 = \text{AMCO} \times \text{F.A. C}_1$$

The maintenance of the DSESS cost coefficient annual costs of mechanisms destruction is quantified as repair and operation. It is a uniform annual cost (PWC) as [47]:

$$\text{PWC} = \text{FA C}_1 + \text{AM C}_1 - \text{AS V}_1$$

DSESS is produced freshwater dependent on the annual distillate water (D.W.). The freshwater cost per liter (ACPL) [48] is

$$\text{ACPL} = \frac{\text{PWC}}{\text{DW}}$$

Economic analysis of DSESS has benefited cost ratio (BCR), which has been calculated as [48]:

$$\text{BCR} = \frac{\text{PWC}}{\text{PWB}}$$

DSESS can be calculated by the present worth of benefit as [32]:

$$PWB = DW \times PAPF \quad (30)$$

DSESS presents the annual productivity freshwater (PAPF). The 1-L water buying cost varies in each country profit-expense percentage might be greater than the agreement asset is an effective process.

2.5.2. Exergo-economic analysis of DSESS

Exergy and economic analysis of cost-effective by the exergoeconomic parameter for the DSESS using energy and exergy output equivalent to the ratio is a useful combination of each annual equivalent yearly budget [49] as

$$EEP_{Ex} = \frac{(E_{en})_{out}}{UAC}$$

$$EEP_{En} = \frac{(E_{ex})_{out}}{UAC}$$

DSESS has been produced as an annual to calculate exergy out (E_{ex}), energy out (E_{en}):

$$(E_{en})_{out} = \frac{DW \times h_{fg}}{3600} \quad (31)$$

$$(E_{ex})_{out} = \frac{DW \times h_{fg}}{3600} \left(1 - \frac{T_a}{T_w} \right)$$

2.5.3. Environmental cost analysis of DSESS

2.5.3.1. *Enviro-economic analysis.* During the DSESS, a lifetime analysis of enviroeconomic parameters has been obtained to equal the cost by CO₂ reduction. The enviroeconomic parameter [50] is

$$EP_{CO_2} = IN_{CO_2} + \phi_{CO_2} \quad (32)$$

2.5.3.2. *Exergo-environmental analysis.* Fossil fuels are required for energy consumption for water production pollutes the environment. Renewable sources have reduced this level of pollution. The exergy creates the CO₂-generated decrease exergo-environmental parameters to evaluate this equation [51] is

$$\phi_{exCO_2} = \frac{2((E_{ex})_{out} \times n - E_{in})}{1000} \quad (33)$$

DSESS has achieved by the CO₂ reduction an energy and exergy sum of CO₂ mitigation

$$\text{Total } CO_2 \text{ mitigation} = \phi_{exCO_2} + \phi_{CO_2}$$

2.5.3.3. *3 exergo-enviro-economic analysis.* Exergoenvironomic parameters ($EP_{ex CO_2}$) [52] are evaluated to the cost of CO₂ mitigation created on exergy as

$$EP_{ex CO_2} = IN_{CO_2} + \phi_{ex CO_2} \quad (34)$$

3. The numerical approach in the DESD

The performance of the DESD has been modeled as computer software based on the energy and mass balance equations to explore section 2.3. The operating parameters that determine productivity were developed together with an impact of the various designs. The Laplace transform can be used as a simulation program to instantly demonstrate energy physique equilibrium calculations. DESD mechanisms beginning temperatures (initial) were set to be roughly equivalent to the ambient temperature. These temperature and physical property data were used to determine the relevant coefficients of heat transfer and an assumed constant at a certain time step

Table 3
DESD operating parameters.

S. No.	The DESD parameters	Symbol	Values	Units
1	Glass absorptivity's	α_g	00.0475	Nil
2	Absorb plate Absorptivity's	α_b	00.95	Nil
	Water absorptivity's	α_w	00.05	Nil
3	Glass cover mass	m_g	010.12	kg·m ⁻²
4	Water mass	m_w	020.60	kg·m ⁻²
5	Absorb plate mass	m_b	015.60	kg·m ⁻²
6	Evaporator mass	m_e	07.35	kg·m ⁻²
7	Absorb plate thermal conductivity	k_b	016.30	W·m ⁻¹ K ⁻¹
8	An insulation (Glass wool) for the thermal conductivity	k_i	00.039	W·m ⁻¹ K ⁻¹
9	Evaporator with a specific heat	C_e	0385	J·kg ⁻¹ °C ⁻¹
10	Glass reflectivity's	ρ_g	00.0735	Nil
11	Absorb plate with a specific heat	C_b	0480	J·kg ⁻¹ °C ⁻¹
12	Glass in a specific heat	C_g	0800	J·kg ⁻¹ °C ⁻¹
13	Water with a specific heat	C_w	04178	J·kg ⁻¹ °C ⁻¹

to estimate temperatures in the subsequent time step. The energy balance equations above were numerically solved to get novel temperatures and original environments repeated to solve an equation for the per day (working hours) in DESD. In order to compute the heat transfer coefficients, initial temperatures for DESD that depend on temperature were considered. Using the calculated heat transfer coefficients from the basin area to the glass covers and the hypothetical beginning temperatures. It is numerically solved to provide new temperatures to serve as initial conditions of the DESD cycle. Condensation rate calculations are made for each time interval and theoretical temperatures of the DESD components were made for the performance of the parameter. The operating characteristics of the DESD employed in the computer simulation program are the fundamental design parameters and are listed in Table 3. All simulations make use of the thermo-physical characteristics listed in this table as constants.

4. Result and discussions

4.1. TJPSB coated as DESD outcomes

The experimental (DESD) weather settings are depicted by the TJPSB as a KLEF, which is characterized by the various solar radiations, the highest beam of which is 1121.2 W/m^2 at midday. The average solar intensity and ambient temperatures on ordinary days in KLEF, according to a DESD investigation of the local weather are 417.7 W/m^2 and 34.4°C . According to a DESD calculation for the basin's internal area, a regular day in KLEF would have an ambient temperature of 17.4°C and solar radiation of 446.8 W/m^2 . The results of TJPSB coating as DESD have been discussed in the section below based on parameters performance.

4.2. Hour changes the distinction in TJPSB

The experimental analysis of DESD has used TJPSB results from the system activity. 0.1%, 0.2%, and 0.3% focus on the samples' concentrations and their stability behavior and clearly show that the moral constancy as TJP is 0.3% absorption. The hour changes the distinction of solar radiations, ambient temperature, and determining values of daylight living an investigational history is shown in Fig. 3(a).

As shown in Fig. 3(b), DESD with heat was applied to moist air, silver balls, glass covers, JPT-coated absorber plates, and heated saline water. The high temperatures arcs (glass cover, moist air, silver balls basin, saline water) equivalent to the sun ray's form can cause the heat assimilation DESD. The temperature in the basins was raised by DESD, and the evaporator's interior heat reached almost 69°C . About 60°C . is the lowest (decrease) pre-established heat temperature of the glass cover. It has been determined by a system that the individual specific heats of moist air, silver balls, a basin of salt water, and a glass cover are 66.82°C , 69.17°C , 64.35°C , 59.76°C , and 42.11°C . According to Fig. 3(b), a system's various temperature analysis components include a glass cover, a basin, salty water, moist air, and silver balls. At 17:00, they were increased by almost linear inclination attainment, resulting in a rate of roughly 13.5°C . The nature of the greater glass cover temperature suggests that the DESD impression and force damage curve at midday limit values were real in TJPSB. The temperature analyzer with 5.00 cm thick glass wool was solved using the MATLAB SIMULINK database and the Laplace method. The temperature of the silver ball is equivalent to the high-temperature transmission coefficients due to the performance of the nanocomposite (TJP), moist air on the glass cover, basin area, and system-evaluated water temperature.

4.3. Performance of TJPSB

As part of the DESD's operation, the heat transfer coefficients are estimated with a time variation of around 30 min, and vaporization to seawater has moved, having little effect on other temperature quantities. By using a trendline to draw the graphs and getting experimental and theoretical rates, the Laplace method's linear equations were confirmed. To calculate the remaining components of the temperatures, an experimental observation DESD using the Laplace method obtained the temperature values as a trendline strain equation. According to Fig. 4(a), the freshwater hourly yield flow is verified to be 0.039 L , 0.051 L/m^2 absorber plate for 0.9 m^2 deliberated (Table 1) of the system at almost 7:00 to receive the water. Hourly changes in the value of 0.343 L/m^2 at 13:00 were caused by the DESD's absorption of solar energy produced on the right side and the growth of freshwater. To create a reasonable Laplace

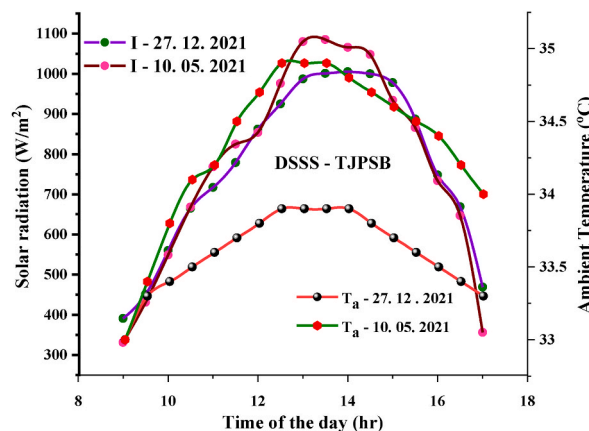


Fig. 3(a). Solar radiation (I) and Ambient temperatures (T_a) distribution of the DSSS (DESD) - TJPSB constant flow rate.

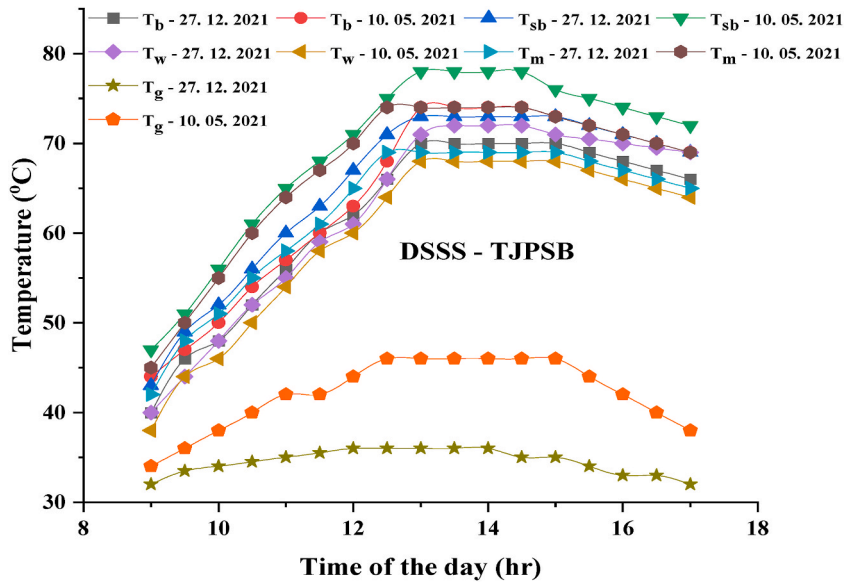


Fig. 3(b). Temperatures are a distribution of a glass cover (T_g), basin (T_b), silver balls (T_{sb}), moist air (T_m), saline water (T_w), in DESD - TJPSB (0.3%) constant flow rate.

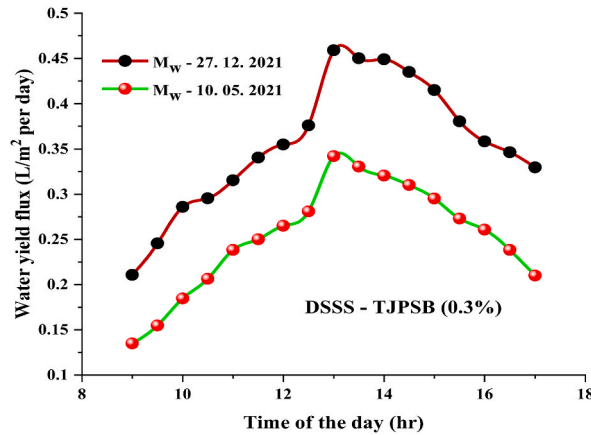


Fig. 4(a). Water yield flux of the DESD - TJPSB (0.3%) continuous flow rate.

technique by the system, they have significantly raised the initial quality water amount of 8.96 L to account for the time needed for evaporation to create the thermal energy acquisition. The total amount of freshwater produced by DESD results in a daily output of 8.7919 L/m² from (8.00 a.m.–5 p.m.) during the day's intensive care execution hours (17:00).

4.4. Numerical approach results in DESD

Other than collecting heat force (JPT) continuous cumulative mineral water yield of the DESD disclosed in Fig. 4(b), the Laplace method approach that TJPSB employing the DESD is recognized as an additional measure of the distillation water creation of 0.183 L/m² at night. Given the production of purified water, an energy method of 7.621 MJ was established to give Eq. (8) 51.49% overall thermal efficiency. Fig. 5 shows the system's performance with saline water to glass covers at different temperatures (T_{w-g}) and (T_g-T_a) glass covers to ambient temperature. The saline water-glass cover temperature difference was increased by near lines of success, which is determined by the situation average amount of 19.80 °C and the conduction cover-ambient temperature shadows in sunbeam circulation curvature. The condition is ambient temperature surrounding the system to strongly control the glass cover and ambient temperatures with heat loss. Fig. 5 demonstrates that at noon when the glass cover temperature was developed, there were specified energy losses everywhere. The TJPSB with the twofold outcome has been extracted from the DESD performance studies as the actual operative.

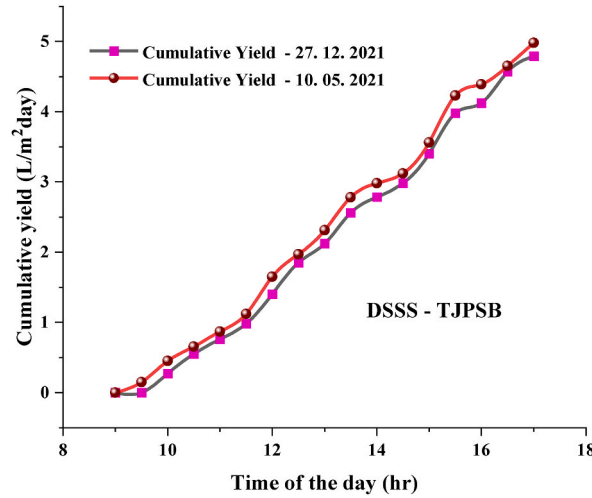


Fig. 4(b). Cumulative water production of DESD – TJPSB (0.3%).

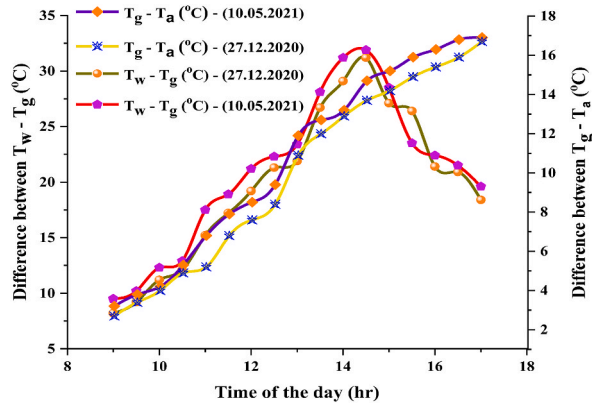


Fig. 5. Difference between $T_w - T_g$ and $T_g - T_a$ of the DESD – TJPSB (0.3%).

4.5. The correlation establishes in DESD

Experimental results employing the coating materials of TJPSB with different ratios of 0.1%, 0.2%, and 0.3% are used to manufacture DESD. The least squares method of DESD is illustrated in regression lines, and R^2 (correlation coefficient) values of the DESD parameters as productivity ($L/m^2/d$) and the saline water (cm) are used in TJPSB for 0.3%. The concluding correlation to build the power regression in the form $Y = c(D)N$ for the TJPSB-coated basin area is as follows

$$Y = 5.976 D^{-0.289}, R^2 = 0.879 \quad (35)$$

When compared to the concluding correlation in TJPSB (0.3%) created by Khalifa and Hamood [39], the DESD correlation's performance with the experimental results correlation is superior. It is the regression coefficient, which is equal to or greater than the correlation for the TJPSB for 0.3% at 0.878 then 0.1%, 0.2%. It is noted that there is a minimal error between the theoretical and experimental results that are in close accord.

4.6. DESD compares the study

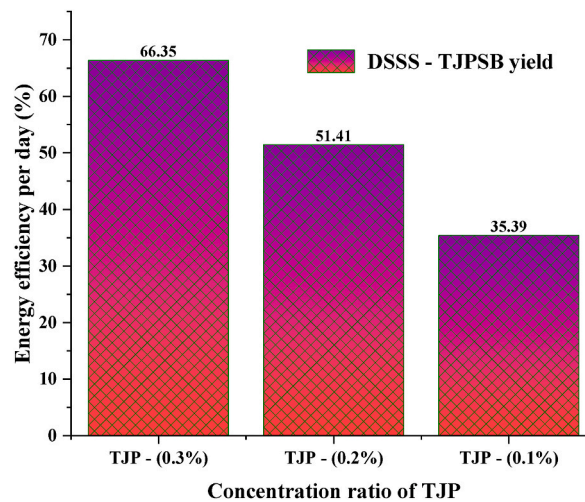
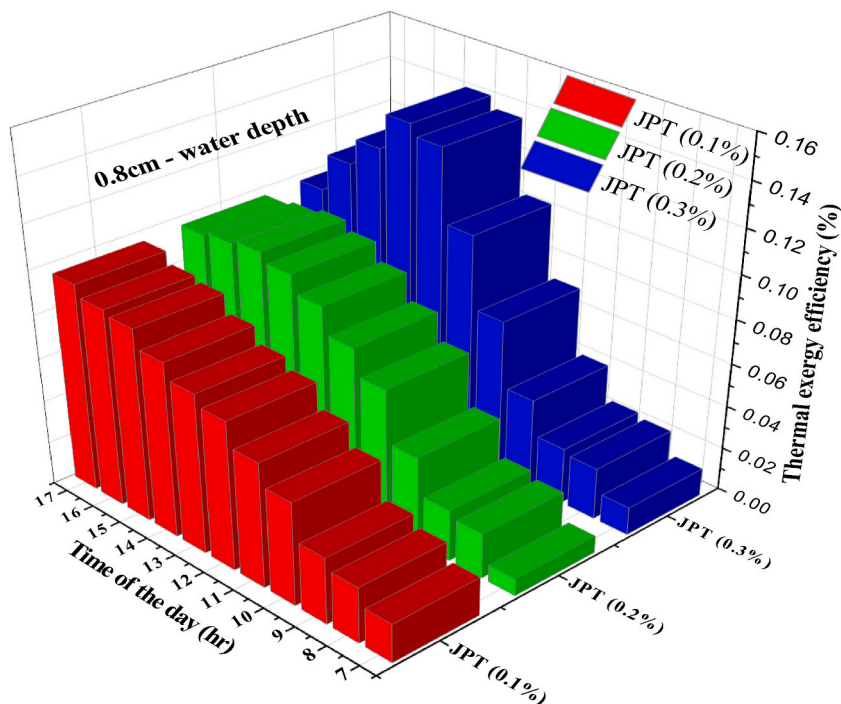
Table 4 is addressed in DESD to assess the results of the performance-related data outputs that were obtained. Design efficiency for DESD - TJPSB has also been created by Elashmawy et al. [40] and is higher than that reported by other investigators by a range of 141.16%. A developed for 21.13%, by Shanmugan et al. [41] and detailed for 28.4% by Abdullah et al. [42] separately, the solar yield is still created in freshwater. With a qualifying inferior solar beam absorption of $648.7 W/m^2$ throughout the winter, Table 4 evaluates the lower production. Comparing DESD to that of Zanganeh et al. [42], it can be shown that the addition of TJPSB performance of 139.12% and 21.13% mass flow rate is a constant movement about the JPT has 58.75% reduction at lowest values of increases for the degradation, as shown in Fig. 6. Experimental results employing the coating ratios of 0.1%, 0.2%, and 0.3% are used to manufacture DESD. The average freshwater input is 4.9, 5.47, 6.12, and 4.07 L/m^2 , respectively. DESD produces work on average at a rate of 57.64%, with an emphasis of 0.3% on general analysis. Temperature sensitivity of the thermal exergy efficiency fluctuation rate was

Table 4

The main findings of the previous research are compared to those of the current study.

Resources	Current work	Zanganeh et al. [43]	Swellam et al. [44]	Belkheir et al. [45]	Shanmugan et al. [46]	Hitesh et al. [47]
Residence	India	Iran	Egypt	Algeria	India	India
Times	Existing	2019	2021	2021	2020	2019
W/m ² Iavr.	417.70	520.23	610.47	712.10	637.98	578.69
Calendar month	Month of may	December	May	Month of June	Month of April	October
Nanomaterials	TJPSB	nanosilicons	carbon black	Al ₂ O ₃	TiO ₂	Graphite powder
Yield L/m ² /day	8.7919	1.324	59.05%	3.02	5.39 W & 7.89 S	2.98
Eff. (η_e %)	50.55	27	55.38	64.24	57.16	40

S – Summer; W – Winter.

**Fig. 6.** Energy efficiency focusing on 0.1%, 0.2%, and 0.3% of DESD - TJPSB.**Fig. 7.** Hourly changes in the thermal energy efficiency and the water depth concentration on the DESD-TJPSB (0.1%, 0.2%, and 0.3%).

driven by the stability of good act on DESD validated ways a key character in the heat process as shown in Fig. 7. Higher DESD is attained with TJPSB performance at the water depth of 0.8 cm, where the highest rates of temperature exergy productivity are extensively explored. Based on a different focus on TJPSB employing 0.8 cm of water depth, an instant heat potency productivity has been determined to be 44.37%, 47.17%, and 51.33%. For the respective TJPSB ratios of 0.1%, 0.2%, and 0.3%, the thermal exergy efficiency of the DESD was 10.43%, 12.29%, and 14.11%. As indicated in Table 4, DESD is noticeably higher than the highest heat energy/exergy productivity attained by saline water with a strength (depth) of just 0.8 cm. In TJPSB, the original work is employed as a DESD based on 0.8 cm of water depth for various weather circumstances derived from the systems. The systems find the east side while comparing the west side favorably to the single slope side. TJPSB (20%) scheduled more years of quantity to compare other concentration ratios based on 0.8 cm water depth, which is viewed as better products and finished weather conditions. The system's yield has increased in a variety of seasonal conditions, which is also the conclusion drawn from Fig. 8. As illustrated in Fig. 9, DESD has provided the price of annual produce per liter and made it clear that DESD has an inverted influence on the price of the annual produce. As a DESD using TJPSB with a water depth of 7234 L/m², above-average annual efficiency has been attained. The findings showed that the lowest possible CPL approach has a maximum of 00.31 \$/L and 00.007 \$/L, respectively. Additionally, a longer TJPSB lifetime for DESD and a lower benefit % result in a cheaper cost for producing freshwater. The DESD has been utilized in situations where it is impractical to use well, piped, or rainwater, such as in rural dwellings or during power outages. DESD can offer a different source of portable water in subtropical hurricane-target areas, where power outages can last for days in practical applications of the new design.

5. Conclusion

TJPSB employed the DESD's performance in these studies, which validated the finding of 29.95% higher production for 0.3% (TJP). The development of more stable sunbeam absorbers for DESD is employed in TJPSB with a 0.3% increase in thermal conductivity. The various temperature of DESD has been used in the parameters studies of the basics, including the time basis, an energy balance equation, and accurate experimental observations, to approach the Laplacian method. The production of the DESD based on TJP coating the basin area effectively transported the temperature from basin to glass cover an attractive naturally renewable source of jackfruit peel fundamental mechanism an absorbing property as a first introduce outlay green peel organization have been increased in thermal conductivity. The TJPSB (0.3%) coating in the basin region has more in the summer and winter, with a proficiency of 50.55%, based on an analysis of DESD productive of 8.7919 L/m² per days, based on meteorological conditions (Vijayawada - KLEF). With nanoparticle sizes ranging from 40 to 60 nm for the nearly spherical shape, the photosensitive incorporation wavelengths available for TJP are 295 nm. An economic study of DESD revealed the cost of concentrating that portable water (per liter) and appraised around 0.0726\$ by reimbursement term of 14 months. The average thermo-enviro-economics analysis of DESD is 3.35 (exergy) and 4.71% (Energy).

Ethical statement for solid state ionics

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.

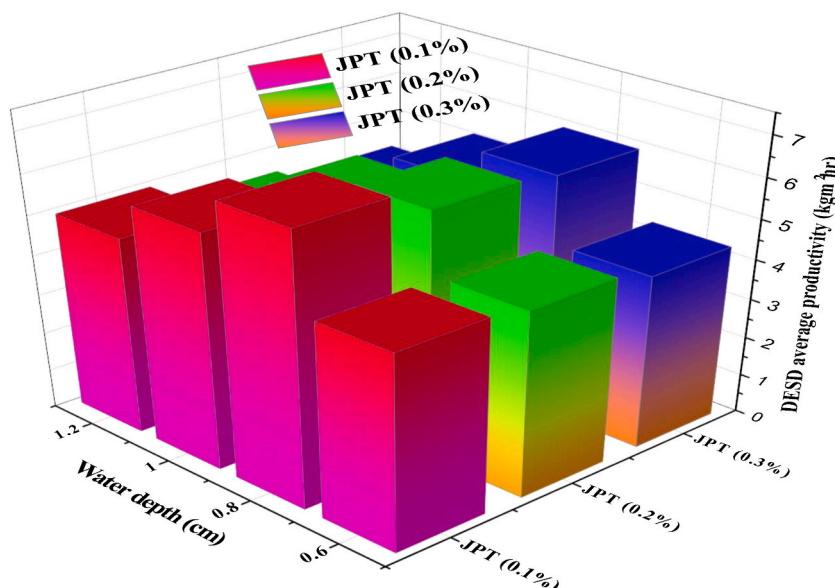


Fig. 8. DESD is the average productivity for different ratios of TJPSB with water depth.

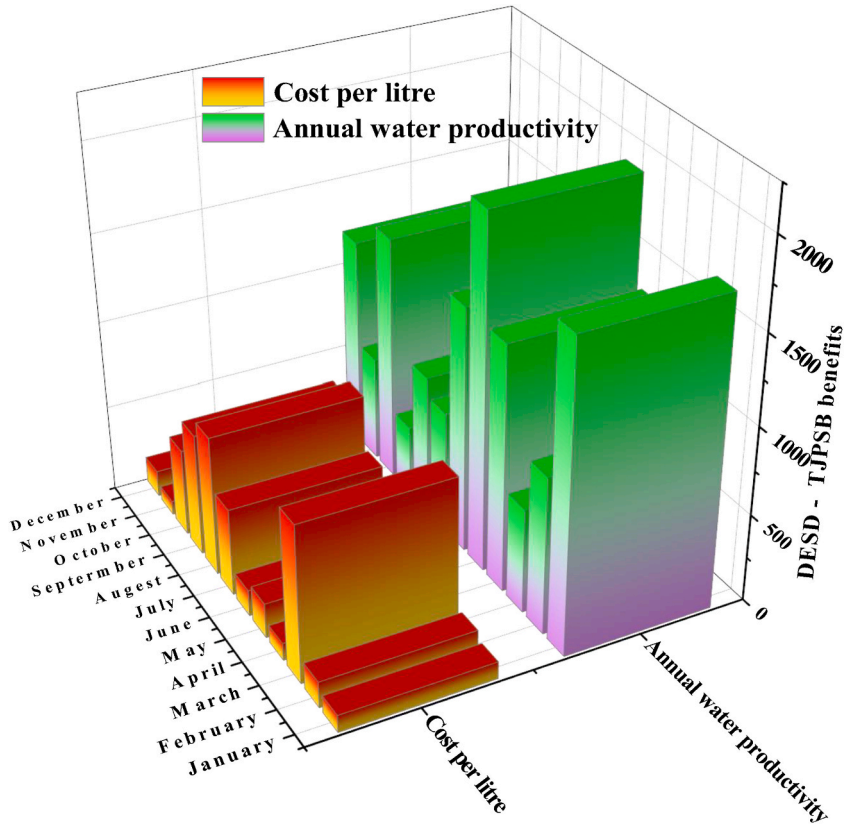


Fig. 9. DESD is benefits for Annual water productivity and cost per liter.

- 5) The results are appropriately placed in the context of prior and existing research.
- 6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
- 7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Nomenclatures

A_{gsn}	Area glass cover in South and north facing (sn) (m^2)
A_0	Initially from methyl orange absorptions (nm)
A_t	Subsequent degradation (PPF)
M_{gsn}	Mass of the glass covers, i.e., South and north facing (Kg/m^2h)
m_w	Saline water mass flow rates (Kg/m^2h)
h_{gsna}	DESD used for an overall heat transfer coefficient as of glass covers (South & North facing = sn) to ambient air (W/m^2K)
T_{gsn}	Temperature of glass covers in South & North facing ($^{\circ}C$)
T_a	Ambient temperature ($^{\circ}C$)
I	DESD is absorbed by solar radiations (W/m^2)
h_{mgsn}	DESD is saved the total energy for heat transfer coefficient as of moist air to glass covers (sn) to ambient air (W/m^2K)
T_m	Moist air used in DESD ($^{\circ}C$)

h_{sbgsn}	Total heat transfer coefficient from silver balls to glass covers (sn) (W/m^2K)
T_{sb}	Silver balls temperature ($^{\circ}C$)
P_w & P_G	As a unit used in partial vapor pressures from saline water to glass cover temperatures (Nm^{-2})
M_{sb}	Mass of the silver balls (Kg/m^2h)
h_{gsb}	DESD is used the total heat transfer coefficient of glass covers (sn) to silver balls (W/m^2K)
T_{sb}	DESD has used the temperature of the silver balls ($^{\circ}C$)
A_{sb}	DESD has used that area of the silver balls (m^2)
h_{sbm}	DESD is used as the total heat transfer coefficient of silver balls toward moist air (W/m^2K)
T_m	Moist air temperature ($^{\circ}C$)
h_{mgsn}	DESD is used as the total heat transfer coefficient of moist air to glass covers (sn) (W/m^2K)
M_w	Total amount of water (Kg/m^2h)
M_b	Total amount of saline water involuted to absorber area (Kg/m^2h)
h_{bw}	DESD used the total heat transfer coefficient of basin-TJP toward water (W/m^2K)
A_b	DESD has used an area of the basin (m^2)
T_b & T_w	Basin and water temperature ($^{\circ}C$)
h_{sbb}	DESD is used as the total heat transfer coefficient of silver balls toward basin area (W/m^2K)
h_{wsb}	DESD is used the total heat transfer coefficient of saline water toward silver balls (W/m^2K)
T_w & T_{sb}	Water and silver balls temperature ($^{\circ}C$)
h_{bw}	DESD is used the total heat transfer coefficient as of basin area (TJP) toward saline water (W/m^2K)
T_b	Basin (TJP) temperature ($^{\circ}C$)
m_y	cumulative yield (L/m^2)
L	DESD has used the latent heat (J/kg)
k	DESD has used the thermal conductivity (W/mK)

Greek Symbol

α_{gsn}	DESD is absorptivity by glass covers (sn)
α_{sb}	DESD is absorptivity by silver balls
ε	DESD is used in glass cover emissivity values
σ	DESD is used in Stefan – Boltzmann constant values
η_e	DESD thermal efficacy per day (%)
τ_w	JPTSB transmitted to saline water absorber
$\tau_{g(sb)}$	Heat energy transmitted to the glass cover absorber on both sides (South and North)

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