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Methods for Improving the Absorptive Capacity of Solar Stills: A Review of Current Technology

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Solar desalination, solar still, absorption, evaporation, condensation processes.

ABSTRACT

Solar still owns low distillate productivity. Many researchers enhanced the performance of solar still by variable the design of its components. The combination of internal/external reflectors, absorber materials (fins, sponge, pebbles), and external condensers had a substantial impact on the absorption, evaporation, and condensation processes of the classic basin type solar still. This paper is showing how existing methods for increasing solar still absorption, evaporation, and condensation may be used to improve solar still absorption, evaporation, and condensation.

From this review, it is found that for solar still, that adjusting the internal/external reflectors might increase daily distillate yield by 70% to 100%. Added Absorbent materials improve the thermal performance of a still by increasing production by over 20%. In addition, the external condensers enhanced still freshwater yield by 62% more than the regular still.

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طرق تحسين القدرة الاستيعابية للمقطرات الشمسية: مراجعة للتكنولوجيا الحالية

علي مفتاح، علي سعيد، صالح البدري، ازهرالعبد، غسان سميسم.

ملخص: المقطر الشمسي يمتلك إنتاجية منخفضة من نواتج التقطير. قام العديد من الباحثين بتحسين أداء المقطر الشمسي من خلال تغيير تصميم مكوناته. كان لمزيج العاكسات الداخلية والخارجية، والمواد الماصة (الزعانف، والإسفنج، والحصى)، والمكثفات الخارجية تأثير كبير على عمليات الامتصاص والتبخر والتكثيف للمقطر الشمسي من النوع الكلاسيكي للحوض. توضح هذه الورقة كيف يمكن استخدام الطرق الحالية لزيادة امتصاص المقطر الشمسي والتبخر والتكثيف لتحسين امتصاص المقطر الشمسي والتبخر والتكثيف.

من خلال هذه المراجعة، وجد أنه بالنسبة للمقطرات الشمسية، فإن ضبط العاكسات الداخلية/الخارجية قد يزيد من إنتاج نواتج التقطير اليومية بنسبة 70% إلى 100%. تعمل المواد الماصة المضافة على تحسين الأداء الحراري لجهاز التقطير من خلال زيادة الإنتاج بنسبة تزيد عن 20%. بالإضافة إلى ذلك، عززت المكثفات الخارجية إنتاجية المياه العذبة بنسبة 62% أكثر من المكثفات العادية.

الكلمات المفتاحية – تحلية المياه بالطاقة الشمسية، المقطرات الشمسية، عمليات الامتصاص، التبخر، التكثيف.

1. INTRODUCTION

Distillation is a common treatment method used globally. As a result, it is no surprise that a wide range of solar distillation systems has evolved throughout time. The distillation method is limited by using huge volumes of conventional energy sources, which results in pollution. Distillation technologies include stills, thermally driving a free and pure energy source. The still is a simple device that requires little maintenance and is inexpensive. Furthermore, because of its low productivity, it is not commonly employed. The essential aspects that determine the yield of stills are climate, design, and operating features [1].

The still output depends on the water depths, cover thickness, the water and condensing cover gap, increasing initial water temperatures, and improving water absorptivity by applying dyes. In addition to this, installing a basin type will increase output by 36%. They boost the quantity of solar energy that reaches the basin liners and daily distillate output may increase by 70% to 100%. The largest output increase of 98% was achieved using a tiered basin with fins and stones. In low and high latitudes, a single-sloped still surpasses a double-sloped in terms of productivity. The evaporative heat transfer coefficient decreases with increasing basin water depth. Surfactant additives also help in water distillation, and the reduction in transmittance increases as the amount of dust deposited increases.

Daily productions are inversely related to salt concentrations in thermo-siphon modes; furthermore, forced circulation generates higher yields. Besides the fins, the distillate production is aided by various materials, including jute-cloth, sponge, black cotton fabric. The productivity increased due to the PCM's heat-storage characteristics and increased dramatically with greater mass. Recent work on stills has been thoroughly investigated by several researchers, including the classification [2], the design [3], improvement techniques [4], passive [5], active [6], inclined [7], stepped [8], wick type [9], outside condensers [10], reflectors [11], and inclined triangular pyramid stills [12].Enhancement strategies and innovations such as the still with blackened sponge layers as a covering absorber and thermal energy storage materials have been implemented in the distillation process [13]; [14]; [15]. Different factors influenced the rate of evaporation and condensation in a passive still and the usage of solar photovoltaics in association with an active solar-still to boost distillate output [16]; [17]. There is no publicly available research on stills that enhance absorption, condensation, and evaporation. In this vein, this research aims to demonstrate the advantages of particular basin-type still design concepts in terms of increasing absorption and condensation processes while also speeding up the evaporation process.

2. Improving the absorption, evaporation, and condensation processes

The fundamental solar-still distillation processes are solar radiation, basin plate, heat transfer between basin plate and saline water, heat transfer between brine and condensation surface, and heat loss from the condenser to ambient. However, several approaches to improve the productivity of the sub-processes have been developed and comprised of two options: firstly, increasing the convection of the evaporator and the condenser by chilling the condenser's surface properly, and secondly, limiting the vapor diffusing distance by creating a tight condensation surface. If a large amount of vapor remains in the evaporator, the sunlight intensity on the basin plate is reduced, and the vapor pressure rises, preventing saline evaporation in the basin. Increasing the absorber plate area and surface area of water, on the other hand, boosts still productivity, which can be accomplished by adding fins, black rubber, sand, pebble, or sponge cubes.

2.1. Internal and or External Reflectors

Many attempts have been made to increase the productivity of the distillate of a solar still. Adding internal and/or external reflectors can be a useful modification that will increase the solar radiation incident on the basin liner, as well as the productivity of the still. Figure 1 depicts the internal reflecting mirrors proposed by Abdallah et al. (2008) [18] using a basic single still slope. In this case, the solar basin was 80cm2.

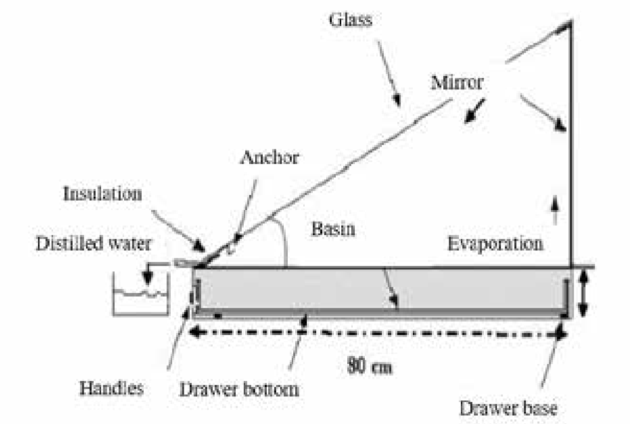


Figure 1. Single slope still with an internal reflector.

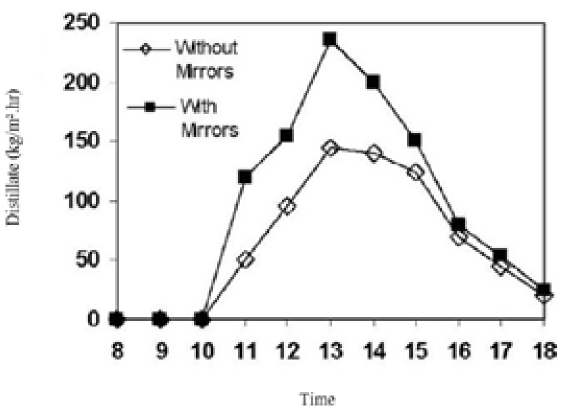


Figure 2. Collected distilled water for stills with and without mirrors.

As shown in Figure 2, the still with and without reflectors yield was 2.077L and 1.408L, respectively. Tanaka and Nakatake (2006) [19] investigated the influence of internal and external reflectors on solar radiation absorbed by a basin liner and distillate output in a single-slope conventional still at 30°N and shown schematically in Figure 3.They discovered that both internal and external reflectors can boost distillate output while boosting absorbed solar radiation by 48%.Tanaka (2011) [20] investigated a standard basin still with a flat plate outside the bottom reflector and internal reflectors (two sides and back walls), as shown in Figure 4. The capacity of external/internal reflectors to redirect rays from the sun into the bottom of the basin and boost distillate productivity has been demonstrated. Internal/external reflectors slanted at various angles (0° (vertical), 10°, 20°, and 30°) affected the production of typical basin tills in the fall, summer, and winter as indicated in the work conducted by Khaliah and Ibrahim (2009) [21]. As a result of the external reflector's higher inclination angle of 30 degrees from its vertical axis, productivity suffered during the summer.

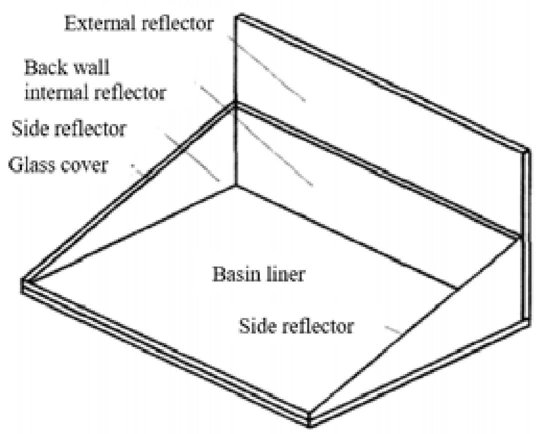


Figure 3. Schematic diagram solar still with reflectors.

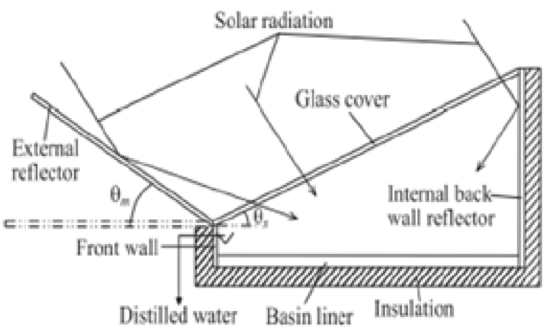


Figure 4. schematic diagram solar still with internal and external reflectors.

Tanaka (2009) [22] tested an internal/external reflector basin still in Kurume, Japan. He stated that adjusting the internal/external reflectors might increase daily distillate yield by 70% to 100%. On the other hand, Omara et al. (2014) [23] used internal and external reflectors to study the performance of the stepped still. Figure 5 shows the stepped still with exterior (top and bottom) and interior mirrors. The researchers found that stepped still with exterior (top and bottom) and interior mirrors generated a 12% higher accumulative distillate than the ordinary still.

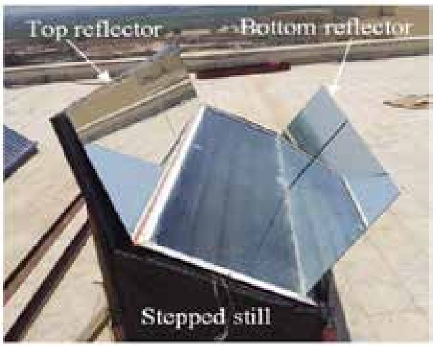


Figure 5. A stepped solar still with reflectors.

2.2. Absorber Materials

Increasing the absorptivity of the solar still—for example, by adding charcoal or coal to water will increase the energy supplied for evaporation by increasing the amount of solar radiation absorbed in the water, which in turn will increase the absorptivity and decrease heat losses. This is just one method of increasing the incident solar radiation Cooper (1972) [24]. Absorbent materials improve the thermal performance of a still by boosting total water accumulation. As seen in Figure 6 the black rocks absorb incident solar energy superior to either of the coated and untreated metallic wire sponges, increasing production by over 20% Abdallah et al. (2009) [25]. Sakthivel and Shanmugasundaram (2008) [26] used the black granite gravel as an energy storage medium.

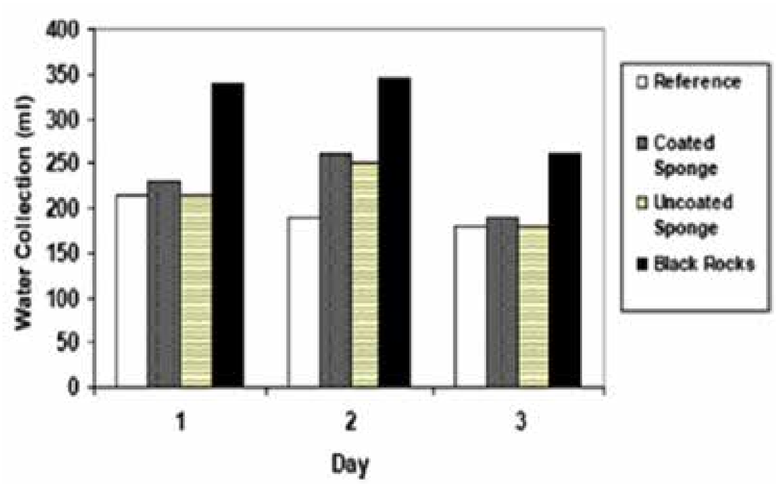


Figure 6. Water collection data for the four stills.

Still output increased from 17% to 20%. To boost production, Rajaseenivasan et al. (2013) [27] used a basin and mild steel as a storage medium. According to Murugaveland et. al. (2008) [28] a basin-style double-slope still utilizing thin cotton cloth, coconut husk, sponges sheet and wasted cotton sections is more effective than stills employing cotton fabric aluminum fins. They found that, black light cotton cloth was more productive than sponges, sponges and porous materials like quartzite rock and washed natural stone. Hota et al. (2022) [29] attempted to study a passive solar still with a partially coated condensing surface and thermoelectric cooling. They concluded that the freshwater output of the proposed system increasing with a traditional solar still by almost 126%.

Moreover, Sambare et al. (2023) [30] used heat-storing materials to enhance solar still performance. They used jute wick, iron pieces, and wire mesh in the solar still basin with a water depth of 2 cm. Their research revealed that the wire mesh outperformed the others. Wire mesh increased solar still production and efficiency by 41.35% and 35.1%, respectively. Noman et al. (2024) [31] used pistachio shell powder, with an average particle size of 1.5 mm, as a heat-storage medium inside the solar still. There was a 46.26% and 32.62% increase in water productivity and thermal efficiency, respectively.

For the purpose of cold harvesting at night, Li et al. (2024) [32] looked into the cold energy storage of a horizontal shell-tube latent heat thermal energy storage (LHTES) unit. The goal was to design and create an experimental device with a horizontal circular tube that had circumferential heating and cooling. Phase change material (PCM) based on paraffin. The findings indicate that 0.05 weight percent nanoparticles accelerate PCM melting when the heat transfer temperature differential is 20 °C. The PCM melting rate is greatly impacted by 0.10 weight percent nanoparticles when the heat transfer temperature difference is 40 °C. Murugavel and Srithar (2011) [33] tested a double-slope basin still with rectangular aluminum fins. In the basin, thin cotton, coconut husk, sponges, and leftover cotton bits were used as wicks. As shown in Figure 7, yet fitted with a thin cotton material is more effective.

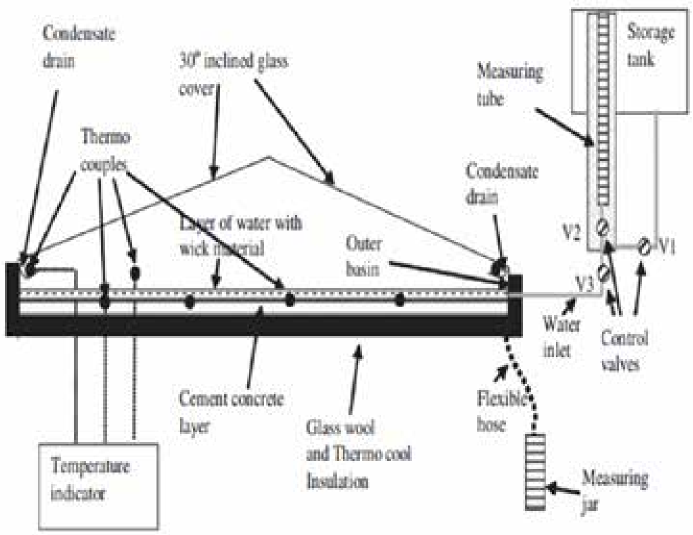


Figure 7. A double slope basin type solar still.

Panchal et al. (2020) [34], Fath (1998) [35] noted that the (PCM) as a storage medium is becoming more popular in still. Radhwan (2004) [36] investigated the transient performance of an immersed solar still with built-in thermal energy storage to heat and humidity a greenhouse. According to data, a reduction in airflow rate has a considerable impact on output production. With a 57% efficiency rate, total productivity is expected to be 4.6L/m2. El-Sebaii et al. (2009) [37]. suggested a transient mathematical model for a single slope-single basin still, as shown in Figure 8, with or without (PCM) beneath the basin liner. On typical summer and winter days, numerical simulations of PCM using stearic acid were performed. According to the research, because of the heat trapped within PCMs, productivity is inversely related to PCM mass. The convective heat transfer was doubled when the PCM was discharged. As a result, the evaporative heat transfer coefficient on 3.3cm stearic acid below the basin liner rose by 27%, and productivity on an average summer day is 9.005 L/ m2/day, with an 85.3 % daily efficiency, compared to 4.998 L/ m2/day without the PCM. PCMs, by the way, are more efficient in the winter when water masses are lower, Murugavela et al. (2008) [38].

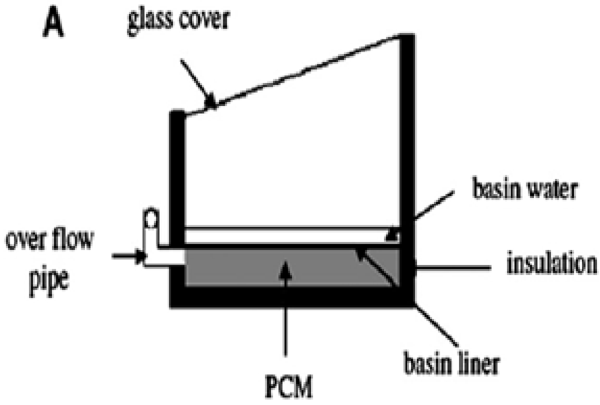


Figure 8. Single slope basin still.

An integrated double-pass air collector and (PCM) systems were studied by Omara et al. in 2016 [39] to optimize the distillation process (see Figure 9). The results showed productivity of 9.36L/m2/day for integrated double-pass solar air collector, whereas the conventional still had productivity of 4.5L/m2/day. Asbik et al. 2016[40], investigated the exergy of the still with a heat storage system employing (PCM). Solid to liquid energy can be stored in paraffin wax as (PCM) and discovered that storing latent heat boosts distillation productivity while lowering exergy efficiency.

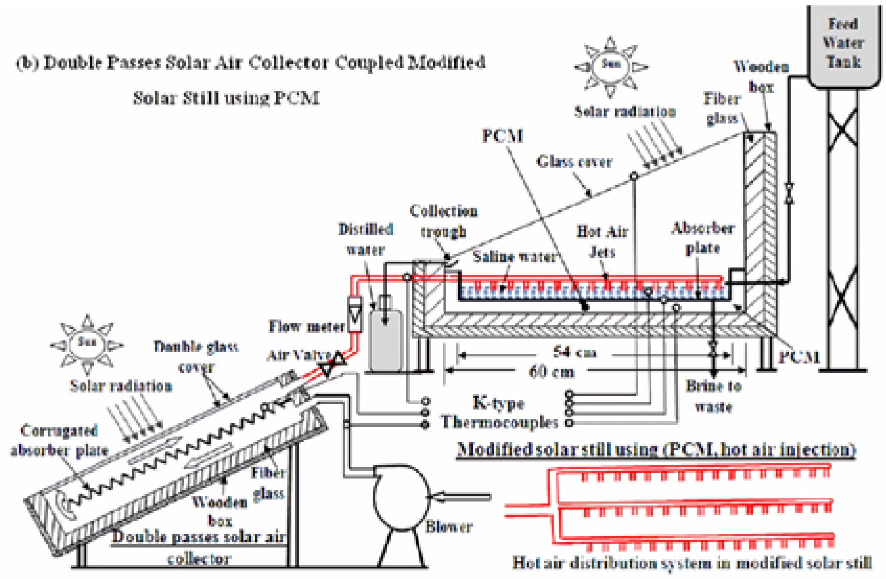
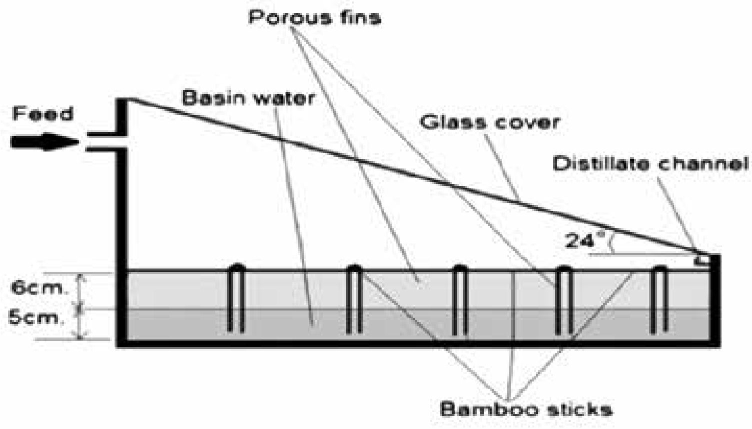
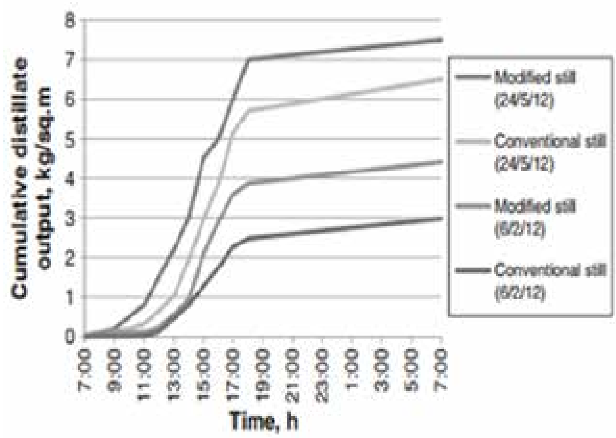


Figure 9. The double-pass solar air collector–a modified still with PCM.

Kabeel and Abdelgaied 2016 [41] presented an experimental investigation to enhance the performance of a solar still by increasing the distilled production. A phase change material was added as a heat storage medium, in order to enhance the performance of a solar still. Two solar stills (a solar still with PCM and the conventional solar still) were designed, constructed and tested. The results show that, the productivity for solar still with PCM is The efficiency and output production of the solar still were enhanced by 41.26 % and 32.42 %, respectively, when using PCM. Figure 10a by Srivastava and Agrawal (2013) [42] shows a standard still with and without a porous fin. A maximum distillate productivity of 7.5kg/ m2 was shown in Figure 10b.



(a)



(b)

Figure 10. (a) Schematic of a still with porous fin;
(b) Comparison of winter and summer total distillate output for both stills.

Arjunan et al (2014) [43] conducted an experimental investigation on the performance of solar still augmented with pin-finned wick evaporation surface.
They compared between tow solar stills, one of the stills is conventional still and the other has an evaporation pin-finned wick surface.
The fins are supported vertically on the basin linear. They found that the increase in distillate varies with ambient conditions. Enhancing the still productivity of the still with an evaporation pin-finned wick surface is higher than that in conventional still by about 23%.

2.3. An External Condenser

Many Researchers studied the effects of installing an external condenser. Madhlopa and Johnstone (2009) [44] studied the performance of Figure 11 shows the schematic configuration. The device's performance was compared to a traditional still in similar environmental conditions. Figure 12 shows that the enhanced still generates 62% more distillate than the regular still.
According to Abu Qudais and Othman (1996) [45], an external active condenser increased efficiency by 47%, as shown in Figure 13.

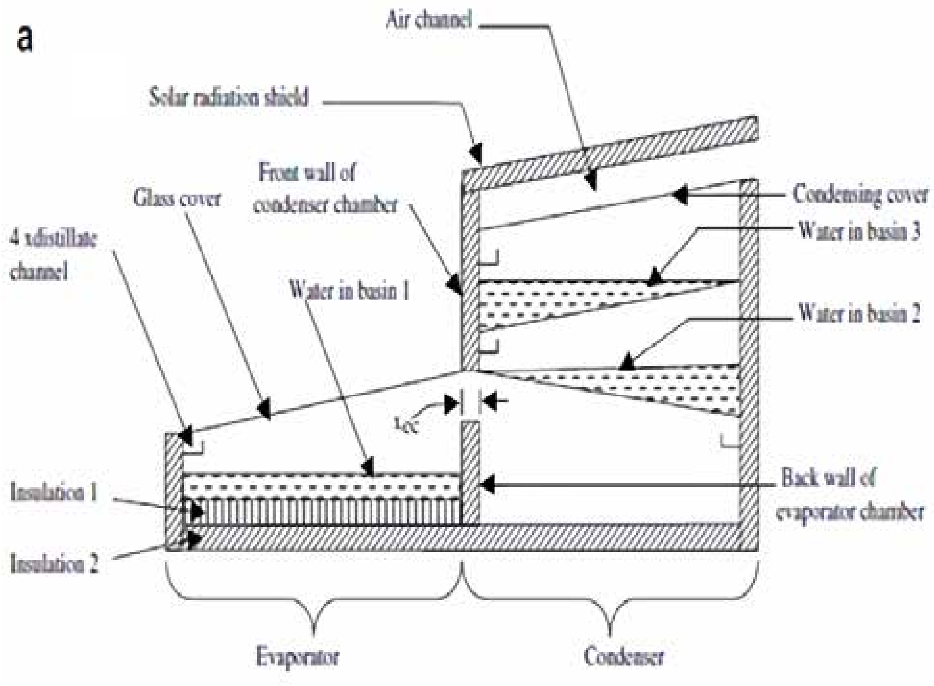


Figure 11. The schematic of a passive still with a separate condenser.

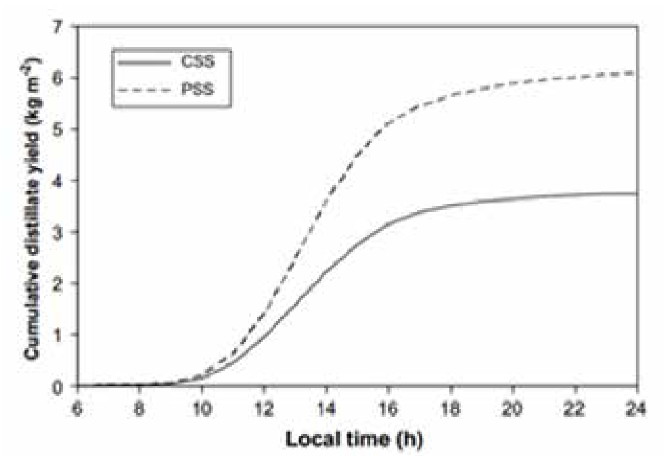


Figure 12. Comparison of the standard still's distillate yield with that of the modified one.

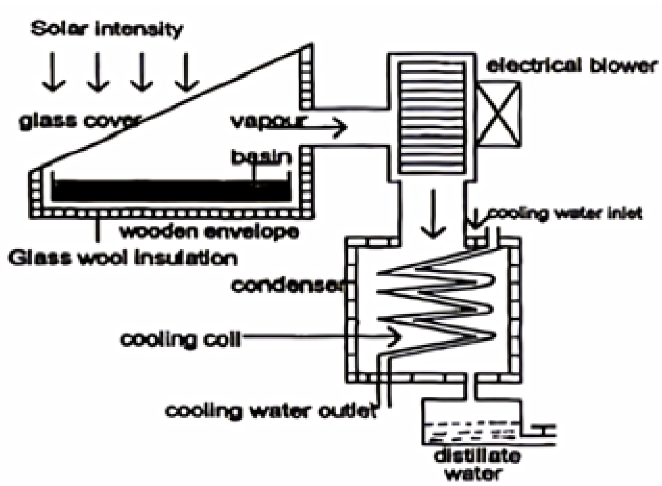


Figure 13. The schematic diagram of the experimental setup.

Figure 14 shows a single-basin still with an external passive condenser added by El-Bahi & Inan (1999) [46]. They discovered that utilizing an external condenser increased the yield by 70% and the distilled freshwater production by up to 7L/m2day using an external condenser. However, as Xiao et al. (2013) [47] pointed out, a separate condenser might boost distillate productivity, and the vapor channel should be built more sophisticatedly to prevent increasing vapor diffusing resistance. Monowe et al. (2011) [48] looked into a new portable thermal, electrical still design that includes an exterior condenser and an external reflecting surface, as shown in Figure 15. Despite this, the latent heat amount of condensation lost to the atmosphere is reduced. The latent heat is collected in a condenser to preheat saltwater for domestic use or power the still at night. The modified efficiency stayed at 77%, according to the findings.

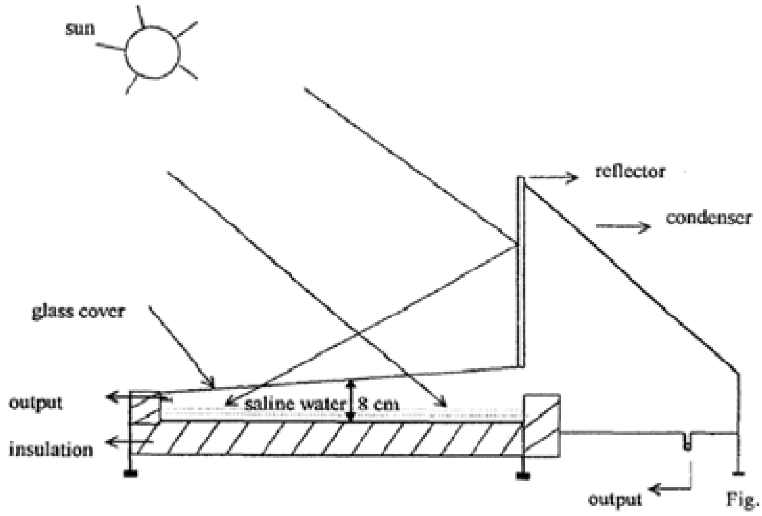


Figure 14. A single-basin-type still with an outside passive condenser.

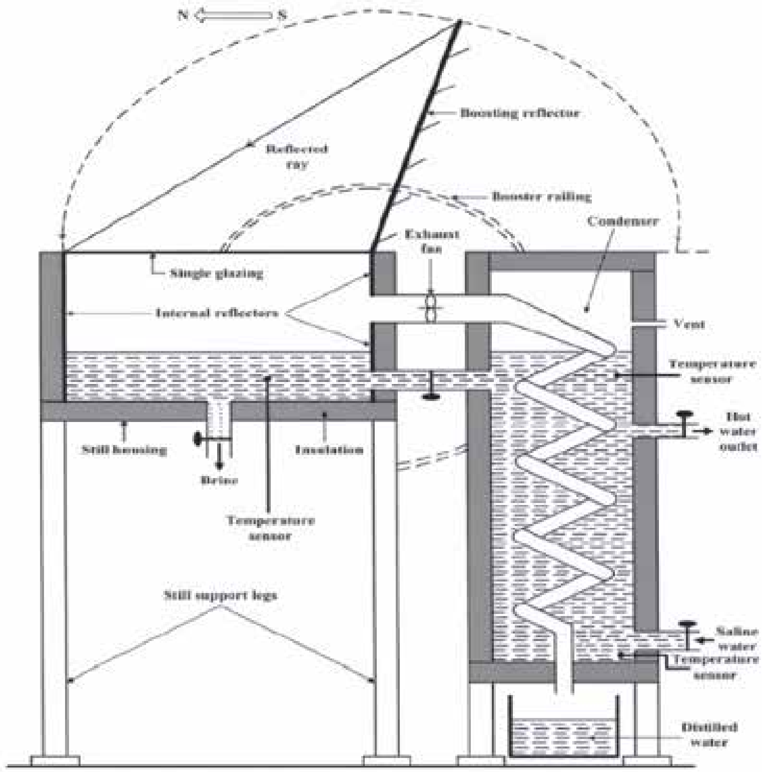


Figure 15. The combined thermal–electrical still with a boosting reflector.

El-Samadony et al. (2015) [49] examined a 100mm-wide stepped still with an external condenser as per in Figure 16. This was done to see how stepped stills performed. Internal and external reflectors heated the glass by 9°C, preventing condensation. So the external condenser was vital. Using an external condenser and a reflector increased daily stepped still distillate output by around 165%.

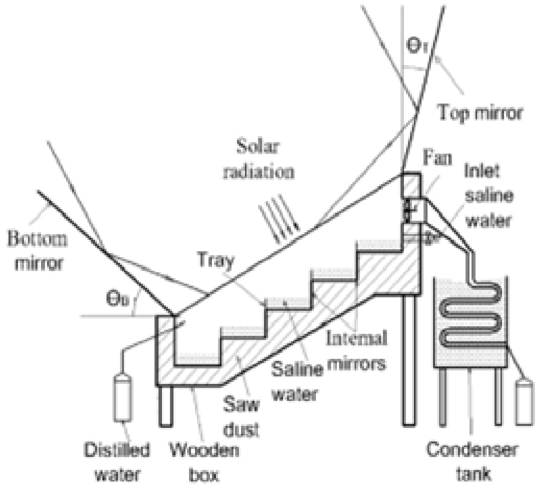


Figure 16. Stepped still integrated with reflectors and condenser.

2.4. Stepped Still

Due to their large surface area, classic basins are nevertheless difficult to keep deep. According to Velmurugan et al. (2008) [50], a stepped still maximizes production per unit area by minimizing thermal inertia and decreasing basin area. Kabeel et al. (2016) [51] tested the performance of two types of stills: standard single-slope and modified stepped. Figure 17 shows the design schematic. You can change the height and breadth of the stepping still. Various sized trays can be utilized to customize the stepping still. A solar collector mounted on the structure's vertical sides can heat water. Simultaneous standard and tiered standing tests as shown in Table 1, tray depth and width affect stepped still yield. The maximum output was 57.3% higher than a standard still with a tray depth and width of just 5mm and 120mm.

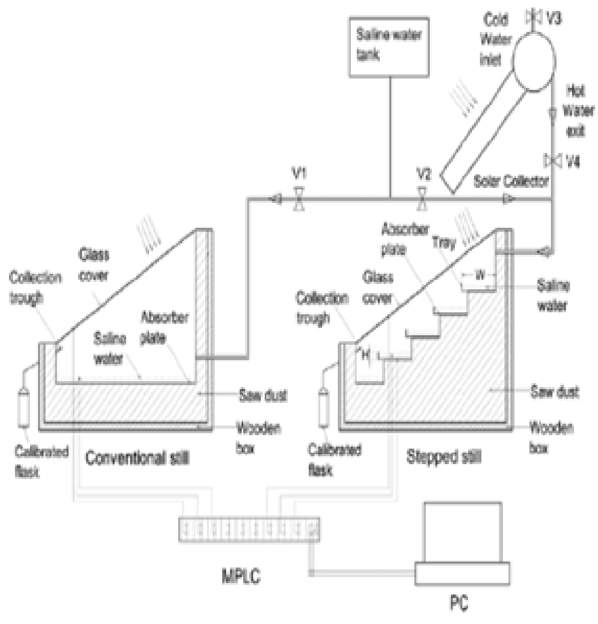


Figure 17. The step still integrated with a vacuum tube solar collector.

Table 1 Daily Productivity of some days for conventional and stepped designs.

	H(mm)	W(mm)	T_{fw}(°C)	Wick	productivity ml/m^{2}day		productivity rise %
20.7.2010	5	100	35	without	3470	4525	30.4
16.8.2010	5	110	33	without	3880	5650	45.6
28.8.2010	5	120	33	without	3580	5630	57.3
23.9.2010	5	130	31	without	2810	4260	51.6
28.7.2010	5	100	32	with	3485	4685	34.4
06.8.2010	5	100	80	with	3940	6020	52.8
18.8.2010	5	110	87	without	3710	6060	63.3
21.8.2010	5	110	34	with	3460	5190	50.0
22.8.2010	5	110	85	with	3330	5530	66.0
29.8.2010	5	120	86	without	3650	6080	66.6

Abdullah (2013) [52] studied a solar air warmer using a single slope passive still and a stepped active still. 5-stage still absorber plate (each measuring 0.1m x 1m). Stills produced 3400ml to 6300ml per day. Omara et al (2013) [53] compared a traditional solar still to a modified stepped solar still with trays (5 mm depth 120 mm width). Internal reflectors were added to the stepped solar still on the vertical side of the steps, as shown in Figure 18.

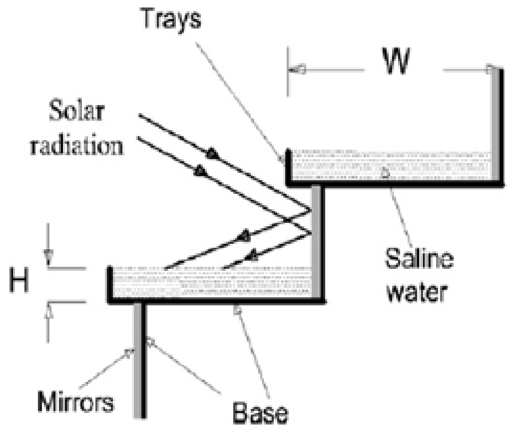


Figure 18. A Trays and mirrors on the steps of the modified step still.

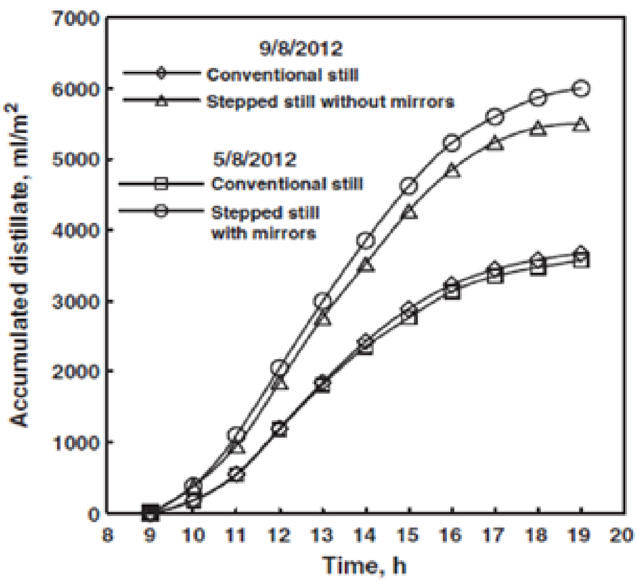


Figure 19. Accumulative variation of freshwater for the stepped and the conventional still.

The modified stepped solar still with/without internal reflectors beat the conventional still by 75 % and 57 %, respectively, according to the findings, as shown in Figure 19.
Alaudeen et al. (2014) [54] presented study to enhance the evaporation rate of a basin type stepped solar still as per in Figure 20. On each tray were three 60 x 70 cm2 flat plate collectors. It has wicks to speed up the capillary evaporation. Boulders and stones were placed in the tiered trays of the conventional basins to heat the water. Adding wicks and stones to the trays increased evaporation. The stepped type basin's flat plate had a maximum efficiency of 16% with hardwood chip wicks.

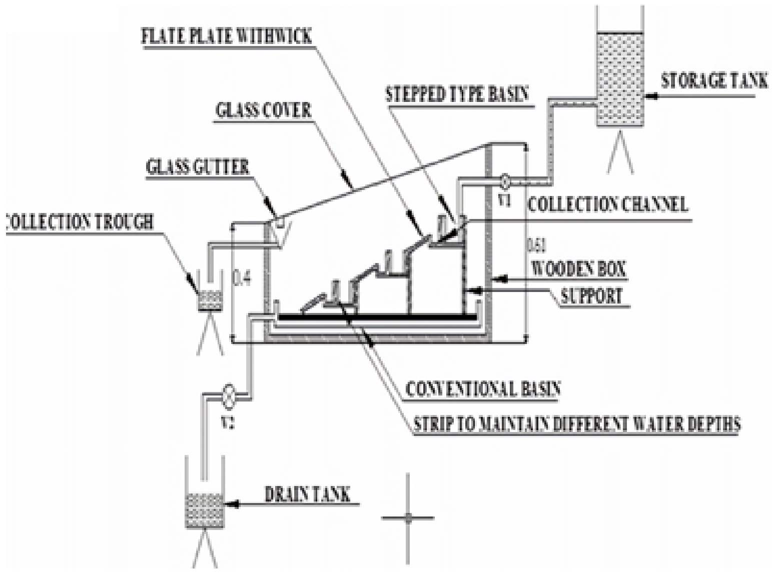


Figure 20. Sectional view of the stepped type still.

Velmurugan et al. (2008) [55] used two tray depths to boost productivity. 10-mm and 5-mm deep trays featured fins and sponges in a tiered still. 1m2 x 0.5m2 The modified stepped still was 1.98L more productive than the normal stepped still. Velmurugan et al (2009) [56]. The basin plate includes 10 mm trays and 5 mm trays. 1m2 x 0.5m2 in the basin plate and the trays, little fins were tested to boost water output. Table 2 indicates that adding fins, sponge, and pebbles increased productivity by 98%. Comparatively, adding fins to the basin plate boosted evaporation rates.

Table 2 Productivity of still when fin, sponge and pebbles are used.

No.	Modifications	Productivity L/m^2
1	Conventional still	0.83
2	Integrating with fin	1.27
3	Integrating with fin and adding pebble in the basin	1.37
4	Integrating with fin and adding sponge in the basin	1.4
5	Integrating with fin and adding pebble and sponge in the basin	1.65

The stepped still architecture proposed by Muftah et al. (2018) [57] is displayed in Figure 21. After rectification, the stepwise daily production increased by 29% from 6.9 to 8.9kg/m^2.

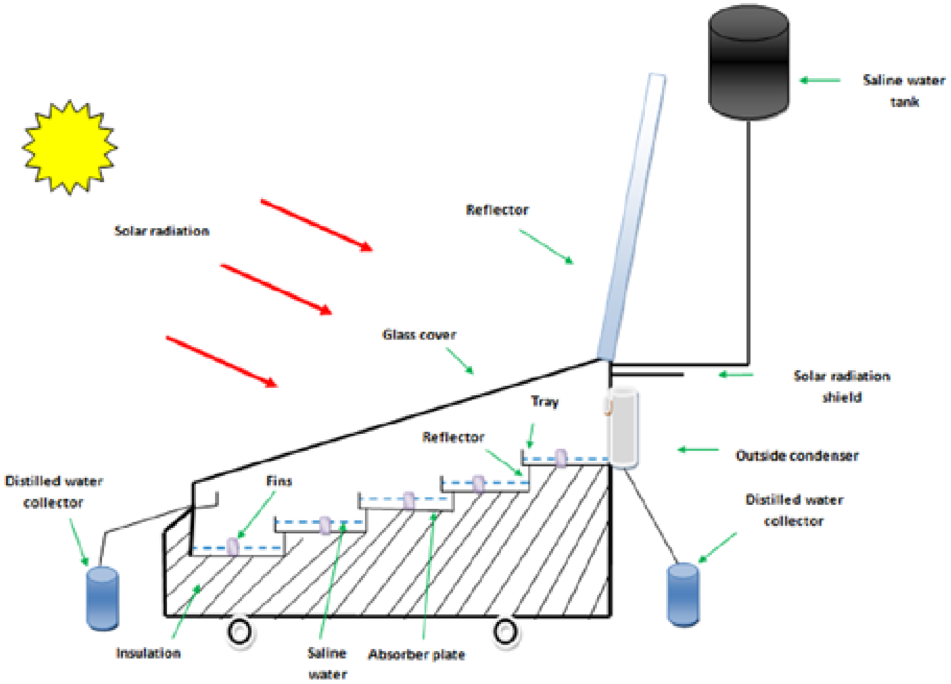


Figure 21. The schematic drawing of the modified stepped still.

2.5. Nanofluid and Nanoparticles

The heat transfer system and operating temperature were the two most important factors affecting still production.

Adding nanoparticles to the still increases the heat transfer coefficient of saline water. The production of distilled on the solar still with Al_2O_3, SnO_2, and ZnO nanofluids increased by 29.5%, 18.63%, and 12.67% [58;59;60]. Using vacuum and Al_2O_3 nanoparticles boosted 53.2 % and 116 % daily productivity, respectively. With and without vacuum, CuO_2 nanoparticles boosted production by 133.6 and 93.8%. Al_2O_3 nanofluid enhanced yield by 12.2% at 35kg and 8.4% at 80kg bottom fluid mass. On still performance, Sharshir et al. [61] looked at graphite micro/nano-flakes and copper oxide particles. Weight concentrations, salinity levels, and glass cover cooling speeds were evaluated. Still with GMF (CuO) has a daily efficiency of 49% vs 30% for the regular. Sahota and Tiwari (2016) [62] used three nanofluids in the basin liner and discovered $Al2O_3$, TiO_2, and CuO had the highest mass concentrations. The high absorptivity of Al_2O_3 metallic nanoparticles heated the basin water. In the testing, Al_2O_3 nanofluids outperformed TiO_2 and CuO nanofluids. Nanoparticle-to-fluid thermal energy transmission decreases after 0.25 mass concentration (TiO_2 and CuO). Sahota and Tiwari (2017) [63] studying the DSSS with TiO_2, CuO, and Al_2O_3 nanofluids. The experiments employed a helically coiled heat exchanger and also did not A DSSS was employed to gather PV thermal energy using semitransparent monocrystalline FPCs inside the DSSS is approximately 21m. The DSSS theoretically modelled the double basin stills' east and west sides and the basin liner and fluid mass within the basin as showed in Figure 22. The study found that water-based CuO nanofluids outperformed TiO_2 and Al_2O_3 nanofluids in terms of productivity, enviroeconomics, and exergoeconomics. Water-based nanofluids were found to have a positive impact on exergoeconomics.

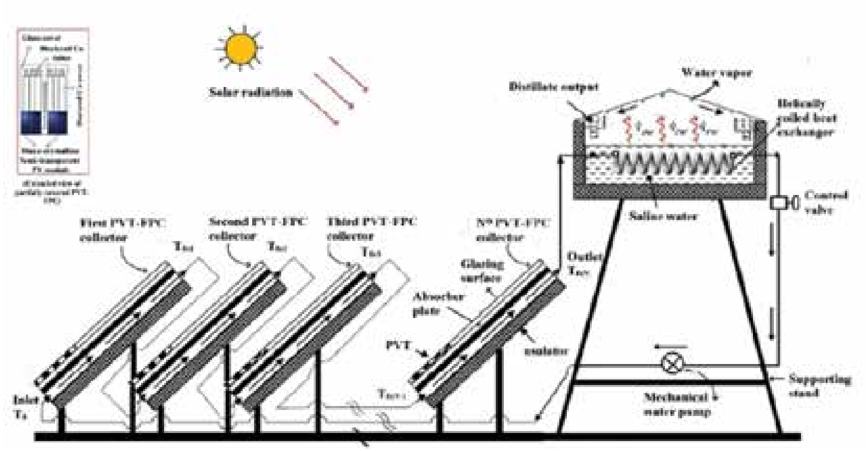


Figure 22. Double slope still integrated with PVT-FPC.

3. Techno-economic analysis

The cost of on-site energy affects water production. Cost and energy expenditure (2.25 MJ/kg for evaporation) are key components to desalinated water unit cost (Fath et al., 2003) [35]. Solar distillation has a major economic advantage over other small distillation techniques, according to Delyannis & Delyannis (1985) [64]. Keeping the cost of a solar system as cheap as feasible is the major goal when building one. The most expensive component is the Plexiglas container. Although stills can be used to produce water that is safe for consumption, academics have found that the expense of using them is quite low.

Fath et al. 2003 [35] estimated a cost of \$0.03/L (about Rs. 1.20/L) for distilled water used to create beverages in remote places. Al-Hinai et al. (2002) [65] calculated the cost of distillate production at \$16.3/m3 using 250 conventional stills for 52 weeks. In a year with 269 clear days, a hybrid (PVT) active still can produce distillate water at Rs. 1.93/L, according to Kumar and Tiwari (2009) [66]. PVC Pyramidal stills and triangular-prism PVC stills were created and tested by Wassouf et al. (2011) [67]. The triangular prism had an average water cost per liter of \$0.063, while the pyramidal prism had an average water cost per liter of \$0.046. Recently, Kumar et al. (2020) [68] revealed that distillate water production could be sold for Rs 22.6 and 22.67 per kilogram, respectively, with a payback year of 0.52 and 0.82 years for both stills [69].

3.1. variables that influence the price of distilled water generated

As demonstrated in Table 3, the cost of distilled water is influenced by the interest rate and the system lifetime. In Figure 23, the cost of distilled water decreases with system lifetime. As shown in Figure 24, the variable interest rate cost of distilling water is also depicted (5, 10, 12 and 15%).

Table 3. Effect of different parameters on the cost of water produced.

Interest rate (%)	useful life (years)	Capital recovery	First annual cost (FAC)	Sinking fund factor (SFF)	Annual salvage value (ASV)	Annual cost (AC)	Annual output (liter)	Product cost per liter (PC)
5	5	0.57589	336.86	0.0758	8.872038	664.84	2226.5	0.2986
5	10	0.50884	297.66	0.0088	1.032383	594.29	2226.5	0.2669
5	15	0.50114	293.16	0.0011	0.1339	586.20	2226.5	0.2632
10	5	0.26377	154.32	0.1637	9.16431	289.47	2226.5	0.1300
10	10	0.16275	95.206	0.0627	7.341211	183.07	2226.5	0.0822

10	15	0.13144	76.912	0.0314	3.682432	150.14	2226.5	0.0674
12	5	0.27741	162.28	0.1574	18.41694	306.15	2226.5	0.1375
12	10	0.17694	103.53	0.0569	6.667147	200.40	2226.5	0.0900
12	15	0.14684	85.89	0.0268	3.138436	168.64	2226.5	0.0757
15	5	0.29836	174.51	0.1483	17.35292	331.67	2226.5	0.1489
15	10	0.19922	116.56	0.0492	5.762491	227.36	2226.5	0.1021
15	15	0.17107	100.04	0.0210	2.458995	197.63	2226.5	0.0887

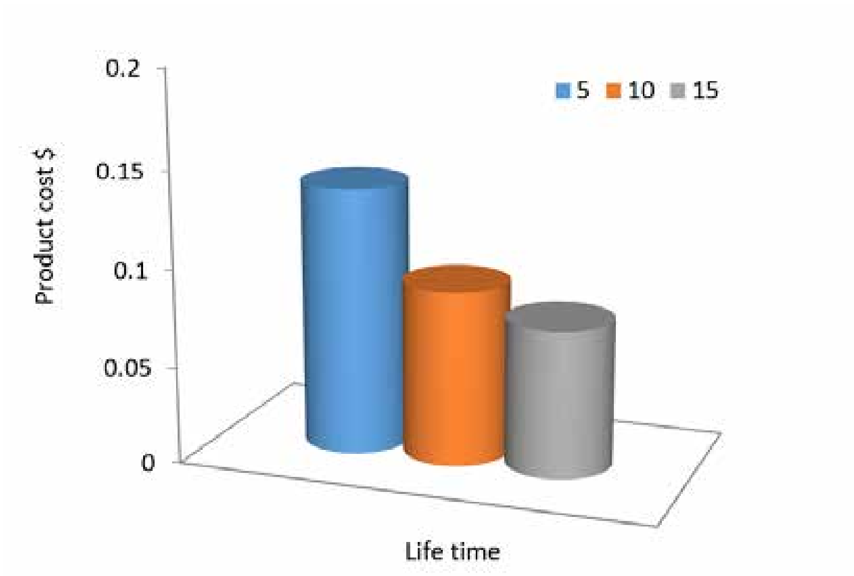


Figure23. Effect lifetime on distilled water produce.

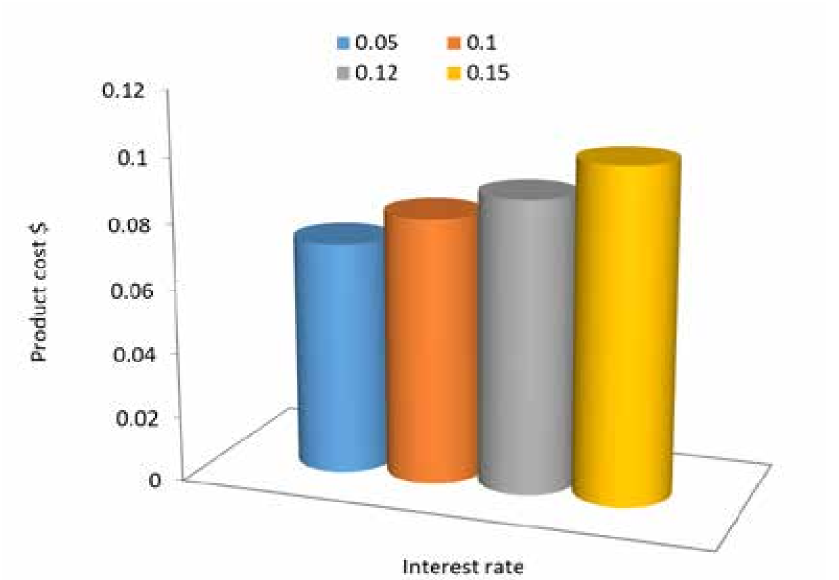


Figure 24. The variable interest rate cost of distilling water.

As a result of the still's portability, this cannot be avoided [70–71] provide a cost-benefit analysis of water desalination systems. Capital recovery factor (CRF), FAC, SSF, ASV, ASV, M, and AC are the most important cost characteristics for stills in the cost analysis of stills (annual cost). AMC (annual maintenance costs) and CPL (cost per kilometer) (cost per litter). AMC calculates maintenance costs for salt deposits, DC pumps, fans, thermoelectric modules, and brackish water fills. Maintenance costs are 15% of the current price [72].

4. Conclusion

This study hypothesized that improving the still's absorption, evaporation, and condensation processes. The design elements discussed above are employed in a still to increase absorption and condensation while also speeding up evaporation. Reflectors (internal/external and external), absorber materials (filament and sponge), external condensers (and nanoparticles), all have a significant impact on the production optimization of classic still photography. Stills can boost output per unit area by minimizing water mass thermal inertia. Findings show that fresh water production costs depend on the desalination system cost. Solar energy systems are sometimes capital-intensive despite their affordable operational and maintenance expenses. The materials used in the construction of a desalination system determine its price. As a final step, the addition of reflectors, absorber materials (sponge, pebbles), and external condensers increases evaporation speed and enhances absorption and condensation.

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