Design of New Solar Desalination Purification Unit for Maximizing the Performance and Enhancing the Yield Rate Using Solar Energy

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Abstract: *Solar energy is no pollution energy and is also a free renewable energy source. The quality of drinking water is a fundamental need of human life. So good and clean water is necessary for food, drinking, and washing purposes. Various methods are available for converting saline water into good drinking water. Those methods include desalination, vapor compression, reverse osmosis, and electrodialysis. Solar water desalination is one of the most popular solar technologies. In this innovation, the unadulterated water is created without salt substance from the aromatic water, including drag and ocean water. At the same time, contrasting and the different energy stockpiling materials, for example, glass balls, rocks, and rock. The stones and rock bed material yield more than other hot retaining materials. The best incline of the glass cover is 450, and the water profundity still is 0.040 m. The greatest day yield for saline water with rocks and rock bed materials was 7520 ml/m2/day without thermocol protection, and the most extreme day yield for saline water from stones and rock bed material was 7750 ml/m2/day with thermocol protection and the most extreme yield productivity of sun- powered still is 60%.*

Keywords: *Solar still, Energy storage materials, Desalination, Solar Energy, Purification.*

I. INTRODUCTION

Shukla et al. [1] led investigates of both single incline and twofold slant Solar energy still by keeping the jute fabric in an even position and drenched in the bowl saline water. In this still, day-by-day yield throughout the late spring was 2.0 kg/m2, and for the twofold slant still, it was expanded to 2.5 kg/m2. Boukar et al. [2] suggested the plan boundaries and primer test examination of a roundabout vertical Solar energy. A backhanded vertical sun-powered comprises a level plate authority, a vanishing chamber, and a buildup chamber structure, a Solar- oriented still. The sun-powered still plan boundaries and the consequences of sunlight-based still starter execution tests are dissected for solar energy presentation. The plan boundaries and primer execution testing of the sunlight based still with an apparent level plate gathering area of 0.942 m² and a vanishing area of 0.869 m², using Solar energy as Source of heat. The daily productivity of the Solar still varied from 0.863 to 1323 ml/m²/d. Velmurugan et al. [3] suggested that the sensible heat storage materials increased the solar desalination process production.

The sensible heat storage materials placed along with the solar still basin and absorption of solar energy improved the solar desalination production. The design of fin-type solar still with sensible heat storage materials such as pebbles, coals and sand increased the productivity of the solar. Salah Abdallaha et al. [4] analyzed that some gripping materials like stringy sponges and black rock increase the performance of Solar still. The coated silver stringy sponges and black rock gave less yield of a solar still, and the uncoated silver stringy sponges and black rock gave more yield of 43%. Hitesh Panchal et al. [5] experimentally designed a single basin single slope solar still and analyzed the sensible heat storage material like cow dung cakes in the solar still basin.

They observed that the hotness move coefficients were significantly more and expanded the yield of sun-based still. While utilizing the cow waste cakes, the Solar energy exhibition was still 25% more. Colangelo et al. [6] directed a few examinations about the hotness conductivity of nanofluids given diathermic oil for high-temperature applications. They tracked down that the warm conductivity upgrade of the nanofluids with diathermic oil is higher than that of water, equivalent nanoparticles, and similar circumstances. They likewise observed that the warm conductivity is decreased with expanding the size of particles. Anburaj et al. [7] explored the trial execution of another sort slanted sun oriented still with rectangular sections and edges in safeguard plate, tried for various tendency points with various wick materials like dark cotton fabric, squander cotton pieces, jute material, dirt pot, and gentle steel pieces at genuine sun based conditions. They observed that 300inclination is ideal, and dark cotton fabric wick material upgrades the creation rate by 12%.

Elango et al.[8] analyzed the energy storage material like nanomaterial to enhance the yield of single basin single slope solar still. They experimented with different nanofluids like iron oxide, aluminum oxide, Tin oxide, and Zinc oxide. They found that the aluminum oxide nanomaterial was still enhancing the performance of solar. The enhanced yield rate of aluminum oxide was 29.95% more than the other nanomaterials. Samuel Hansen et al. [9] tentatively directed with a new plan of slanted Solarbased still for expanding the yield of Solar based still. They examined various wick materials like wood mash paper wick, wicking water coral wool material, and polystyrene wipe to work on Solar energy still presentation. They observed coral wool material with wire network ventured spongy plate gave more yield than different materials. Rashidi, S et al. [10] explored the job of nanoparticles in Solar energy-oriented still desalination usefulness [11]-[15]. They found that the nanoparticles are expanded the yield pace of sun based still desalination framework [16]-[22]. They proposed that the water atoms move through narrow miniature channels to a porous and hydrophilic vanishing of nanoparticles, where a poor energy source, like daylight [23]-[29].

II. EXPERIMENTAL SET-UP

This is put with the south-north heading because the sun is in the south-north course. The general size of the bowl is 1.000 m x 0.720 m x 0.900 m (longer side) x 0.280 m (Shorter side). The highest point of the sunlight-based still is covered with straightforward glass [30-35]. There are 4 thermometers put on the solar-powered still in various areas, and the perception readings are taken from 9.00 am to 6.00 pm. The temperatures of encompassing bowl water, bowl fume, condensate water are taken note of each 1 hour by thermometers [36]-[42]. All the while, the power of sunlight-based radiation is recorded utilizing a sun meter, an anemometer estimates the breeze speed, and a gathering container estimates the pace of the hourly desalinated water [43]-[47]. The single bowl single glass cover solar energy has been manufactured with a dark limestone base (Cuddappa stone).

Construction Details of Solar Still

The solar still is constructed by single basin, glass cover, energy storage materials, condensate drain cover, storage tank and collecting jar [48]-[51]. The basin contains brackish or sea water. This is enclosed in a completely air tight envelope and a transparent cover at top. The basin absorbs the maximum part of the transmitted radiation through the glass cover. The glass cover is top of the black basin [52]-[58]. The glass cover is single inclined type [59]-[64]. The glass cover thickness is 0.004 m and its inclination is 450. The effective depth of the water level in solar still is 0.040m (figure 1).
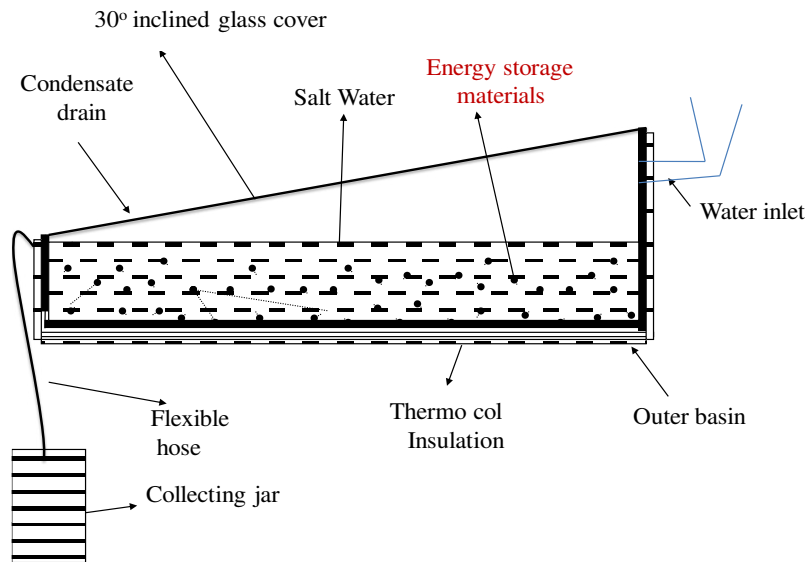

Fig. 1. 2D diagram of single basin slope solar still

Energy Storage Materials

The single basin single glass cover passive type solar still is fabricated with black lime stone (cuddappa stone) and the performance of the solar still is to be compared with different energy storing materials such as glass balls, , pebbles and gravels [65]-[101]. The energy materials are used to absorb and stores the solar energy and that energy enhanced the production rate of solar still. At the same time the solar still basin material black lime stone also stores the solar energy and that energy also is used to increase the yield of solar still [102-132].

III. EXPERIMENTAL RESULT

Day and Night yield comparison for saline water

Table 1 shows that the day yield is without thermocol protection and thermocol protection for saline water utilizing different energy stockpiling materials [133-157]. The night yield is without thermocol protection and thermocol protection for saline water utilizing the same energy stockpiling materials [158-179]. The constantly yields are more with thermocol protection conditions than without thermocol protection state of saline water [180-189].

Table 1. Saline water with storage materials in solar-Day

Sl.No.	Content	Day Yield (ml)	
		Without thermocol	With thermocol
1	No energy material	840	970
2	Glass ball	2320	2480
3	Pebbles	3540	3730
4	Gravels	3980	4240
5	Glass ball + Pebbles	5580	5790
6	Gravels + Glass balls	6800	7020
7	Pebbles + Gravels	7520	7750

Table 2 shows the night yield of solar energy still for saline water with different energy stockpiling materials bed of without protection and thermocol protection.

Table 2. Saline water with storage materials in solar- Night

Sl. No.	Content	Night Yield (ml)	
		Without thermocol	With thermocol
1	No energy material	40	50
2	Glass ball	80	110
3	Pebbles	200	250
4	Gravels	320	370
5	Glass ball + Pebbles	350	390
6	Gravels + Glass balls	420	490
7	Pebbles + Gravels	580	650

IV. RESULT AND DISCUSSION

Different energy stockpiling materials are utilized in the bowl alongside water to develop the hotness limit further, radiation retention limit, and upgrade the dissipation rate [190-197]. The solar energy still bowl improvement water level, the yield of the sun based still are investigated under the states of without thermocol and with thermocol condition.

Rate of Production

The creation rate additionally relies upon the power of solar-based radiation. The base solar energy radiation gives less creation rate. Toward the start of the cycle, less power of Solar based radiation prompts more slow pace of creation of desalinated water. The most extreme creation rate is in the middle of 1.00 pm to 2.00 pm. The greatest day yield is 7750 ml/m2/day for saline water with thermocol conditions. The greatest night yield is 650 ml/m2/day for saline water with thermocol conditions.

Saline water with storage materials in solar- Day with thermocol insulation

Figure 2 shows the day yield pace of saline water for different energy stockpiling materials under the

states of without and with thermocol. The greatest yield rate got from stones and rock bed materials with thermocol protection.
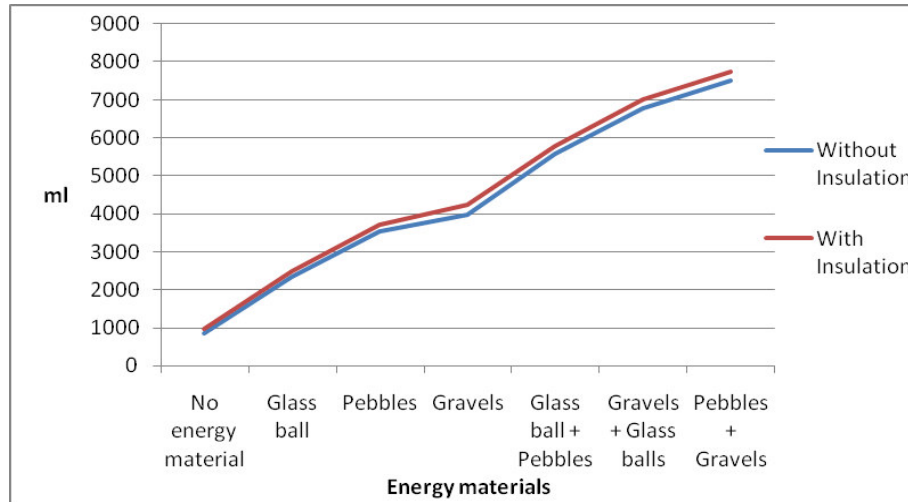

Fig. 2. Saline water with various energy materials in Day-yield

Figure 3 shows the complete day yield pressure of saline water for different energy stockpiling materials under the states of without and with thermocol. The greatest yield rate is acquired from stones with rock materials with thermocol protection.
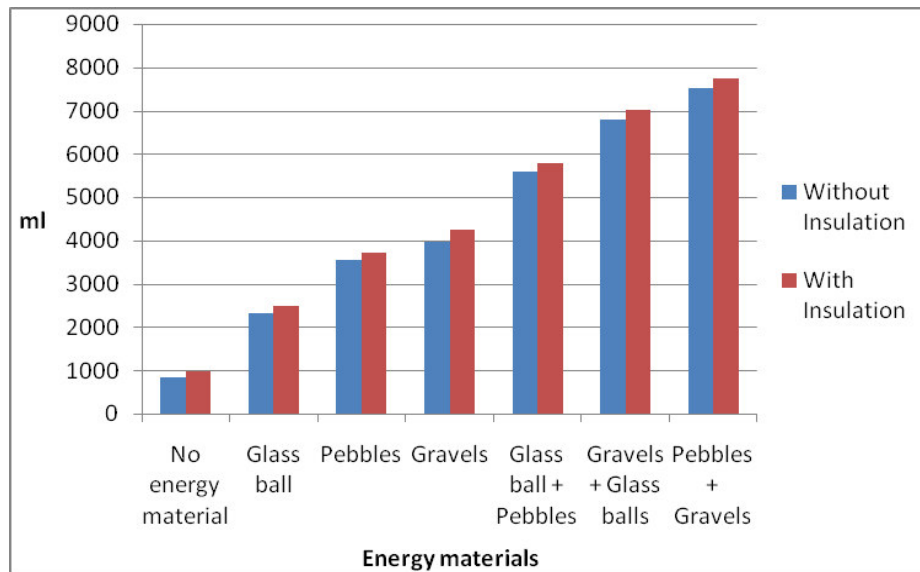

Fig. 3. Saline water with and without insulation in total

Figure 4 shows the night yield rate of saline water for various energy storage materials under the conditions of without and with thermocol. The maximum yield rate was obtained from pebbles with gravels materials with thermocol insulation.
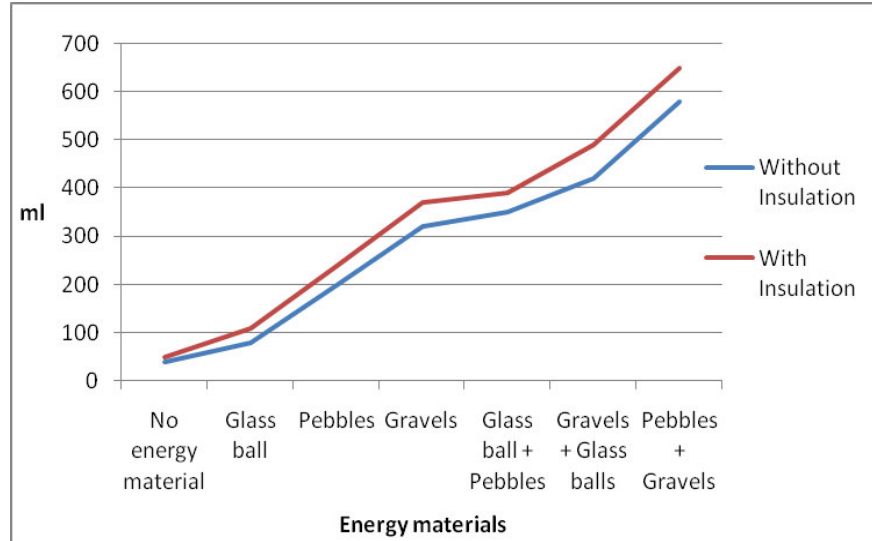
Fig. 4. Saline water with various energy materials in Night

Figure 5 shows the complete night yield pressure of saline water for different energy stockpiling materials under the states of without and with thermocol. The greatest yield rate got from stones with rock materials with thermocol protection
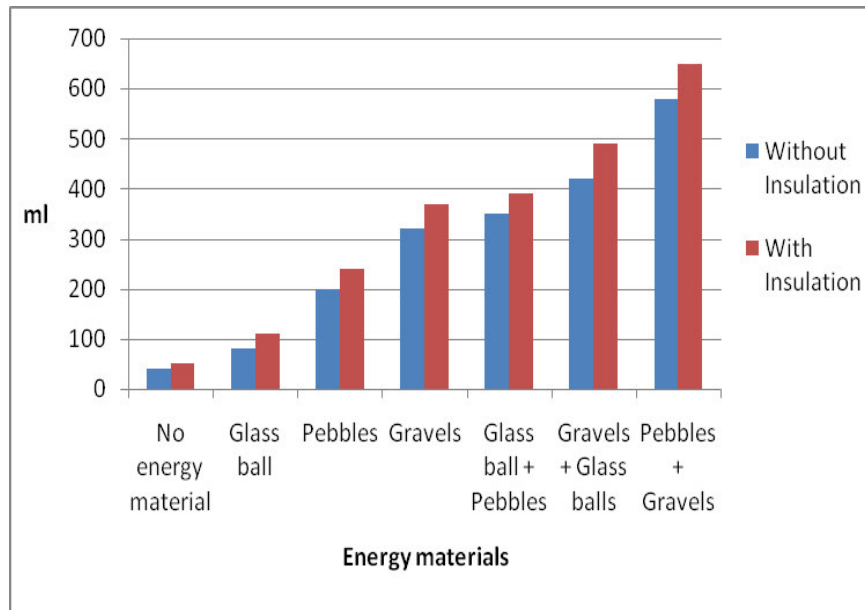

Fig. 5. Saline water with and without insulation in Total Night

The inlet and exit face pressure variance have appeared in fig 6. Inlet contour temperature pressure inputs are 110 MPa, and varying pressure values are 131 MPa. Ansys workbench 16.2 version with help done to complete the pressure variance range of solar still (figure 6).
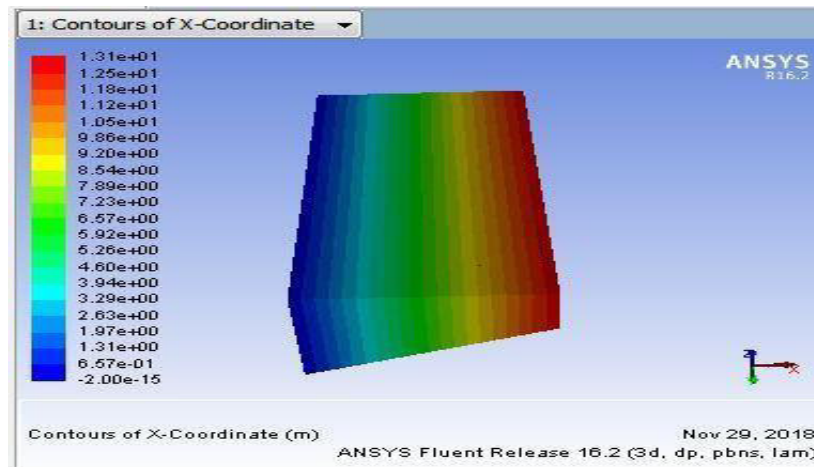
Fig. 6. Contour pressure range of solar still

V. CONCLUSION

Form the experimental results, the following conclusion was stated. Observations from the various energy-absorbing materials, the pebbles and gravels bed materials based solar still production rate was higher than the rest of bed materials. The pebbles and gravels bed has higher solar absorption co-efficient than other materials. From the energy storage materials, the best energy storage material was pebbles and gravels bed materials because it has more surface area than the other energy storage materials. After the sun sets, the pebbles and gravel bed release the stored heat to continuously keep the evaporation. In that way also, the system produces additional pure distilled water. Thus, pebbles and gravels bed enhance the production of distilled water compared to plain solar still.

Acknowledgments

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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