ENHANCING THE PRODUCTION RATE OF DESALINATION STILL AND ANALYZING THE NATURAL OPTIMIZATION PARAMETERS FOR PRODUCTIVITY OF CONVENTIONAL SOLAR STILL

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Abstract

The solar energy is free pollution and free renewable energy. Desalination is one of the water purification methods. In this method, the pure water is produced without salt content from the salty water. When comparing with the various energy storage materials such as iron scrap, steel scrap and aluminium scrap, the aluminium material gives more yield than other heat absorbing materials. The best slope of glass cover is 45^0 and the water depth of still is 0.050 m. The maximum day yield for sea water from aluminum materials was 4740 ml/m^2/day without insulation and the maximum day yield for sea water from aluminium material was 5130 ml/m^2/day with insulation .The maximum yield efficiency of solar still is 40%.

Keywords: Desalination; Solar still; Energy materials; Thermal insulation; Solar energy

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1. Introduction

Boukar et.al. [1] Suggested about the design parameters and preliminary experimental investigation of an indirect vertical solar still. The solar still consisting of a flat plate collector, an evaporation and condensation chamber. The nominal flat plate collecting area is 0.942 m^2 and an evaporation area is 0.869 m^2. The daily productivity of the solar still varied from 863 to 1323 ml/m^2/day. Lin et al. [2] evaluated the effect of filling ratio of the solar still. The filling ratio increases from 30% to 40%, significant enhancement in the production rate of desalinated water is observed. higher filling ratios (40% to 60%) reduce the rate of production. Salah Abdallaha et al. [3] 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 solar still and the uncoated silver stringy sponges and black rock gave more yield of 43%.. Hitesh N et.al.[4]suggested about the various parameters for experimental investigation of on double slope solar still and analysis the effect of that parameters for optimization productivity of double slope solar still. Colangelo et al. [5] conducted more experiments about the heat conductivity of nano fluids based on dia-thermic oil for high temperature applications. They also found that the thermal conductivity is reduced with increasing the size of particles. Elango et al.[6] analyzed about the energy storage material like nano material to enhance the yield of single basin and single slope top cover solar still. They conducted experimentally with different nano fluids like iron oxide, aluminium oxide, Tin oxide and Zinc oxide. They found that the aluminium oxide nano material was enhancing the performance of solar still. The enhanced yield rate of aluminum oxide was 29.95% more than for the other energetic materials. Samuel Hansen et al. [7] experimentally conducted with new design of inclined solar still for increasing the yield of solar still. They analyzed with different types of wick materials like wood pulp paper wick, wicking water coral fleece material and polystyrene sponge for improving the performance of solar still. They found coral fleece material with wire mesh stepped absorbent plate gave more yield than the other materials.

Kiriarachchi, H.D., et al. [8] evaluated the effect of cotton nano composite fibers using in the solar still basin and improving the efficiency of solar still water desalination. The surface evaporation has reduced and very quickly increased the phase change of water. Rashidi, S, et al. [9] reviewed about the role of nano particles in solar still desalination productivity. They found that the nano particles are increased the yield rate of solar still desalination system. They suggested that the water molecules are transferred through capillary microchannels to an absorptive and hydrophilic evaporation of nano-particles, where a low-grade energy source, such as sunlight. Wilson, H.M, et al. [10] conducted the experiments about the Ultra-low cost cotton based solar evaporation device for seawater desalination. They suggested that the cotton based waste water purification solar still desalination system increased the production rate of pure water from salty water.

Construction details of solar still

The solar still is constructed by single basin and single slope glass cover. The basin contains brackish or sea water with energy absorbing materials. Solar still basin is enclosed in a completely air tight envelope and a transparent cover at top. The top glass cover thickness is 0.004 m and its inclination is 45^0. The effective depth of the water level is 0.050 m. Figure 1 shows that the 2D geometry view of solar still. Ansys workbench 16.2 version with help of done to complete the geometry.

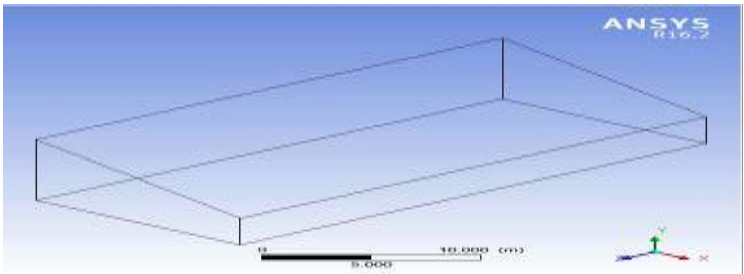

Figure 1. 2D Geometry view of solar still

Experimental setup

The overall size of the basin is 1 m x 0.7 m x 0.9 m (longer side) x 0.3 m (Shorter side). Some holes are provided on the solar still for inserting the thermo meters. The observation readings are taken from 9.00 am to 6.00 pm. The ambient temperature, basin water temperature, basin vapor temperature, condensate water temperature are recorded every 1 hour by thermometers. Simultaneously, the intensity of solar radiation is recorded using sun meter, the wind speed is measured by anemometer, and the rate of the hourly desalinated pure water is measured by a collecting box. Figure 2 shows that the 3D geometry views of solar still. Ansys workbench 16.2 version with help of done to complete the geometry.

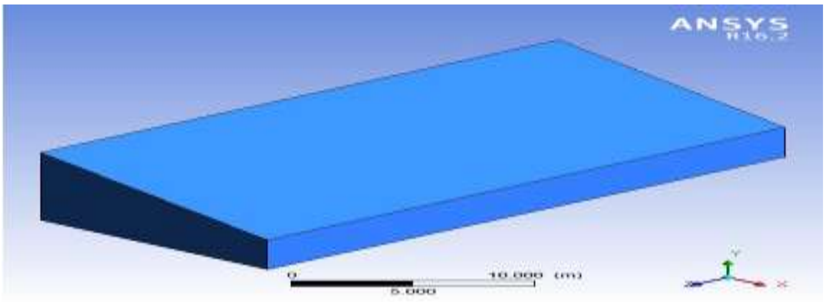

Fig.2. 3D geometry of solar still

Day and Night yield Comparisons of Solar still

The Table 1 shows that the day yield in without thermocol insulation and also with thermocol insulation for sea water. The day yield is more in with thermocol condition than without thermocol condition of sea water. The Table 2 shows that the night yield in without thermocol insulation and with thermocol insulation for sea water.

Table 1. Day yield of solar still for energy storage materials

Sl.no	**Content**	**Day Yield (ml)**	
		Without insulation	**With insulation**
1	No energy material	460	510
2	Iron Scrap	1210	1480
3	Steel Scrap	2910	3420
4	Aluminium Scrap	4740	5130

Table 2. Night yield of solar still for sea water with energy storage materials

Sl.no	Content	Night Yield (ml)	
		Without insulation	With insulation
1	No energy material	30	40
2	Iron Scrap	90	105
4	Steel Scrap	140	160
3	Aluminium Scrap	180	200

Table 3. Properties of energy materials

Sl.No	Energy materials	Specific Heat Capacity KJ/kg.K
1	Iron Scrap	0.45
2	Steel Scrap	0.61
3	Aluminium Scrap	0.85
4	Black lime stone	0.91

2. Result and Discussions

Different energy storage materials are used in the solar still basin along with basin water to improve the heat capacity, radiation absorption capacity and enhance the evaporation rate. The solar still basin optimization water level, yield of the solar still are analyzed under the conditions of without thermocol and with thermocol condition. The aluminium material absorbs more solar energy and increase the storage of the solar energy more.

The aluminium material yield is more than the other energy absorbing materials. The production yield is depending on the depth of basin water. The production of yield water depends on solar still top glass cover inclination. The maximum production rate of yield water is achieved at an inclination of glass angle of 45°.

The maximum day production rate is in between 1.00 pm to 2.00 pm. The maximum day yield is 5130 ml/m^2/day with thermocol insulation condition. The maximum night yield is 200 ml/m^2/day with thermocol insulation condition.

Day Yield of Solar Still Without and With Thermocol Insulation

Figure 3 shows that the day yield comparison of sea water for various energy storage materials under the condition of without and with thermocol. The maximum yield rate obtained from nano materials with thermocol insulation.

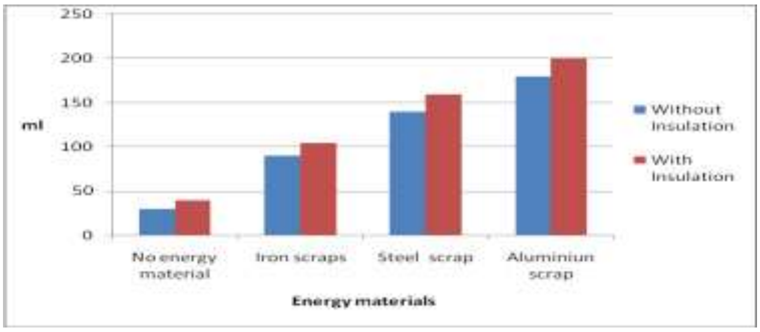

Figure 3 Day yield comparison for energy materials

Figure 4 shows that the total day yield rate of sea water for various energy storage materials under the condition of without and with thermocol. The maximum yield rate obtained from nano materials with thermocol insulation.

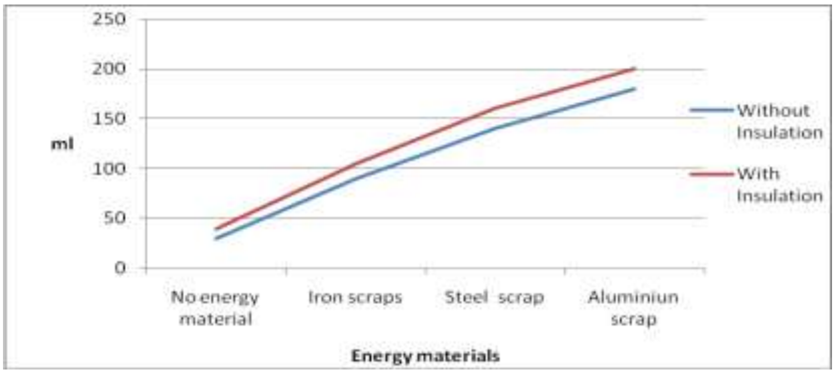

Figure 4 Total day yield rate of solar still

Figure 5 shows that the night yield comparison of sea water for various energy storage materials under the condition of without and with thermocol. The maximum yield rate obtained from nano materials with thermocol insulation.

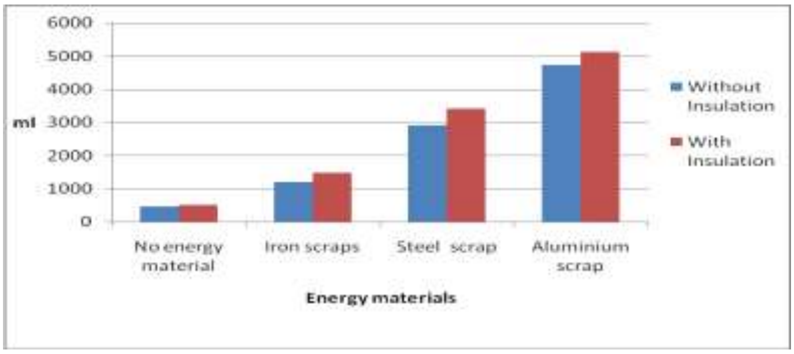

Figure 5 Night yield comparison for energy materials

Figure 6 shows that the total night yield rate of sea water for various energy storage materials under the condition of without and with thermocol. The maximum yield rate obtained from nano materials with thermocol insulation.

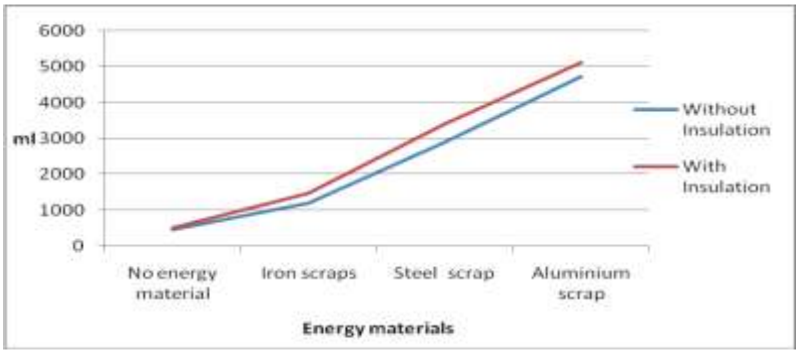

Figure 6 Night yield rate of solar still

Figure 7 shows the variation of wind speed with respect to local time during the experimental days the wind speed is low in mid-day hours and high in morning and evening hours

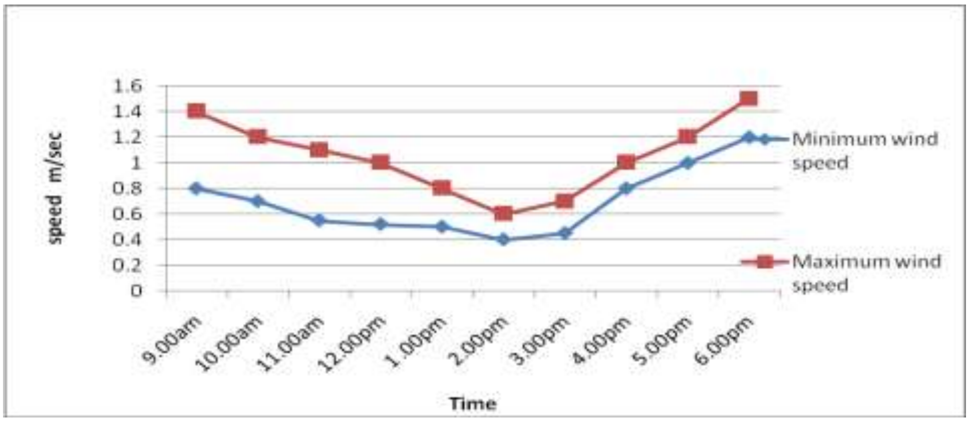

Figure 7 Day variation of wind speed

Contour pressure variances are changes from discretization process with heat affect conditions.. The highest pressure acting surface regions are top end corner and lowest pressure acting in bottom surface end corner shown in figure 8. Ansys workbench 16.2 version with help of done to complete the pressure variance in solar still.

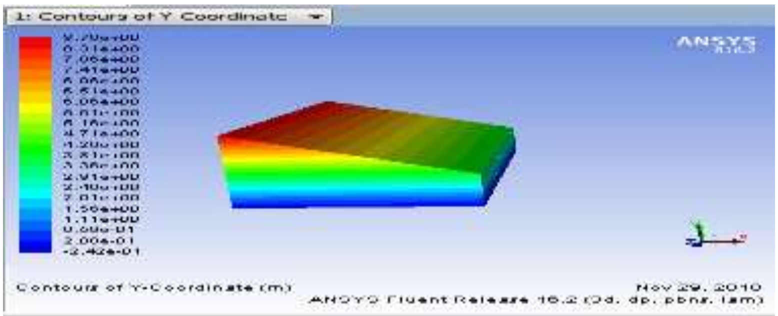

Figure 8 Pressure variance in solar still

Total surface endurance values are appeared the help of Ansys workbench. In this results are shows the tilted edge of sun lights and normal velocity controlling systems. Heat flux and heat generation areas are appears in the figure 9. Ansys workbench 16.2 version with help of done to complete the surface heat flux in solar still.

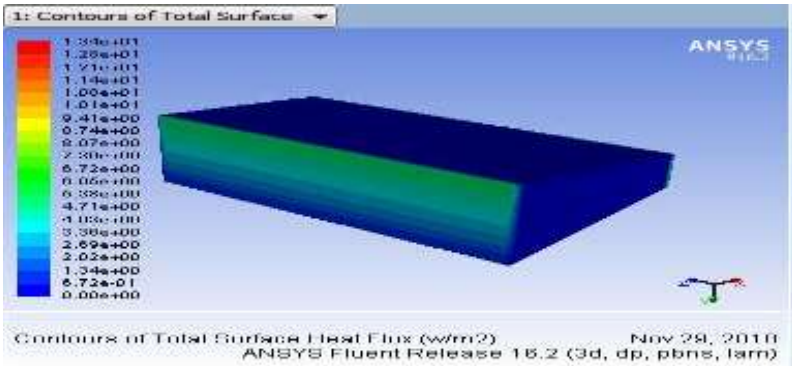

Figure 9 Simulation of surface heat flux of solar still

Simulation of static pressure ranges are appeared in this figure 10. In this work calculated with different position of constant pressure and changing velocity. In this process proves the effect of constant room temperature and surface endurance. ANSYS workbench 16.2 version with help of done to complete the static pressure in solar still.

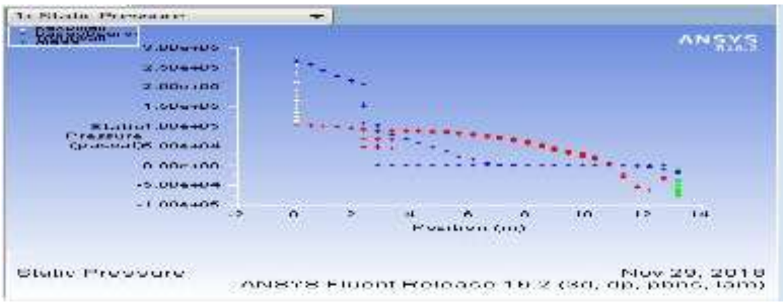

Figure 10 Simulation of Static pressure of solar still

3. Conclusion

From the experimental results the following conclusion were stated. Observations from the various energy storing materials, the aluminium materials based solar still production rate was higher than the rest of materials such as iron scrap and steel scrap. The best slope of glass cover is 45^0 and the water depth of still is 0.050 m. The maximum day yield for sea water from aluminium materials was 4740 ml /m^2/day without thermocol insulation and the maximum day yield for sea water from aluminium material was 5130 ml/m^2/day with thermocol insulation. The maximum day yield efficiency of solar still is 40%.

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