Scientific Journal of Impact Factor (SJIF) : 3.134

ISSN (Print) : 2348-6406
ISSN (Online): 2348-4470

International Journal of Advance Engineering and Research Development

# REVIEWSON DIFFERENT ENERGY ABSORBING MATERIALS FOR PERFORMANCE ANALYSIS OF SOLAR STILL

Hitesh Panchal[1], Prathik Patel[2], Ramesh Mevada[3], Hitesh Patel[4]

*[1]Assistant Professor, Mechanical Engineering Department, Gujarat power engineering & research institute, Mehsana*
*[2]M.E. Student, S R Patel Engineering College, Unjha, Mehsana.*
*[3]Head, Mechanical Engineering Department, S R Patel Engineering College, Unjha, Mehsana.*
*[4]Asst. Professor, Mechanical Engineering Department, Gujarat power engineering & research institute, Mehsana*

***Abstract:*** *Solar still is a very simple device to convert available brackish or saline water into drinkable water by use of solar still. Due to its lower distillate output, it is not widely used in the household and industrial applications. This review paper, shows researches on solar still still based on various energy absorbing materials. Energy absorbing materials absorbs the heat of the sun during peak hours and release during off-sunshine hours for increment in distillate output.*

***Keywords :*** *solar still, energy absorbing materials*

## I. INTRODUCTION

Mehsana city is located in the North Gujarat region of India. It is a good place for the solar energy site. Hence, many researches held on solar still in region Mehsana [ 1-19]. Solar energy can be used either for seawater desalination by producing the thermal energy required to drive the phase change processes or by generating the electricity required to drive the membrane processes. Solar desalination systems are classified into direct and indirect collection systems. As their name imply, direct-collection systems use solar-energy to produce distillate directly in the solar collector, whereas in indirect collection systems, two sub-systems are employed. Researchers on solar still based on energy absorbing materials are shown below.

## II. SOLAR STILL WITH VARIOUS ENERGY ABSORBING MATERIALS

### 2.1 Dyes

Anil k. Rajvanshi [20]present the analytical and experimental study of the effect of adding dyes to a solar distillation unit. Different dyes like Black napthylamine, Redcarmoisine and Dark green used. It was found that Black napthylamine dye foundto be most suitable which increase the distillate output by 29%. The analytical model observes that increase of an ambient temperature by 40% increase the distillate output by 27% and increase of output by about 10% with a wind speed increase from 1 to 32 km/hr. the increase of the distillate with increasing concentration of dye up to 500ppm, after which it is independent of the concentration.

M. S. Sodha et al. [21]Were used Red, Violet and Black dyes for investigating the effects of dye on the performance of a solar still.result were found that the Black and Violet dyes more effective than other dye. It increases the productivity of the still.

### 2.2 Black rubber matt, Black ink and Black dyes

Akash A.Bilal et al. [22]Study about the effect of different absorbing materials in a solar still, and thus enhance the productivity of distilled water. Black rubber matt, Black ink and Black dyes were used in the experiment. The results show that the productivity of distilled water using an absorbing black rubber matt increased the daily water productivity by 38%. Using black ink increased productivity by 45% and Black dyes increased productivity by 60%. So Black dye is the best absorbing material used in terms of water productivity.

### 2.3 Different sizes of black rubber and black gravel

A.S. Nafey et al. [23]For the investigation of the productivity of solar still, Different size of black rubber (2, 6 and 10 mm) thickness and black gravel materials (7-12, 12- 20 and 20-30 mm) size used as energy storage materials. Black rubber with size of 10 mm thickness, improve the productivity by 20% at brine volume condition 60 $l/m^2$ and black gravel material with a size of 20-30 mm improves the productivity by 19% at brine volume condition 20 $l/m^2$.Also black gravel absorbs and release incidence solar energy faster than black rubber.

 

M. Sakthivel et al. [24] were used Black granite gravel as energy storage materialto investigate the performance of a solar still. An experiment was conducted with different depths of the gravel layer in steps of 12, 18, 20 and 25mm. the Still productivity per day with the gravel increased by about 17%. Still yield was 3.9 kg/m$^2$per day, which is higher than that of still with energy storage medium of black rubber sheet reported by Nafey et al. [23]. The mathematical model was also developed to match with the experimental predictions. The maximum percentage of discrepancy for all the parameters is about ±18%. The theoretical value of yield per day has 8% discrepancy over experimental value.

**2.4 Mica Plate**

A.A. El-Sebaii et al. [25] were used aluminum, copper, stainless steel and mica plates as suspended absorbers material in single basin solar still during experiment.It was found that using metallic plates as suspended absorbers (Aluminum, Copper and Stainless steel) the daily productivity of still about 15–20% higher than that of the conventional still. But it has problems of corrosion to use metallic plates as suspended absorbers. So it was advisable to use suspended plates made from insulating materials such as mica, glass, plastic, etc.

The measured daily productivities of still with mica plate and conventional still was obtained as 4.796 and 4.065 (kg/m$^2$-day) with daily efficiencies of about 43.8 % and 35.12%.

It was also found that the annual average of productivity of the modified still is found to be 23 % when mass of water 80kg and 15.8% when mass of water 40 kg, which was higher than that of the conventional still.

**2.5Charcoal particles**

Mona M. Naima et al. [26] specially designed solar still were used with different size of charcoal particles like (Coarse, medium and fine) used in this experiment to investigate the productivity. Results were obtained at different flow rates of brine water.It has been shown that the solar stills with charcoal particles as absorber medium presents a 15% improvement in productivity over wick-type still. Also coarse size charcoal particles give acceptable results at high flow rates.

C. E.Okeke et al [27]used coal and charcoal particle to study its effect on solar still productivity. The test was carried out with fine particles of charcoal, charcoal pieces, coal prices, and coal and charcoal mixture.

Both coal and charcoal improve the still performance. The average daily productivity and efficiency of the still were 1.12 l/m$^2$ and16.5%, respectively.

**2.6Energy storage material mixture**

Mona M. Naima et al. [28] Used energy storage material mixture. The materials were mixed of paraffin wax, paraffin oil and water in which aluminum turnings added. The solar still parts were designed with different elements like aluminum, galvanized iron, and copper.

Using of an energy storage material mixture increase the productivity of distilled water, butat the largest concentration of the saline water lower the productivity of the still. Also the higher inlet saline water temperature and higher flow rate improve the still efficiency.

During experiment found that maximum day and night productivity of the still was found 4.536 L/m$^2$at the saline water flow rate 40 ml/min and the still efficiency was 36.2%.

**2.7 Aluminum sheet**

N.H.A. Rahim [29] used aluminum sheet as a heat storage element. Heat storage zone is constructed by placing an aluminum sheet, painted black on the top surface and thermally insulated on the bottom; 25 mm below the water level. It divides the horizontal still into evaporating and heat storing zones and combines the advantages of shallow and deep stills.

After an experiment results found that Average system efficiency for Shallow basin still is 44.8% and Average yield is 3.1 (l /m$^2$/day) and Average system efficiency for System under study basin still is 53.7% and Average yield is 4.2 (l /m$^2$/day).So Average system efficiency and productivity more than Shallow basin still.

**2.8 Sponge cubes**

Bassam A. et al. [30] were used different size sponge cubes which placed in the basin to study enhance the distillate production (yield). Yellow sponge, Black sponge, Black steel, Black coals were used in experiment.It was found that the sponge cubes were more effective than the use of cubes made from black steel and coal. The yellow sponge cubes were more effective in increasing the production ratio than both black steel and coal cubes. The sponge cubes increased the surface area over which evaporation of water occurs hence caused the increase of distillate production of the still ranged from 18% to 273% compared to an identical still without sponge cubes under the same conditions.

**2.9 Black coated and uncoated metallic wiry sponges, Black rocks**

 

Omar Badran et al.[31] were using different types of absorbing materials like Black coated and uncoated metallic wiry sponges, black rocks (collected from Mafraq Area in north-eastern Jordan) to examine their effect on the productivity of solar stills.

The uncoated sponge has the highest water collection during day time, than black rocks and coated metallic wiry sponges. On the other hand, the overall average gain collected distilled water consideration the overnight water collections were 28%, 43% and 60% for coated and uncoated metallic wiry sponges and black rocks respectively. One of the main drawbacks of metallic wiry sponges that corrosion started to appear in certain parts of the sponge. Also the black rocks absorb, store and release the incident solar energy better than the coated and uncoated metallic wiry sponges and can enhance the productivity by nearly 20%.

So, Black rocks give better overall production rate than coated and uncoated metallic wire sponge.

**2.10Small and large size of different materials**

**(Quartzite rock, Red brick pieces, Cement, Concrete pieces, Washed stones and iron scraps)**

K. Kalidasa Murugavel et al. [32] were used different size of Small and large materials like Quartzite rock, Red brick pieces, Cement, Concrete pieces, Washed stones and iron scraps during experiment to investigate the effect of energy storage materials onproductivity of Single basin, double slope, solar still with minimum basin depth. Basin still with 0.5 cm water depth and smaller size of different absorbing material, the still with ¼ in.Quartzite rock has given higher production rate compared with other materials. Also basin still with 0.75 cm water depth and large size of different absorbing material, the still with 1½ in.cement concrete piece has given higher production rate and $1^{1}/_{4}$ in. Brick pieces still gave lesser productivity during the morning hours and higher during the evening.

The still with 3/4 in.Quartzite rock gives uniform production from morning to night. So it is the effective basin material.

**2.11 Jute cloth**

M. Sakthivel et al.[33] were used jute cloth as energy storage medium. The experiments were conducted on a conventional single slope solar still and on a regenerative solar still with jute cloth. In regenerative solar still jute cloth was kept vertically in the middle of basin saline water and also attached with the rear wall of the still. The still was also theoretically molded by Dunkle's model.The experiment were conducted with different quantity of (20, 30, 40 kg) saline water. It was found that the still with 30 kg of saline water gave 4 kg/m$^2$ cumulative still yield in the regenerative still with jute cloth which about 20% more than the conventional still yield.as shown in fig 13. The yield was increase 12%. Higher than that of still with energy storage medium of black rubber sheet reported by Nafey A.S et al. [4]Also the theoretical predictions from Dunkle's model found that the maximum percentage of discrepancy for the still productivity is about 9%.It was also found that Maximum efficiency of the still with the jute cloth is found as 52% which is 8% higher than the conventional still efficiency.

**2.12Different wick materials (Light cotton cloth, Sponge sheet, Coir mate and Waste cotton pieces)**

K. Kalidasa Murugavel et al. [34] were useddifferent wick materials like light cotton cloth, sponge sheet, coir mate and waste cotton pieces during experiments.The experiments were also carried out with 65 mm × 45 mm aluminum rectangular finsarranged in breadth wise and length wise directions in the basin covered with cotton and jute cloth.The layer of water equivalent to 0.5 cm depth was maintained in the basin in all case. The still was also theoretically modeled.After an experiment it was found that among all different basin wick materials, light black cotton cloth was the most effective basin material which yielded higher production per day. Withthe different fin arranged breadth wise and length wise directions in the basin covered with cotton and jute clothin the basin, the aluminumrectangular fin covered with cotton cloth and arranged in length wise direction was more effective and gave slightly higher production than the light black cotton cloth.Also the theoretical production rate using the proposed model were close to the experimental.

**2.13 Aluminum and Galvanized iron plate**

H.N. Panchal et al. [35] used Aluminum and Galvanized plate as energy storage materials. Two different solar stills consist Aluminum and Galvanized plate iron inside for absorbing energy and compare results with conventional type solar still.Aluminum plate (Al) has good thermal conductivity compared with Galvanized Iron (GI) plate as well as Conventional solar still absorbed; so the distillate output and Cumulative distillate output of a solar still having Al.plate is more compared with solar still having GI plate and conventional solar still.

Solar still inside with an aluminum plate gives 30 % and Galvanized iron plate gives 12% more output compared with conventional solar still.

**2.14 Porous Absorbers (Blacked jute cloth Insulated on thermocol)**

Pankaj K. Srivastavaet al. [36] was usedPorous Absorbers(made of blacked jute cloth Insulated on thermocol)as energy storage materials.It was found that on clear days, about 68% and on cloudy days (or partially clear days) nearly 35% more distillate output was obtained by the modified still compare with conventional still.
It was also found that by applying twin reflector booster ( Constructed by placing two plane mirrors mutually perpendicular to each other on solar still as shown in fig 20).with the modified still an increase the distillate gain of 79% over the modified still without booster.

**2.15 Concrete stonesPebbles and black granite stones**
Dr. S. Shanmugan [37] investigated the effect various energy absorbing materials on the performance of single slope, single basin solar still with Hot water Provision. Concrete stones Pebbles and black granite stones used as energy absorbing materials. The dripping arrangement and copper coil used in solar still.
Results shown that the solar still with concrete stones as energy storage material to give higher performance compared to other energy storage materials.it gives 8.40 liters/day total distillate water and 9.10 Liters/day hot water, also by using drip arrangement efficiency of still increased 17%.

**2.16 Ink and Black dye**
Dr. S. Shanmuga Priya et al. [38] were used ink and black dye as energy absorbing materials. During an experiment tests were carried out of black dye in feed water at 20ppm, 30ppm, 50 ppm and 70ppm concentration.Black Dye has improved the distilled water production by almost 65%, whereas Ink in water solution improves it over 35%. Results also shown that the improvement was observed with increasing concentration of dye from 20 ppm to 50 ppm and the rate of evaporation remain same during increasing concentration from 50 ppm to 70 ppm.
**2.17 Black granite gravels, Pebbles, Blue metal stones and Paraffin wax**
T.V Arjunan et al. [39] Were used various energy storage materials like black granite gravels, pebbles, blue metal stones and paraffin wax during an experiment to study the effect of energy storage materials on the performance of simple solar still. The energy storage materials in the still store the heat during noon hours and release that stored heat to the basin water in the evening when the radiation is low and night hours. The black granite gravels are more effective material than pebbles, blue metal, stone and paraffin wax materials. It gives higher distilled output water than other materials, stills and its efficiency 10.06% higher than the conventional still.

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