IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Water properties and measuring instruments of solar still and enhancement techniques of evaporation rate.

Dongare Santosh Dattatraya [1]
PhD scholar
Oriental University, (M.P.) Indore

Prof. (Dr.) Netra Pal Singh[2]
Professor –Mechanical Engineering
Oriental University Indore (M.P.)

Abstract: Water is particularly important basic need of human life for purposes of drinking, cleaning, and washing. Normally water resources are underground water, rivers, lakes, seas, and ponds. Water is also needed for many fields such as agricultural field and for industrial field. 70% of freshwater utilized through humans goes to agriculture. The river water, lake water, underground and sea water are directly not used in the human life. Water is essential for humans and other life forms to survive, even though it contains no calories or organic nutrients. In nearly every part of the world, access to clean drinking water has risen in recent decades, but nearly one billion people still lack access to safe water, and over 2.5 billion lack accesses to sufficient sanitation. So less than 0.3% of fresh water is not enough for all over the world, particularly in dry remote areas. A huge quantity of water is found in the earth's interior. So, the ground water source is especially important for human life and for industries. In some places, the ground water is very salty with the presence of more salt and harmful organisms in the natural water sources. This ground water is not used for drinking purpose. So, this water is needed to be converted into a good drinking water. Water purification is fulfilling for the drinking water requirements.
Keywords: properties of water, measuring instruments, energy storage system and materials

1 PROPERTIES OF WATER

1.1Freshwater

The pH of natural water is an important chemical property that influences its ability to dissolve minerals and influence chemical reactions. Water with a pH more than 0 and less than 7 is classified as acidic; water with pH value 7 is classified as neutral; and water with a pH between 7 & 14 is classified as alkaline (or basic). Distilled water has a pH value 7 and is considered neutral. Natural waters may also be neutral, but they are most often slightly acidic or basic. Rainwater is neutralized through chemical reactions with minerals in soils & rocks, resulting in a pH value 6.5 to 8.5 in most streams and lakes. The Total dissolved solid range is minimum of 100 mg/L of TDS and the maximum level is 500 mg/L. Seawater is denser than both pure water &fresh water at 4°C.

1.2Saline Water

The saltiness or dissolved salt content of a body of water is known as salinity. The following are the various amount of salt contents dissolved in the saline water.

- Freshwater: <100ppm
- Brackish water: 1000 - 35,000ppm
- Seawater: 30,000 - 50,000ppm
- Brine: > 50.000ppm
- Dead sea: 330.000ppm

1.3SeaWater

Water from a sea or ocean is known as seawater or salt water. The total salinity of seawater in the world's oceans is around 3.5 percent (35 g/L), which corresponds to a specific gravity of about 1.025. The salinity of seawater varies between 3.1 and 3.8 percent, although it is not universally salty around the world. Since dissolved salts raise the mass by a greater proportion than the volume, seawater is denser than both pure water fresh water. Sea water's freezing point drops as the of salt's concentration rises in water. The pH of seawater ranges from 7.5 to 8.4. The thermal conductivity decreases as salinity rises and increases as temperature rises.

Table-1 Properties of sea water

Property	Unit	Temperature oC	Salinity g/kg
Density	kg/m^3	0 - 180	0 - 160
Specific heat capacity	J/kg/K	0 - 180	0 - 180
Thermal conductivity	W/m.K	0 - 180	0 - 160
Dynamic viscosity	kg/m.s	0 - 180	0 - 150
Vapor pressure	kPa	0 - 200	0 - 240
Boiling point elevation	K	0 - 200	0 - 120
Latent heat of vaporization	J/kg	0 - 200	0 - 240

1.4p^{H}VALUE

The basicity (alkalinity) &acidity of an aqueous solution is measured using the pH scale. It is the negative of the logarithm to base 10 of hydrogen ions' concentration, or H+, measured in moles per liter. So, the pH of a solution is either the concentration or the behavior of hydrogen ions. Acidic solutions have a pH less than 7, whereas simple solutions have a pH greater than 7. Pure water has a pH of 7 and is neutral, meaning it is neither acidic nor basic. For strong acids and bases, the pH value may be less than 0 or more than 14. The pH of surface water is usually between 6.5 and 8.5, while the pH of groundwater is usually between 6.0 and 8.5. A glass electrode and a pH meter or indicator may be used to assess the pH of aqueous solutions.

1.5Total Dissolved solids

The inorganic salts and small quantities of organic matter found in solution of water are referred to as total dissolved solids (TDS). Magnesium, sodium, calcium, and potassium cations and carbonate, chloride, hydrogen carbonate, sulphate, and nitrate anions are the most common constituents. Dissolved solids' existence in water can alter its taste, with excellent being fewer than 300 mg/liter, good being 300 to 600 mg/liter, fair being 600 to 900 mg/liter, bad being 900 to 1200 mg/liter, and unacceptable being more than 1200 mg/liter. TDS concentrations of less than 1000 mg/liter are normally appropriate to consumers. TDS levels in fresh water are limited to 500 mg/L, while brackish water ranges from 500 to 30,000 mg/L. Corresponding to the Indian Standards' Bureau, the desirable limit is 500 mg/L, and the acceptable limit is 2000 mg/L, so drinking water with TDS greater than 2000 mg/L must be refused.

2 Solar Energy

Sunlight is one of numerous forms of heat energy that can be utilized to powers that process. The solar energy is non-pollution energy and free renewable source of energy. The Sun releases an enormous amount of radioactive energy to its surroundings 176610 W (174 PW), (1015 W=1 PW) at the upper atmosphere of the Earth. When the solar energy arrives at the surface of the Earth, losses of 6% (10.44 PW) by reflection and 16% (27.84 PW) by absorption by atmosphere and 20% (34.8 PW) by reflection and 3% (5.22 PW) by absorption by the clouds. The remaining 51% (89 PW) of solar radiation reaches to land and the earth surface including ocean, forest, and mountains etc. The solar power is approximately1.8MW.

2.1 Solar Radiation

Sunlight is Sun's electromagnetic radiation's a subset, which contains visible, ultraviolet infrared light. Sunlight is filtered through Earth's atmosphere, when the Sun is above the horizon and visible like daylight. Sunlight is radiant heat and bright light's mixture that occurs when direct solar radiation is not obscured through clouds. It is perceived as diffused light when it is obscured by clouds or reflects off other surfaces.

2.2 Solar Radiation Geometry

In the northern hemisphere, when sun is due south, and in the southern hemisphere, when sun is due north. During daylight hours, angle's average cosine between the sun and directly overhead. Horizontal surface solar beam radiation to direct natural radiation ratio, on a monthly average basis. Heat gain, shading, and the potential for day light penetration are all determined by the solar radiation geometry. The basic solar angles are Hour angle (m), Declination angle (6) and Latitude angle (Ø), the derived solar angles are Zenith angle (0z), Solar azimuth angle (ys) and Altitude angle (a), the surface angles are Incidence (0), Surface azimuth angle (y) and Slope (þ).

3 Measuring Instruments

An experimental work, the various readings are measured by using some measuring instruments. The basin water (T_b), temperatures of atmosphere (T_b), condensate yield (T_c), basin vapor (T_v), and diffused radiation are noted every hour through thermometers. A Lux Meter is utilized to measure the intensity of solar radiation. A jar is used to calculate the rate at which desalinated water is collected hourly. The wind velocity is measured by Anemometer.

3.1 Thermometer

Thermometer is an instrument used to measure the temperature of solar still and its range is 0^0C to 100ºC. There are five thermometers used to measure the various temperature of solar still. The following temperatures are measuring by the thermometer.

Figure-1 Thermometer

They are as follows:

Atmospheric temperature, solar still inlet water temperature. Solar still basin water temperature.

Solar still basin water vapour temperature Solar still condensed water temperature.

The first thermometer is utilized for measurement of the atmospheric temperature. The second thermometer is placed in the inlet way of the solar still and measures the solar still incoming saline water temperature. The third thermometer is placed in basin bottom side of the solar still and measures the solar still basin saline water temperature. The fourth thermometer is placed in basin top side of the solar still and measures the solar still basin saline water vapour temperature. The fifth thermometer is placed in the outlet way of the solar still and measures the solar still outgoing water temperature. All the temperature readings are measured in every hour. The measuring temperature readings are in ºC.

3.2 Lux meter

The Lux Meter is used as a measure of the solar intensity. Lux is the SI unit of illumines and it is equal to 1 lumen per square meter (lm/m^2) and the subsequent radiometric unit, which determines irradiance, is watt per square meter (W/m^2).

Figure-2 Lux meter

3.3Anemometer

Figure 3 anemometer

Anemometers used to measure the atmospheric air circulation and its range is 0–15 m/s. So, the ambient air velocity is measured by using Anemometer. The Anemometer readings are measured in every hour. The measuring air velocity readings are in m/s.

3.4 P^H and TDSMeter

P^H meter is an instrument, and it is utilized to measure water's quality. The presence of hydrogen atom in water is measured by using pH meter. The pH rate is used to estimate whether the water is drinking or not. Normally the pH rate is 6-10. The pH value for good drinking water is 7. The salt content increase in condition; the pH rate is also increased, and it is not used for purpose of drinking. The sea water pH value is 10.TDS meter is a one kind of measuring instrument and it is used to measure the solid contents dissolved in the water. Total dissolved solid rate is also indication quality of the water. The presence of some unwanted materials mixing with water is measured by using TDS meter. Normally the TDS rate is 500 mg/L to 2000 mg/L. The TDS value for good drinking water is 10

Figure-4 P^H and TDS Meter

0 mg/L. The unwanted mixing contents are in water; the TDS rate is also increased, and it is not used for purpose of drinking. The sea water TDS value is 1000 to 30,000mg/L.

Table-2: Properties of testing of sea water

Sl.No.	Properties of testing	Test Value			
		Raw water		water	
		saline	sea	saline	sea
1	PH	6.98	9.1	6.51	7.8
2	TDS in ppm	512	9250	22	116

3.5 Collecting Jar

The collecting jar is a glass or plastic container with a narrow neck, used for collecting the yield water. It is used to measure the yield of the solar still. The measurements readings are marking on the body of the bottle from bottom side to upper side. The marked measurement readings are 0-50ml- 100ml-150ml up to 1000ml indicated the stored water level. This measuring jar storing capacity is one liter of water. The collecting jar is made up of clear visible, cylindrical shape
Plastic material.

Figure-5 collecting jar

Table-3 Accurateness and error used for measuring Instruments

SL No	Instruments	Accuracy`	Range	% of error
1	Thermometer	± 10 C	0 – 100o C	0.25%
2	Sun meter	± 1 W/m2	0 – 2500 W/m2	2.50%
3	Anemometer	± 0.1 m/s	0 – 15 m/s	1%
4	Measuring jar	± 10 ml	0 – 1000 ml	1%

4 Energy Storage system

Normally heat energy is stored by two systems. They are,

- Active storage system
- Passive storage system

4.1 Active Storage

The active heat storage system has more extra parts for improving the effectiveness of solar still. It is applicable only in large scale application purpose. Some extra arrangements are utilized to enhance solar still's efficiency. They are,
For water circulation purpose, a water pump is used for circulation to feed of saline water from water tank to solar still basin.
For collecting more solar radiation purpose, the solar radiation collectors are fitted in the solar still.
For evaporating purpose, the solar heat energy materials are placed inside the solar still.
For condensing purpose, the additional condensers are used for cooling the vapour of solar still. This condenser is fitted inside or outside of the solar still.

4.2Passive Storage

The passive heat storage system is a simple and low-cost system. This system does not need any pump for circulation to feed of saline water from water tank to basin of solar still. It is applicable only in small scale application purpose. To improve the effectiveness, the following factors are involved. They are, Using the heat energy absorbing materials to increase the solar still's efficiency. Lowering the solar still basin saline water level Using the color dye to increase the solar absorption. Insulation coverage of solar still.Cooling the glass cover.

4.3 Sensible Heat Storage

When heat is applied to an object, the temperature rises. The term "sensible heat" refers to the rise in heat. Similarly, when heat is extracted by an object and temperature decreases, the heat is referred to as sensible heat. Sensible heat is heat that induces a temperature shift in an object. Sensible heat energy storage is heat energy storing process by permitting a material's temperature to rise or fall.

4.4 Latent Heat Storage

The latent heat energy storage is another kind of thermal energy storage system. The heat energy is stored by causing a material to phase change. Nature's pure substances have the ability to alter their state. Solids can turn into liquids, and liquids can turn into gases, but these transformations necessitate heat's removal or addition. The heat that produces this change is termed as latent heat. Latent heat of evaporation is 2390kJ/kg. K for water.
The storage mechanisms for solar TES materials can be classified into 3 categories: latent heat (LHS),sensible heat (SHS) and thermochemical (TCS). Since SHS is the most advanced of the systems, it has the benefit of being able to utilize a large variety of low-cost materials [18], but it also has the smallest storage space, which increases the system's dimensions. SHS is widely commercialized relative to other energy storage modes, while LHS and TCS are still in the development process [1].

Furthermore, the SHS system has a twenty-year lifespan, while the LHS (one-fourth of SHS) and TCS (one-tenth of SHS) systems have shorter lifespans[2].

5 Energy Storage materials

Different materials of energy storage are utilized in the basin along with water for improving the capacity of heat, capacity of radiation absorption and enhancing the rate of evaporation. Normally the energy material categories are,

- Wick materials
- Energy storage material

5.1 Wick Material

The following wick materials are used in the solar still in previous research work for storage the solar energy. They are:

a) Black Cloth

Matrawy et al. [3] developed a model for modified basin style solar stills and tested them. The corrugated black cloths on the porous material were immersed in water in their model, and the cloths absorbed the water because of the capillary effect. As compared to a traditional still, the improved solar still produced approximately 34% more distillate.

b) Jute

For a variety of heat transfer coefficients (convective and evaporative) of traditional solar stills, [4] has given Heat and mass transfer equations. The biggest downside of traditional solar is still its low performance. As a Result, researchers have made many improvements, such as using jute cloth, wick, sponges, and various heats Storage materials to increase the evaporation field. Sodha et al. [5] produced a multiple wick solar still in Which a blackened wet jute cloth was utilized to increase the evaporation rate. On winter days in Delhi, the Overall efficiency and distillate production were 34 percent and 2.5 L/m^2per day, respectively.

c) Cotton Waste

Murugavel & Srithar [6] studied the efficiency of a double slope basin style solar still with a variety of wick materials, including light jute cloth, coir mat, light black cotton cloth, waste cotton bits, and sponge sheet. In addition, several combinations of rectangular aluminum fins covered in a variety of wick materials were examined. The light black cotton fabric provided the most regular distillate production of all the materials examined. It was found that aligning rectangular aluminum fins with cotton cloth in a longitudinal pattern was more accurate.

The use of sensible, strong heat storage materials in the still enhances efficiency by 84 percent as compared to a traditional still [7]. It was discovered that by combining the solar stills with fins and increasing the heat transfer coefficients, the productivity of wick style solar stills can be increased by about 53%. Utilizing distinct inclination angles and reflectors in the solar stills, the daily yield of distilled water can be improved by about 14 percent to 34 percent [8].

5.2Energy Storage Materials

The following energy storage materials are utilized in the solar still in previous research work for storage the solar energy. They are Brick, Concrete jelly, Baby chips, Cement block, Black rubber mat.

Research Work Energy Storage Materials The materials which stores energy, in the still store a significant of heat's amount for the duration of the noon hours and release it to the basin water in the late afternoon hours when radiation is minimal, and they have been found to have a significant impact on the temperature of the solar still components [9]. As PCM is utilized as a storage material in a solar still, the distilled water production increases by around 2% for every cm of water depth and 1.96 percent for every 2 cm of water depth[10].PCM, Reflectors and Black Pebbles, all help to improve solar still productivity[11].

In this research work, the following energy storage materials are utilized in the solar still desalination process. Optimum depth of water with distinct heat absorbing materials to increase the capacity of heat storage and improve the quantity rate of production of good water. The single basin single glass covers passive type solar still is fabricated and solar still's performance is to be compared with distinct types of materials of energy storing such as glass balls, gravels, pebble, and nanomaterial like nano-aluminum oxide material (Al_2o_3). All the energy storage materials are placed along with the solar still basin.

a) Glass Balls

Silica is a common fundamental constituent of glass. Its chemical compound is SiO_2. Glass is a non-crystalline amorphous solid that is often transparent. Glass is in round shape and normally in black color. The sizes of balls are 0.010m to 0.014m diameter. The specific heat capacity of the glass ball is 840 J/Kg-K. Glass balls are sensible heat storage material and it is placed inside of the solar still basin. These glasses balls are used to absorb the solar radiation from sun rays and store the solar heat energy in sensible heat storage method's form.

Harris et al. [12] utilized low-cost energy storage materials to improve CSS efficiency and significantly decrease costs. The function of low-cost spherical ball salt storage materials in yield enhancement was investigated utilizing both methods (experimental & theoretical). The research reveals a promising method for producing low-cost potable water. Related research has also been published in literature [13, 14].

b) Glass Balls with Color Dye

The green color dye is liquid, and it is also mixed with solar still basin saline water and glass balls. This color dye is extracted from vegetable oil. The 20 ml of green color dye is used for mixing purpose with saline water. This color dye is used to increase the absorption of solar radiation.

c) Pebbles

A pebble is a small irregular stone that has been smoothed and formed by the action of water. Pebbles are available in a variety of textures &colors. Pebbles are usually with smooth outer surface and in size is0.004 to 0.064 m. Pebbles usually come in round or oval shape. Pebbles are extremely hard natural stone. The specific heat capacity of the pebbles is 775 J/Kg-K. Pebbles are sensible heat storage material and it is placed inside of the solar still basin. These pebbles are used to absorb the solar radiation from sun rays and store the solar heat energy in sensible heat storage method's form. Black Pebbles & Phase change material [15]. A black paint covering, pebbles, fins, and eventually vacuum are applied to the copper solar still. The still's production was greatly improved by using a black paint coating, pebbles, and fins [16]. To boost the daily productivity of a single slope solar still, responsive energy storage mediums (Al turning) of distinct masses (3 kg & 5 kg) were utilized in the basin [17].

The still's energy storage materials store a significant heat's amount during the hours of noon and release it to the basin water in the late afternoon hours when radiation is minimal, and they are observed to have a significant impact on the temperature of the solar still components [18]. When PCM is used as a storage material in a solar still, the distilled water production increases by around 2% for every cm of water depth and 1.96 percent for every 2 cm of water depth. [Nineteen] Reflectors, Black Pebbles, and PCM all help to improve solar still productivity[20]. A black paint covering, pebbles, fins, and eventually vacuum are applied to the copper solar still. The still's production was greatly improved by using a black paint coating, pebbles, and fins [21]. For increasing the daily productivity of a single slope solar still, responsive energy storage mediums (Al turning) of distinct masses (3 kg & 5 kg) were utilized in the basin.

d) Pebbles with Color Dye

The green color dye is liquid, and it is also mixed with solar still basin saline water and pebbled. This color dye is extracted from vegetable oil. The 20 ml of green color dye is used for mixing purpose with saline water. This color dye is used to increase the absorption of solar radiation.

e) Gravels

Gravels are small irregular shapes of black color stones and the outer surface is rough one. Gravel is made up of unconsolidated rock particles with a wide particle size spectrum, ranging from granules to boulders. Granular gravel size is 0.002 to 0.004 m. Gravel's specific heat capacity is 920 J/Kg-K. Gravels are sensible heat storage material and it is placed inside the solar still basin. These gravels are used to absorb the solar radiation from sun rays and store up the solar heat energy in the form of sensible heat storage process.

Nafey et al. (2001) performed experimentations in a reworked solar still through utilizing black gravels and black rubber sheets as medium of storage. They had performed experiments for distinct gravel's sizes, and they had attained the still output of approximately 4.5 liters/m^2 perday[22].

f) Gravels with Color Dye

The color dye is liquid, and it is also mixed with solar still basin saline water and gravels. This color dye is extracted from vegetable oil. The 20 ml of green color dye is used for mixing purpose with saline water. This color dye is used to increase the absorption of solarization.

g) Nanomaterial

The color of the nanoparticle is white. The purity of nanoparticle is nearly 99+% The mean particle size of nanoparticle is>60 nm. Morphology of the nanoparticle is nearly spherical. The specific heat capacity of the nanoparticle is 900 J/Kg-K. Its size is uniform. It has high degree of particle spherically as result, high flow ability and high packing density. It has high thermal conductivity, hardness etc. Nano metal oxides have greater surface area. Over a broad temperature range, alumina nanoparticles are thermodynamically stable particles. The Nano material (Aluminum Oxide) is not dissolved in water and not destroyed under sun light. Hence it is re- usable, lost longer. The nano material could retain more heat energy and easily available Nano- material (Al_2o_3) is a sensible heat storage material and it is placed inside of the solar still basin.

Shanmugan et al. [23] utilized nanoparticles (Al2O3),PCMs, and various basin wick materials to improve the thermal efficiency of a single basin solar still. For the duration of winter &summer, the distillate production values of nanoparticles and a single basin solar still (fin with cotton wick) with PCMs were 4.120 &7.460 kg/m2, correspondingly, from 9:00 a.m. to 5:00 p.m. It was investigated in terms of yield utilizing a nano-composite phase change content (paraffin wax & Al2O3), and a significant increase in yield was observed.

h) Nano- Material with Color Dye

The color dye is liquid, and it is also mixed with solar still basin saline water and nano material. This color dye is extracted from vegetable oil. The 20 ml of green color dye is used for mixing purpose with saline water. This color dye is used for increasing solar radiation's absorption.

i) Color Dye

The color dye is in liquid form or powder form. This color dye is extracted from vegetable oil. In solar desalination process the color dye is mixed with saline water. A green color dye is used for the desalination process in the solar still. The 20 ml of green color dye is mixed with solar still basin water. This color dye is utilized to increase solar radiation's absorption in the solar desalination process. The mixing of dyes with solar still saline water, the performance of solar still is increased and increased the production rate of solar still.

The inclusion of heat-storing materials increases the Solar's performance much more than it would be without them. Absorbing materials like black ink, black dye & black rubber mats increase production by 45%, 60%,&38%, respectively[24].

j) Rocks

Rocks have several benefits, including their low cost, lack of toxicity, accessibility,andnonflammability. However, there are certain drawbacks, like the requirement for air mass flow speeds and higher pressure drops [25].

6) Conclusion

This paper includes Properties of water which, Solar Energy and Measuring Instruments Energy Storage system Energy Storage materials which is for improving the performance of solar still also this paper will help in the choice of suitable materials for attaining effective solar thermal energy storage

7) References

[1]. Nazir H, Batool M, Osorio FJB, et al. (2019) Recent developments in phase change materials for energy storage applications: A review. Int J Heat Mass Transfer 129: 491–523.
[2]. Abedin AH, Rosen MA (2011) A critical review of thermo chemical energy storage systems.
[3] K.K. Matrawy, A.S. Alosaimy, A.F. Mahrous, Modeling and experimental study of a corrugate wick type solar still: comparative study with a simple basin type, Energy Convers. Manag.105 (2015) 1261e1268.
[4] R.V. Dunkle, Solar water distillation: the roof type still and multiple effect diffusion still, International Developments in Heat Transfer, ASME, in: Proceedings of International Heat Transfer Conference, University of Colorado V, 1961, pp. 895e902
[5] M.S. Sodha, A. Kumar, G.N. Tiwari, R.C. Tyagi, Simple multi wick solar still: analysis and performance, Sol. Energy 26 (1981) 127e131.
[6] K. KalidasaMurugavel, K. Srithar, Performance study on basin type double slope solar still with different wick materials and minimum mass of water, Renew.Energy 36 (2011) 612e620.
[7]JyotiBhalaviRuchikaSaini" Performance Enhancement of Solar Still using Energy Storage

Material"International Journal of Current Engineering and Technology,Vol.8, No.4 (July/Aug 2018)
[8]A. SenthilRajana,K. Rajab, P. Marimuthu "Increasing the productivity of pyramid solar still augmented with biomass heat source and analytical validation using RSM" Desalination and Water Treatment (2015)1–14
[9].Avesahemad S.N. Husainy, Omkar S. Karangale, Vinayak Y Shinde "Experimental Study of Double Slope Solar Distillation with and without Effect of Latent Thermal Energy Storage" Asian Review of Mechanical Engineering ISSN: 2249 - 6289 Vol. 6 No. 2,2017.
[10]Kantesh.D.C "design of sloar stills using phase changing materials as a storage medium" International Journal of Scientific & Engineering Research, Volume 3,Issue 12, December-2012.
[11]SumitSomeshwarNaygaonkar, R.H.Yadav "Design and Experimental Analysis of Double Slope Single Basin Solar Still Using Phase Changing Materials, Sensible heat
[12]Samuel DH, Nagarajan P, Sathyamurthy R, El-Agouz S, Kannan E. Improving the yield of fresh water in conventional solar still using low cost energy storage material. Energy Convers Manag. 2016;112:125–34.
[13]. Panchal H, Sathyamurthy R, Kabeel A, El-Agouz S, Rufus D, Arunkumar T, et al. Annual performance analysis of adding different nanofuids in stepped solar still. J Therm Anal Calorim. 2019;138(5):3175–82.
[14]. Sasikumar C, Manokar AM, Vimala M, Winston DP, Kabeel A, Sathyamurthy R, et al. Experimental studies on passive inclined solar panel absorber solar still. J Therm Anal Calorim. 2020;139(6):3649–60.
[15]Naygaonkar S S&Yadav R H, *Int J EngSciInven*, 7 (2018) 11
[16]Gnanadasona M K, Kumar P S, Wilsonc V H &Kumaraveld A, Desalination and Water Treatment, Balaban Desalination Publications,2014.
[17]TiwariDevashish&Rai A K, *Int J MechEngTechnol*, 7(2016
[18].Avesahemad S.N. Husainy, Omkar S. Karangale, Vinayak Y Shinde "Experimental Study of Double Slope Solar Distillation with and without Effect of Latent Thermal Energy Storage" Asian Review of Mechanical Engineering ISSN: 2249 - 6289 Vol. 6 No. 2,2017. [19].Kantesh.D.C "design of sloar stills using phase changing materials as a storage medium" International Journal of Scientific & Engineering Research, Volume 3, Issue 12, December-2012.
[20].SumitSomeshwarNaygaonkar, R.H.Yadav "Design and Experimental Analysis of Double Slope Single Basin Solar Still Using Phase Changing Materials, Sensible
[21].Heat Storing Elements and Reflectors" International Journal of Engineering Science Invention Volume 7 Issue 7 VerIV , July 2018, PP 11-20.
[22]Nafey, A. S., Abdelkader, M., Abdelmotalip, A., and Mabrouk, A. A.001Solarstill productivity enhancement.Energy Convers. Manage. 42:1401–1408.
[23] S. Shanmugan, S. Palani, B. Janarthanan, Productivity enhancement of solar still by PCM and Nanoparticles miscellaneous basin absorbing materials, Desalination 433 (2018) 186e198.
[24]HeminThakkar, Dr. Hitesh Panchal "Performance Investigation on Solar Still with PCM and Nano-Composites: Experimental Investigation" International Journal of Research and Scientific Innovation ISSN 2321- 2705
[25]Hänchen M, Brückner S, Steinfeld A, et al. (2011) High-temperature thermal storage using a packed bed of rocks–heat transfer analysis and experimental validation. ApplThermEng 31: 1798– 1806