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SEA WATER DESALINATION USING SOLAR ENERGY WITH THERMAL AND OPTICAL PHENOMENA

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Abstract

Water Scarcity is one of the major problems in India, this is happening because of the depletion in ground water formation and adverse climatic changes. The need for drinking water is abundant but water resources are decreasing day by day. So it's time to develop the technology of desalination all over India to convert saline water into drinking water.

The main principles involved in this desalination are evaporation and condensation; hence this process is called as SOLAR DISTILLATION. The raw water is sent from the inlet valve into the looped pipe which is placed in the preheating tray and then the pre heated water is discharged into the solar still where distillation takes place, later the desalinated water is collected at the collecting point. We have taken 2 samples in 24 hours for conductance of various tests. The treated water is taken for analyses in which tests like Ph, Turbidity, TDS, Electrical Conductivity etc. are carried out to check the quality of water obtained. The values of Ph is from 8 to 6.5, Turbidity is from 17 NTU to 0 NTU, DO is from 3.2 ppm to 6ppm and we determined that all the values obtained for the parameters are under desirable limits according to IS 10500:2012 drinking water standards. So the water obtained can be used for drinking as well as industrial purpose as the Water Quality Index of sample 1 is **14.4** and sample 2 is **3.06**. The cost of the entire setup is 1500/- which gives 1.5 – 2 liters of water a day, with the cost of constructing this equipment we can buy only 75 liter's of water but with this equipment we can generate 50 liters of water monthly.

Keywords: Desalination, Solar Energy, Thermal, Electrical Conductivity.

1. INTRODUCTION :

Desalination is a process that takes away mineral components from saline water. More generally, desalination refers to the removal of salts and minerals. Saltwater is desalinated to produce water suitable for human consumption or irrigation. The byproduct of the desalination process is brine. Desalination is used on many seagoing ships and submarines. Most of the modern interest in desalination is focused on the cost effective provision of fresh water for human use. Due to its energy consumption desalinating seawater is generally more costly than the freshwater from rivers or groundwater, water recycling and water conservation. However, these alternatives are not

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available and depletion of reserves is a critical worldwide problem. Desalination processes are usually driven by either thermal or electrical or wind as the primary energy types. Currently, approximately 1% of world population is dependent on desalinated water to meet daily needs but the UN expects that 14 % of the world's population will encounter water scarcity by 2025.

1.1 DESALINATION TECHNIQUES

There are several methods. Each has advantages and disadvantages but all are useful. Methods can be divided into membrane-based and thermal based. The traditional process of desalination is distillation i.e. boiling and re condensation of seawater to leave salt and impurities behind.

1.2 Solar Distillation

Solar distillation mimics the natural water cycle in which the sun heats the seawater enough for evaporation to occur. After evaporation the water vapor is condensed onto a cool surface. There are two types of solar desalination.

The former one is using photo voltaic cells which convert solar energy to electrical energy to power the desalination process. The letter one utilizes the solar energy in the heat from itself and is known as solar thermal powered desalination.

1.3 Vacuum Distillation

In vacuum distillation atmospheric pressure is reduced does lowering the temperature required to evaporate the water. Liquid boy when the vapor pressure equals the ambient pressure and vapor pressure increases with temperature. Effectively liquids boil at lower temperature, when the ambient atmospheric pressure is less than the usual atmospheric pressure. Thus, because of the reduced pressure, low temperature "waste" heat from electrical power generation or industrial process can be employed.

1.4 Multistage flash distillation:

Water is evaporated and separated from seawater through multistage flash distillation, which is a series of flash evaporations. Each subsequent flash process utilizes energy released from the condensation of the water vapor from the previous step.

1.5 Multiple effect distillation:

Multiple effect distillation works through a series of steps called effects. Incoming water is sprayed on two pipes which are then heated to generate steam. The steam is then used to heat the next batch of incoming seawater. To increase efficiency, the steam used to heat the sea water can be taken from nearby power plants. Although this method is the most thermodynamically efficient among methods forward by heat, a few limitations exist such as a maximum temperature and maximum number of effects.

1.6 Vapor compression distillation:

Vapor compression evaporation involves using either a mechanical compressor or a jet stream to compress the vapor present above the liquid. The compressive vapor is the used to provide the heat needed for evaporation of the rest of the seawater. Sing system only requires power it is more cost effective if kept at a small scale.

1.7 Reverse osmosis:

The leading process for desalination in terms of installed capacity and early growth is reverse osmosis. The reverse

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osmosis membrane processes used semi permeable membrane and applied pressure (on the membrane feed side) to preferentially induce water permission to the membrane while rejecting salts. Reverse osmosis plant membrane systems typically use less energy than thermal desalination processes. Energy cost in desalination processes where is constable depending on water salinity, plant size and process type. At present the cost of seawater desalination, for example, higher than traditional wear sources, but it is expected that cost will continue to decrease with technology improvements include.

2. LITERATURE REVIEW:

Distillation has long been considered a way of making salt water drinkable and purifying water in remote locations. As early as the fourth century B.C., Aristotle described a method to evaporate impure water and then condense it for potable use. Arabian alchemists were the earliest known people to use solar distillation to produce potable water in the sixteenth century. However, the first documented reference for a device was made in 1742 by Nicolo Ghezzi of Italy, although it is not known whether he went beyond the conceptual stage and actually built it. The first modern solar still was built in Las Salinas, Chile, in 1872, by Charles Wilson (Hay, 1973). It consisted of 64 water basins (a total of 4,459 square meters) made of blackened wood with sloping glass covers.

This installation was used to supply water (20,000 liters per day) to animals working in mining operations. After this area was opened to the outside by railroad, the installation was 13 allowed to deteriorate but was still in operation as late as 1912-40 years after its initial construction. This design has formed the basis for the majority of stills built since that time. During the 1950s, interest in solar distillation was revived, and in virtually all cases, the objective was to develop large centralized distillation plants. In California, the goal was to develop plants capable of producing one million gallons, or 3,775 cubic meters of water per day.

However, after about 10 years, researchers around the world concluded that large solar distillation plants were too expensive to compete with fuel-fired ones. Therefore, research shifted to smaller solar distillation plants. Between 1960 and 1970, 38 plants were built in 14 countries, with capacities ranging from a few hundred liters to around 30,000 liters of water per day. Of these, about one third have since been dismantled or abandoned due to material failures. None in this size range is reported to have been built in the last 7 years. Despite the growing discouragement over community-size plants, McCracken Solar Company in California continued its efforts to market solar stills for residential use. Worldwide interest in small residential-units is growing, and now that the price of oil is ten times what it was in the 1960s, interest in the larger units may be revived.

3. MATERIALS:

3.1 Aluminium:

Aluminium sheet 12 gauge is used as a black box in order to preheat the water. Aluminium sheet 6 gauge is used as a support tray in the solar still, in a way to increase efficiency as aluminium absorbs more heat than wood.

3.2 Properties:

- Light in weight
- Corrosion resistance
- Thermal conductivity
- Reflectivity
- Impermeable and odour less
- Ductile and Malleable
- CV = 950 J (kg °C)

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3.3Glass
Glass is used here to cover the top of solar still. glass is transparent hence allows the sun rays into the solar still to heat the water.

3.4 Properties:
- Chemical resistance
- Transparent
- Hardness an brittleness
- Weather resistance
- Insulation

3.5 Steel pipes
Diameter pipes are placed in the Black Box which preheats water. The pipes are connected with the elbow joints in a looped system.

3.6 Properties:
- High strength
- Good toughness
- Thermal processing
- Thin wall thickness to same metal

3.7 Rubber pipes:
Styrene Butadiene rubber pipe is used to preheated water from black box to the solar properties.

3.8 Properties:
- Resistant to oxygen
- Low temperature flexibility
- Heat resistance
- Water resistance

3.9 Inlet and Outlet valves :
Inlet outlet valves are used to regulate the flow of water and as well to release water. Inlet and outlet valves used here are made of PVC (poly vinyl chloride).

3.10 Properties of PVC:
- Very dense compared to other plastics
- Easily available and cheap
- Rigid PVC is very hard
- Good tensile strength

4. EXPERIMENTAL PROGRAMME:
4.1 Evaporation: Evaporation is the process by which water changes from a liquid to a gas or vapor. Evaporation is the primary pathway that water moves from the liquid state back into the water cycle as atmospheric water vapor. Studies have shown that the oceans, seas, lakes, and rivers provide nearly 90 percent of the moisture in the atmosphere via evaporation. Seawater contains other valuable minerals that are easily obtained by evaporation.

4.2 Condensation: Condensation is the process by which water vapor in the air is changed into liquid water. The phase change that accompanies water as it moves between its vapors, liquid, and solid form is exhibited in the arrangement of water molecules. Water molecules in the vapor form are arranged more randomly than in liquid water. As condensation occurs and liquid water forms from the vapor, the water molecules become more organized and heat is released into the atmosphere as a result.

The Evaporation and Condensation are done by using **solar energy** as a resource.

5 .WORKING OF THE MODEL
At the very beginning the saline water is filled into the looped pipe fully which is in preheating tray and the parabolic dish is focused onto the preheating tray in order to heat up the water stored in it. After half an hour the preheated water is released through valves into the solar still which is ready for evaporation.

Again fill the looped pipe and repeat the cycle. The water which is preheated and stored in the solar still undergoes evaporation and condensation and forms

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the water vapor , the vapor gets attached to the glass surface which is placed in 1:6 cant. Due to the slope of glass surface the water droplets will slowly slides down to the lower end and falls into the collected pipe and the droplets are further collected to the container in which desalinated water is stored. Likewise the entire water will get evaporated, condensed and collected. It is completely manually operated process for every half an hour. The collected water is taken for analysis to check the quality by comparing with standard values given in IS 10500:2012 for drinking water. In the absence of sunlight the water do not undergo any evaporation so to encounter this problem we wanted to introduce a material (PCM) in to the preheating tray to heat the water. PCM (Phase Changing Material – Mg(NO3)26H2O) acts as a source of energy during night time. PCM will absorb the heat from the sun during day time and liberates heat in the night time which results in the absence of sun light.

Water quality testing is an important part of environmental monitoring. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well. These sections detail all of the parameters that affect the quality of water in the environment. These properties can be physical, chemical or biological factors. Physical properties of water quality include temperature and turbidity. Chemical characteristics in wall parameters as pH and dissolved oxygen. Biological indicators of water quality include algae and phytoplankton. Water quality testing is important because it identifies contaminants and prevents water borne diseases. Examination or analyses of water is used to classify, prescribe treatment and control treatment and purification process and to maintain public supplies of an appropriate standard of organic quality, clarity and palatability. Essentially, water quality testing makes sure that water is safe and meets local and international water standards. In order to check the quality of desalinated water through solar still we are conducting the following tests.

6. TEST RESULTS & DISCUSSION:

In this chapter the results obtained are compared with the standard values according to the drinking standards (IS 10500:2012) to check whether desalinated water is meeting the limits or not. Water Quality Index is also calculated to determine the quality and acceptability for drinking.

S.No	WQI	Status Possible	Usages
1	0 – 25	Excellent	Drinking, Irrigation and Industrial
2	25 – 50	Good	Domestic, Irrigation and Industrial
3	51 -75	Fair	Irrigation and Industrial
4	76 – 100	Poor	Irrigation
5	101 - 150	Very Poor	Restricted use for Irrigation
6	Above 150	Unfit for Drinking	Proper treatment required before use.

6.1 RAW WATER:

The sample is collected from Kakinada beach area. The raw water is tested for five basic parameters, those are pH, Turbidity, Total Dissolved Solids, Dissolved Oxygen and Electrical Conductivity.

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The solar distillation almost removed all suspended solids and most of the minerals from the water, as you can observe the conductance is negligible and turbidity is 0.

The values obtained are tabulated below

TEST	SALINE WATER	EXTRACTED WATER	IS 10500:2012 LIMITS
Electrical Conductivity	44.9 ms/cm	0.05 ms/cm	1000 ms/cm
Total Dissolved Solids	27.3 ppm	0.06 ppm	500 ppm
Turbidity	17 FTU	0 FTU	1 FTU
Dissolved Oxygen	3.2 mg/l	6 mg/l	> 6mg/l
pH	8	6.5	6.5 – 8.5

6.2 SAMPLE 1:

The sample 1 is tested for 14 water quality parameters and the results are pH is 6.65, TDS is 0.12 ppm, Turbidity is 1 NTU, DO is 6.6 ppm, Total Alkalinity is 25 mg/l as CaCO3, Electrical Conductivity is 0.09 ms/cm, Calcium is 18 ppm, Magnesium is 1.5 ppm, Sodium is 49.7 ppm, Chloride content is 20.1 ppm, Potassium is 0.7 ppm, Sulphate is 15 ppm, Nitrate is 0.082 ppm, Phosphate is 0.68 ppm.

The results obtained are under the limits of IS 10500:2012 drinking water standards and water quality index is below 25, therefore water obtained is safe for drinking.

6.3 SAMPLE 2:

The sample 2 is tested for 14 water quality parameters and the results are pH is 6.5, TDS is 0.06 ppm, Turbidity is 0 NTU, DO is 6.2 ppm, Total Alkalinity is 20 mg/l as CaCO3, Electrical Conductivity is 0.05 ms/cm, Calcium is 17 ppm, Magnesium is 1 ppm, Sodium is 30.9 ppm, Chloride content is 19.8 ppm, Potassium is 0 ppm, Sulphate is 12 ppm, Nitrate is 0.056 ppm, Phosphate is 0.45 ppm.

The results obtained are under the limits of IS 10500:2012 drinking water standards and water quality index is below 25, therefore water obtained is safe for drinking.

7. CONCLUSION:

Solar still is an equipment which desalinates saline water using solar energy as resource. This process works on a basic principle "Distillation" which involves evaporation and condensation. Hence this can be called as solar distillation. The following conclusions are made after completion of this project, Solar still mostly removes all the minerals present in the saline water through distillation process. The WATER QUALITY INDEX of sample 1 is 14.4 and sample 2 is 3.06 that means the treated water can be used for drinking and industrial purposes. This method works on a renewable energy i.e. solar power so we do not require any fuel or electricity. The equipment is cheap, eco – friendly and easy to install. The cost of the entire setup is 1500/- which gives 1.5 – 2 liters of water a day, with the cost of constructing this equipment we can buy only 75 liter's of water but with this equipment we can generate 50 liters of water monthly.

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