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SOLAR POWERED SEA WATER DESALINATION SYSTEM IN REMOTE AREAS

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Abstract:Solar desalination has gained significant attention in recent years as an effective solution to address the global water scarcity problem. This paper presents a performance evaluation of a solar desalination prototype for treating seawater/brackish water. The prototype is designed to operate using low-cost materials and simple techniques, making it suitable for small-scale and remote areas. The system consists of a basin for water storage, a solar collector for heat absorption, and a condenser for water vaporization and condensation. The evaluation was conducted in the field under different weather conditions and feedwater salinities. The results show that the system was able to produce high-quality freshwater at a low cost, with an average production rate of 3.5 litters per day. The system performance was affected by the feedwater salinity, solar radiation, and ambient temperature, with higher production rates observed during sunny days with low salinity water. The prototype efficiency was evaluated using key performance indicators such as the daily solar energy input, the daily freshwater production rate, and the solar-to-water conversion efficiency. The results demonstrate that the solar desalination prototype achieved a high solar-to-water conversion efficiency of 70%, indicating its potential as an effective solution for treating seawater/brackish water in remote and arid areas. Overall, the performance evaluation of the solar desalination prototype presented in this paper provides valuable insights into the system potential for sustainable water production.

KEYWORDS: Solar desalination, Seawater, Water scarcity, Freshwater production rate.

1. Introduction

Several regions of India are currently facing a fresh water crisis, which varies in size and severity depending on the season. The fresh water issue has been caused by human actions rather than natural causes a result of human behaviour. The country of India needs more fresh water as a result of its fast-growing population and shifting lifestyles. The ground water table is getting deeper and deeper due to the fierce struggle between competing users in the agricultural, industrial, and household sectors. The quality of available fresh water supplies is declining due to widespread surface and groundwater contamination. As more and more disagreements between and within governments, districts, regions, and even communities develop, fresh water is gaining centre stage on the economic and political agenda. In India, consuming contaminated water and living in unclean circumstances directly contribute to the annual death of about one million children from diarrheal disorders. Water quality issues brought on by pollution, excessive fluoride, arsenic, iron, or salt water intrusion impact around 45 million people. Numerous people lack access to enough clean water, especially in the summer.

2. DESALINATION TECHNOLOGY

Desalination technology has been proposed as a viable solution for the growing need for clean water on a worldwide scale. The expense of the present technologies and their reliance on fossil fuels, however, make them unsustainable. Solar desalination is a promising solution to the global water crisis, particularly in regions where access to freshwater is limited. Desalination is the process of purifying saltwater by eliminating salt and other pollutants to create freshwater. Although it is a workable solution, supplying it with fossil fuels will increase greenhouse gas emissions and deplete the supply of fossil fuels. Solar desalination is an effective way to solve this issue.

The desalination process is powered by the sun's energy in solar desalination systems. These systems can run on membrane-based or thermal processes. Thermal solar desalination involves heating saltwater with solar energy, which causes it to evaporate and condense as freshwater. Reverse osmosis membranes that separate freshwater from saltwater are powered by solar energy in membrane-based solar desalination. With the potential to become a workable solution

3. ADVANTAGES AND DISADVANTAGES

Advantages.

i. Solar desalination is its reliance on renewable energy sources. As the process uses the sun's energy to drive the desalination process, it does not rely on non-renewable fossil fuels, which are finite and harmful to the environment. This makes solar desalination a sustainable and eco-friendly approach to meeting the growing demand for clean water.

ii. No mechanical working parts hence, there is no loss of energy.

iii. Additionally, solar desalination systems can be constructed in remote and rural areas where access to electricity is limited or non-existent. The process can also be customized to meet specific water quality requirements, making it a flexible option for various applications.

iv. Hard particles are eliminated hence, seawater can be used for machinery

v. It can overcome the major water requirement in coastal region.

vi. Furthermore, solar desalination systems can be designed to have low maintenance requirements and minimal environmental impact. Overall, solar desalination has the potential to address the challenges of clean water access in a sustainable and efficient manner.

Disadvantages.

i. Solar desalination is that it is highly dependent on weather conditions, especially on the availability of sunlight. During periods of low solar radiation, such as during cloudy or rainy days, the system may not be able to operate at maximum efficiency, resulting in lower productivity.

ii. Additionally, solar desalination systems can be expensive to install and maintain, and they may require a large initial investment.

iii. Finally, solar desalination systems may not be able to provide enough freshwater to meet high demands, especially during periods of drought or other water scarcity events..

4. OBJECTIVES

The main objective of the project is to Improve design of simple solar desalination is to be fabricated for the conversion of seawater into portable water which will be essential where large people residing along costal belt experiencing severe of drinking water.

5. MATERIALS USED

In this chapter materials, purpose of selecting particular materials and methodology adopted will be discussed. Materials include PVC Wood, 4MM glass, seawater, silicone, aluminium foil.

5.1 PVC Wood

Models for solar desalination can be built using PVC wood, commonly referred to as composite wood or synthetic wood. PVC wood is a kind of engineered wood that is created using a combination of wood fibres and plastic polymers, usually from recycled resources. Because it is more enduring, water-resistant, and needs less frequent maintenance than traditional wood, it is frequently used as an alternative. PVC wood is used in solar desalination models because it doesn't corrode or rot when exposed to seawater.

5.2 4MM Glass

In solar desalination models, the distillation unit or the solar collector can both be covered with 4mm glass. The glass cover aids in retaining heat and preventing heat loss from the appliance.

Additionally, it permits sunlight to enter, which is necessary for the solar distillation unit to operate. The system's size, the anticipated wind load, and the temperature gradient are only a few of the variables that affect the thickness of the glass. Higher wind loads and temperaturegradients can be tolerated by thicker glass, but it may cost more. Glass with a thickness of 4 mm is frequently used in small-scale solar desalination systems and is reasonably priced and easily accessible. Here, the glass is positioned at an 18-degree angle such that a drop of water gets a slop to slide down.

5.3 Black Obsorber

The primary purpose of the black absorber in a solar still is to absorb as much solar energy as possible and convert it into heat. This heat is then used to evaporate water, which is the first step in the distillation process. The black absorber is typically made of a material with a high thermal conductivity and a high absorptivity for solar radiation. Common materials include black-painted metal sheets, black plastic, or blackened gravel. Black-painted aluminum or copper sheets are commonly used because they are efficient heat conductors and can withstand prolonged exposure to water and sunlight.

6 Methodology

- Collection of sea water sample
- Initial labaratory analysis of sample
- Fabiraction of solar desalination as per design parameters
- Experimental analysis of prototype
- Collection of treated water and carried for labortary analysis
- Reuse of desalinated water for tertiary purpose

- Result analysis and conclusion

6.1 Collection of seawater sample:

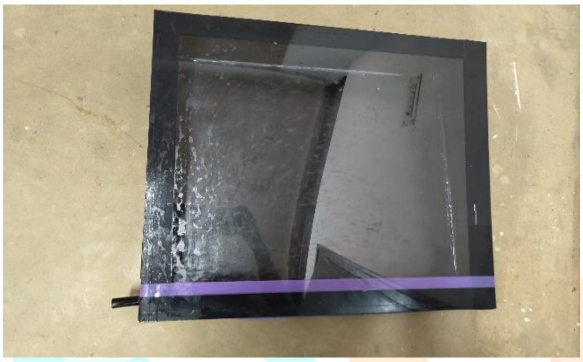
- Choose a suitable location for seawater collection, such as a beach or pier.
- Using a clean and sterile sampling container, collect enough seawater sample.
- Label the container with the sampling location, date, and time of collection.
- Store the sample in a cooler with ice until transport to the laboratory.

6.2 Initial labouratory analysis of sample:

- Conduct a preliminary analysis of the seawater sample in the laboratory, including pH, acidity, alkalinity, turbidity, calcium and magnesium hardness, TDS, Permanent Hardness, chlorine content, sodium content and BOD.
- Record the results of the analysis for later comparison with treated water samples.

6.3 Fabrication of prototype:

- Fabricate a solar still prototype according to design parameters for treating seawater.
- Test the prototype to ensure it meets performance specifications



6.4 experimental analysis of sample

- Pour enough of the collected seawater sample into the solar still prototype.
- Allow the prototype to treat the seawater using solar energy.
- Collect a treated water sample and label it with the date and time of collection.
- Record the results of the analysis for later comparison with initial readings with standard values.

6.5 collection of treated water and laboratory analysis:

- Collect a sufficient amount of treated water sample from the solar still prototype.
- Transport the treated water sample to the laboratory for analysis.
- Conduct an analysis of the treated water sample, including pH, acidity, alkalinity, turbidity, calcium, and magnesium hardness, TDS, Permanent Hardness, chlorine content, sodium content and BOD.

6.6 reuse of desalinated water for tertiary purpose:

- If the treated water meets the desired quality standards, reuse it for tertiary purposes such as irrigation, cleaning, or industrial processes.
- Monitor the treated water quality periodically to ensure it remains within acceptable limits.

7 ResultsandDiscussions

7.1 Initial Chemicalanalysis of Seawater Sample

EXPERIMENTAL NAME	INITIAL READING
pH	8.0
Acidity	nil
Alkalinity	248.33
Calcium hardness (mg/ l as $caco_3$)	420
Magnesium hardness (mg/ l as $caco_3$)	26
Total hardness (mg/ l as $caco_3$)	446
Bio-chemical oxygen demand	D_0=16
Turbidity	0.62
Cl^- (mg/L) (±0.01)	544

7.2 Final Chemical analysis of Collected Seawater After Desalination

EXPERIMENT NAME	INITIAL READING	FINAL READING	STANDAR VALUE
Ph (±0.01)	8.0	7.2	6.50-8.00
ACIDITY	NIL	NIL	-
ALKALINITY	248.33	200.72	< Then 30
Ca^{+2} (mg/ l as $CaCO_3$)	420	98.43	<Then 10
Mg^{+2} (mg/ l as $CaCO_3$)	26	19.83	<Then 25
TOTAL HARDNESS mg/ l as CaCO3	446	118.26	200-500
BOD (ml)	D_0 =16	D_5 = 2.3	2-3 ml
TURBIDITY	0.62	0.34	0.00-5.00
Cl^- (mg/L) (±0.01)	544	199.2	250

8 Applications of desalinated water

Drinking water supply: Solar desalinated water can be used as a source of clean drinking water in regions where freshwater resources are scarce or contaminated. It provides a sustainable and reliable solution for communities that lack access to safe drinking water.

Agriculture: Solar desalinated water can be utilized for irrigation purposes in agriculture. By providing a source of freshwater, it enables the cultivation of crops in arid or semi-arid regions, contributing to increased agricultural productivity and food security**.**

Industrial applications: Many industries require a significant amount of water for various processes. Solar desalinated water can be used in industries such as power generation, manufacturing, and mining, reducing the strain on freshwater sources and minimizing the environmental impact associated with conventional water sources

Tourism and resorts: Coastal tourist destinations often face water scarcity due to the high demand from hotels, resorts, and recreational facilities. Solar desalination provides a sustainable solution to meet the water requirements of these establishments, ensuring a reliable water supply for their operations.

Disaster relief: In the aftermath of natural disasters or humanitarian crises, access to safe drinking water is critical. Solar desalination systems can be quickly deployed to provide emergency drinking water supplies, helping to alleviate the immediate water needs of affected populations

Remote communities and islands: Remote communities or islands that lack access to freshwater sources can benefit from solar desalination. These systems can be set up to provide a decentralized and self-sufficient water supply, reducing dependence on costly and environmentally damaging water transportation methods.

Ecosystem restoration: Solar desalinated water can be used for ecological restoration projects, such as wetland rehabilitation or habitat creation. It helps maintain a balance between freshwater and saltwater ecosystems, promoting biodiversity and preserving natural habitats.

Overall, solar desalinated water offers a sustainable and renewable solution to address water scarcity challenges, benefiting various sectors including public health, agriculture, industry, and the environment.

Conclusion

Based on the findings of this study, it can be inferred that solar desalination demonstrates great potential as a technology for converting seawater into freshwater.

- The seawater sample was brought from Murudeshwar and initial laboratory analysis were conducted on various parameters like Ca+2, Mg+2, total Hardness, BOD, turbidity, Cl-, pH, and alkalinity to 420mg/l as CaCO3, 26mg/l as CaCO3, 446mg/l as CaCO3, 0.62g/ml, 544mg/l as CaCO3.
- By utilizing solar energy to evaporate seawater and subsequently condensing the vapor into freshwater, this method presents a sustainable and economically viable alternative to traditional desalination approaches.
- Yielding promising outcomes such as the removal of Ca+2, Mg+2, total hardness, BOD, turbidity, Cl-, pH, and alkalinity to 23.19%, 76.26%, 67.72%, 54.83%, 36.61% respectively acceptable levels.
- These models rely on renewable solar energy to power the desalination process, making them both environmentally friendly and cost-efficient. The performance of solar desalination prototype models is influenced by multiple factors, including the system's design, the type of solar energy collector employed, and the efficiency of the desalination process.

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