"DESALINATION OF SEA WATER BY USING SOLAR POWERED DESALINATION SYSTEM FOR REMOTE AREAS"

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Abstract - India is facing a severe freshwater crisis due to population growth, changing lifestyles, and contamination of existing water sources. The country's groundwater table is depleting rapidly, and the quality of available freshwater supplies is declining. This crisis has led to widespread water scarcity, affecting millions of people, particularly in rural and coastal areas.

Desalination technology has emerged as a viable solution to address the growing need for clean water. However, traditional desalination methods rely on fossil fuels, which are unsustainable and contribute to greenhouse gas emissions. Solar desalination offers a promising alternative, using solar energy to power the desalination process. This technology has the potential to provide clean water to millions of people, particularly in remote and coastal areas where access to traditional water sources is limited.

This report explores the potential of solar desalination technology in addressing India's freshwater crisis. It discusses the advantages and disadvantages of solar desalination, its feasibility in the Indian context, and its potential to provide clean water to millions of people.

Key words- Freshwater crisis, desalination technology, solar desalination, water scarcity, renewable energy sustainable solution and clean water access.

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 death of about one million children from diarrheal disorders. Water quality issues brought on by pollute on, 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. NEED FOR THE STUDY

• 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.

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

• 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.

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

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

• 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.

3. 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.

SPECIFIC OBJECTIVE:

- Collection of and characterize various physio-chemical characteristics seawater sample.
- To design & study an effective prototype model of solar desalination for treatment of seawater.
- To determine the desalinator's efficiency in achieving the removal of salts and unwanted solids.
- To reuse the desalinated/treated water for the tertiary purpose as per BIS standard.

4. MATERIALS USED

1. PVC Wood

The 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 fibers 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.

Fig 1: PVC Wood

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 temperature gradients 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.

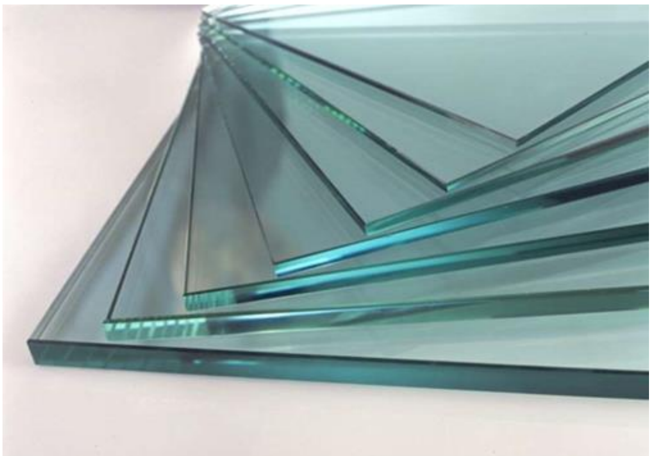

Fig 2: 4mm glass

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.

Fig 3: Black Obsorber

4. Silicon

A silicone or polysiloxane is a polymer made up of siloxane. They are typically colourless oils or rubber-like substances.

Silicones are used in sealants, adhesives, lubricants, medicine, cooking utensils, thermal insulation, and electrical insulation.

Fig 4: Fevi seal

4. METHODOLOGY

1. Collection of seawater sample:

a. Choose a suitable location for seawater collection, such as a beach or pier.

b. Using a clean and sterile sampling container, collect enough seawater sample.

c. Label the container with the sampling location, date, and time of collection.

d. Store the sample in a cooler with ice until transport to the laboratory.

2. Initial laboratory analysis of sample:

a. 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.

b. Record the results of the analysis for later comparison with treated water samples.

3. Fabrication of phototype:

The plastic bottle bricks were then prepared by

a. Fabricate a solar still prototype according to design parameters for treating seawater.

b. Test the prototype to ensure it meets performance specifications.

Fig 5: FABRICATION

4. Experimental analysis of sample:

a. Pour enough of the collected seawater sample into the solar still prototype.

b. Allow the prototype to treat the seawater using solar energy.

c. Collect a treated water sample and label it with the date and time of collection.

d. Record the results of the analysis for later comparison with initial readings with standard values.

5. Collection of treated water and laboratory analysis:

a. Collect a sufficient amount of treated water sample from the solar still prototype.

b. Transport the treated water sample to the laboratory for analysis.

c. 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. Reuse of desalination water foe tertiary purpose:

a. If the treated water meets the desired quality standards, reuse it for tertiary purposes such as irrigation, cleaning, or industrial processes.

b. Monitor the treated water quality periodically to ensure it remains within acceptable limits.

7. TEST RESULTS AND DISCUSSIONS

A. INITIAL CHEMICAL ANALYSIS OF SEAWATER SAMPLE

TABLE NO.: 1 Physico -chemical analysis of seawater sample.

Experimental name	**Initial reading**
pH	8.0
Acidity	nil
Alkalinity	248.33
Calcium hardness (mg/l as cacuio3)	420
Magnesium hardness (mg/l as cacbo3)	26
Total hardness (mg/ l as caco3)	446
Bio-chemical oxygen demand	D0=16
Turbidity	0.62
Cl- (mg/L) (±0.01)	544

B. FINAL CHEMICAL SNALYSIS OF COLLECTED SEAWATER

TABLE NO.:2 Chemical analysis of seawater samples before and after solar desalination process

Experimental name	**Initial reading**	**Final reading**	**Standard value**
pH	8.0	7.2	6.50-8.00
Acidity	Nil	Nil	-
Alkalinity	248.33	200.72	<Then 300
Ca	420	98.42	<Then 100
Mg	26	19.83	<Then 250
Total hardness mg/l as CaCO3	446	118.26	200-500
BOD (ml)	D	D	2-3 ml
Turbidity	0.62	0.34	0.00-5.00
Cl- (mg/l) (0.01)	544	199.2	250

• Above table shows comparison between initial, final and standard values

• Hence from Table No 1 it can be concluded that the values obtained are under the permissible limit.

• Results after conduction on various parameters like Ca+2, Mg+2, total Hardness, BOD, turbidity, Cl-, pH, and alkalinity was 98.43mg/l as CaCO3, 19.83mg/l as CaCO3, 118.26mg/l as CaCO3, 0.997g/ml, 19.2mg/l as CaCO3

C. PERCENTAGE EFFICIENCY FOR SOLAR DESALINATOR WITH DIFFERENT INPUTS

The actual efficiency of the distillatory for 6 hours of observation can be seen in Table 4.3. The actual efficiency of the distillatory in this study tends to be Moderate —the lowest efficiency is 16.58%, and the highest is 147.91%. Only a tiny part of the feed water becomes distillate water, and most of it becomes brine. It can be caused using solar energy and the evaporation process that is not optimal, the duration of observation is not long, the surface area of the glass in the distillatory is not large.

Sample trial	**Volume input (ml/day) (2ml)**	**Volume output (ml/day) (2ml)**	**% efficiency day (0.01)**
1	500	102	16.58
2	1000	226	34.25
3	1500	298	50.08
4	2000	329	69.62
5	2500	350	89.58
6	3000	400	108.33
7	4000	450	147.91
Average % efficiency per day = 73.47%			

TABLE NO.: 3 % Efficiency for SD for different input volumes.

• The percentage efficiency of a solar desalinator varies significantly based on different inputs, highlighting the need for careful consideration and optimization to maximize its overall performance.

• As seen from above table. No 2, the average percent efficiency Obtained was 73.47%.

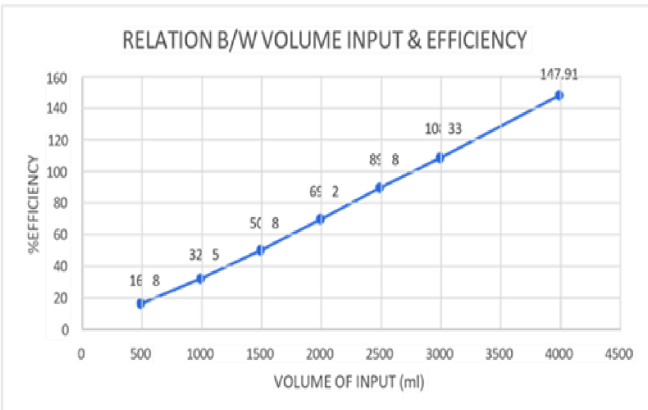

Fig: Relationship between input volume with % efficiency.

•Above graph shows the Relationship between input volume with % efficiency, where x-axis represents volume input(ml) and y-axis represents the % efficiency.

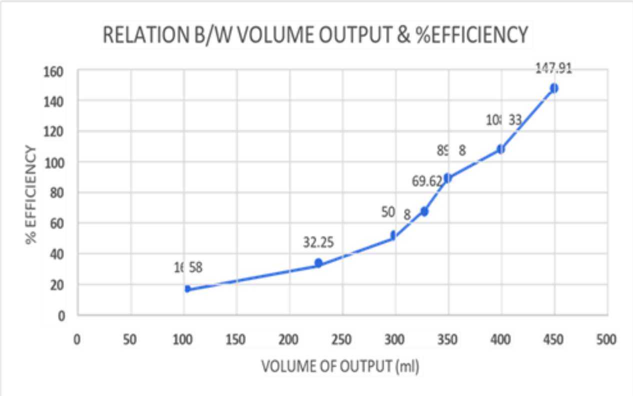

Fig: Relationship between output volume with % efficiency.

• Above graph shows the Relationship between output volume with % efficiency, where x-axis represents volume output(ml) and y-axis represents the % efficiency.

CHEMICAL ANALYSIS OF SYNTHETIC SEAWATER.

Experimental name	Initial reading	Final reading	Standard value
pH	8.0	7.2	6.50-8.00
Acidity	Nil	Nil	-
Alkalinity	285.63	255.22	<Then 300
Ca	622.3	98.66	<Then 100
Mg	16.99	10.36	<Then 250
Total hardness mg/l as CaCO3	583	436	200-500
BOD (ml)	D	D	2-3 ml
Turbidity	0.62	0.34	0.00-5.00
Cl- (mg/l) (0.01)	544	199.2	250

TABLE NO.:4 Chemical analysis of synthetic seawater samples before and after solar desalination process.

• Above table shows comparison between initial, final and standard values

• Hence from Table No: 3 it can be concluded that the values obtained are under the permissible limit.

PERCENTAGE EFFICIENCY FOR SOLAR DESALINATOR WITH DIFFERENT INPUTES

The actual efficiency of the distillatory for 6 hours of observation can be seen in Table 4.5. The actual efficiency of the distillatory in this study tends to be Moderate —the lowest efficiency is 17.16%, and the highest is %. Only a tiny part of the feed water becomes distillate water, and most of it becomes brine. It can be caused using solar energy and the evaporation process that is not optimal, the duration of observation is not long, the surface area of the glass in the distillatory is not large.

Sample trial	Volume input (ml/day) (2ml)	Volume output (ml/day) (2ml)	% efficiency day (0.01)
1	500	88	17.16
2	1000	180	34.16
3	1500	220	53.33
4	2000	330	69.58
5	2500	366	88.91
6	3000	380	109.16
7	4000	433	148.62
Average % efficiency per day = 74.41%			

Table No.:5 %efficiency for SD for different input volumes

• The percentage efficiency of a solar desalinator varies significantly based on different inputs, highlighting the need for careful consideration and optimization to maximize its overall performance.

• As seen from above table. No.:4, the average percent efficiency

Obtained was 74.41%.

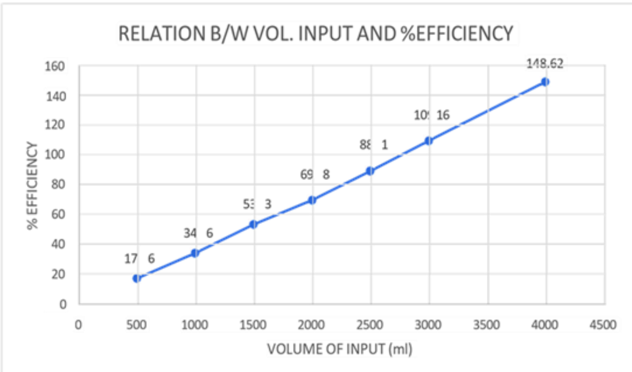

Fig: Relationship between input volume with % efficiency.

• Above graph shows the Relationship between input volume with % efficiency, where x-axis represents volume input (ml) and y-axis represents the % efficiency.

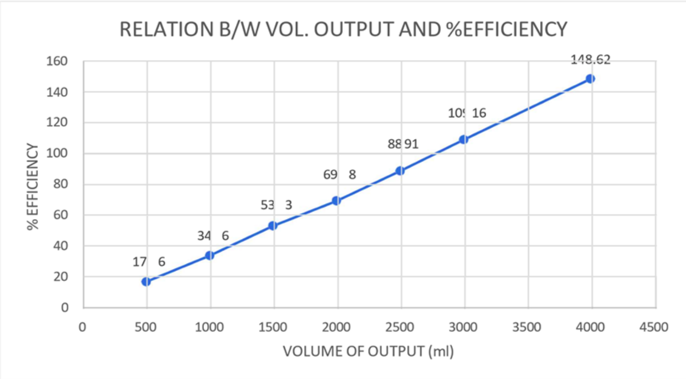

Fig: Relationship between output volume with % efficiency.

• Above graph shows the Relationship between output volume with % efficiency, where x-axis represents volume output(ml) and y-axis represents the % efficiency.

TABLE No.:6 Temperature observation of feed water, desalinated water and glass cover.

Parameter	Day 01	Day 02	Day 03	Day 04	Day 05	Day 06
Feed water (C)	32.22	31.56	30.56	34.11	29.3	28.65
Desalinated water (C)	39.45	37.2	34.22	35.1	33.65	32.27
Glass temp (C)	41.73	44.99	43.37	41.41	39.8	39.5

The value of the temperature's desalinates water and the glass in the desalinator increases with the sun's intensity. It is the plate that absorbs the sun's energy as it receives it at that time and uses it to evaporate the feed water contained in the desalinator. Black's Principle states that the heat absorbed is equal to the heat received by the substance and will be proportional to the increase (change) in the temperature of the substance.

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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