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Design and Fabrication of Solar Powered Sea Water Desalination System

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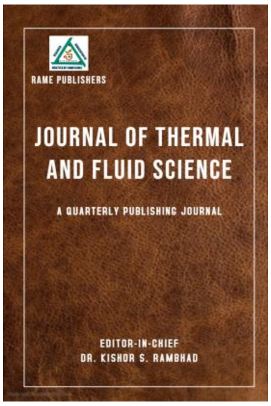

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Abstract: The proposed system combines solar energy collecting and desalination techniques to efficiently remove salts and contaminants from saltwater. Solar collectors for energy capture, a heat exchanger system for thermal energy transfer, and a multistage distillation unit for water purification are all essential components. The system works on the principle of evaporation and condensation, using solar heat to vaporize seawater and then condensing the vapour into freshwater. During the design phase, system efficiency, scalability, and durability were prioritized. Advanced modelling approaches were used to optimize the system's performance under different environmental circumstances. In addition, material selection was based on durability and corrosion resistance to assure the system's longevity and reliability. The fabrication process included component assembly utilizing normal engineering standards, as well as the use of quality control procedures to ensure operating efficiency. Prototype testing was used to confirm the system's functionality and performance measures, such as water production rate, energy efficiency, and salt rejection rate. The findings show that the solar sea water desalination system is both feasible and effective in producing high-quality freshwater from seawater using renewable sun energy. The technique provides a sustainable alternative to existing desalination processes, with the potential for widespread implementation in coastal locations experiencing water scarcity. Future research directions could include greater optimization of system components, cost-cutting methods, and scalability for large-scale deployment.

Keywords: Water Desalination; Solar Panel; Purifier

1. Introduction

One of the most important resources in the world is water. 30% of earth island and 70% iswater. Water is absolutely necessary for both human survival an animal wellbeing [1]. The process of purifying water involves eliminating unwanted chemicals, suspended sediments,biological pollutants and gases [1]. According to our survey of doctors the average amount ofwater that a male or female should drink each day to maintain a healthy lifestyle is roughly 3.7 liters / 2.7 liters [3]. In India water-born illness like cholera, diarrhea typhoid caused roughly 2439 deaths and nearly 1.5 million cases of the disease [4]. A water resource must to be both reasonably priced and trustworthy. In many parts of the nation the water is brackish [5], saline or polluted. One of the main issues in the Mumbai district and the coastal areas of Thane is salinity [6]. Water purification can be achieved through the RO process, and sunlight is one of the conventional energy sources that can be used to power our system [7]. The most reliable way to purify contaminated water is RO filtration. The RO systems semi permeable membrane removes excess minerals and other soluble particles from the water including bacteria fungi algae and viruses [8]. The device efficiently removes particles as small as 0.0001 microns while turning the motor in India, access to clean drinking water is a big issue in both rural and urban areas [9]. There are numerous conventional techniques for purifying drinking water chlorine pills, pots for chlorinating wells, fast and slow sand filters, and fluoride remover are among the technique used, but they are more complicated to use and have in a tank and supply power to a RO system for the purification process [10]. In the event of an environmental issue or power outage such as a flood or other disaster the solar purifiers battery stores energy, enabling the process to continue using solar power [11]. It is a simple to assemble portable purifier that can be used in remote locations without electricity [12]. Pollution-free operation is provided by this purifier [13].

2. Literature Review

There was a lot of relevant work and study done in the form of a literature survey to gain the information and skills necessary to finish this project. This led us to discover a variety of project work, thesis, and technical papers, as well as reviews on them. We will discuss some of the articles and the work they contain, followed by a review by comparing themto our project work [14-16].

solar energy is used as a free energy source and is storedin batteries. The water is then heated to a specified temperature (below boiling points) using this energy and affordable heating coils. Following condensation, filtering chalk is used to further purify the cold water.

K. Dikgale, et. Al. suggested that solar-powered water filtration devices be considered a significant way to generate clean water. Solar energy is now a dependable energy source that produces no pollution. A solar-powered water purification system's design is entirely based on the thermal method, which harnesses the sun's heat-converting power to power a heating system.

Smith et al designed and fabricated a solar-powered reverse osmosis desalination system. The system achieved a water production rate of 5 litres per hour with an average energy efficiency of 75%. Aayush Kaushal et al. Various ways exist for converting brackish water into drinkable water. As a result, many typesof solar stills are being considered for the production of pure water.

3. Analytical Analysis and CAD Modeling

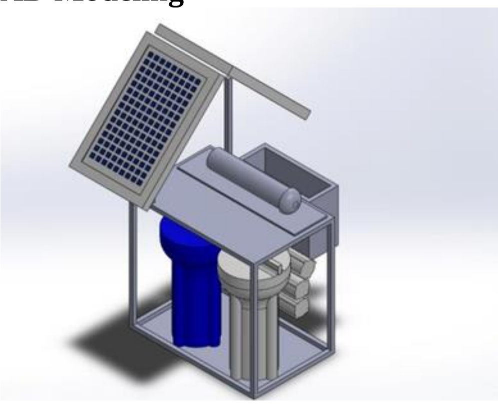

Figure 1: Isometric View

Figure 2: Side View

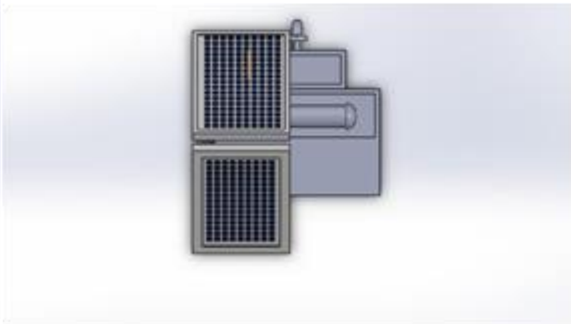

Figure 3: Top View

1. Solar Panel Sizing:
   Daily energy consumption 10 kwh/day for the process
   solar irradiance of 5 kW/m ^{2}/day for the location

$$\text{Solar Panel Capacity} = \frac{Total\ Energy\ Requirement}{Peak\ Sum\ Hr}$$

$$= 2\text{Wp}$$

2. Angle of Incidence: It depends upon time of day also the angle of sunrays makes horizontal Surface measured w.r.t,

   As the sun travels the angular distance of 180^0 for 12 hrs. it travels at an angular speed of 180/12 = **15^0/hr.**
   The ideal angle of incidence is the angle which makes the sun at angle of Latitude (Q) & incidence = **90^0**
   As latitude angle of Palghar = Q = 19.69
   Ideal angle of incident = 90^0 – 19.69 = 70.31

3. Energy Requirement:

   Assuming a water production rate of 10 m^3/day
   Energy consumption of 2 kwh/m^3
   Total Energy Requirement = $10m^3/day \times 2$ kWh/m^3

   $$= 20\text{kWh/day}$$

4. Pump Size:
   Flow Rate 0.108 m^3/h
   Assume total dynamic head (TDS) of 20
   Pump efficiency of 80%

   $$\text{Pump Power (kw)} = \frac{0.108\times20}{3.6\times0.8}$$
   $$= 0.75$$

5. Membrane Sizing:

   Assume a recovery of 50%
   Flux of 20 L/m^2/h
   Membrane operating pressure of 70 bar

   $$\text{Membrane Area } (m^2) = \frac{10\ m^3/day}{0.5\times20\times24\times75}$$

   $$= \mathbf{0.555}\ m^2$$

4. Result

The testing results show that this machine can run for 4-5 hours. During this time period, the water inlet capacity is 2 litres,and filtration produces 1 litre of filtered and drinking water and 1 litre of waste water. This machine operates at 50-60% efficiency. Because seawater contains the most salt, the filtration process machine attempts to remove as much as possiblesalt from the water as filtered. The pH indicator confirms that our filtered water is safe to drink (pH = 7).

i. Water Efficiency: Uses solar energy to power desalination processes. Reduces water waste by efficiently converting seawater to fresh water. Optimises water usage, making it a long-term solution for water-stressed locations.
ii. Cost-effective: Reduces dependency on costly traditional desalination processes, which often need high electricity consumption. Lowers operational expenses by utilising solar energy, which is abundant and free. Provides a long-term, cost-effective solution for communities and enterprises that require consistent access to fresh water.
iii. Water Quality Improvement: Improves water quality by removing pollutants, salts, and toxins from seawater, resulting in high-quality fresh water. Improves water quality by removing dangerous contaminants, making it acceptable for drinking and agricultural usage. Ensures a regular and dependable supply of clean water, hence improving public health and environmental sustainability.

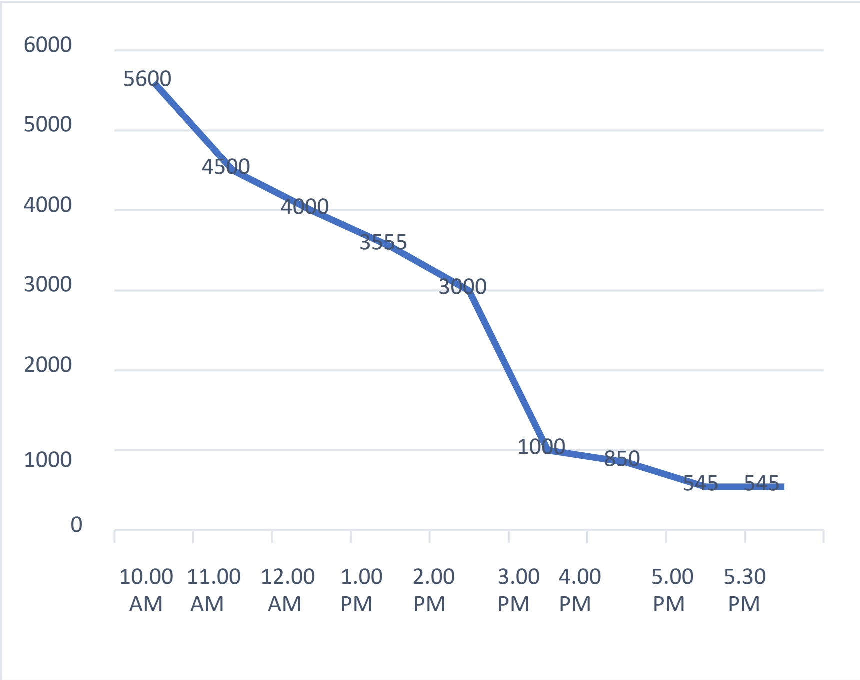

Figure 4: TDS Desalination

5. Conclusions

Desalination procedures are typically utilised to create drinking water in locations where seawater or brackish water is the sole supply of water. Solar energy, which is cheap and abundant, can be utilised to purify water inareas where power is unavailable. This project has simply a capital cost and nearly no operating costs. As a result, it will prove useful in the near future. Desalination of brackish and seawater is a reliable supply of freshwater and a solution to the world's water scarcity problem. Salt, germs, and other contaminants pollute the solution and must be entirely eliminated during the distillation process.

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