ADVANCED TREATMENT METHOD OF SALINE WATER USING THERMAL DESALINATION, OSMATIC MEMBRANE AND GEO-TEXTILE FILTER MEDIA

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Introduction:

India is facing a severe freshwater shortage primarily due to population growth and changing lifestyles, which have driven increased human activity. The overuse of groundwater by agriculture, industry, and households exacerbates this scarcity. Additionally, water quality degradation from various pollutants intensifies the problem, leading to significant economic and political conflicts over water distribution. The health impacts are substantial, with around one million children dying annually from water-related diseases and approximately 45 million people affected by poor water quality.

To tackle this crisis, membrane desalination (TOG) emerges as a promising solution. This technology offers a sustainable way to produce freshwater, reducing dependence on fossil fuels and lowering greenhouse gas emissions. Membrane desalination systems purify saltwater using electric energy, addressing the growing demand for clean water in regions with limited access. This study examines the factors affecting the efficiency of membrane desalination prototypes, including design, materials, insulation, and other key parameters. It proposes an innovative approach that combines evaporation and desalination using electric energy,

followed by reverse osmosis with osmotic membranes and geo-textile membranes to filter saline water. Both experimental and theoretical evaluations are conducted to assess the system's effectiveness in utilizing electric energy for freshwater production. Furthermore, the study discusses the current state of membrane desalination technology in India, highlighting its potential, challenges, and future prospects for addressing freshwater scarcity, especially in coastal areas.

Objectives Of the Project:

The primary goal of this project is to enhance the design of a simple membrane desalination system for converting seawater into potable water, addressing the critical need for drinking water along coastal areas with large populations.

The specific objectives of the project include:

- Evaluate and characterize three methods of desalination identified for study through prototype model (Thermal, Osmosis, Geo-textile).
- To analyze the various Physico-chemical characteristics of collected saline water adopting all three methods.
- To design and fabricate prototype model to treat saline water at an optimum efficiency level.
- Comparative analysis of water treatment by all three methods adopted for their efficiencies as filter media.

Methodology:

MATERIALS:

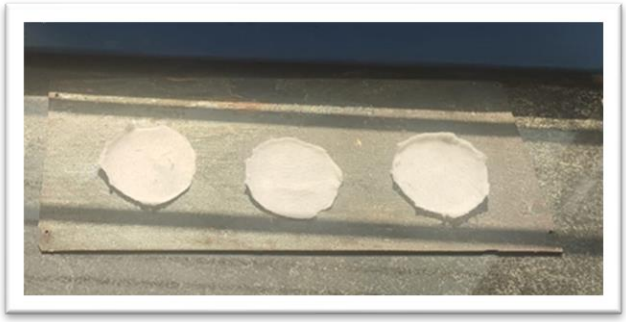
a. **Stainless Steel Container** used for initial prototype fabrication, we used stainless steel container of 303 grade to boil the water, commonly used due to their corrosion resistance properties, heat resistance, provide added durability and resistance to deformation or warping at higher temperatures.

b. **The copper coil** is attached to the thermal desalination prototype, which is acts as cooling system. Copper is chosen for its excellent thermal conductivity and corrosion resistance properties, making it ideal for transferring heat efficiently and withstanding the corrosive nature of saline water and steam.

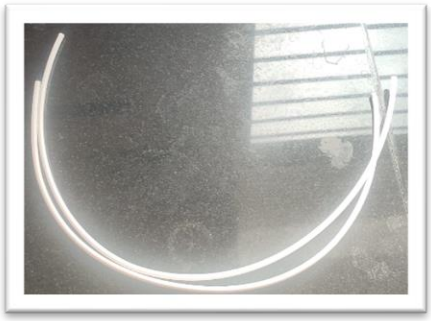
c. The spiral wound membrane with a 0.2-micron layer in a reverse osmosis system offers precise filtration, comprehensive contaminant removal, high efficiency, durability, and versatility, making it an ideal solution for producing safe and portable water from saline sources. The overall filtration capacity is of 6000L.

d. **Osmosis membrane cartridge** offer efficient, selective filtration of contaminants from water, providing high-quality, purified water for various residential, commercial, and industrial applications. Their durability, compatibility, and ease of installation make them essential components in reverse osmosis water treatment systems.

e. **200 GSM of non – wov**e water. Non-woven geotextile offers a range of features that make it well-suited for filtering saline water, including high filtration efficiency, chemical and biological resistance, strength, flexibility, permeability, UV resistance, cost-effectiveness, and environmental sustainability.



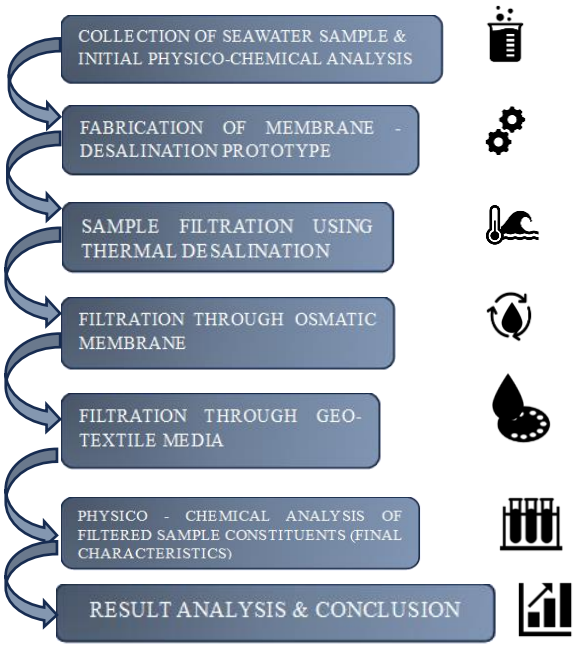
f. **PVC pipes** with a diameter of 30mm offer a range of features including durability, corrosion resistance, lightweight, smooth interior surface, chemical inertness, low thermal conductivity, flexibility, impact resistance, long service life, and cost-effectiveness. These features make them versatile and widely used in residential, commercial, industrial, and agricultural applications for conveying water.

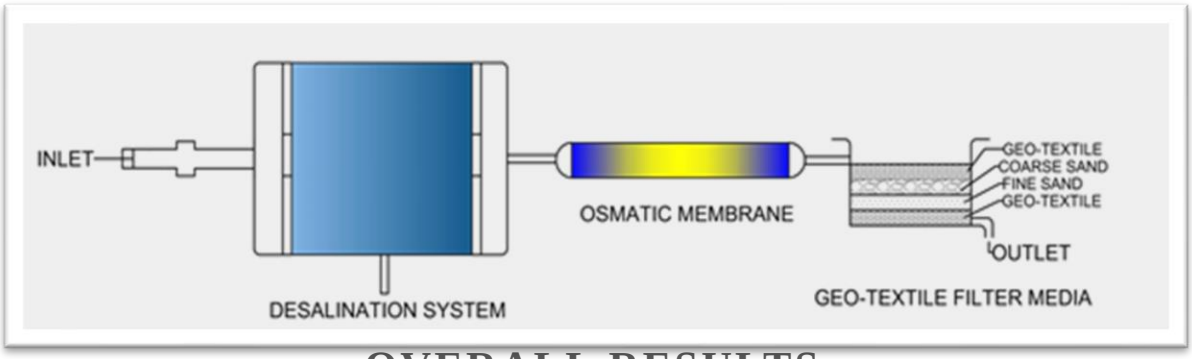


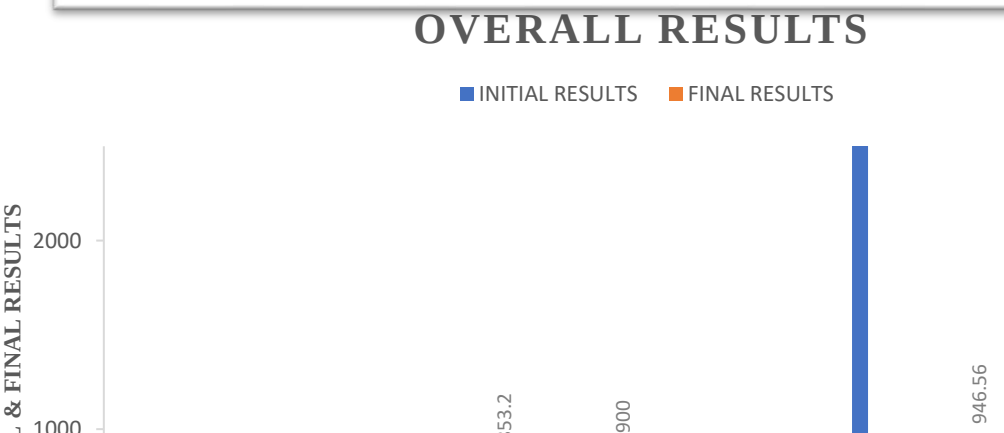
g. **Fiberglass tubes**, also known as fiberglass reinforced plastic (FRP) tubes or fiberglass composite tubes, are cylindrical structures composed of fiberglass

strands embedded in a resin matrix. fiberglass tubes are versatile, lightweight, durable, corrosion-resistant, electrically and thermally insulating, and cost-effective structural components used in various industrial, commercial, and residential application

[B] Process:







Physico-Chemical Analysis of Seawater Sample After Overall Filtration Through Fabricated Prototype

Fabricated Prototype Model

Results & Conclusions:

Based on the study's findings, it can be concluded that membrane desalination holds great potential as a technique for converting saltwater into freshwater.

- The seawater sample was brought from Mangalore and initial laboratory analysis were conducted for various parameters like pH, Alkalinity, Ca^{2+}, Mg^{2+}, Total Hardness, Turbidity, TDS, Cl^-, Nitrate, Iron was **7.12**, **85.6**mg/l as $CaCO_3$, **73.2**mg/l as $CaCO_3$, **50.1**mg/l as $CacO_3$, **353.8**mg/l as $CaCO_3$, **1.21**NTU, **402.7**mg/l, **295.7**mg/l, **29.53**mg/l, **0.15**mg/l respectively.
- By utilizing electric energy for evaporating seawater in the desalination process, then condensing and transferring it to osmatic membrane to decrease

mineral content, and subsequently filtering it through geotextiles to remove any remaining salt content, provides a **sustainable** and **economically** viable option compared to conventional membrane desalination methods.

- Promising results were achieved, demonstrating significant reductions in pH, alkalinity, Ca^{2+}, Mg^{2+}, total hardness, total dissolved solids (TDS), turbidity, Cl^-, nitrate, and iron by **16.33%**, **65.84%**, **83.73%**, **94.13%**, **60.69%**, **86.56%**, **98.03%**, **68.76%**, **50.78%**, and **89.29%** respectively, reaching acceptable levels.
- Membrane desalination models, which depend on electric energy for operation, prioritize environmental sustainability and economic viability. The efficiency of prototype membrane desalination models is affected by various factors, including system design and the effectiveness of the membrane desalination process.

INNOVATION:

- The project is unique in utilizing three distinct types of filtration models.
- Custom fabrication of a thermal desalination model to meet our specific needs.
- Incorporating and strategically positioning the adopted filtration techniques to achieve optimal results.

SCOPE FOR FUTURE WORK:

- Testing this proven setup at a coastal place to have real-time analysis.
- Installation of sensors for monitoring the effectiveness of the membrane desalination system can be conducted at both the inlet and outlet/collecting point, in accordance with established standards.
- Instead of relying on AC power sourced from the grid, we can develop a method that utilizes DC power stored from solar panels for the process.