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MICRO RO DESALINATION UNIT

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Abstract - *Water is the backbone of our economy and development. An adequate and safe water supply is vital for progress in agriculture, industry, recreation, and human consumption. As a country, we face increasing water supply challenges in the form of droughts, increased water demands due to population growth, densely polluted waters, and demand competitive demand from many different users. To overcome these challenges for the present and future, water treatment technologies including desalination will significantly contribute to ensuring a safe, sustainable, affordable, and adequate water supply for the public of India. Desalination is commonly applied today to overcome the scarcity of fresh water in some parts of the world such as Israel, Bahrain, Kuwait, China, Qatar, UAE, Saudi Arabia etc. Different types of technologies have been proposed over the past century. In this report, the status of the mainstream solution, reverse osmosis (RO) is reported. In this case, the seawater treatment plants operate the same way as the traditional, except that they are designed to be portable. The document reviews filtration techniques and the evolution of the device into compactness, they can be used without complicated installation procedures, and the treats seawater everywhere. The classifications are therefore given first, taking into account the principles of operation, the main energy inputs required for the treatment, the parts needed, the processes involved, and the unit test.*

***Key Words*: Desalination, portable, water bodies, water treatment, freshwater, seawater, sustainable, reverse osmosis, installation.**

1. INTRODUCTION

Desalination is a technique of removing salts or other minerals and contaminants from seawater, brackish water, and wastewater and it is a unique solution to obtain fresh water for consumption and for domestic/industrial utilization. Desalination plants convert saline water into pure water that is fit to drink. The most common technique used is reverse osmosis where high pressure is applied to push saline water from an area of high salt concentration to low salt concentration through a membrane.

1.1 Need

Only 2.5% of the water available on earth is fresh water. Two-third of this freshwater is present in frozen glaciers. On an average over 1.1 billion people lack proper access to any freshwater reserves and over 2.7 billion people face scarcity of water at least once a month. But fortunately, as we know 71% of the earth's surface is water and 97.5% of that water is seawater.

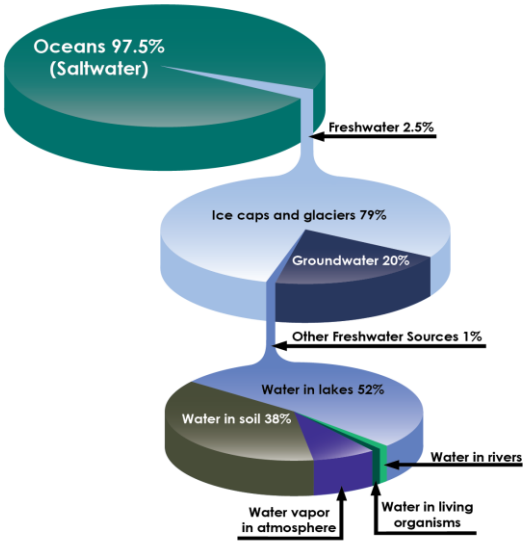

Fig-1: Water Distribution on Earth

In many parts of the world, there is a scarcity of clean and fresh water. For industries to survive, they need a system that can help them utilize the available water resource more efficiently. With the help of desalination plants, Governments and people can be prepared for the times of droughts and ensure an efficient supply of water.

1.2 India's Water Resources

In India, an average precipitation of 118 cm per year is experienced. Most of the rains occur during its monsoon seasons with the north-eastern and northern areas like Assam, Meghalaya, and Arunachal Pradesh receiving 400 cm of rainfall. The regions Tripura, Nagaland, and Manipur receive 200-300 cm of rain. Areas such as West Bengal, Bihar, Odisha experience 100-200 cm of rainfall. Maharashtra, Punjab, Haryana, and Tamil Nadu receive 50-100 cm of rain. Desert and semi-desert areas including Rajasthan, Gujarat, Ladakh plateau receives rains below 50 cm. due to this flooding occurs in the Himalayan basin and water scarcity in others. Generally, desalination is considered to be more expensive compared to other existing sources, yet it is more reliable in meeting the country's water needs. Desalination will help to end India's water problems

only because India has sufficient renewable energy resources if utilized properly can bring down the cost per litre of the desalination process rapidly.

2. DESALINATION TECHNOLOGY

Desalination is the process of removing dissolved minerals including salt from water supplies such as seawater, treated sewage, or brackish water. Several methods of purification include distillation, ion exchange, membrane processes, solar purification, and more. The reverse osmosis method is most commonly used.

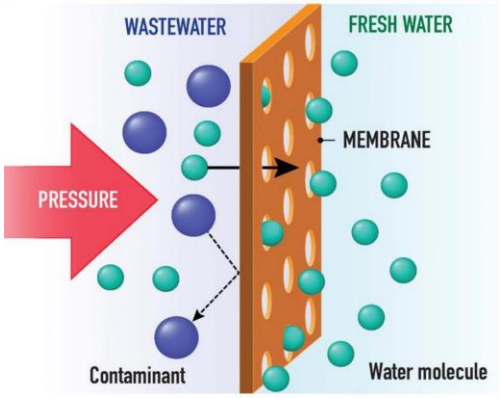

Fig-2: Reverse Osmosis Process

The reverse osmosis process is simple and straightforward. This is done by water pressure pushing seawater through a semi-permeable membrane, removing contaminants from the water. It is a process that removes dissolved solids from a liquid. This process differs from standard filtration in which contaminants are collected within the filter media. The reverse osmosis process pushes the water through a series of semi-permeable layers and the clean water then goes into a collection tank and the contaminants are flushed down the drain.

Objectives

1. To eliminate depletion of drinking water in India.
2. To treat seawater so that the water is suitable for drinking.
3. To make robust and portable device that is easy to use.
4. To make the best use of seawater available in plenty.
5. To make a cost-efficient desalination unit available and affordable in rural areas.

Design

A Micro RO Desalination unit is designed based on the working principles of actual RO desalination plant.

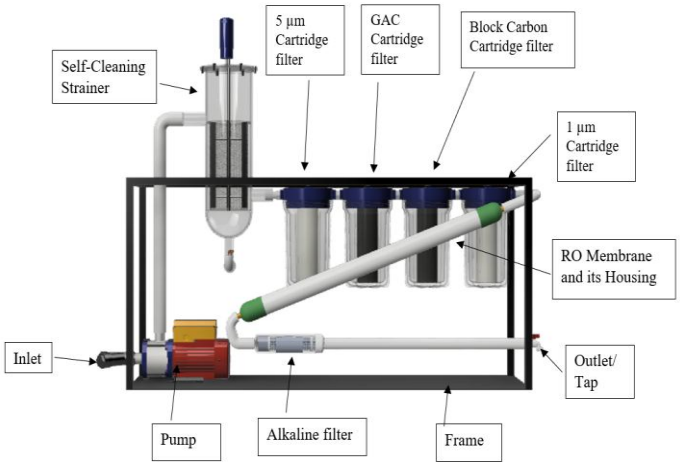

Fig-3: CAD Model of Unit

The desalination unit works in the following way:

I. First water will be sucked into the Automatic Self-Cleaning Strainer which contains a mesh of 250 µm. Water fills up in the housing and passes through the strainer which will remove sediments, rocks, sand, organic and inorganic components.

II. The strainer is attached before pump, at inlet line, so that inorganic material does not get stuck into pump.

III. Then the water enters the pump and is discharged out with high pressure at 10 bar.

IV. Pressurized water is passed through the first Cartridge Filter housing where a 40 µm filter is used for filtration. Here water is filled in housing and water enters the cartridge filter from its outer surface and filter water comes out from inside of filter.

V. Next process of filtration takes place in GAC Filter (Granulated Activated Carbon). Here the microparticles, microbes, dirt, etc. are removed.

VI. Then the water is again passed through Carbon Filter but this time a Block type carbon filter which removes viruses, micro particles which escaped from the GAC filter.

VII. And last pre-filter of the process is again a Cartridge Filter with a micron rating of 5 µm, this is just for the precaution so that any remaining particulate from carbon filter is removed.

VIII. The next step is to pass the water from the RO membrane where the RO process will take place and TDS of the water is reduced for human consumption. Here the water is converted to pure water, which has extremely low mineral contain which can be harmful for humans.

IX. For this particular reason, post-filtration is done where minerals are added to the water and in this case Alkaline Filter is used which adds minerals and soothing taste to water.

X. Finally, we obtain potable water from desalination process.

Fabrication

For pre filtration automatic self-cleaning filters are used automatic self-cleaning strainers are motorized strainer that is used to continually remove contaminants and debris from a fluid pipe system. The flow of liquid enters the strainer at the top inlet and works its way downwards through the strainer and then out from the below outlet. Any unwanted debris is caught inside the strainer and pushed to the bottom. When the differential pressure reaches a certain pressure point the flush valve at the bottom opens and removes the contaminants.

Fig-4: Automatic Self-Cleaning Strainer

Regular strainers require manual cleaning, but self-cleaning strainers do it themselves through backwashing and mechanical cleaning technology, all while allowing the system to continue to work. For the current application of compact desalination unit 1-1/2" pipe size self-cleaning the strainer will be used. Since the working fluid is seawater, SS316 is the best suitable option for the material of the strainer body/housing. The material for the mesh screen and internal mechanism will be SS316L as both materials possess excellent corrosion resistance. Mesh Size is 250 µm.

Fig-5: Actual Model

The figure shows the assembled model of the micro desalination unit. The self-cleaning filter and RO housing is made up of Super Duplex Steel ASTM SA 790. Cartridge filter of ACME Engineering Products Pvt. Ltd. of size 40 µm and 5 µm is being used to achieve micro filtration. Material of cartridge filter is Polypropylene. As Polypropylene can withstand intense physical stress and corrosion caused by the sun, mold, bacteria, rot, oils as compared to nylon, bleached cotton, and polyester. It is also highly moisture-resistant. Carbon filter Cartridges are most effective at removing chlorine, sediment, volatile organic compounds, taste and odour from water. Typical particle sizes that can be removed by carbon filters range from 0.5 to 50 µm; the lower the micron rating the greater the filter. For this unit two types of carbon filters are being used;

i. Granulated Activated Carbon filter

ii. Activated carbon block filter.

Cartridge filter housings are used for holding Polypropylene and carbon cartridge filters.

For this unit, RO membrane of Hongtek Filtration Co. Ltd. is used SW-2521 (25 is diameter which is 2.5" and 21 is length which is 21"). Pressure gauges and ball valves are used for measuring and controlling the pressure in the lines.

Testing

Initially to check the leakages in components fittings, water was passed through the components, and it also helped to clean the internals of the housings and filter. Once the cleaning and leak test was done cartridge filters, Carbon filters and seawater RO membrane were installed in the housings. Actual test run was started by starting the pumps which pumped the dirty saline water with high TDS level.

Fig-6: Leakage Testing and Cleaning

TDS and pH of saline water was checked with TDS and pH meter before running through the desalination unit.

TDS value of saline water – 8791 ppm

pH value of saline water – 8.57

Fig-7: TDS and pH Value of Saline Water

Later TDS and pH of Saline water was checked after running through the desalination unit at the pressure of 10 bar.

TDS value of Filtered water – 46 ppm

pH value of Filtered water – 7.99

Fig-8: TDS and pH Value of Saline Water After Desalination Process

Based on the output, desalination unit proved to be working on a satisfactory level. It is determined that TDS of saline water can be reduced with this system and it can remove unwanted elements from sea water.

Based on the experimentation result was found out that the desalination unit is capable of providing filtered water of 70 LPH. It was experimented and found out that the RO membrane is capable of providing 95 LPH of water if the pressure was increased up to 20 bar, but the pump we selected was not capable to deliver output pressure of 20 bar.

Advantages

1. Water production rate is 850 liters per day.
2. Unit is compact and simple in design.
3. Low operational and maintenance costs.
4. Unit is easy to use and portable.
5. High corrosion resistance.
6. Feed water can be taken from the sea itself.
7. Water softening does not require the use of any chemicals.

Disadvantages

1. Frequent cleaning of membrane to avoid fouling.
2. Unit requires routine maintenance.
3. Undetected leaks lead to wastage of water.
4. Require high pressure pump to pass water through membrane or else the system won't work.
5. Clogging in filters or membrane may lead to shutting down of the entire system.

3. RESULTS

Robust unit designing was the main area of concern in order to convert seawater and brackish water to pure drinking water. The design was made on the basis of the working of an actual desalination plant. For the desired output, various materials were studied and based on their specification like compactness, water purification and production capacity components were selected. Based on the components selected desalination process was designed and CAD models were prepared, following that pressure drop calculations were performed for each and every filtration media.

Table-1: Result Obtained from Desalination Unit

Parameters	Before	After
TDS Concentration (ppm)	8791	46
pH Level	8.57	7.99

For the same application MSF, MED and EDR are being used, but they have some limitations that needed to be overcomed during operation. Considering those, MICRO DESALINATION UNIT USING RO MEMBRANE was designed. This unit can replace the usage of other complex process in order to increase efficiency and lower the costs.

4. CONCLUSION

As increasing water pollution and decreasing fresh water supply is becoming an unignorable issue, demand of water for various purposes is going on exceeding day by day. Reducing pollution caused in water bodies and reusing waste water in some or the other form, or looking for an alternative water source are the only solutions to cope up with the depleting water supply. To combat this issue, a study was carried out related to adopting a typical desalination process and a compact MICRO RO DESALINATION UNIT was designed. This simple unit can be used to treat any kind of sea water, brackish water, ground water, etc. As there are many different types of desalination processes for the same type of application which are somewhat more cost effective and highly efficient than RO system, but they have their own limitations as well. This method is adopted in most of the water purifiers such as Kent, AO Smith, Pureit, Aquaguard, Blue Star to name a few that are available at our homes. A number of techniques are under R&D for desalination. Though its cost seems to be decreasing, they are still costlier than conventional drinking water filtration processes. Desalination will improve the situation of millions of people across the globe that are facing water crisis and strive for clean drinking water.

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