Sea Water Desalination using Renewable Energy

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***Abstract*— We all are now living through a severe problem, it is none other than the global climate change. We are now witnessing a rapid change in our environmental conditions triggered by many factors. Our fresh water sources are now becoming polluted every day. It is expected that about 70% of the total global population will be under severe water scarcity. The water scarcity is not only affecting human beings, it is also affecting the wildlife. To satisfy the increasing water requirement, the only solution is the desalination of sea water that is available in excess. There are many technologies available for desalination of sea water, among them the most prominent one is the Reverse Osmosis. In our project also the desalination is based on Reverse Osmosis. Our system is designed to be used as a desalination mobile unit, and it is powered by a battery, and to charge the battery we are using solar photo voltaic panels.**

Keywords*— *Reverse Osmosis, Desalination, Photovoltaic.

I. INTRODUCTION

The increasing demand and diminishing water supply can lead to severe water scarcity. The population is increasing rapidly. Natural available fresh water sources cannot meet our needs in future [1]. As the recent survey suggests, 40% of the global populations are facing water scarcity. This can be 60% by 2025[2]. This situation can be tackled by finding some other way to produce fresh water. The sea water which is available in plenty can be a solution to this problem. Desalination is a method by which the sea water is converted into pure drinkable water. Some of the countries already adopted desalination technology [3]. This has some negative impact on the environment. Renewable energy-based desalination units are more suitable for remote regions and have less environment impact [4]. Most of the desalination units required thermal or electrical input that can be provided by solar energy. In our project we are considering a solar-powered desalination unit which is highly suited for small-scale production.

II. MOTIVATION AND OBJECTIVES

Unconventional water sources, for instance, desalinated water, is expected to fill the gap between supply and demand for fresh water. The main challenge is that it has additional energy requirement and has certain environmental consequences. The desalination sector has witnessed a huge rise in CO2 emissions and has proven unsustainable practice to the environment. Reverse Osmosis (RO) is a pressure-driven desalination technique which involves feeding the pressurized water to the reverse osmosis membrane. If the applied pressure is greater than osmotic pressure, we can obtain pure water. In our project, photovoltaic panels are used as the energy source for the desalination unit. Reverse Osmosis units powered by solar PV have greater socioeconomic and environmental advantages than reverse osmosis units powered by diesel generators. The proposed system is intended to serve as a mobile desalination unit. It will target underdeveloped villages, military camps and agricultural sectors.

III. METHODOLOGY

This section provides an overview of the proposed method. The objective of our project is the realization of a desalination mobile unit, and it is used for sea water desalination. The desalination unit is powered by a battery and, whereas to charge the battery, a solar photo-voltaic panel is used. To maximize the electrical energy produced by the solar photo-voltaic panel, a MPPT charge controller is used. The block diagram of the desalination unit is shown in Fig. 1.

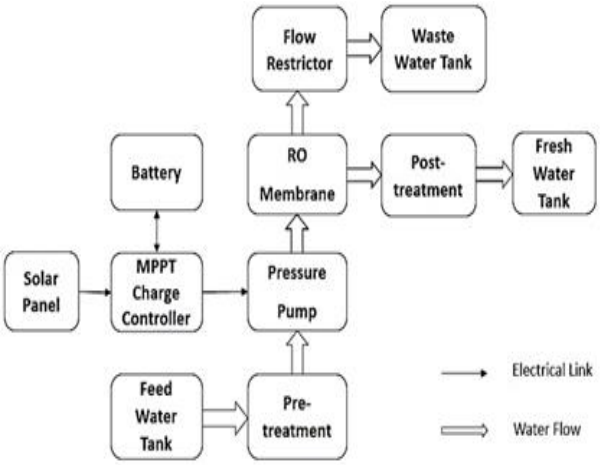

Fig. 1. Block diagram of desalination unit

The desalination unit consists of four sections: power supply section, pre-treatment section, reverse osmosis membrane section and post-treatment section.

A. Power Supply Section

The desalination unit is powered by a battery. The only load that needs to be supplied by the battery is the diaphragm pump, and the power rating of the diaphragm pump is 30 W. The energy required to charge the battery is obtained through a solar photovoltaic panel. To maximize the electrical energy produced by the panel, we are using a MPPT charge controller. The diagram showing the electrical connection is shown in Fig. 2.

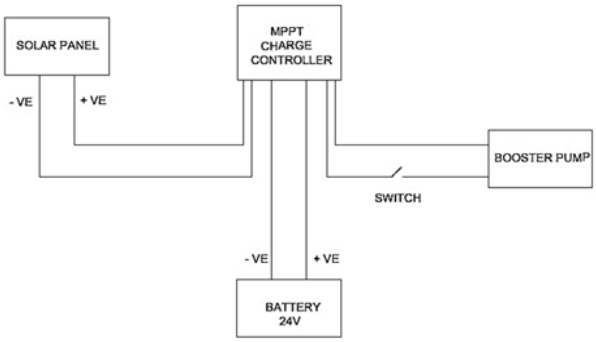

Fig. 2. Electrical layout

B. Pre-treatment Section

The pre-treatment stage is a very important stage in the Reverse Osmosis desalination process. This stage is used to remove large suspended particles present in the water and to make the water suitable for the upcoming stages. The water to be purified is stored in a storage tank, and it is allowed to pass through the pre-filter which is also known as the spun filter. The main function of the pre-filter is to remove large and fine particles such as sand, dirt, silt, and rust from drinking water. Then the water is passed through a sediment filter. The sediment filter traps and removes suspended solids from the water. The last stage in the pre-treatment stage is the activated carbon filter. The activated carbon filter removes chlorine content in the water and makes it taste better by removing the smell and hardness. The block diagram representation of the pre-treatment stage is given in Fig. 3.

Fig. 3. Pre-treatment stage

C. Reverse Osmosis Membrane Section

After the pre-treatment stage, the water is pressurized by the booster pump and the pressurized water is passed through the Reverse Osmosis (RO) membrane. The RO membrane produces water free from all types of impurities. The RO membrane has two output ports, one for collecting the waste water called the drain and another for collecting purified water. For maintaining high pressure inside the RO membrane, a flow restrictor is connected with the drain port. The flow restrictor acts as a regulator valve, and by controlling the restrictor we can control the water recovery rate.

The water obtained after the RO membrane filtration is not suitable for drinking because the water obtained doesn't contain essential minerals. As per international standards, the total dissolved solids (TDS) in water should be in the range of 50-150 PPM. The TDS refers to the iron, minerals and other elements present in the water. To make the water suitable for drinking, the TDS content of the water is increased by using a TDS controller. The TDS controller is essentially a regulator valve. The TDS controller is connected in such a manner that the water entering the RO membrane is bypassed to the purified water coming out of the RO membrane. The TDS controller acts as a regulator so that we can regulate the TDS content in the purified water.

D. Post-treatment Section

The purified water coming from the RO membrane is delivered to the mineral cartridge. The mineral cartridge gives a soothing and sweet taste to the pure drinking water. The last stage of the post treatment stage is the ultrafiltration filter. The function of the ultra-filtration filter is to remove the presence of virus and bacteria present in the water.

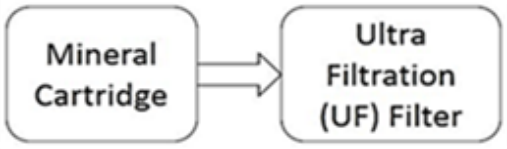

Fig. 4. Post-treatment stage

E. Computer Aided Design of Desalination Unit

For our project we have created a computer-aided design (CAD) of the desalination unit. The CAD model of the desalination unit is shown in Fig. 5.

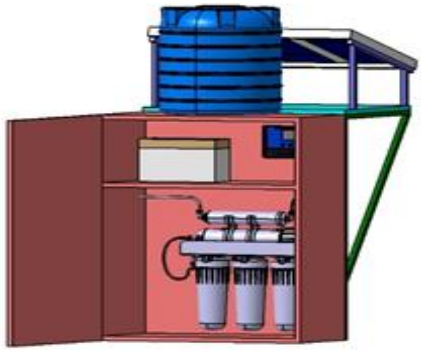

Fig. 5. Computer aided design of desalination unit

The filter assembly is shown in Fig. 6.

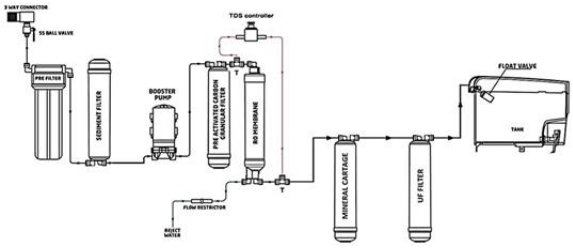

Fig. 6 Figure showing the filter assembly

IV. Results and Discussion

This chapter provides the detail regarding the desalination unit that we have developed and about results obtained after the desalination process. The figure of the desalination unit is shown below.

Fig. 7 Developed desalination unit

We have tested our desalination unit, and we have obtained purified water free from all types of impurities. The quality of the water obtained after the desalination process is verified using a TDS meter. By using a TDS meter, we can measure the amount of total dissolved solids present in the water, and the results are given in parts per million (PPM). We were able to operate the desalination unit for about 5 hours per

day by the energy obtained from the solar panel. The results obtained after the desalination process are given in TABLE 1.

TABLE I. DESALINATION RESULTS

Sample Number	PPM before desalination	PPM after desalination
1	3500	86
2	2750	41
3	3290	53

PPM –Parts per million.

The figure showing the water taken for the desalination and the water obtained after the desalination along with the TDS readings is shown in the Fig. 12.

Fig. 8. Water taken for desalination and water obtained after desalination

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