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Solar Powered Reverse Osmosis Water Purifier and Conditioner Using Peltier Effect

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ABSTRACT

One of the widespread problems facing by the world is unavailability of pure water. Water is a requisite resource, and its supply need to be guaranteed with an inexhaustible power source such as renewable energy. Almost 1.6 billion people have no access to potable water in the world. This paper focused on providing potable water by using solar panels (PV modules). A suitable charge controller of desired voltage (24v here) is used to regulate the voltage coming from panels. Since the solar power is intermittent, a charge controller is needed for continuous supply of desired voltage to run the motor. A DC motor is used to run the RO system without the use of inverter. Later the pure water is circulated through heat sinks at which a heat flux is generated by using a peltier to get hot and cold water simultaneously.

Keywords: PV Modules, Solar Charge Controller, TDS, RO, Peltier, Heat Sinks

I. INTRODUCTION

Access to clean water is still a sour grape for many nations. This problem is aggravated by the rise in population. Approximately one-sixth of world population hasn't tasted clean water. In 2015, water crisis was listed by the World Economic Forum as largest global risk in terms of potential impact over next decade. Developed countries are less endangered than developing countries. India is on verge of serious water scarcity since two-thirds of its area is drought prone. Also the water per capita has decreased progressively from 1816m^3 in 2001 to 1545 m^3 in 2011.

In Rural India, planting Reverse Osmosis unit is a challenging task since it requires expansion of electric grid. So search for alternative energies started such as solar, diesel, natural gas etc. Among these, solar energy provides best solution for this large energy requirement thus used to run the RO plant. So in place of 230V AC supply, 24V DC is supplied by aid of solar panel to run the plant which in turn reduces the electricity bills.

Developing a stand alone PV RO system and water conditioner is cardinal since it provides pure hot and cold water at economical price. Installing conventional RO purifier and dispenser units require more power compared to the proposed system. Solar RO system requires initial capital investment due to the solar panels, solar charge controller and the batteries, but down the line pay back can be achieved. This system is mainly developed by keeping the high chemical contaminated areas in mind.

II. CONVENTIONAL SYSTEM

The conventional RO purifier works on 230 V AC and 50 Hz and a water dispenser works on 230 V AC and a power rating of 500W. This is a residential RO system with around 15 LPH.

III. STAGES IN REVERSE OSMOSIS FILTERATION:

The proposed RO filtration process is a total 14 stages starting from pre filtration to UV filtration. In UV filtration, an UV beam is sent through the water, which eventually kills the bacteria and other micro organisms. This UV lamp works on 24V. This can be changed annually. The following is the schematic diagram of Reverse Osmosis in a nutshell.

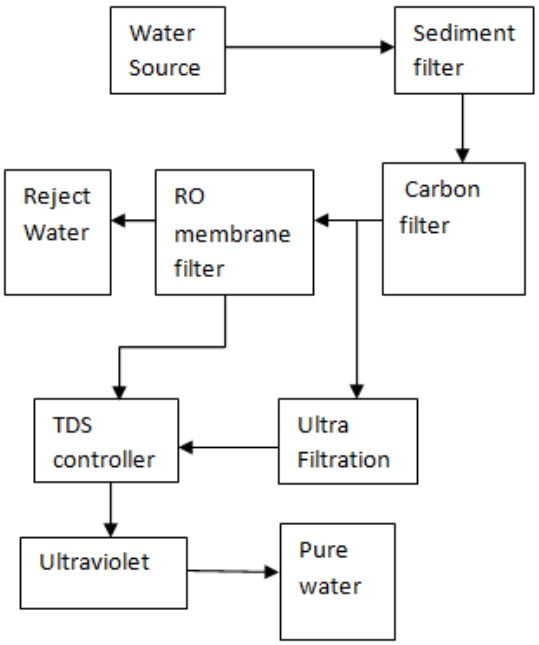

Figure 1. Schematic diagram of the stages in Reverse Osmosis

IV. SOLAR WATER CONDITIONER

Here a Peltier is supplied with 12V DC power, thus it generates a heat flux on either sides. This process is called Thermoelectric generation. Now two heat sinks are placed on either sides of peltier, which give away the temperature to water upon pouring. The temperature of cold water will be around 12-14^{0}c and hot water of 40^{0}c.

V. PROPOSED SYSTEM

5.1 REVERSE OSMOSIS:

Proposed system is a standalone PV powered RO water purification system which works on 24 V DC supply and a solar charge controller is used to regulate the required voltage of 24V. The dispensing unit works on 12 V DC and around 60 W power. This helps to reduce the use of conventional power thus contributing to energy efficient environment.

The proposed system is a 14 stage filtration process. The water from the source enters into a pre filter. The pre filter arrests the sand particles entering the motor. Then the water is sent into the pump run by the DC motor. The pump then pumps the water to 5micron Spun (polypropylene) filter which acts as a sieve dirt particles, rust and bacteria. Then the water is sent to the sediment filter of 1 micron thick which removes dirt particles affecting pre carbon filter. The next filter, pre carbon will remove carbon particles and organic impurities from water. Now the water splits into two ways. One enters the important filter which is Membrane filter, a micro porous plastic film which regarded as heart of the RO system. This filter eliminates the microbial contaminants like protozoa, mercury, lead, bacteria and virus. The reject water is drained from here. Another half enters UF (Ultra Filtration) which arrests colloidal particles, bacteria and cysts. Then it enters the TDS controller which is a manual adjuster to retain minerals. Now both the waters gather and start moving as single flow. The membrane filter almost filters 95% of the suspended particles which results in wash away of essential minerals. So by controlling the TDS valve, TDS of water can be controlled.

1) If flow of input water from the RO membrane is increased and the flow of input water from UF membrane is reduced, the TDS is decreased.

2) If flow of input water from the RO membrane is reduced and the flow of input water from UF membrane is increased, the TDS is increased.

By this way, the TDS of water can be controlled according to the requirement. Now this water enters UV filter. Ultraviolet lamps generate light at a wavelength of 254 nm; this wavelength penetrates the bacteria found in water and damages the DNA of the bacteria and virus to prevent replication rendering the organism inactive (bacteria, virus, molds, algae, and yeast). This works on 24V DC supply.

5.2 WATER CONDITIONER:

Two water collectors were taken. A peltier made of plastics and ceramics of 60W wattage is stuck in between those two water collectors. By supplying a power of 12V DC, the peltier produces a heat flux across the junction. Now, two heat sinks are set in a position such that the obtained pure water from the RO plant flow over the heat sinks and captures the flux leading to change in its temperature. Hence, both cold and hot waters are obtained simultaneously.

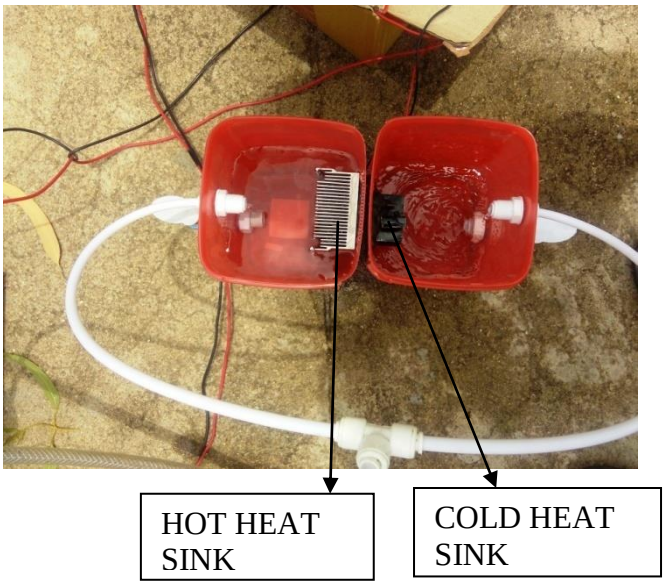

Figure 5.2.1. Proposed water conditioner

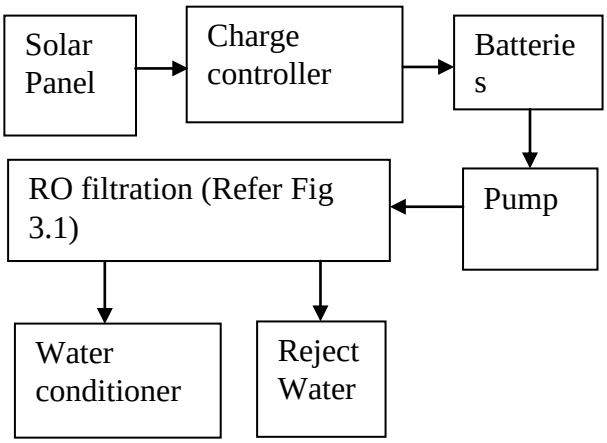

Figure 5.2.2. Schematic representation of proposed Reverse Osmosis filtration and water conditioner

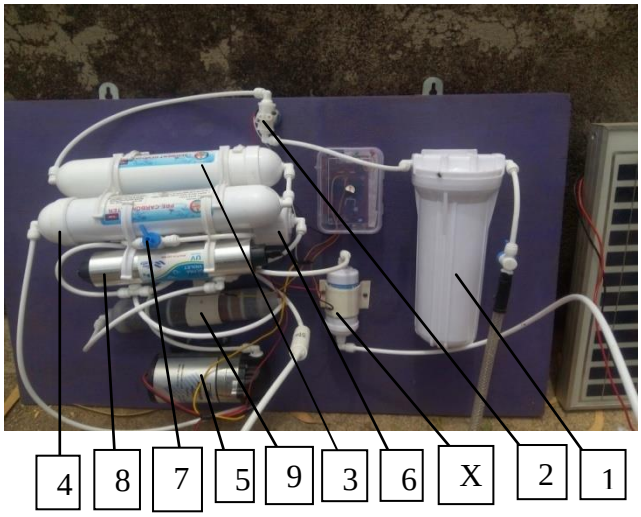

Figure 5.2.3

Nomenclature of numbered parts:

Table 1

S. No	NAMES
1	PREFILTER
2	SOLENOID VALVE
3	SEDIMENT FILTER
4	PRE CARBON FILTER
5	PUMP
6	RO MEMBRANE FILTER
7	TDS CONTROLLER
8	UV STERILISATION
9	THIS FILTER CONTAINS FIVE DIFFERENT ESSENTIAL MINERALS.
X	ULTRA FILTRATION

VI. OBJECTIVE OF PROPOSED SYSTEM

The aim of this work is to develop a standalone solar RO system working on 24V DC supply and also a solar water conditioner (both hot and cold) working on 12V DC supply for residential purpose especially in rural areas.

VII. RESULTS

Table 2. Properties of obtained water

	Raw Water	Obtained Water
pH	7.62	7.04
ORP in mV	-43	-36
Salinity in ppt	2.57	0.43
Conductivity (μS /m)	4440	277
TDS in ppm	1820	471
Dissolved Oxygen in ppm	4.6	5.7

7.2 POWER PARAMETERS

Table 3. Power parameters of conventional and solar RO system

	VOLTAGE (V)	CURRENT (A)	POWER (W)
Conventional RO System	230	0.15	34.5
Solar Powered RO System	24	1.1	26.8

Table 4. Power parameters of Conventional and solar water conditioner

	VOLTAGE (V)	CURRENT (A)	POWER (W)
CONVENTIONAL DISPENSER	230	2.2	500
SOLAR WATER CONDITIONER	12	5	60

Table 5. Temperatures obtained at water conditioner

Type of heat sink	Temperature obtained
Hot sink	41^0c
Cold sink	12^0c

VIII. DISCUSSIONS

- The TDS of the raw water is 1820 ppm. After filtration, the TDS came down to 471 ppm, which lies in the range of pure water.
- The pH value of obtained water is 7.3, which describe it as suitable to drink.
- Salinity reduced from 2.57 to 0.68 in the obtained water eventually making it potable water.
- The water conditioner works on just 60W DC power rather than conventional one working on AC.
- Coming to Power Parameters,

  With AC, power utilized is 34.5 W

  With DC, power utilized is 26.8 W

  Therefore, the loss is around 8W and this 26.8W is pure DC power eliminating the use of conventional power.

IX. CONCLUSION

This solar powered RO system can be used in remote areas where there is no access to conventional power. The properties of obtained water lie in the range of potable water. The solar water conditioner provides cold and hot water simultaneously thereby eliminating the use of conventional water dispenser. This paper concludes that the solar powered RO water purifier and conditioner is working on DC power thus eliminating conventional source of power.

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