Solar Powered Reverse Osmosis Water Purifier

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Abstract - This paper is intended true make use of solar energy by using solar PV cells for residential application. Also if modified the proposed model of solar RO water purifier can be made portable and extend its application area. The use of solar PV cell along with suitable controller circuits for RO water purification (small capacity). Controller circuit consisting charge controller which increase the solar efficiency which having various protection. it can be worked out only on DC eliminating the use of inverter, thus giving out more efficient system is discussed.

Keywords — RO, PV Cell, TDS, Charge Controller, UV, SMF.

I. INTRODUCTION

Reverse Osmosis is extensively applied in the water treatment industry as well as residential purposes. These applications include both the industrial sector as well as (to a lesser extent) the municipal sector. Reverse osmosis for the production of drinkable water is still not widely applied despite high feed TDS and low flow rate requirements being the prevailing characteristics for drinkable applications. The exception is of course the production of drinkable water from seawater by reverse osmosis, but this has thus far found limited application in India.

Reverse Osmosis has however found use in several small-town areas. Here, the treatment of brackish water, with typically high levels of hardness or Fluoride content, has been favored by Reverse Osmosis as opposed to Ion Exchange and other technologies. Typically the main water source for such towns is an active borehole or aquifer. Unfortunately, though there is an abundance of boreholes for possible treatment, these sites are often in remote areas with little or no infrastructure to install a reverse osmosis treatment unit.

The Indian government has been especially active in the supply of water to township and rural areas, but the expansion of the electrical grid to supply electricity to all these areas is still lagging behind. Several alternative energy sources are being evaluated in the interim, with diesel, car batteries, LPG and paraffin power being the norm. However, these forms of energy can only be applied for low energy requirements, i.e. cooking and lighting requirements or at best the transport of drinkable water. These energy resources are however not viable for reverse osmosis systems where high energy requirements from the high pressure feed pumps add severe operating costs to the equation. For some time one of the most promising and widely applied energy sources has been the use of solar energy. Thus far solar power has, as with diesel, LPG and paraffin, also been applied to mainly cooking and lighting requirements with severe limitations on the size and application of typical cooking utensils. Here solar power is typically combined with wood, LPG, paraffin or diesel to supply refrigeration, cooking and other energy intensive applications.

The development of reliable solar powered DC borehole pumps, has further helped with bringing water to the people. Several small installations, more than often in very remote areas, have made it possible to supply water from active boreholes to animals, farms and people. Unfortunately, the typical areas where the use of boreholes is required for the supply of water, are also those areas with very brackish water – not fit for human consumption.

The development and implementation of a solar powered RO unit will not only be of great benefit for communities in rural areas; but is also seen as a cost effective method of supplying drinkable water from brackish sources, in disadvantaged and or remote areas. The concept is relevant to areas where small communities are spread over large areas, where the high cost of erecting large desalination plants and reticulation of desalinated water, or alternatively, the piping of fresh water from other sources, is neither practically nor economically viable. The use of solar panels, which generate the power required to drive the RO unit, constitutes an initial capital investment that can be written off over the lifetime of the unit.

Results, gained from the test runs with the demonstration unit, will significantly contribute toward the optimization of future units and plants of increased capacity[1].

II. STUDY OBJECTIVES

The aims of the project may be summarized as follows:

To design and construct a reverse osmosis unit, powered by solar energy, capable of producing drinkable water from brackish borehole feed for rural households or small communities.

- Flood affected area.
- Military applications in remote places.
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To motivate peoples about renewable energy resources by using solar RO system.

To select desalination membranes which will deliver the maximum amount of potable water at the prevailing operating conditions.

To demonstrate the operation of such a unit by field trials.

III. RESEARCH INVESTIGATIONS

The research programme was formulated in such a way as to establish a study protocol in order to obtain results and conclusions for each of the project objectives.

The order, or project, execution was as follows:

Determine solar panel production capabilities
Design and construct pilot unit
Laboratory tests and optimization of unit
Laboratory tests – production vs. Time of day
Field tests – continuous unassisted operation
Laboratory tests – production vs. Conductivity of feed
Field tests – daily optimized operation
Data analysis and conclusions

The field trials included under the research programme included the monitoring and logging of the following process parameters:

Level of Sunlight
Feed Conditions of Well Water
Permeate Product Quality and Production [3]

Latitude and longitude angle

Latitude angle -

Imagine the Earth was a transparent sphere (actually the shape is slightly oval because of the Earth's rotation, its equator bulges out a little). Through the transparent Earth (drawing) we can see its equatorial plane, and its middle the point is O, the center of the Earth.

In Jalgaon latitude angle is 21.0076578.

Longitude angle -

On the globe, lines of constant longitude ("meridians") extend from pole to pole, like the segment boundaries on a peeled orange.

In jalgaon longitude angle is 75.5626039.

IV. SYSTEM DEVELOPMENT

A. *Existing RO system*

This RO system is work on 230 V 50 Hz AC supply. This RO system is 5 stage system such as pre filter, sediment filter, RO membrane, UV tube, and ultra-filtration. Following diagram shows the existing RO system which is operated on AC supply.

In this RO system majority of elements are operated on DC supply hence 230 v AC is Converted into 24 V DC with the help of AC to DC converter. To light a UV tube there is required UV chock which is operated on AC supply and the water level switch is connected between the AC supply to disconnect the given supply when tank is completely filled by water. There is also solenoid valve to stop the flow of water when the tank is completely filled by water, to increase the pressure of the water flow there is booster pump which forces the water to flow through the filters and membrane.

B. *Objective of current system*

Main purpose of RO system is to give purified water, where the water contamination is high or the water is hard. majority of RO system are working on ac 230 V 50 Hz supply in India because easy availability of AC supply But the basic structure of RO system containing booster pump or pressure pump and other electrical element is mainly constructed to work on DC supply. So the working of RO is involves mainly conversion of AC 230 V to 24 V DC in majority of RO units. The RO units we are discussing here are home RO system with limited capacity.

The system on which we are going to work is 15 litre RO water purifier system. Objective of this project involves development of standalone system. Which is a separate unit working on DC. By doing so it gives us advantage of the system which is free from 230 V AC supply to DC supply conversion. So with DC system having batteries one can also make it portable

Mainly portability with help the RO system to be available in remote areas or rural area where the water quality is not good and electricity is not available But at the same time this needs to be continuously working even after the battery discharged so the concept of introduction of solar power will help to a great extent as power source for charging the batteries. [2]

This concept requires certain modification in existing RO system but once the modification are done it is highly usable in remote areas for rural application or for military or flood affected regions where availability of pure water is rare and situation are emergency.

C. *Model or Block diagram of solar RO system*

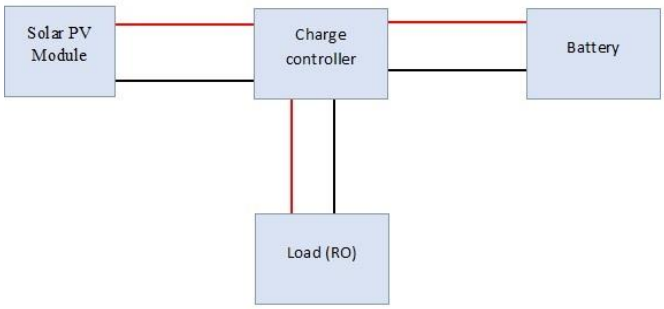

Figure 4.1 Block diagram of solar RO system

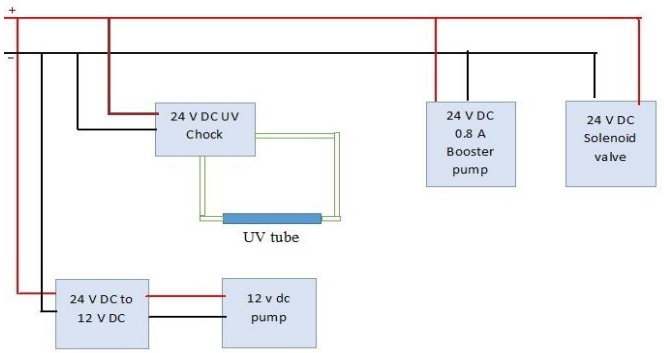

Figure 4.2 Modified Block or circuit diagram of solar RO

D. *Specification of required solar RO*

Applications	**suitable for purification of brackish / tap water**
purification capacity	up to 15 lph
body material	abs food grade plastic
Mounting	on the wall
dimensions(mm)	l 410 w 260 h 520
inlet water pressure/temp (min)	0.3 kg / cm^2 or 4.267psi / 10°c
inlet water pressure/temp (max)	3 kg / cm^2 or 42.67psi / 35°c
filter cartridges	sediment, carbon block filter, UF & post carbon
auto-flushing system	-
UV lamp wattage	11 watt
Weight	8.500 kg
storage capacity	15 l
power consumption	30.2
membrane type	thin film composite RO
booster pump voltage	24 v dc
Voltage	24 v dc

E. *Calculation*

Ampere hours capacity

Voltage Rating of load = 24
Total Hours Required = 8
Maximum Current = 1.12

Ah Capacity of battery = Maximum current × Total Hours

Ah Capacity of battery = 1.12 × 8
= 8.96
= 9 Ah (Approx.)

Hence here we use two battery having 12 V voltage rating connected in series. A higher voltage battery pack with a lower capacity (amp-hours) can deliver the same total energy as a lower voltage pack with higher capacity

F. *Testing before finalizing the Solar RO unit*

AC load test on RO -

Apparatus used:-

1) Voltmeter (0-300)V
2) Ammeter (0-2)A

Observation –

Voltage	**Current drawn by Purifier**	**Power consumption**
230V	0.15A	34.5 watts

Rated power consumption

1) Pump:- 24 V × 0.8 = 19.2 watts
2) UV lamp:- 11 watts

Total power consumption = 30.2 watts

***AC & DC Measurement* –**

For AC Measurement –

VOLTAGE (V)	**CURRENT (I)**	**WATT (W)**	**Time Taken For One Litre Water (Minute)**
230	0.15	34.5	6:37

For DC Measurement –

VOLTAGE (V)	**CURRENT (I)**	**WATT (W)**	**Time Taken For One Litre Water (Minute)**
24	1.08	26.49	6:30

AC & DC Conversion Loss –

AC watt = 34.05 W

DC watt = 26.49 W

Total loss = 8.01 W

*G. **Finalized system***

After the calculation and survey we design such system which fulfil our requirements. And made solar powered water purifier (RO), this system consisting equipment such as solar panel, battery backup, charge controller, RO unit, cables, UV tube with DC UV choke.

This system does not require inverter because whole system works on DC that's why inversion losses are reduces also cost of inverter is reduced. This system works in whole day as well as night also because battery backup is given to the system. In this system input is given from solar panels and then fed to the charge controller. Battery also connected to the charge controller to set the references voltage of the system. Here our system is works on 24 Volt DC that's why we connect two 12 V batteries in series to set 24 V reference voltage, charge controller regulate the voltage of solar panel to the battery which varies in day due to position of sun. The main function of charge controller is to regulate the voltage which fed to battery and also prevent battery from over charging. In our charge controller protection is given such as short circuit protection, overload protection, overvoltage protection, polarity protection. [4], [5].

The charge controller number of output terminals such as solar terminal, battery terminal and load terminal. The load terminal of charge controller is connected to RO Unit. Total system consume 30.2 W and operated at 24 V D.

In our system the storage tank capacity is 15 litre for its full tank require time is 1 hours 20 minute.

V. CONCLUSION

This work of operating is simple assembly which is a good prototype to have a portable source of RO purified water this has less weight. And smaller size. And testing calculation showed that this is quite a good product to have in situations of floods and remote areas where the water purification is needed to be done. Future purifiers may be less costly and convenient to use. This paper conclude fully utilization of renewable energy by using small RO unit which reduce energy cost and totally independent from grid network.

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