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DRINKING WATER SHORTAGE - A SOLUTION

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Global changes and population growth at sinister proportions has created a water crises that is burgeoning every passing day. Water quality is linked to the density of population. Higher the population density, higher is the expectancy of pollution. An exponential growth in water demand has arisen over the past 50 years. Poor water quality imposes ruthless pressures especially on human health and adjacently plays negatively with the environment and agriculture production (that has slowed down over the past 20 years, Rhodes 1999). It is an alarming apathy that 884 million people have inadequate access to safe drinking water and 2.5 billion people do not have adequate facilities for sanitation and waste disposal. In the next two decades, water stress will mount in many of the countries in South Asia, Middle East, and Africa. International World Water-Day is held annually on 22nd March as a means of focusing attention on the importance of freshwater and advocating for the sustainable management of fresh water resources. Each year, World Water-Day highlights a specific aspect of fresh water.

Pakistan is one of the 30 countries of the world, facing an acute water deficiency, which is likely to aggravate during the forthcoming decades. More than 80% of Pakistan lies in the arid and semi-arid zones, characterized by highly erratic, unpredictable and low precipitation, excessive evaporation and high summer temperatures. Water availability has plummeted from about 5,000 cubic meters per capita in the early 1950s to less than 1,500 m^3 per capita today. According to 2008 data from the Food and Agriculture Organization, Pakistan's total water availability per capita ranks dead last in a list of 26 Asian countries and the United States ("Running on Empty: Pakistan's Water Crisis", Edited by Michael Kugelman and Robert M. Hathaway, Woodrow Wilson International Center for Scholars, Washington D.C., 2009).

Pakistan is expected to become water scarce (the designation of a country with annual water availability below 1,000 m^3 per capita) by 2035, though some experts project this may happen as soon as 2020, if not earlier (Asia's Next Challenge: Securing the Region's Water Future, Report by the Leadership Group on Water Security in Asia, N.Y.: Asia Soc., April 2009, 45).

Most people are forced to use unclean water in Pakistan not only for all their sanitation needs, farming, and livestock but for drinking as well. The water supplied by the municipal is of inferior quality. The problem is more associated with civil works and less with the water source quality standards. Drinking water supply lines and open sewage drains in the streets are laid side by side. Most main sewers are laid at a depth of 30 – 50 ft and at places only at 10 – 15 ft. and are made of 10 ft. cement sections. These are linked casually with poor cement grout. These connections are responsible for the leakages in the sewer pipes. If the water pipes deteriorate due to some reason then outflow from sewer pipes with higher pressure mixes with municipal supply water that is at a lower pressure. Sometimes, the seepage contaminates the deeper ground water and the water quality becomes highly objectionable. The problem escalates during the rainy seasons when Monsoons shower water that is much more than the capacity of the sewer pipes. Water profligacy reaches its peak. Several diseases break out e.g., dysentery, bloody diarrhea, cholera, typhoid, hepatitis, and thyroid malfunction, stomach tumors that lead to miscarriages and still births. Other diseases that no less than the already mentioned are Anemia, Ascariasis, Cyanobacterial Toxins, Fluorosisand Arsenicosis associated with the tragedy of Chahkalanwala, suberbs of Lahore, Pakistan ("Arsenic in Ground water: a growing threat in Pakistan", Int. Sem. LCU, Lahore, Sept. 22, 2005), Dracunuliasis, Leptospirosis, Methaemoglobinemia, Schistosomiasis. Masses show visual symptoms of paleness and loss of body weight and energy.50 million do not have access to safe drinking water; and 74 million have no sanitation(Insights from the Comprehensive Assessment of Water Management in Agriculture" by International Water Management Institute (IWMI), Colombo, Sri Lanka, 2006).

Hence, availability of safe drinking water is a problem that cannot be regarded as trivial as it carries immense threats to human health and the associated risks are too high to be ignored or be kept pending to deal with later. The recent floods of 2010 in Pakistan have compounded the problem of safe water and no sanitation in several areas.

There are several methods available for the treatment of water to bring the pollutants/ contaminants within safe permissible limits. Such methods range from crude treatment as flocculation/sedimentation, through simple filtration, chlorination, boiling, distillation to more sophisticated techniques as use of special filters and last but not the least reverse osmosis (RO).

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The present paper focuses upon reverse osmosis, as it provides very clean safe drinking water as compared to water given by distillers. It is further coupled with solar energy photo voltage to operate the assembly. Luckily, Pakistan is blessed with bright Sun shine to obtain the amount of KWs required to operate the RO assembly at a reasonable efficient rate.

The principle of **Reverse Osmosis (RO)**is a simple**.** Water pressure is used to force water molecules through a membrane that is designed to allow only the water molecules to pass. The larger contaminants are left behind that are flushed out and clean water is collected on the other side of the membrane. Applying an external pressure to reverse the natural flow of pure solvent, is reverse osmosis. It involves a diffusive mechanism so that separation efficiency is dependent on solute concentration, pressure and water flux rate (Crittenden, J. Trusell, R., Hand, D., Howe, K & Tchobanoglous, G., "Water Treatment Principles and design", 2nd ed., John Wiley and sons, N.J., 2005). Ordinarily, one unit comprises of a pre filter, the reverse osmosis membrane, a water storage tank, and an activated carbon post filter.

The RO technique is able to provide more clean water as compared to distillers per day. The technique is not fit for home units as pressure is low to force the water molecules through the semi permeable membrane. However, it can be found efficient to supply safe clean drinking water (WHO standard) to small communities like a village and resident colleges and Universities.

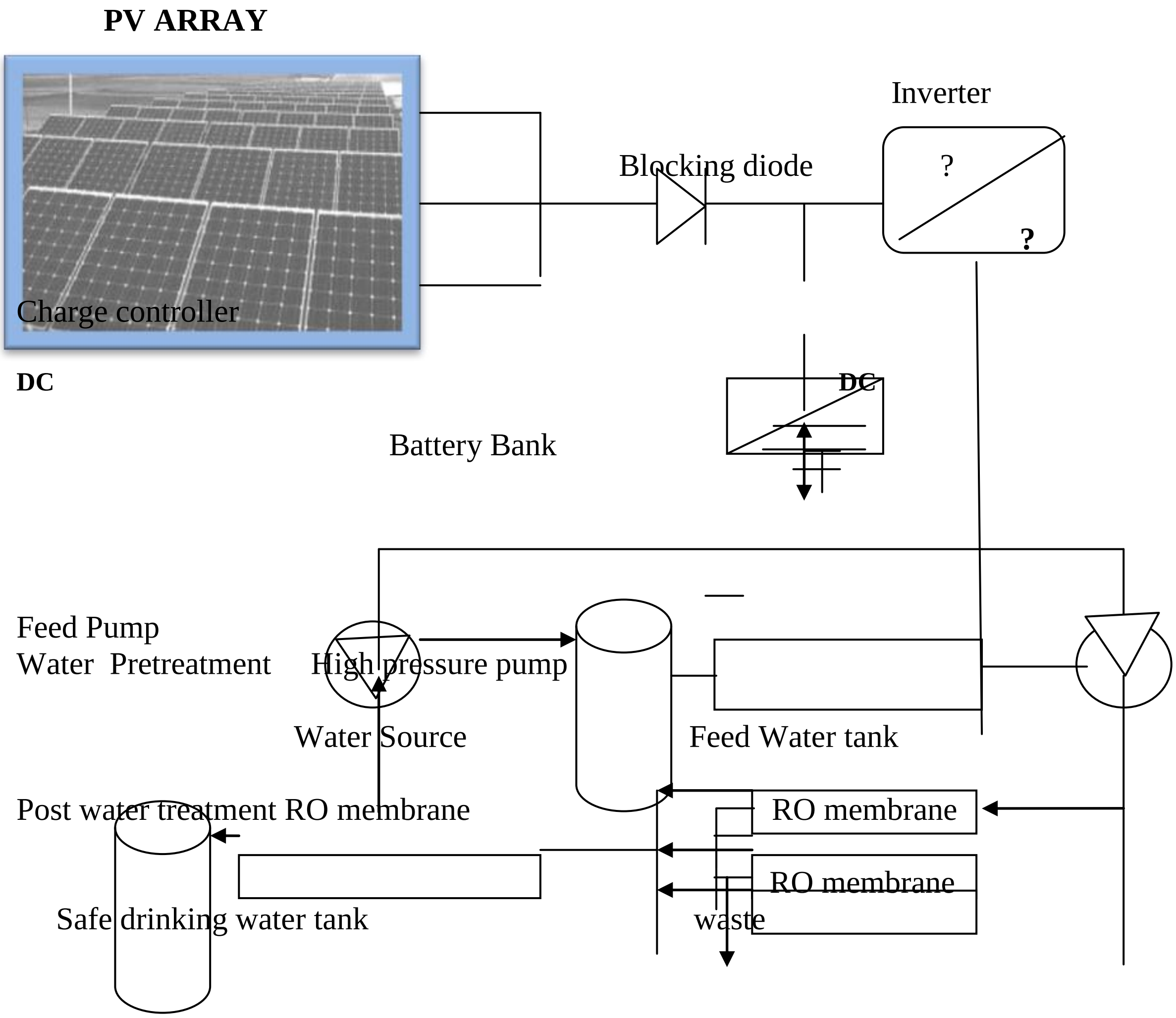
Photo Voltage (PV)suggests itself to be the energy source of the future for water purification, because there is a high sun irradiation and a large water shortage. The sun radiation of 3–8 kWh per m^2 / day and is a similar to the energy content of 1–2 barrels oil per year. (Markus Forstmeier, Wilhelm Feichter, Oliver Mayer, Science Direct, Desalination 221 (2008) 23–28).

PV is highly reliable and is often chosen because it offers the lowest life-cycle cost, especially for applications requiring less than 10 kW, where grid electricity is not available and where internal-combustion engines are expensive to maintain (M. Thomson, M. Miranda and D. Infield, A small scale seawater reverse-osmosis system with excellent energy efficiency over a wide operating range, Desalination, 153 (2002) 229–236).

The assembly consists of a solar energy driven power generators and DC or AC driven reverse osmosis units with the desired capacity e.g., 3000 gallons per day. The water is cleaned by utilizing high quality membranes, high pressure pumps and integrated energy recovery devices. The plant can be driven by a photo voltage (PV) generator of 2.5 to 3.5 kilowatts of solar arrays with appropriate electronics and control devices for near optimal performance of the system. Photo voltage power produced to run this system is 2.88 kWp giving water production of 2 m^3/d.

The system suggested for the provision of clean drinking water will have a very low maintenance cost. The PV panels will generally last for approximately 25 years. The batteries give a long service of 10 years. Since, it is hyper filtration best quality water is obtained. . The membranes and filters are periodically replaced. The frequency of these replacements will depend upon the contamination level of the source water. The system requires periodic maintenance and at a damaged membrane is usually difficult to detect from out side. In addition to that there will be moderate cost for the chemicals and dozing gases such as chlorine which can be borne easily by the community itself.

The schematic diagram for such an assembly is given below:



SCHEMATIC SHOWING PHOTOVOLTAGE COUPLED WITH REVERSE OSMOSIS FOR THE PRODUCTION OF SAFE DRINKING WATER

These prototype systems are already in operation for the treatment of brackish water by reverse osmosis (BWRO) in Turky, Eygpt, Morocco, Cyprus, Jordan, South Mediterranean and Middle East regions. In Tunisia hybrid systems as wind – Photo voltage – diesel and Wind – diesel are working at pilot plant level.

ADVANTAGES OF PV-REVERSE OSMOSIS SYSTEM

1. Availability of safe water quality meeting WHO's standards.
2. Quality water is obtained at a lower cost
3. No electricity bill
4. Clean energy and clean water system

This will be a step towards introducing concepts of sustainable development and green technology programs in the country. Such steps are crucially important to save lives where small civil communities can themselves involve in the process of monitoring and maintenance of their own and play a constructive role in development and remove dependence on state.

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