SUBMISSION TEMPLATE

Research-2-Practice Forum on Renewable Energy, Water and Climate Security in Africa
16 - 18.04.2018, Tlemcen, Algeria

Category: Research and Scientific Contributions

The main topics of the extended abstract should fit within the areas of water, energy, climate change, the nexus within water, energy and climate change. The abstract should also be in line with ongoing projects and priorities of the research agenda at PAUWES as a contribution to the Agenda 2063 of the African union.

General Guidelines:

Extended abstracts should be written according to structure given in the template below, including the following headings: abstract and keywords, introduction, method, results and discussion, conclusion and recommendations, references. There is flexibility as to the naming of the sections. Sub-headings can be used when necessary.

Extended abstract shall be written in Calibri font, single line spacing and 10 font size. Extended abstracts can contain figures, tables and/or images. Page format should be A4 page size with margins 2.5 cm wide from the right, left, top and bottom. **Extended abstracts should not exceed 4 pages (including references)** and pages should not be numbered.

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Supported by:

Small Scale Photovoltaic-Driven Reverse Osmosis (PV-RO) Desalination Plant for Pure Water Production

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Short Abstract

Currently, renewable energies can provide a sustainable and alternative solution for generating reverse osmosis systems operating at high pressure. The production of fresh and potable water by solar water desalination remains a sustainable strategy and economic option to fill the water deficit in areas that do not have access to safe drinking water and electricity. For this, this principle is developed industrially for the desalination of the sea waters and the purification of the water.

The main objective of the present work is the study of a small capacity (100 l/h) reverse osmosis plan intended for desalination and water treatment operation. We have especially worked on the effect of pressure and salinity on the production and quality of the water produced. The performed work is purely experimental and is part within the framework of improving the profitability of an RO device. Initiation of coupling of the reverse osmosis pilot to solar energy in order to reduce energy consumption (4 KW/1m^3) is being investigated. During this period of experimentation a physicochemical and bacteriological analysis of the water before and after treatment were carried out.

Keywords: Desalination process; reverse osmosis (RO) ; membrane; pure water; solar energy

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1. Introduction

Solar energy is the most abundant natural resource in Algeria. It becomes imperative for Algeria to exploit this important resource. The overall installed photovoltaic (PV) power is about 1.2MW[Boudghene Stambouli A]. The insolation time over the quasi-totality of the national territory exceeds 2000 h annually and may reach 3900 h (Sahara). The daily obtained energy on a horizontal surface of 1 m^2 is 5 kWh over the major part of the national territory, or about 1700 kWh/(m^2 year) for the north and 2650 KWh/(m2 year) for the south of the country[Hattabi S]

Numerous renewable energy-powered RO plants, primarily PV-battery systems of small to medium capacity (0.5 to 50 m^3/day), have been built in different locations of the world. For example, Herold and Neskakis[D. Herold and al] presented a small PV-driven reverse osmosis desalination plant on the island of Gran Canaria with an average daily drinking water production of 0.8 - 3 m^3/d. The plant was supplied by a stand-alone 4.8 kWp photovoltaic (PV) system with additional battery storage of 60 kWh. The nominal production was 1 m^3/day. The specific energy consumption of this system was considered high with 16 \$/m^3 production cost.

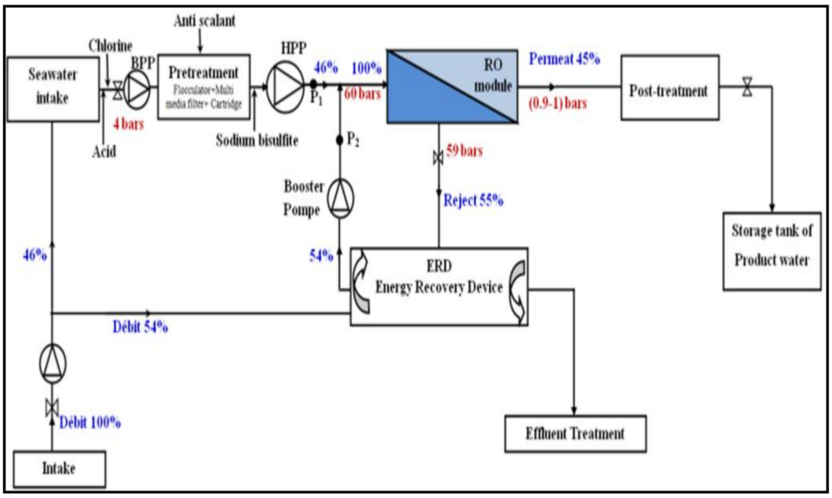
An experimental study on water desalination by using a small pilot scale reverse osmosis has been performed in our laboratory. A preliminary study to coupling the system to the solar energy is being investigated.

2. Methods

In our laboratory we acquired a 100 l / h low reverse osmosis pilot (figure1). This experimental reverse osmosis system consists of a high pressure pump (PHP) model in stainless steel with variable pressure (plunger pump) which offers a pressure of up to 105 bars. This pump is placed on a 304 stainless steel base connected to a valve that allows controlling the inlet pressure. A high-pressure gauge is installed to measure pressure.

The pilot contains two spiral membranes placed in a casing in series so that the concentrate of the first membrane is received by the second. A flow meter placed at the diaphragm outlet is used to control the permeation rate and hence the conversion rate. The various electrical power cables are grouped in an electrical box with an on / off circuit breaker. The high pressure pipes are made of 316L stainless steel. The low pressure pipes are made of polyvinyl chloride PVC. Two filter cartridges for filtering water at 5 microphones are located behind the stainless steel frame which carries all the components of the equipment and others (conductivity meter on the production line, flushing valve, automated panel ... Ect).

(a)



(b)

Figure 1: (a): Reverse Osmosis pilot installed in the DDEMS laboratory, (b): General diagram of the seawater desalination plant.

3. Results and discussion

3.1. Effect of feed water salinity on the physico-chemical parameters

Two different salt concentrations were prepared in order to study the effect of salt. For low salinity, we used the well water of UDES characterized by a salinity of 7.7 g/l, to obtain hight salinity a quantity of salt is added to have a salinity of 32 g / l.

Table 1: Results of physicochemical analysis . (a) feed water (b) permeate

	Low salinity	Hight salinity
Temperature(°C)	17.8	18
pH	8.05	8.11
Salinity (g/l)	7.7	32
Conductivity(ms/cm)	13.36	55.52
MES (mg/l)	12.6	117
TDS (g/l)	4.63	17,2
Ammonium(mg/l)	8.0876	0.0465
Nitrites(mg/l)	0.0751	0.1307
Nitrates(mg/l)	202.56	4.5976
Phosphates(mg/l)	0.0086	0.3593
Chlorides(mg/l)	1762.57	1562
Carbonates(mg/l)	0.1065	0.075
Sulfates (mg/l)	0.0000	361.32

(a)

	Low salinity	Hight salinity
Temperature(°C)	18.5	18.2
pH	7.74	7.10
Salinity (g/l)	0.00	0.05
Conductivity(ms/cm)	0.397	4.64
MES (mg/l)	1	4
TDS (g/l)	0.53	6.2
Ammonium(mg/l)	0.0139	0.0555
Nitrites(mg/l)	0.0110	0.1017
Nitrates(mg/l)	33.54	1.29
Phosphates(mg/l)	0.0115	0.3416
Chlorides(mg/l)	92.3	0
Carbonates(mg/l)	0.009	0.0097
Sulfates (mg/l)	388.51	346.90

(b)

From table 1, we observe that physicochemical analysis of the well water indicates that this water conforms to the quality parameters of the surface and ground water for the population water supply. On the other hand, permeate quality is influenced by the salt amount in the feed water.

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3.2. Dimensioning the PV system for the osmosis feed

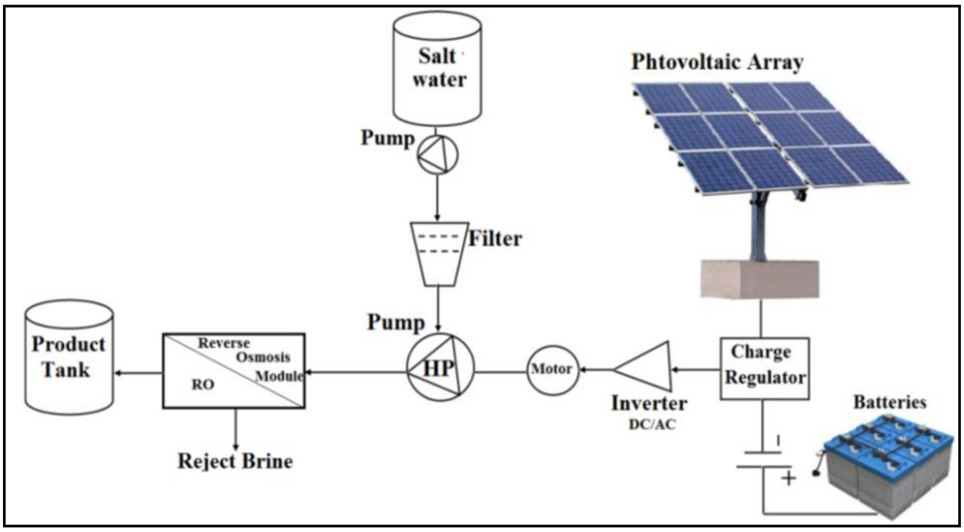

Figure 2: Schematic diagram of the PV powered RO system

The design of a stand-alone photovoltaic conversion system is based on the electrical and physical characteristics of the pump and the mode of operation of the system in order to couple the reverse osmosis pilot by solar energy (PV generator).

this autonomous photovoltaic conversion chain is composed of(figure2):

1. 20 PV modules of 150 Wp
2. Two 50A / 48V regulators
3. A 3KW inverter (48VDC / 400VAC)
4. Solar batteries 250AhX2X4
5. Mounting and protection accessories (Wiring, electromagnetic circuit-breaker, electrical box).
6. Aluminum module support

4. Conclusions

We carried out an experimental parametric study of the characteristics of the reverse osmosis system in order to desalinate and treat the well water of the UDES (salinity=7,7 g/l) and a synthetic water (salinity= 32 g/l and 20.78 g/l) by membrane process (OI).The pre-treatment is provided by cartridge filters of 5µm . The study of the physicochemical and bacteriological quality of water should be carried out regularly and periodically (winter, spring, autumn and summer) in order to control and follow changes in water parameters.

The device is suitable for small and large concentrations and it is noted that the minimum pressure to desalinate sea water begins at 40 bars for a high salinity 30 g / l.

Reducing the energetic consumption (4 KW to produce 1 m^3 of pure water) of the device by using sustainable energy is the aim of our research.

5. References

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