Reverse osmosis (RO) as a Palliative to Address Water Scarcity in the Argentinian North Region

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Abstract Although is not a new that the people need clean water to live nowadays there are still people around the world who do not have access to this vital element. Reverse Osmosis is a process to purify water by using a membrane and pressure. This method is not expensive and its installation is simple due to the fact that the purification plant is smaller compared to other plants of this kind. Argentina is a large country that has different climates and regions. For this reason, there are areas, such as the North, where the access to clean water is difficult because of the remote location of these places or because they lack economic resources to improve infrastructure. This paper introduces reverse osmosis as one possible method to provide clean water to the north of Argentina.

Index Terms: **Argentinian north region, reverse osmosis, water**

I. Introduction[1]

At present, something so basic like a glass of fresh drinking water is a luxury for a lot of people around the world. According to the Sustainable Development Goals Report of the United Nation, 765 millions of people have not got access to clean water services [1]. Argentina is not the exception.

Civil engineering has always delved into ways of providing people with access to clean water. Also, civil engineers are really involved in projects to address the water scarcity issue given the challenge that this entails nowadays.

Although Argentina is a country that is rich in rivers and sources of drinking water, there are some areas in which opening a tap to brush your teeth or doing the dishes is not the daily reality, especially in the north of Argentina. In the poorest zones in the north of the country, one of the principal water sources is groundwater but it usually contains pollution, bacteria and microorganisms that affect the quality of the water. The principal solution to these problems is the development of infrastructure systems like water treatment and purification plants, but given the Argentinian economic present context these systems are not easily afforded. For this main reason, the reverse osmosis (RO) treatment is presented in this paper as an efficient method to obtain clean water at a low cost, because it does not have an important investment in infrastructure and maintenance.

Providing safe water to the world is one of the Grand Challenges of the National Academy of Engineering and this institution motivates engineers to help with this global problem. This institution created different programs that prepare students and professionals in international terms and help to develop globally relevant perspectives and skills [2].

The objective of this work is to present reverse osmosis systems for the purification of water and why it is a good method to address the water problem in the north of Argentina.

This paper contains two parts. Firstly, it shows what reverse osmosis is and how it works. The second part of the paper addresses how this system can help to palliate the water scarcity in the Argentinian north region.

II. Reverse osmosis (RO)

A. Presentation of the system

R.O. is a process to purify water used in most of the desalination plants around the world [3]. This system uses a

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The present manuscript is part of the research activities in the Inglés II lesson at Universidad Tecnológica Nacional, Facultad Regional Paraná. Students are asked to research into a topic so as to shed light on a topic of their interest within the National Academy of Engineering's Grand Challenges or the United Nations' Sustainable Development Goals frameworks. If sources have not been well paraphrased or credited, it might be due to students' developing intercultural communicative competence rather than a conscious intention to plagiarize a text. Should the reader have any questions regarding this work, please contact Graciela Yugdar Tófalo, Senior Lecturer, at gyugdar@frp.utn.edu.ar

semi-permeable membrane and pressure to separate solid, bacterial and pollution matter from the water [4].

Osmosis is a natural phenomenon in which pure water crosses a membrane from a region of lower solute concentration to a region of higher solute concentration. Reverse osmosis uses pressure to move the water from the region with higher solutes (pollution and matter) to the region with lower solutes (clean water) [5].

B. *Requisites and process*

A R.O. plant contains four systems: pretreatment system, high-pressure pumps, membrane systems, and post-treatment. The pretreatment system removes inorganic solids and suspended solids; this can be done with conventional methods. The high-pressure pumps provide the pressure necessary to move the water through the membrane and filter the salt, bacteria and pollution. The post treatment depends on the quality of the water and may consist in disinfection or adjustment to the ph [5].

C. *Uses of RO*

These are some uses of the RO [4][5]:

- Groundwater treatment: the groundwater can contain significant amounts of solutes, suspended solids, microorganism and pollution. RO has proved to be a successful technology that can remove heavy metals, suspended solids, organic matter and other pollutants to meet safe drinking water quality requirements.
- Reclamation of wastewater: wastewaters contain organic contaminants, pathogens, pesticides and other pollutants that are dissolved in water. The RO process purifies wastewater with the objective of using this for indirect potable use.
- High purity water for pharmaceuticals and microelectronics

D. *Advantages of Reverse Osmosis*

This method does not use chemical products in the process of purification, which reduces the maintenance cost avoiding corrosion problems. Also, it uses less energy compared to the usual purification plants, and for this reason it can use alternative energies like the solar energy from solar panels. The systems of RO are compact so they are easy to transport and install in any place. Since the systems are automatic, they do not require a lot of workforce. Inorganic and organic materials are removed simultaneously so the process is made faster than other technologies [4].

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III. Problem in the Argentinian North Region

A. *Contextual factors and problem defined*

The north of Argentina is a dry and hot region where it rains less than 800 mm annually. Also, this zone is one of the poorest of Argentina.

In the provinces of the north like Salta, Jujuy, Santiago del Estero and Chaco, people's lack of access to clean water varies between the 7.42% to 35.34%. The sanitation situation is worse than the lack of clean water, which varies between 48.94% and 86.05% of the inhabitants of the region [6]. Apart from the scarcity of clean water and sanitary installations, this region has serious problems connected with access to electricity.

The lack of infrastructure and extreme poverty are reasons for the poor quality of life of the inhabitants. Most of these inhabitants are indigenous people, like the Wichis, whose rights and needs are often neglected.

The Wichis collect rainwater or extract groundwater using pumps. The problem with this is that the rainwater is sporadic and the groundwater usually contains solids, worms, as well as pollution [7].

Given the quality of groundwater, the poverty of the region and the problem with electricity, the inhabitants of this region need a system to purify water that has to be simple, economic and with low consumption of energy.

IV. Reverse Osmosis as a Palliative in the Argentinian North Region

As previously stated in this paper, the lack of clean water and sanitary installations are a serious problem in this region of the country and have an impact on each other. Since there is lack of sanitation basic services, the wastewater goes to the water sources, polluting them and increasing the clean water scarcity issue.

RO can solve these two problems. It can purify the groundwater obtaining clean drinking water. And the same process can treat the wastewater avoiding the polluting of the water sources and obtaining treated water that can be used to irrigate the crops.

The low cost of maintenance and the low use of energy, which can be obtained by means of solar panels making it a self-sustainable water treatment plant, makes OR a great solution for this area. Also, the equipment needed is of easy installation, can be moved to the place where it is needed and does not require a lot of workforce.

There are different scales of R.O. equipment that can be used in this region:

- Individual system: it is a small R.O. equipment that is connected to the tap with minor modifications and produces clean drinking water. This system has a production of more than 300 liters per day, which is sufficient to give drinking water to a small family but not to be used for sanitization or cleaning the house. [8]
- Home system: this equipment produces 250 to 300 liters per hour and can provide clean water to all the house. The installation of the system is

easy and only needs a tank between the equipment and the water pipe. [9]

- Industrial system: this system can be used in the industry or to provide clean water to a small village because a custom-made equipment can have a maximal production of 20.000 liters per hour. The equipment obtains the water from the source and deposits the clean water in a tank or reservoir [10].
- Big treatment plant: the R.O. can be used for a great scale production of clean water. For example, the AYSA's plant of Virrey del Pino in the Buenos Aires province has a daily production of 47.070 m^3 and provides water to different cities [11].

Due the distribution of smalls and separate villages in the region, the best system to use is the industrial system. It is the best option because of its water production capacity and it can be easily transported by trucks to a region where it is more needed or where the groundwater perforations were made.

The SNAP (Servicio Nacional de Agua Potable) from Argentina establishes a consumption of 200 liters per inhabitant per day [12]. Using this information, it is possible to obtain the number of inhabitants that can obtain clean water if one custom-made industrial system of RO operates all the day. We use the next formula to calculate this number:

$$\frac{20.000\ \frac{liters}{hour}\ x\ 24\ \frac{hour}{day}}{200\ \frac{liters}{habitants\ x\ day}} = 2400\ habitants$$

It is possible to see why the capacity of this system of RO is the best option for the region. Only one piece of equipment can provide clean water for all the needs of the inhabitants from a small village with minor maintainance and infrastructure.

This system does not need a lot of infrastructure the water to reach people's homes. The clean water produced can be deposited in a tank or reservoir where the community searches for it; it can be connected to the water pipes and distributed to the houses of the village; or it can be packaged for its distribution to residents of different very small communities of the region.

V. Conclusion

The situation of lack of clean water and the poverty present in the Argentinian north region is a big problem that needs an economic and efficient water treatment method. For this reason, finding a solution or palliative has to be one of the objectives of the presents and futures civil engineers.

RO is a good system to build in this region due to it is an economic, efficient and low maintenance method that can be used for water and sewage treatment. In addition, the space required for the system is small compared to a normal water treatment plant and can be moved to the region or city where it is more necessary.

Another benefit of an RO system is that different companies manufacture and sell the system. This is very important at the time of the maintenance, operative costs and logistics.

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