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Study of desalination processes of seawater from the desalination plant of Laayoune (South of Morocco)

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ABSTRACT: *The use of water for food purposes requires excellent physicochemical quality. To contribute to the control of water quality. Water treated by reverse osmosis is aggressive and demineralize can not be used directly as a source of drinking water. The objective of this work is to study, physics-chemical analyzes of raw water, pretreated osmosis and treated (permeate) and produced water (reservoir) at the desalination plant of seawater Laayoune (SDL), located in southern Morocco. For this, we have followed several qualitative parameters such as pH, conductivity, turbidity.*

KEYWORDS: *Desalination, Seawater,* Laayoune, *Morocco***.**

I. INTRODUCTION

Although apparently inexhaustible, water is very unevenly distributed in the world. In view of industrial development and increasing demand, all countries will have, more or less quickly, to face the problem of its lack (Kettab 2001). The mobilization of water, whether superficial or underground, has always been a concern for man. In southern Morocco, unconventional resource mobilization for water supply has become a long-term strategic choice (Harrak et al., s. d.).

Desalination is an increasingly common solution for providing fresh water in many parts of the world where this resource is scarce. Of all desalination technologies, reverse osmosis is the most widely used technology internationally (Benradi et al. 2013).

The reverse osmosis process has grown over the last 40 years with a 44% increase in global desalination capacity (Greenlee et al. 2009).

As in most countries of the world, in Morocco, reverse osmosis is the technique adopted by the National Office of Electricity and Water, ONEE-Water Branch, as well to desalt the seawater only for the demineralization of brackish waters (Biyoune et al., s. d.).

The Laayoune desalination plant is located at the entrance of the center of EI Marsa about 25 km west of the city of Laayoune (figure 1). It represents ONEE's first experience in water desalination in the southern region. It goes back to the year 1976, when the Office realized an electrodialysis demineralization unit with a production capacity of 75 m3 per day in order to supply the city of Tarfaya with drinking water. (Zidouri 2000).

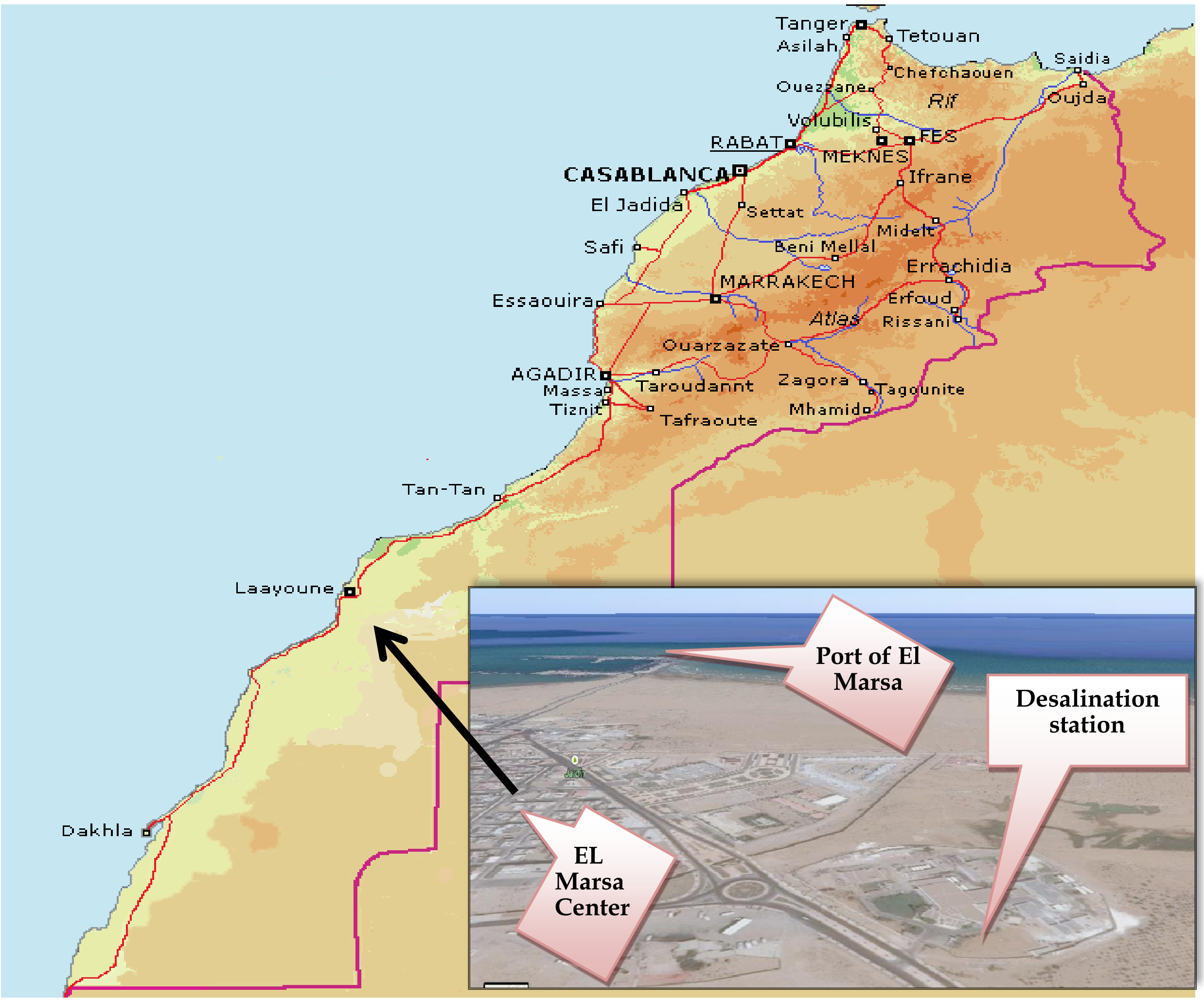

Figure 1: Geographical Location of Seawater Desalination Plant Laaayoune

A year later, in 1977, a new desalination plant using the mechanical steam distillation technique was introduced in Boujdour for a capacity of 250 m^3/day. Thanks to a capitalization on the desalination experiment, ONEE shows a good mastery of this technology and, in 1995, launched two other stations using the reverse osmosis process in Laayoune (7000 m^3/d) and Boujdour (800 m^3/d) (Hafsi 2001). In 2005, these two stations were the subject of extension works to increase their production capacity to reach 13000 m^3/d in Laayoune and 2400 m3/d in Boujdour. In 2010, ONEE launched the project to build a new seawater desalination plant with a production capacity of 13000 m^3/d. Today, the capacity of Laayoune station has doubled the production volume to 26000 m^3/d.

II. MATERIALS AND METHODS

Description Desalination plant for seawater LAAYOUNE:

The LAAYOUNE desalination plant essentially comprises:

- A seawater supply system: coastal drilling and a blanket of raw water for regulation.
- A physical treatment unit for seawater: sand filtration, micro filtration.
- A device for pressurizing water: successively comprises low-pressure pumps and high-pressure pumps.
- the reverse osmosis itself.
- A concentrate energy recovery system: recovery turbines.
- A chemical treatment unit for raw water and permeate distributes between a chlorination station, a reagent station and a remineralisation station.
- Delivery of the product.
- A chemical cleaning station for membranes.

- An electricity supply.
- A central control room.
- A laboratory to control the physicochemical properties of water.

1. Central Control Room and automata.
2. Raw water tarpaulin.
3. Low pressure pumping station.
4. Les filtres à sable.
5. Sand filters.
6. High pressure pumping station.
7. Reverse osmosis.
8. Mooring bins.
9. Remineralisation and chlorination station.
10. Drinking water tarpaulin.
11. Concentrate tank.
12. Reagents and cleaning station.
13. Current transformers substation.

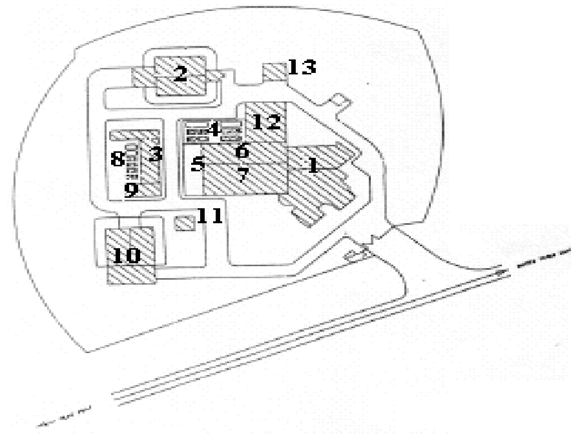

Figure 2: Station model plan

Operation of the station
Coastal drilling

Figure 3: Drilling

The desalination plant is fed by the Atlantic Ocean water, which comes from sixteen coastal boreholes of average depth of 20 m and equipped with centrifugal pumps (four submerged pumps and five shaft pumps). These submerged pumps deliver water with an average unit flow of 38 l / s and a pressure of 2 bar to two tanks (1500 m^3-1600 m^3).

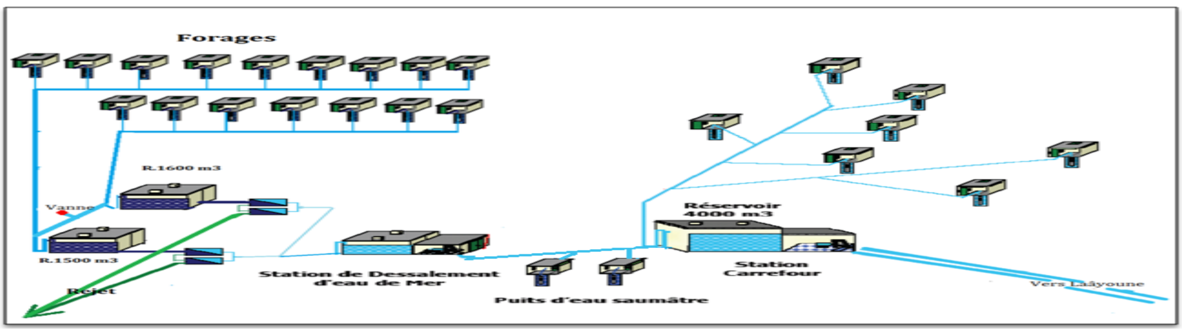

Figure 4: Drinking water supply for the city of Laayoune

- The desalination plant (SD) is supplied with seawater through 16 coastal boreholes
- The desalination plant is currently producing a flow rate of the order of 300 l / s.
- The field captures Foum El Oued (FEO) by means of 07 fresh water wells, returning the water to the tank

of the Carrefour Rework station, at a flow rate of up to 70 l / s.

- Two brackish water wells near the "Carrefour" reservoir, for a flow rate of 31 l / s (15 + 16 l / s), also returning to the reservoir of the crossroads recovery station.

III. RESULTS AND DISCUSSIONS

pH : The pH is a very important parameter giving an idea about the water balance as well as the quality of the water produced (Najy et al. 2018). According to the results found in the Laayoune desalination plant, at the pretreatment stage, the decrease in pH of the raw water from 7.31 to 5.7 is mainly due to the injection of the sequestering agent. And sulfuric acid H_2SO_4. Then, the osmosis water (permeate) passes to the post-treatment to undergo the demineralization by adding the water of lime. As a result, the pH of the produced water rises to 7.8 because of the dissolution of the lime water. The addition of lime water thus makes it possible to regulate the pH of the water produced. The standards set by local and international regulations for drinking water quality recommend a pH between 6.5 and 8.5 (de la Santé 2003).

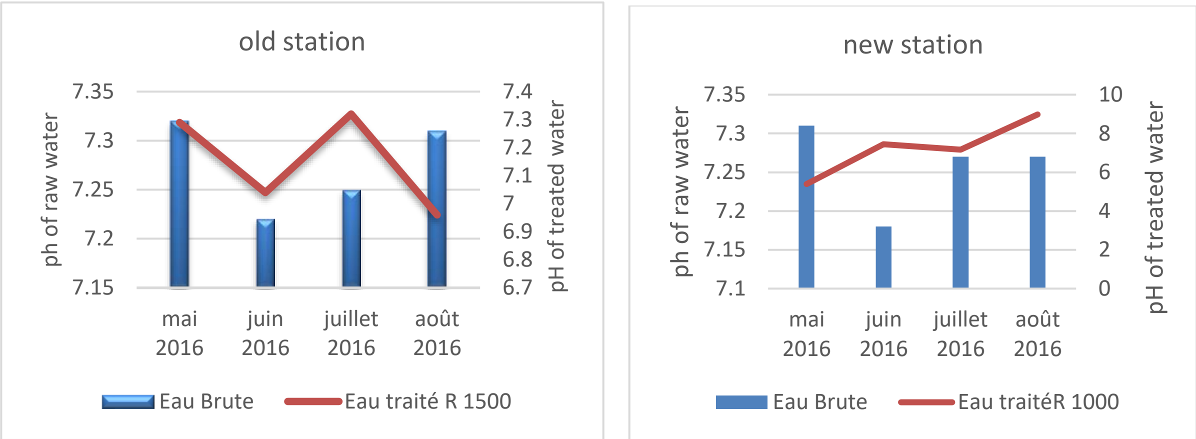

Figure 5: Change in pH of the old and new treated and raw water station as a function of time

Electrical conductivity: According to (Rodier et al., 2009), the conductivity makes it possible to appreciate the degree of mineralization of water insofar as most of the dissolved substances in the water are in the form of electrically charged ions. The values of the raw water electrical conductivity ranged from a minimum of 46875 µS/cm and a maximum of 4660 µS/cm for the old station, and between 45900 µS/cm and 46428.5 µS/cm for the new station. (Figure 6) The treated water (osmosis followed by remineralisation) is characterized by electrical conductivity values ranging from 343 to 379.5 µS/cm for the old station, and from 832.76 to 116.77 µS/cm. for the new station.

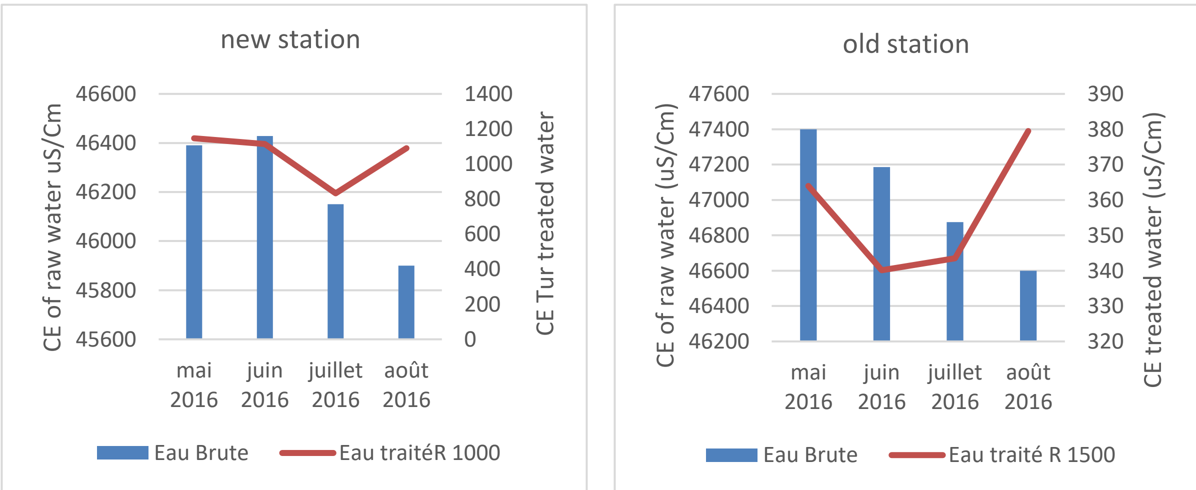

Figure 6: Change in Electrical Conductivity (EC) of Old and New Processed and Raw Water Station vs. Time

Turbidity : The turbidity of the water is caused by suspension materials consisted of clay, silt, organic particles, plankton and miscellaneous other microscopic bodies Turbidity is an indication of the presence of suspended particles in the water. It is determined using a nephelemetry. This device measures light dispersed by suspended particles at an angle of 90 ° to the incident beam of light.

Table: usual turbidity classes (NTU: nephelometry unit turbidity)

NTU < 5	Clear water.
5 < NTU < 30	Slightly cloudy water.
NTU > 50	Troubled Water

There are two methods of measuring turbidity based on two distinct physical phenomena: the Tyndall effect, and the light absorption phenomena whose measurement has been called opacimetry. The Tyndall effect measures the turbidity to know the amount of coagulant (sulphate of alumina) that must be added, and to verify the effectiveness of the treatment (at the end of the treatment).

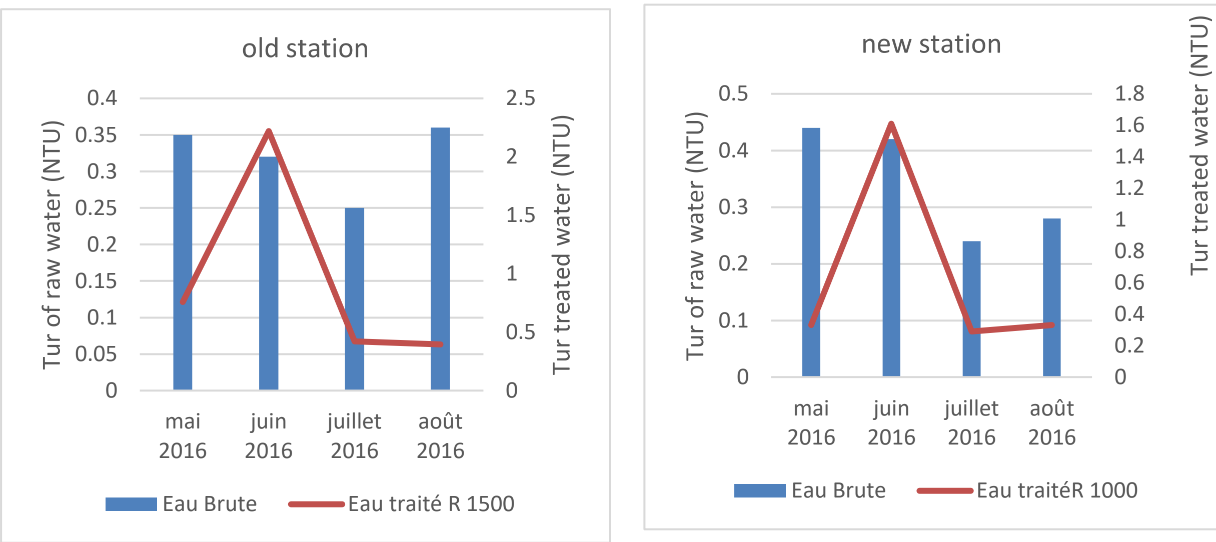

Figure 7: Turbidity variation of the old and new treated and raw water stations

Figure 7 shows the evolution of the raw and treated water turbidity content of the two systems: old and new. Turbidity values for raw water fluctuate between a minimum of 0.24 NTU and a maximum of 0.44 NTU. That at the output of the two systems (treated water), we note a relatively remarkable increase and oscillates between 0.29 NTU and 2.22 NTU.

IV. CONCLUSIONS

The demineralization of brackish water and salt water is a necessity for regions under water stress. Membrane processes are particularly well suited in the case of a low organic load. Among these methods, nanofiltration and reverse osmosis are relatively easy to implement. This study allowed us to conclude that: reverse osmosis, which will only have to overcome a low osmotic pressure, reduces the concentration of inorganic elements that are present in the raw water. Retention rates are high (TR> 95 % for divalent ions and> 85% for monovalents). The selectivity of a reverse osmosis membrane for a given compound is all the more important that this compound is solvated, that is to say that its hydration energy is high. The permeate obtained after treatment of the Zarzis water, complies with WHO standards. It contains some salinity necessary for water intended for human consumption and it does not require additional treatment of remineralization.

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