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Monitoring The Quality of a Reverse Osmosis System in The Energy Systems of The Milk Processing Plant

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Abstracts: The objective of the present work is to monitor and control the physicochemical quality of the osmosis water that feeds the dairy industry in our case the power plant, specifically in terms of energy services. The three energy installations fed by reverse osmosis water are the boiler room, the cold room and the compressed air. These facilities respectively allow the production of steam, the absorption of heat from water through ammonia and the production of compressed air. During a period of 30 days, we monitored the pH, conductivity, alkalinity, hydrometric title, and chlorine content on water samples at the feed tank, boiler, and condenser. The results of the majority of the experimental analyzes comply with the standards imposed except for a few days.

Keywords: Osmosis, Monitoring, Water, Plant, Energy Installations.

1. INTRODUCTION

Water is an essential element for the development of industrial activity, agriculture and agriculture and energy production. The volumes of water used by the industrial sector are sector is the largest consumer of fresh water, and the volumes of water used by the industrial freshwater [1-10]. Some industries, such as the plant, have their own raw water raw water treatment plants to fulfill their functions. Reverse osmosis is currently one of the most widely used means of obtaining ultrapure water in industrial environments. The design of polyamide membranes started in the seventies [11-12].

Their deterioration and the appearance of a progressive blockage film, due on the one Hand to an intense use (6,500 hours per year) [13] and on the other hand to the limits of the pretreatment efficiency, lead to an additional operating cost [14]. The plant salt water plant is equipped with a reverse osmosis treatment plant. The reverse osmosis process is a membrane filtration technique generally used in the desalination of brackish water and sea water. The main objective of this technology is the removal of salts and organic substances present in water [15-18]. Wastewater treatment is the reduction of pollution that is present in the water. This contamination is the product of domestic and factory activities. The treatment of wastewater is to ensure its quality. In fact, the processed water, considering as "clean water", will be used during industrial activities or discharged in the natural environment.

The water supply to the plant is provided through groundwater drilling within the plant. This water contains a high mineral salt content. The objective of our work is to follow the physico-chemical parameters of the water from its origin from the well until it is osmoses.

2. MATERIALS AND METHODS

2.1. Origin, Distribution and Use of Osmosis Water In The Energy Services

The energy services of the Danone plant, Salé factory to meet the need for water for all services of the plant of Salé, including the energy energy services, the Danone plant has a reverse osmosis water treatment unit installedinstalled in 2010. The water supply is ensured by drilling from the water table within the plant. This pumped water requires specific treatment before being used for production production, as it may be contaminated by natural or accidental pollution. The various stages of this treatment are as follows:

- Disinfection with chlorine in the well water basin.
- The physical pre-treatment whose objective is to eliminate all the unacceptable substances particles, colloids, etc. that may be in the feed water, is the filtration by sand filters and in the feed water, is the filtration by sand filters and also by cartridge filters by injecting cartridge filters by injecting chemicals such as bisulfite, sequestering agent and sequestering agent and hydrochloric acid.
- Filtration by reverse osmosis membrane.
- Final disinfection with chlorine.

The osmosis water is then transported to the powdering, pasteurization, process

process, energy and cleaning in place (CIP) areas. Each area has different uses.

uses. In the following, we will only focus on the energy service, which is the most

the most important in the plant, since it consumes the most water.

2.2. Production Of Steam in The Energy Installations

The boiler room, the installation that produces steam, is composed of numerous equipment requiring important controls in order to adapt to the demand of the The boiler room, which produces steam, is made up of numerous pieces of equipment requiring important controls in order to adapt to the production demand which evolves according to the needs of the plant. This includes combustion control, which can be mechanical or electronic. The control of the

burner control allows to operate it in an optimal way for different operating rates. operating rates. It is also important to control the water level, as a minimum is required to ensure minimum level is required to ensure the safety and proper operation of the of the installation. The equipment required for the production of steam are the The equipment required for steam production is the feed tank, the oil circuit and the boiler.

2.2.1. The Feeder Tank

The feeder tank is a tank, generally cylindrical in shape, in vertical or horizontal position, made of horizontal position, made of carbon steel or stainless steel (picture 1). steel (picture 1). The main functions of the tank are to store water to to stabilize the flow of water to the boiler, called feed water. The tank receives and stores the condensed water returns (or condensates) and the treated make-up water. It is therefore the meeting point of the hot condensates and the cold make-up water. The The role of the tank is also to store the calories coming from the recycled condensates and the heat recovery devices and to prepare the feed water for the boiler.

The tank at the plant is fed by condensate water, water from the ER exchanger, compressed air and osmosis water. All these waters are treated by treated with Metalin B and CVA1420. The characteristics of these two chemicals are are shown in Table 1.

The treatment of the boiler feed water is always necessary to to limit foaming in the boiler, the scaling of the tubes, the formation of sludge that would block the tubes or the tubes, or to prevent the entrainment of contaminants in the steam, or to reduce the presence of reduce the presence of dissolved oxygen in the water.

Table 1: Characteristics of the products used in the water treatment at the supply tank

Products	Function	Density	dosage
Metalin B	Descaling agent	1.3	100ppm
CVA1420	Anti-tartar solution and anti-corrosion	1.22	80ppm

2.2.2. Fuel Oil Circuit

The plant of Salé has two fuel oil storage tanks with a capacity of 50 tons each (picture 2). each (photo 2). The fuel oil is first heated to a temperature of 60 to 70 ° C to facilitate to facilitate its flow. The heating then continues until it reaches a value of 120°C by increasing the pressure from 2 to 20 bars with the help of a HP pump.

2.2.3. Boiler

The plant of Salé has two boilers to produce the steam necessary for the operation of processes (picture 3). These boilers are of the type 'with smoke tube' which operate at 6 bars, pressure corresponding to a temperature of 160°C. The heat source of heat is provided by the fuel oil because of its high power. This type of boilers provides a saturated steam flow of 6 tons/hour.

Thanks to the booster pumps, the fuel oil is transported to tanks containing 4 resistances to heat it to a temperature of 70°C. Each tank is equipped with a gauge that indicates its degree of filling and contains two limit switches for starting and stopping the start and stop of the oil suction. Because of the pressure losses caused by the displacement of oil passes through another pump and regenerate a pressure of 2 bar. pressure of 2 bar. The fuel oil then reaches a preheater containing a large heater containing a large resistor which heats it to a temperature of 120°C thanks HP pump of 20 bars, so that it can burn. The preheater is powered by electricity and contains a contains a thermostat to save electrical energy. The fuel oil then arrives at a filter that prevents the passage of impurities. The fuel oil is fed into the boiler by a modulating by a modulating nozzle that also allows the return of the surplus to the original tank. Thanks to the booster pumps, the fuel oil is transported to tanks containing 4 resistances to heat it to a temperature of 70°C.

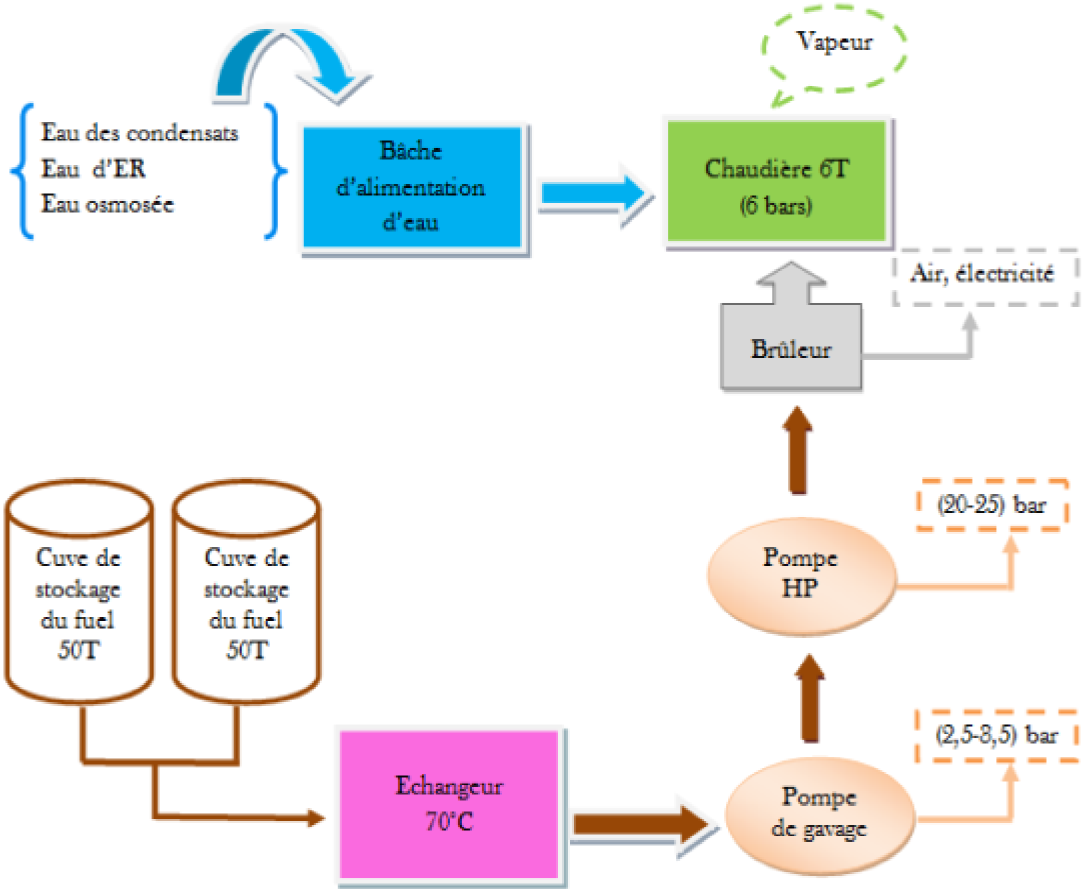


Figure 1: Schematic of the water and oil circuit in the boiler room.

Each tank is equipped with a gauge that indicates its degree of filling and contains two limit switches for starting and stopping the start and stop of the oil suction. Because of the pressure losses caused by the displacement of oil passes through another pump and regenerate a pressure of 2 bar. pressure of 2 bar. The fuel oil then reaches a preheater containing a large heater containing a large resistor which heats it to a temperature of 120°C thanks to a 20 bar HP pump of 20 bars, so that it can burn. The preheater is powered by electricity and contains a contains a thermostat to save electrical energy. The fuel oil then arrives at a filter that prevents the passage of impurities. The fuel oil is fed into the boiler by a modulating by a modulating nozzle that also allows the return of the surplus to the original tank. The steam produced at a pressure of 3 bars is used as a fluid heating the water used in the pasteurization of the mix. Another part of the produced steam is used to increase used to increase the temperature of the oven.

2.3. Production of Compressed Air in The Energy Installations

Almost all the manufacturing machines in the plant operate with compressed air. with compressed air. The ambient air is first filtered by an inlet filter, then passes through two then passes through two compression elements which heat it.

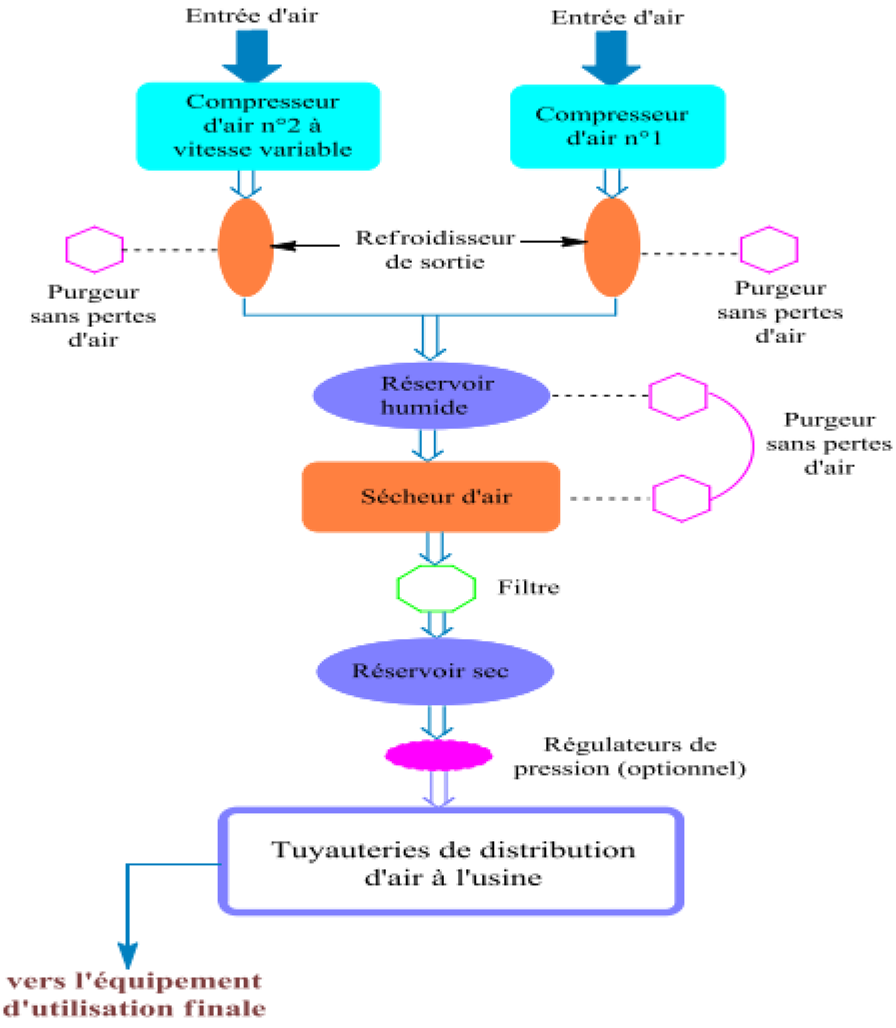


Figure 2: Components of a conventional compressed air system

The first element at BP element increases the pressure from 1 to 3 bars and the second element at HP where the pressure up to 6 bars. The heated air passes through two exchangers in which water at a temperature of 28°C temperature of 28°C acts as a refrigerant. Once heated, this water passes through an ER system (cooling the heated water and recovering the heat). The cooled air undergoes a condensation of part of its humidity which will be recovered manually in floats (traps). The compressed air is then stored in tanks which constitute a storage chamber in case of storage in case of non-use and also to avoid pressure drops. The air is then passed through dryers to remove moisture (Figure 2).

2.4. Cold production in the Energy Installations

The two cold rooms within the plant are ABN and Clauger. The first one allows to glycol water used for the dairy products and the second one allows to cool the water circulated to the cold room and the tunnels. Each cold room Each cold room operates two circuits, primary and secondary. The primary circuit is the cold production circuit itself. It ensures a continuous liquefaction of the gaseous fraction of ammonia. The condensation of ammonia is done in a large condenser thanks to the spraying of cold water in the first instance and then with the help of fans. The secondary circuit is the circuit of use of the cold. The ammonia in liquid form is sent, via pipes insulated with cork and tar, to its use sites, i.e. the glycol water and ice water tanks.

The ammonia in liquid form is sent via pipes insulated with cork and tar to its use sites, namely the glycol water and ice water tanks, the cold tunnel and the cold rooms.

Another system, used for the cold room, includes the storage tank (the tank), a plate heat exchanger, a cold and hot water tank and two pumps for suction and pumps for the suction and discharge of ammonia. In addition to this system, there are four main elements in the plant which are the compressors the condensers, the expansion valve and the evaporator.

2.4.1. The Ammonia Tank

In the ammonia tank, there is a liquid phase and a gaseous phase, as well as a float (level control) and two level probes. The gas phase (low pressure vapors superheated to -8°C) is drawn off to be compressed by screw compressors by screw compressors capable of developing pressures of 13bars (15 bars, 120°C for chilled water production).

2.4.2. Compressor and Condenser

The compressor has two compression stages, a low-pressure stage constituting the suction zone and operating under a pressure of 2 bars and high pressure stage constituting the pressure stage constituting the discharge zone and operating under a pressure 15 bar (11-14 bar). The condensation of ammonia is carried out at a temperature of 33°C. The ambient air enters through the grid, passes through the turbine and then sprays the ammonia line the ammonia line perpendicularly to cool it down. Another cooling system takes place at the foot of each grate. It is the osmosis water osmoses water previously injected in an automatic way of chemical product ALG 60 antibacterial chemical.

2.4.3.Expansion Valve

The expansion of ammonia is done by means of a valve. The expansion valve allows to decrease the pressure of liquid ammonia, it then completes its transformation from the gas phase to the from the gas phase to the liquid phase so that it returns to the tank (2 bar and 30C°).

2.4.4. Plate Heat Exchanger and Evaporator

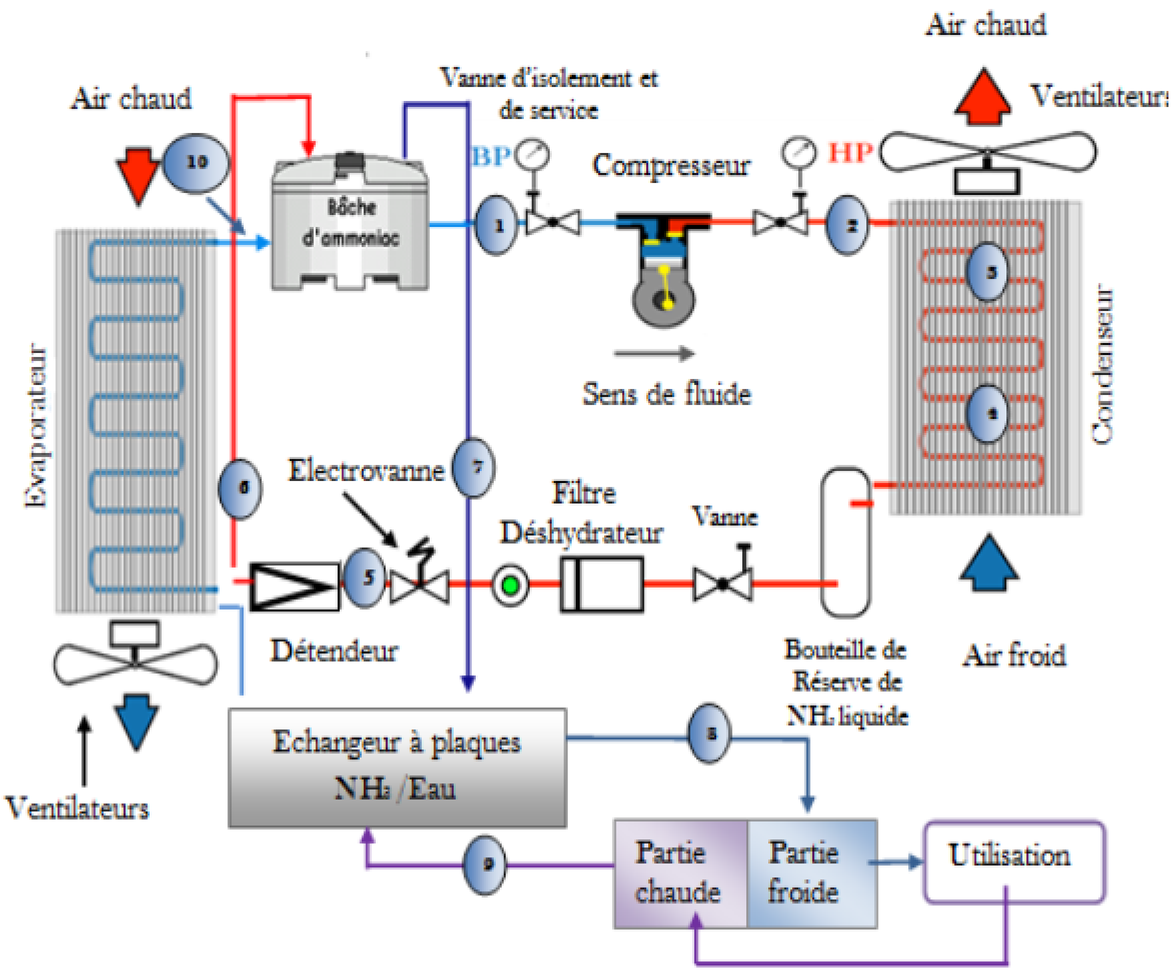


Figure 3: Refrigerant (NH_3) and water circuit in cold room

The liquid ammonia coming from the tank passes to the plate heat exchanger (heat recuperator) to cool the glycol water used for the cooling tunnels and cold rooms of the cooling tunnels and the cold rooms of the powder coating sector. The latter contain Fans whose role is to disperse the cold over the whole of the cold zones. The refrigerant returns to the evaporator for recycling and the glycol water passes through the exchanger for cooling. Another circuit is linked to a pump that sucks the ice water used for cooling the yoghurts cooling of the yoghurts at the exit of the maturation tanks. This water is cooled by the liquid ammonia circulating in a coil in counter-current with the ice water.

3. RESULTS AND DISCUSSIONS

The evaluation of the quality of the water sampled at the feed tank, boiler and clauger condenser was monitored for a period of 30 days. Boiler and clauger condenser was monitored for a period of 30 days from April 16 to May 16 for from April 16th to May 16th for pH, conductivity (CE), hardness (TH) alkalinity (TA, TAC) and chloride content. In the rest of our work, these different analyzed waters are. In the following, the different waters analyzed are named respectively EBA, ECh and EC. The results of the measurements are illustrated in figures 1 to 6 and the corresponding averages for each parameter are grouped in table 4.

- **Evaluation of *pH***

Examination of Figure 4 shows that throughout the analysis period, at the feed tank, pH values ranged from 8.20 to 9.23 with the exception of two the pH values vary from 8.20 to 9.23 with the exception of two high values of 10.15

and 9.83 values of 10.15 and 9.83 corresponding respectively to the 5th and 24 th day and two other low values of 7.42 and 7.00 corresponding respectively to the 12th and 13th day respectively.

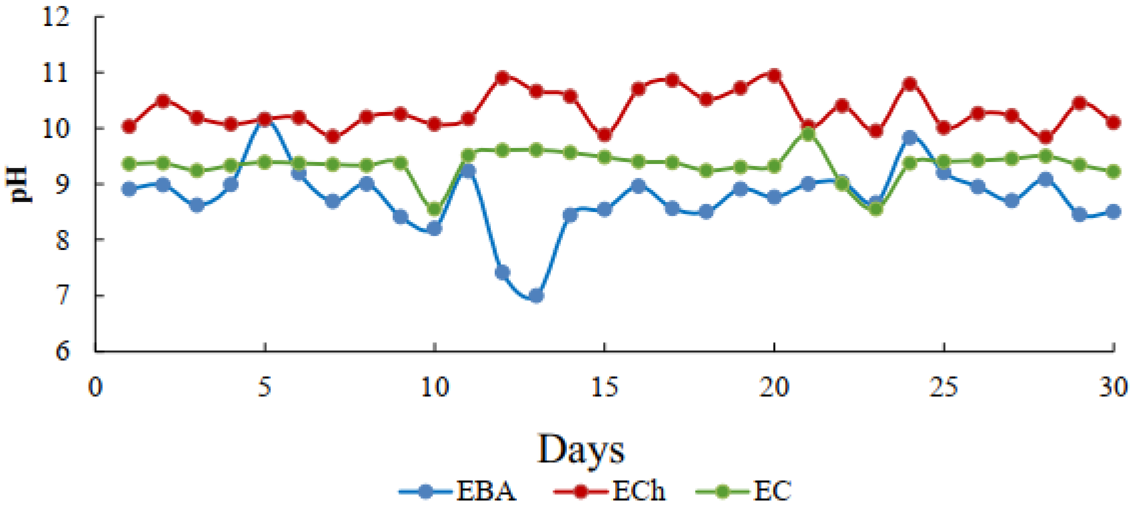


Figure 4: Evolution of the pH of the water in energy installations

These exceptions could be due to the problem existing at the level of dosing by the injected products. With regard to the boiler, the examination of figure 14 shows the chemical characteristics of buffered water with a pH between 9.84 and 10.94. As for the condenser, the pH values vary from 8.55 to 9,89.

- **Evaluation of Conductivity**

The results of the conductivity measurements shown in figure 5, show that for the feeder tank, all the conductivity values are lower than 850 S/cm indicating normal operation of the tank. However, the only relatively high conductivity value, corresponding to day 5, coincides with the high pH value (10.15) (Figure 5).

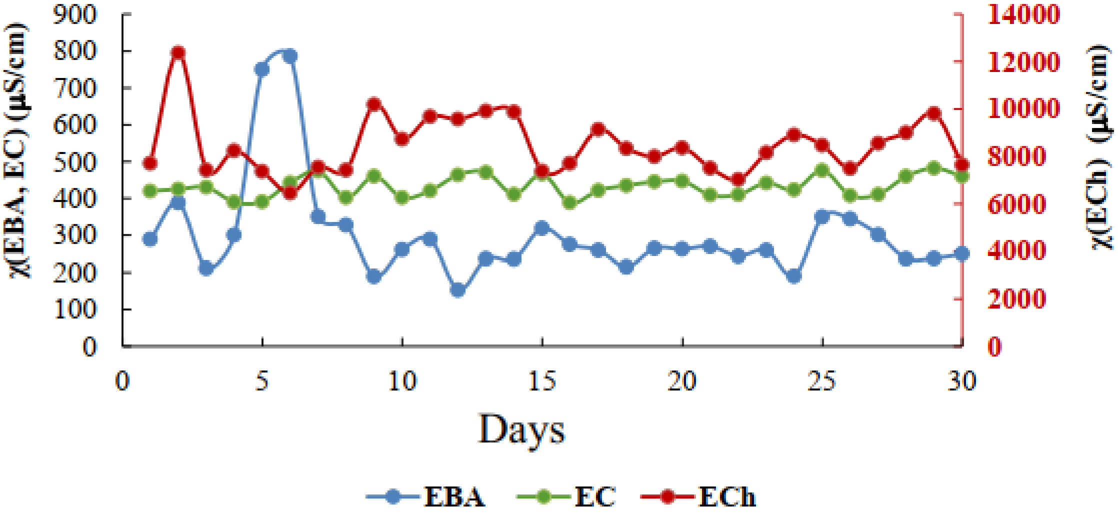


Figure 5: Evolution of water conductivity in energy facilities

For the boiler water, the values of conductivity values are all lower than 10000 S/cm except for the 2nd day which is 12370 S/cm. This increase would be due to the purge problem. The analysis of condenser water shows that the conductivity values are practically constant and are in the constant and are around 400 S/cm. These values are well within the standards.

- **Evaluation of Hydrometric title**

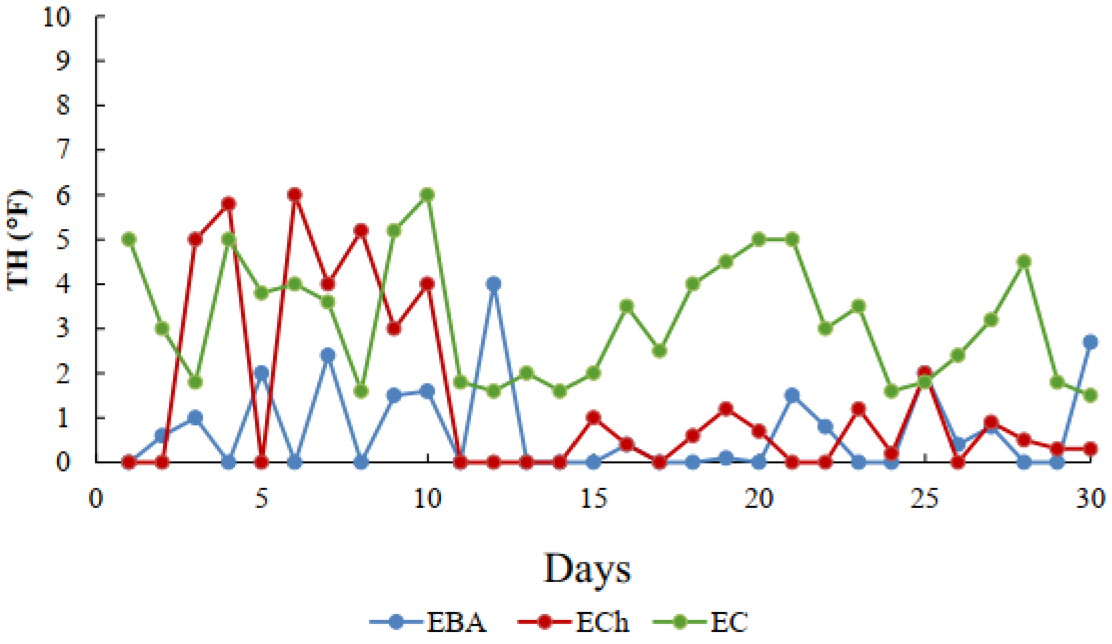


Figure 6: Evolution of the TH of the water of the energy installations

The evolution of hardness as a function of days for the three types of water (Figure 6) indicates that all TH values are below 10°F. This leads us to conclude that the analyzed waters are very soft. Moreover, it should be noted that a high hardness can cause the formation of deposits while a low hardness can cause corrosion problems.

- **Evaluation of Full Alkalimetric Title**

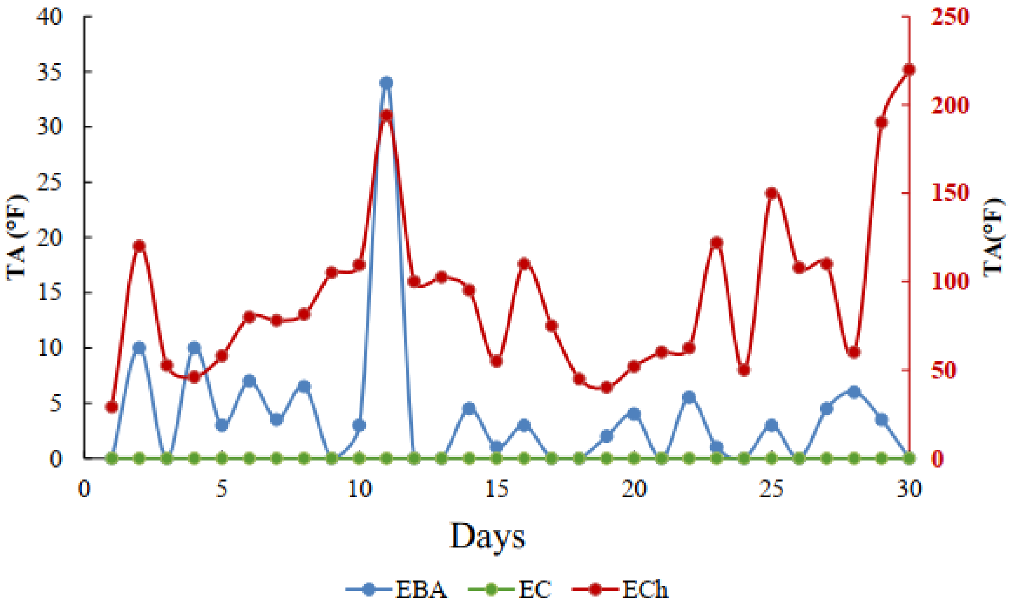
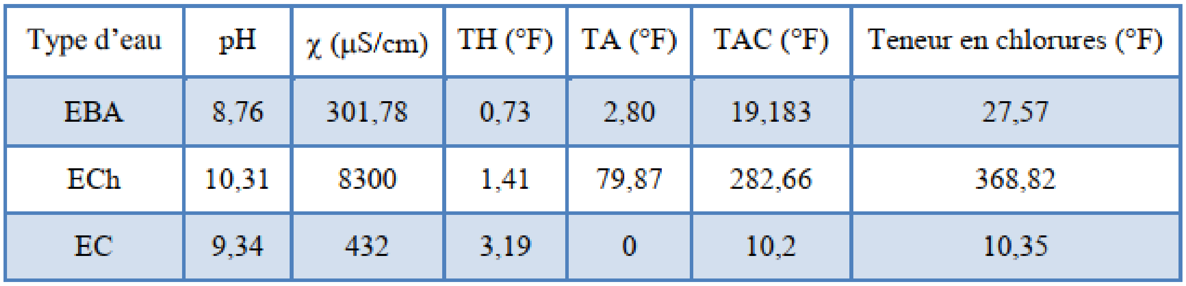


Figure 7: Evolution of water TA for energy facilities

The results of the tank water analysis (Figure 7) show TA values between 0 and 10°F. These values meet the standards except for the value on day 11 which is 34°F. For the water at the boiler, the majority of values are practically between 46 and 120°F except for the three values of 190, 194 and 220°F on days 11, 29 and 30 respectively.

Table 4: Average values of the different parameters



Type d'eau	pH	χ (µS/cm)	TH (°F)	TA (°F)	TAC (°F)	Teneur en chlorures (°F)
EBA	8,76	301,78	0,73	2,80	19,183	27,57
ECh	10,31	8300	1,41	79,87	282,66	368,82
EC	9,34	432	3,19	0	10,2	10,35

This anomaly would mean a high concentration of carbonate ions (CO_3^{2-}) and hydroxyl ions (OH-) present in the boiler water. Indeed, the alkalinity of a water is strongly linked to its hardness linked to its hardness and therefore to its corrosive character and its capacity to scale the pipes. Concerning the condenser water, the TA values are null during the 30 days of analysis. This could be explained by the absence of carbonate ions and hydroxyl ions *in the condenser.*

CONCLUSION

The quality of the osmosis water in the plant at the energy services level is very important for the operation of the three facilities, the boiler room, the cold room and the compressed air. The monitoring of the quality of the physico-chemical parameters of the osmosis water used in the energy installations shows that:

- The average pH value is 8.76 at the feed tank level, it is 10.31 at the average pH value is 8.76 for the feed tank, 10.31 for the boiler and an average pH value of 9.34 for the condenser water. This value is within the norms.
- The average conductivity value of the feed tank is 301.78, for the boiler, it is 8300 S/cm and it is 432S/cm for the condenser water.
- The hydrometric title of the three types of water has average values lower than 10°F.
- The average values of alkalinity are 19.183; 282.66 and 10.2 for the feed tank, boiler and condenser waters respectively. All three types of water then have normalized chloride contents.

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