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The Minister of Secondary, Technical, and Vocational Education

(MESTEP)

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Participation in the STOCKHOLM Junior Water Prize

TOPIC: DESALINISATION OF SEAWATER WITH WOOD ASH

Names:

1- AÏMASSE Esaïe

2- HOUNKPE Jennifer

Field of study: Water and Sanitation (EA)

Coach : Mr. AGUIAR Jean-miracle

Sipervisor : Mr. ENONHEDO Frédéric

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FOREWORD

This document was produced as a project by a pair of learners in the Water and Sanitation specialty of the Coulibaly Technical High School in Cotonou. The content of this document is a set of observations; research; hypotheses; analyses; experiments; references that allowed this pair of learners to present their project which is entitled **the desalinisation of seawater** with the intention of reducing the cost of carrying out this operation compared to existing methods. It should also be noted that the implementation of this project required sufficient research time to find shortcomings in several areas; verification hypotheses and comparisons.

ACKNOWLEDGEMENTS

We express our sincere thanks to all those who have contributed in one way or another to the fulfillment of this project. In particular:

- All the administration of the Coulibaly Technical High School for granting us access to the water treatment laboratory for our various experiments.
- Our coaches Mr. ENONHEDO workshop manager of the EA sector and Mr. AGUIAR teacher of the EA track who followed us during the development of this project.

ABSTRACT

On land, the waters of the seas and oceans occupy about 71% of the planet (according to www.pure-ocean.com). Yet its use is impossible in several areas, apart from its use for the manufacture of salt, due to its high salt concentration (about 35g/L). Several studies and research have nevertheless led to the discovery of methods of reducing or eliminating this amount of salt present in these waters. But these techniques do not bring their accessibility to all because of their very high costs. This is the reason why my life. Our research has led to the establishment of this project which is entitled **the desalinisation of seawater** using a solution that we had called "**solution E**". This solution was prepared based on coal (or wood) ash mixed with tap water. Solution E, by its addition to seawater accompanied by alcohol, which accelerates the reaction, will trigger the formation of salt flakes (flocculation phenomenon) which will be precipitated at the bottom of the container (beaker) containing the mixture: settling phenomenon. The salt concentration at the end of the reaction decreases considerably compared to that of seawater in the natural state.

INTRODUCTION

Seas and oceans together represent the largest water reserve as they cover about 71% of the Earth's surface. Seawater, present in very large quantities, can still not be used directly for consumption because of its high salt concentration (about 35g/L). The elimination or reduction of this large amount of salt from marine waters for consumption or other purposes has been the subject of numerous research studies in several fields of science (chemistry, biology, etc.). This research has led to the discovery or invention of several methods for solving this problem, such as, for example, dilution, which requires a very large quantity of water to achieve it; reverse osmosis, which is carried out by membrane filtration and which is very expensive (from 1 to 2 euros/m.sup.3); freezing; distillation, which provides very little quantity and which is also very expensive. The high cost of these methods often limits their use to wealthy countries such as Qatar; the United Arab Emirates...It is with this in mind, which is to innovate with the curiosity to reduce the cost, to allow the accessibility of a reliable and simple method, that is part of the establishment of our project which will focus on the reduction of the amount of salt contained in the seawater using a **solution called solution** E. We will use one of the methods of reducing the salt concentration to show, by comparisons; deductions, and other chemical tricks, how the realization of our project will improve the problem.

I - <u>Generalities</u>

1-1 Distribution

The seas and oceans represent the immense expanse of salt water separating continents or penetrating some. On land, there are five oceans: the frigid Arctic Ocean; the frigid Antarctic Ocean; the Atlantic Ocean; the Indian Ocean; and the Pacific Ocean. Seawater occupies about 71% of the Earth's surface or 97.2% of the Earth's surface waters.

<u>Photo</u> 1: *Source: Wikipedia. Children's Tales of the Blue Planet.*

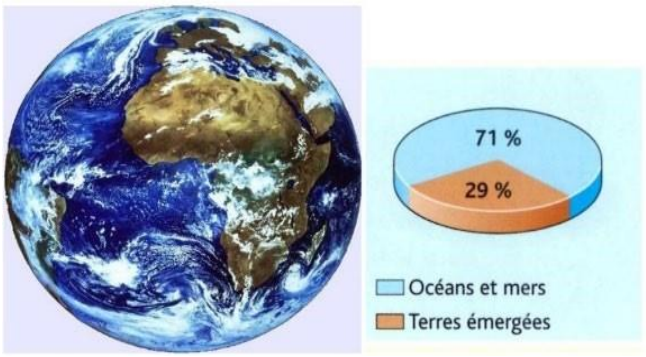


Photo 2: *Source:* www.pure-ocean.com

1-2 Some physico-chemical compositions.

Seawater is a saline solution with an average dissolved mineral salt concentration of about 35 parts per thousand (35 g/L). Its main chemical substance is sodium chloride (cooking salt), but 79 other elements make up it. It is a solution ofH2Ocontaining many very different substances. Up to 2/3 of the natural chemical elements are present in seawater, but most only in trace amounts.

Seawater has a high electrical conductivity; it is the abundance of dissolved ions that contributes to the polarity of salt water. The seawater is slightly alkaline, and the pH value is between 7.5 and 8.4.

Chlorides are more than 55% originally, with sodium chloride NaCl (cooking salt), but it also contains sulfates, bicarbonates, bromides and fluorine.

1-3. Water desalination methods

Current water desalination technologies are classified into two categories, according to the principle applied:

- Thermal processes involving a phase change: freezing and distillation.
- Processes using membranes: reverse osmosis and electrodialysis.

Among the aforementioned processes, distillation and reverse osmosis are technologies whose performance has been proven for the desalination of seawater. Indeed, these two processes are the most marketed on the global desalination market. Other techniques have not experienced significant growth in the field because of problems generally related to energy consumption and/or the size of the investments they require.

Reverse Osmosis

Reverse osmosis is a process of separating water and dissolved salts by means of semi-permeable membranes under the action of pressure (54 to 80 bars for the treatment of seawater). This process operates at ambient temperature and does not
involve any phase change. The polymer membranes used allow water molecules to pass through and do not allow particles, dissolved salts or organic molecules10-7 mm in size to pass through. The energy required by reverse osmosis is solely the electrical energy consumed mainly by high-pressure pumps. The salt content of the osmosed water is of the order of 0.5 g/L.

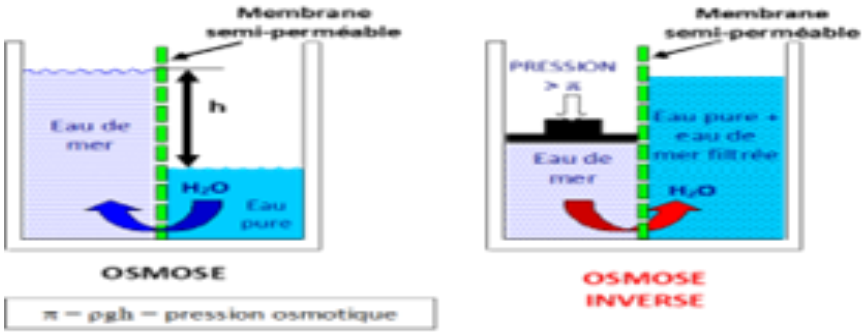


Figure 1: Osmosis and Reverse Osmosis

Author(s): Viviane Renaudin

An increase in the pressure beyond the osmotic pressure will result in a flow of water directed in the opposite direction to the osmotic flow (see FIG. 1), that is to say from the concentrated solution to the diluted solution: this is the reverse osmosis phenomenon.

An improved distillation process

In distillation processes, it is a question of heating the seawater in order to vaporize part of it. The vapor thus produced does not contain salts, it then suffices to condense this vapor to obtain liquid fresh water. It is really about accelerating the natural water cycle. Water naturally evaporates from the oceans. This very simple desalination principle has been used since ancient times to produce very small quantities of fresh water on boats.

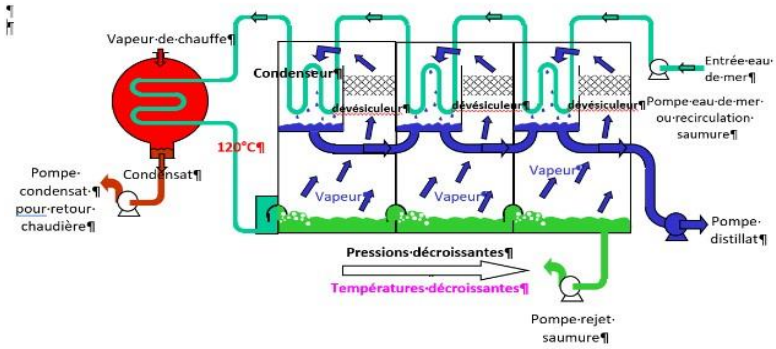


Figure 2: Distillation process of a system by successive expansion with 3 stages.
Author(s): Viviane Renaudin

The major disadvantage of distillation processes is their high energy consumption related to the latent heat of vaporization of water. In fact, to convert one kg of liquid water into 1 kg of steam water at the same temperature, it takes about 2,250 kilojoules (if the change of state is made at 100 ° C.).

II. EXECUTION

This part of our project will be the exhibition of our theme. We will therefore focus on the sampling technique; hypotheses and experiments in the laboratory.

2-1. Transport and sampling

We had made a trip to the seaside located 1.1 km behind the convention center in Cotonou (southern Benin) where the seawater was taken. The temperature at sampling was about 33ºC.

Photo 3: Seawater sampling

2-2 Assumptions

- The experiments will be carried out under normal temperature and pressure conditions (25ºC).
- Seawater contains only salt.
- Solution E reacts by collecting the dissolved salt particles into salt flakes.

2-3. Experiments 2-3-1. Experience with Solution E

Objective: To reduce the salt concentration of seawater with solution E.

Principle: The addition of solution E to the seawater will trigger the phenomena of flocculation and settling of the salt dissolved in the seawater. The salt flakes will rush to the bottom.

Preparation of the solution

- Weigh 0.5 kg of wood ash and the verse in 1L of water.
- Shake the mixture and allow the ash sludge to settle for 24 hours.
- Carefully remove the supernatant water from the sludge and store it.

Course of the experiment

During the course, the amount of salt dissolved in the various solutions will be evaluated according to the conductivity of the latter.

- Measure beforehand the conductivity of seawater in the natural state.
- Arrange 5 beakers each containing 50 ml of seawater.
- Take respectively 10 ml; 30 ml; 50 ml; 70 ml; and 90 ml of solution E and pour each quantity into a beaker.
- Add 5 ml of alcohol to each beaker.
- Wait for flocculation (formation of salt flakes in the solution) and settling (precipitation of salt flakes at the bottom of the beaker) for at least 45 minutes.
- Measure the conductivity of each solution and record the values obtained in a table.
-Track the volume curve as a function of conductivity.

Note: The longer the settling time, the more effective the expected result will be.

Materials: glassware; conductivity meter; pipette containing distilled water.

Reagents: solution E; seawater; Alcohol.

Photo 4: Experiments in the laboratory

2-3-2 Experiments with tap water (Dilution)

- Repeat the same previous experiment by replacing solution E with tap water.

- Measure the conductivity of each solution and record the values obtained in a table.

- -Track the volume curve as a function of conductivity.

Results and Discussions

The results obtained after the two experiments will be used to show how the method of using solution E for desalination provides an improvement over the dilution method.

The experiments carried out in the laboratory resulted in the following results: During the performance of the experiment, after addition of solution E, the formation of salt flakes in the various beakers was observed. There is a chemical reaction that has taken place. But there is no release of heat or gas.

Photo 4: Decantation phase of the experiment

The results obtained for the measurement of the different conductivities in the respective 5 beakers of the two experiments are given in the following tables:

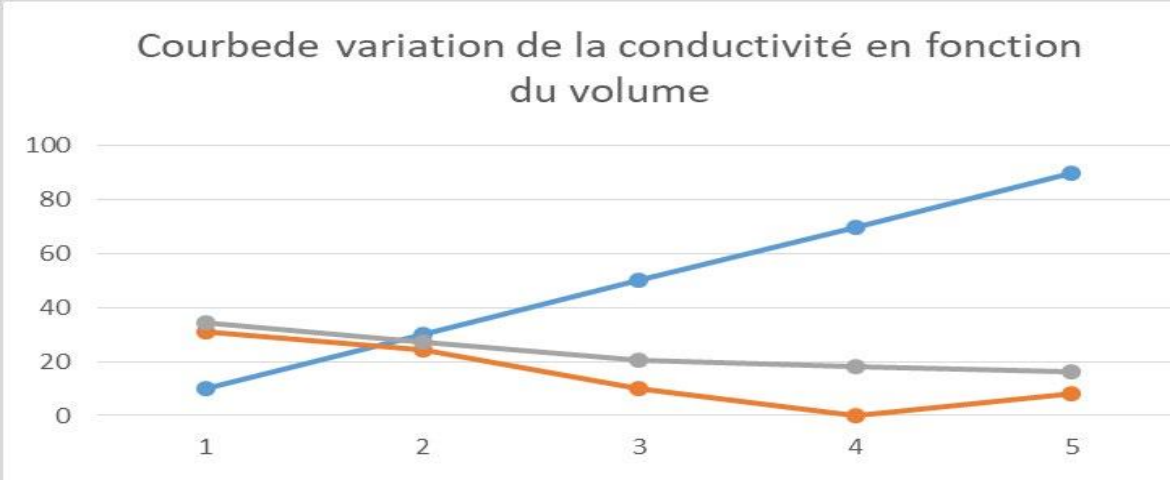
Table 1: Results of the experiment with solution E

Volume of solution E (ml)	10	30	50	70	90
Conductivity (mS/cm)	31	24.2	10.04	9.5	8 2

Table 2: Results of the experiment with tap water

Volume of tap water (ml)	10	30	50	70	90
Conductivity (mS/cm)	34.4	27.4	20.3	18.12.	16.47

NB: Seawater in its natural state has an electrical conductivity of about 43 mS/cm. The results thus obtained made it possible to produce the following curves.



Captions:

: Volume (ml) of solution E and water

: Conductivity (mS/cm) after addition of solution E

: Conductivity (mS/cm) after addition of water

Interpretation

The graph above shows the variation in conductivity as a function of the volumes of reagents added.

Analysis of this graph shows that the conductivity decreases when the volume of water or solution E increases (dilution principle). However, it is noted more particularly that the curve that shows the decrease in conductivity after addition of the quantities of solution E is below that which shows the decrease in conductivity after addition of the quantities of tap water. It is deduced therefrom that the conductivity of the seawater decreases more with the addition of the solution E than with the addition of the tap water. Consequently, the addition of solution E to seawater decreases its salt concentration more than with dilution**.**

It can be concluded from this analysis that the use of solution E to reduce the salt concentration in seawater improves the dilution principle**.**

Conclusion

The salt concentration can therefore be reduced by using this solution E previously presented, which makes it accessible to all. In addition, the use of solution E reduces the amount of water used in the dilution. But an improvement in its use or its combination with other reagents or its use in other desalination processes will be the subject of further research in which we will embark. The optimal dose at which all salt suspended in seawater will be removed will continue to be sought.

Bibliographic reference 23

- Document of the practical work of the Water and Sanitation sectors of Benin.
- Google: *Wikipedia*