

# Feasibility of Producing Sodium Hypochlorite for Disinfection Purposes using Desalination Brine

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**Abstract:** On the Fernando de Noronha archipelago of northeast Brazil, the water supply comes from the desalination of seawater. The main environmental problem related to desalination is the brine resulting from the process, comprised of highly concentrated salts. The present study aimed to produce oxidant solutions from brine for disinfection purposes. The experiment was carried out on a laboratory scale. The brine had a chloride concentration of 40000 mg/L. The electrolysis process lasted twenty-four hours, monitoring pH, electrical conductivity, temperature, and chlorine. The sodium hypochlorite production was 2.27% and 3.61% m/m. The oxidant solutions were tested on domestic effluents and achieved a 99.99% removal rate of thermotolerant coliforms while maintaining the concentration of organochlorines below the upper limit established by legislation for the disposal of effluents. Therefore, the use and more proper brine disposal are sustainable alternatives, enabling the on-site production of sodium hypochlorite on the archipelago in a safe, effective, reliable way and comparable to other oxidants.

**Keywords:** desalination of seawater; electrolysis; sodium hypochlorite; disinfection; reject brine.

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## 1. Introduction

Water scarcity has become a major challenge, and desalination is widely used to provide clean, safe water in many countries. The waste generated by desalination comes essentially from water not permeated by membranes and the backwash process. The effluent generated by the desalination process (brine) poses a threat to the local environment, as brine has high levels of salts, and the current disposal method is generally a receiving water body or indiscriminate disposal in soil, contributing to the contamination of water sources, soil, fauna and flora [1]. Depending on the desalination equipment and water quality, the amount of waste generated is on the order of 30 to 70% of the total water that passes through the equipment [2]. The amount of freshwater that can be extracted from 1 m<sup>3</sup> of seawater is typically close to 0.5 m<sup>3</sup> [3]. Therefore, one can expect that each m<sup>3</sup> of desalinated water leaves behind about 0.5 m<sup>3</sup> of brine, with a salt concentration about twofold as high as seawater.

Brine discharge causes varying disturbances to marine ecosystems [4-7]. Desalination brine has high salinity and contains several chemical contaminants. Therefore, its disposal is a

major economic and environmental concern, especially in regions that depend on desalination for drinking water [8]. Concentration from desalination units on the coast is normally thrown into the sea. The dispersion and natural dilution of brine depend on several factors. The location of the discharge pipe, wave, tidal action, water depth, sea currents, and bathymetry explain the nature and form of the mixture of brine with the sea at the point of the outfall [9]. The largest problem is found in brackish water desalination units installed farther inland, where the brine has a concentration of up to 10 times that of the original raw water [10].

Remediation methods for desalination concentrate include reducing the volume of the effluent and transforming it into a solid product through solar evaporation, resulting in crystallized salts [11, 12]. With this method, the brine is pumped into ponds where the water is evaporated, and the residue is discarded. Evaporation ponds are generally more effective in arid and semi-arid climates, which have relatively fast, constant evaporation rates, as this process relies on solar energy. Ahmed *et al.* [13] studied evaporation ponds and suggested the best design. Porto *et al.* [2, 14, 15] used a halophyte plant (*Atriplex nummularia*) irrigated with brine from the desalination process in fields pertaining to the Brazilian Agricultural Company EMBRAPA. Baydum and Asfora [16] and Matos *et al.* [17] used brine to generate an oxidant solution for disinfection purposes using electrolysis. Another study involved fish farming (crustaceans, tilapia), Spirulina cultivation, and the irrigation of forage shrubs and crops [18]. Abdul-Wahab and Al-Weshahi [27] and Ogunbiyi *et al.* [55] presented an overall review of the current "state of the art" in brine disposal, discussing the advantages and disadvantages of each strategy. Lastly, brine should be seen as a resource and not a waste to attain sustainability in its management approaches [7, 43, 44, 46].

Despite several methods for treating and disposing of the waste generated by desalination processes, it is important to find alternative methods to protect the environment and lower costs. The on-site production of a sodium hypochlorite solution is one of the promising methods that can be used to manage brine.

The manufacturing, packaging, transportation, and distribution of dry disinfecting agents and liquid chlorine are relatively expensive and ecologically unsafe operations [37, 39]. Hypochlorite is the most widely used active chlorine compound for disinfection due to its powerful germicidal action and ease of use. The electrochemical generation of oxidizing agents close to the application site would be useful [38, 39, 40, 48]. Unlike conventional purchased hypochlorite, which degrades over time, sodium hypochlorite generated on-site maintains its strength. Therefore, the on-site generation of sodium hypochlorite on an archipelago is a safe, effective, reliable alternative and comparable to other oxidants.

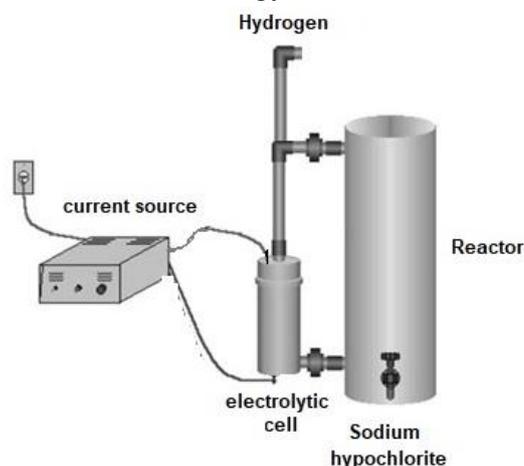
The present study aimed to investigate a method of treating desalination brine to produce an oxidant solution using local sodium hypochlorite generation technology to provide a better use for the concentrate and reduce the amount of waste discarded into the sea.

## 2. Materials and Methods

This experiment was conducted in the laboratory to determine the generation of an oxidant solution from concentrated samples of desalination brine. The main characteristics of the equipment and materials used in the experiments are presented below.

### 2.1. Electrolytic cell.

For the electro-remediation studies, domestically manufactured electrolysis equipment (Hidrogeron static generator) was used, with a production capacity of 150 L of oxidant solution in 24 hours. The equipment has an alternating current source with a power supply of 220V/6A. The electrolysis tests were carried out in batches. For such, an adapted reactor with a capacity of 8 L was used (Figure 1). The titanium anodal and cathodal electrodes were spaced 3 mm apart, and the cell was connected to the energy source.



**Figure 1.** Experimental setup. Adapted from Matos [17].

The electrolytic cell consisted of a pair of electrodes formed by parallel plates with a thickness of 1 mm and an area of 84 cm<sup>2</sup>. The electrode plates were connected to the power cables (red cable connected to the positive electrode and black connected to the negative electrode). A brine volume of 8 L was used for each batch in the reactor. The current source was then connected to the electrical network, initiating the electrolytic process, with the reaction transforming the brine into an oxidant solution. The electrolysis of the brine solution resulted in the production of sodium hypochlorite, hydrogen gas, and other deposits [49, 50, 52]. The by-product generated by the anode (hydrogen) is safely vented into the atmosphere.

### 2.2. Characterisation of brine.

The reject brine samples used in the present study were obtained from a water desalination plant located in the Fernando de Noronha Archipelago, state of Pernambuco, Brazil, which desalinates seawater for human consumption and other purposes. The desalination plant has a production capacity of 48 m<sup>3</sup>/h, producing an average of 15 m<sup>3</sup>/h of waste. The plant operates 24 h/day. Currently, all brine produced is returned to the sea.

Samples were collected in 2021 and stored in plastic containers at 4° C until use. Two brines were evaluated. Brine 1 and brine 2 were collected from the same desalination plant on different days and at different times of the day. The electrolysis tests were performed in Recife, Pernambuco, Brazil, at the Treatability Testing Laboratory of the Pernambuco Water Company (COMPESA). Experimental bench tests were carried out. The samples were characterized in terms of physicochemical, organic, microbiological, and metal variables. The brine was analyzed following the methods recommended by Eaton *et al.* [19]. Concentrations of all major cations and anions were determined using a Varian (Agilent) Spectra 220 FS model GTA 110 inductively coupled plasma atomic emission spectroscope and Metrohm 850 Professional ion chromatography, respectively. Semivolatile organic compounds were analyzed using gas

chromatography-mass spectrometry (TRACE 1300, Thermo Scientific). Brazilian standards established in CONAMA 430/11 [32] for effluents and CONAMA 357/05 [33] for water classes were adopted as reference.

The reflectometric method was employed to determine residual chlorine using a portable DR 300 HACH colorimeter, a cuvette with an optical path of 1.0 cm, and the N,N-diethyl-P-phenylenediamine reagent. The choice of this method is justified because the equipment has high sensitivity and can detect chlorine at low concentrations (0.05 to 2.00 mg/L). An HQ 40 d Multi HACH probe was used to determine pH, temperature, and conductivity. The total electrolysis reaction time was 24 hours. Samples were taken at regular intervals, and residual chlorine, pH, conductivity, temperature, and other physicochemical variables were determined at the end of the reaction. Sample characterization analyses were performed. Analysis of variance (ANOVA) was used to compare the two brines used, and Tukey's test was used to compare means [51].

### 3. Results

#### 3.1. Electrolytic cell.

The experiment was conducted at the Treatability Testing Laboratory (Figure 2) followed the guidelines established in investigations with a similar scope found in the literature.

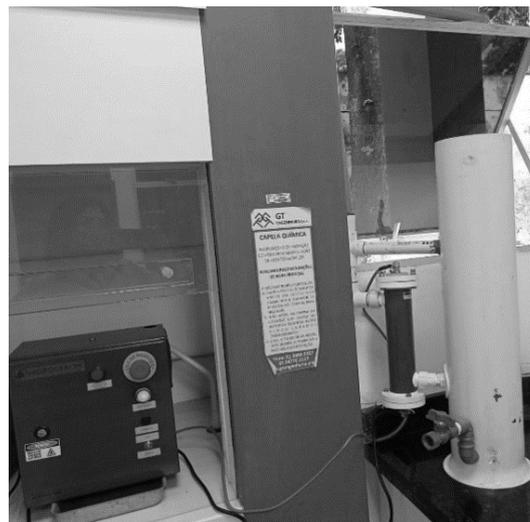


Figure 2. Experiment setup.

#### 3.2. Brine characterization.

The characteristics of the reject brine samples collected from seawater desalination are displayed in Table 1.

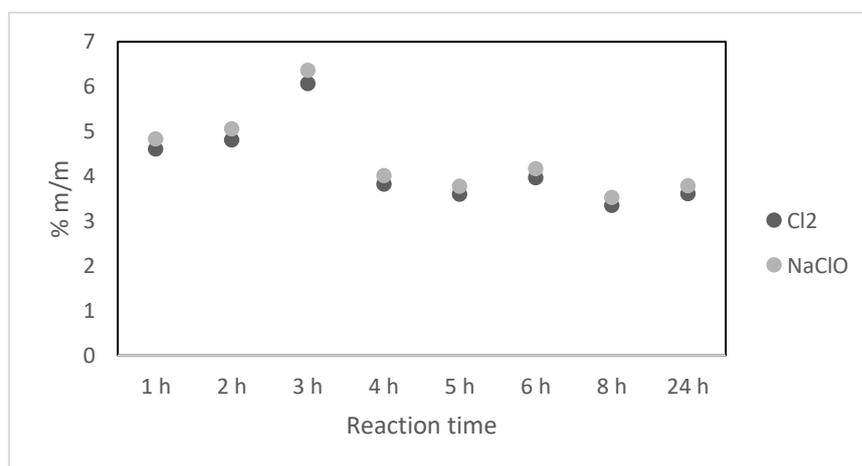
Table 1. Characteristics of reject brine.

Parameters	Reject brine 1	Reject brine 2
pH at 25° C	7.9	8.0
Turbidity (uT)	0.2	0.6
Apparent colour (uH)	2	<0.1
Conductivity (µS/cm)	65800	30665
Alkalinity (mg/L)	227.1	240.9
Hardness (mg/L)	12911.2	13934.8
Calcium (mg/L)	838.1	963.84
Magnesium (mg/L)	2628.2	2800.71
Chloride (mg/L)	40598.9	40931.3

Parameters	Reject brine 1	Reject brine 2
Sulphate (mg/L)	5427.0	6068.8
Nitrate (mg/L)	9.6	11.5
Aluminium (mg/L)	0.4	0.6
Boron (mg/L)	5.6	9.1
Barium (mg/L)	<0.02	<0.02
Copper (mg/L)	0.010	0.147
Iron (mg/L)	<0.1	0.2
Potassium (mg/L)	611.0	1932.9
Lithium (mg/L)	0.5	0.2
Manganese (mg/L)	<0.02	0.07
Sodium (mg/L)	16087	22277
Phosphorus (mg/L)	0.6	0.9
Zinc (mg/L)	<0.05	0.13

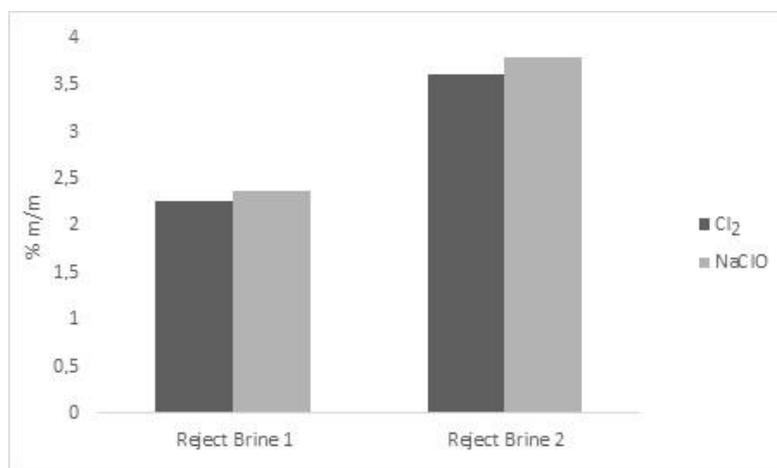
### 3.3. Generation of oxidant solution.

Screening experiments were performed to determine chlorine (Cl<sub>2</sub>) and sodium hypochlorite (NaClO) production throughout the electrolysis time. The brine waste was transferred to the reactor. Electrolysis was initiated, and samples were collected throughout the experiment, as shown in Figure 3.



**Figure 3.** Average Cl<sub>2</sub> and NaClO production.

Around 100 mL of reject, brine was transferred to a flask for each experimental run and analyzed. The active chlorine content and hypochlorite were practically stabilized after four hours of operation.



**Figure 4.** Average production of Cl<sub>2</sub> and NaClO generated from brine at the end of the electrolysis reaction.

Regarding the production of total chlorine, both brines tended to stabilize in the longer operating times of the electrolytic cell (Figure 4). Greater chlorine production was achieved with brine 2 due to the higher concentration of salts compared to brine 1. The chloride concentration was 40598 mg/L in brine 1 and 40951 mg/L in brine 2. At the end of the 24 hours, the mean total chlorine production was 2600 mg/L with brine 1 and 3050 mg/L with brine 2.

Screening experiments were performed to determine the effects of different variables on the efficiency of residual chlorine generation. Table 2 displays the reaction time, pH, conductivity, and residual chlorine findings with each rejected brine.

**Table 2.** Characteristics of reject brine throughout electrolysis.

Reaction Time (h)	Reject Brine 1				Reject Brine 2			
	pH	Temperature (°C)	Conductivity (mS/cm)	Residual chlorine (mg/L)	pH	Temperature (°C)	Conductivity (mS/cm)	Residual chlorine (mg/L)
6	5.5	48	66.9	1950	7.0	45	99.3	4350
8	6.5	52	130.6	2200	6.9	48	98.6	3900
24	6.7	54	127	2600	7.0	55.5	101.2	3050

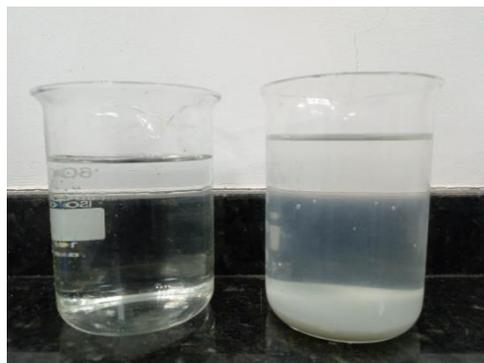
Table 3 displays the concentration of inorganic salts in seawater, seawater brine, the sodium hypochlorite generated from the two brines, and commercial sodium hypochlorite.

**Table 3.** The concentration of inorganic salts in different samples.

Sample	Hardness	Chloride	pH
Seawater	6700	16900	8.0
Brine 1	12911	40599	7.9
Sodium hypochlorite generated after 6 h - Brine 1	11769	26236	5.5
Sodium hypochlorite generated after 8 h - Brine 1	11852	20497	6.5
Sodium hypochlorite generated after 24h - Brine 1	13602	14042	5.5
Brine 2	13934	40931	8.0
Sodium hypochlorite generated after 6 h - Brine 2	11760	36740	7.0
Sodium hypochlorite generated after 8 h - Brine 2	12080	35161	6.9
Sodium hypochlorite generated after 24 h - Brine 2	13360	18036	7.0
Commercial sodium hypochlorite	270	24603	11.2

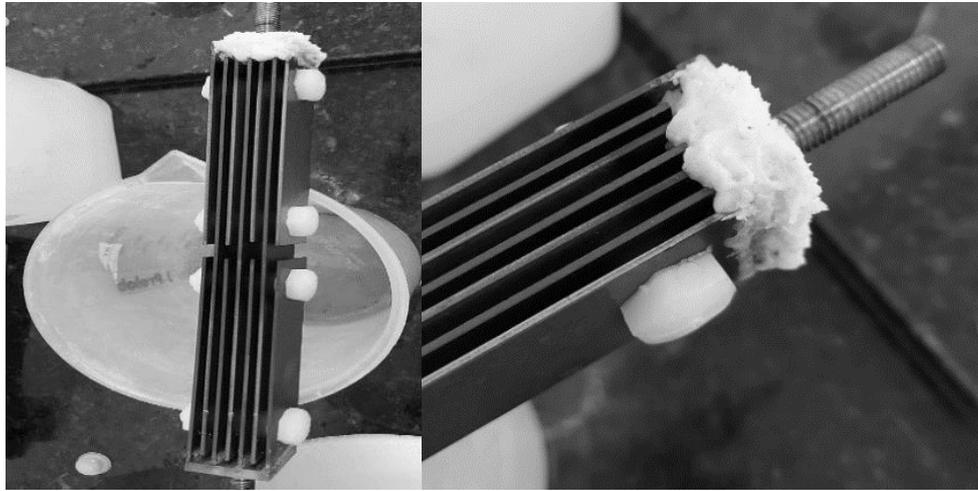
### 3.4. Brine salts.

At the end of the experiment, the residue precipitated from the oxidant solution and adhered to the electrodes was quantified, brine salts (carbonates and hydroxides) were deposited on the bottom. The residues were dried and weighed, resulting in 18.1256 g of precipitate, considering the initial sample volume of 8 L of the brines and the final volume of 6.5 L after the experiment.



**Figure 5.** Oxidizing solution and sedimentation solution after electrolysis reaction at the end of the experiment.

No wear or oxidation was found on the titanium electrodes used to generate chlorine from the brines after 24 h of the experiment. The only change was the formation of precipitate at the ends of the electrode, as shown in Figure 6. It is important to assess the continuity of use and the moment of saturation of the electrodes with the occurrence of greater encrustation.



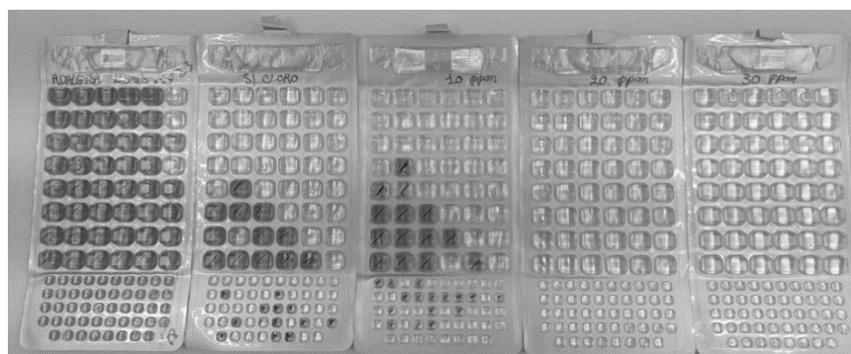
**Figure 6.** Titanium electrode at the end of the experiment.

*3.5. Bactericidal power of the oxidant solution.*

To evaluate the bactericidal power of the oxidant solution, the disinfection of secondary sewage from anaerobic biological processes was tested, as effluents have higher concentrations of pathogens and more challenging properties, such as high or low chemical oxygen demand (COD).

**Table 4.** Characterisation of domestic effluents and results after disinfection with oxidant solution.

Sample	pH	Alkalinity (mg/L)	COD mg/L	Thermotolerant coliforms (MPN/100mL)	Chloroform (µg/L)
Affluent 1	6.5	238	957	1.04E+6	-
Effluent 1	7.3	568	640	30.4E+4	0.945
Effluent 1 after 10 mg/L chlorine	-	-	-	34.2E+4	287.38
Effluent 1 after 20 mg/L chlorine	-	-	-	<1	596.51
Effluent 1 after 30 mg/L chlorine	-	-	-	<1	862.08
Affluent 2	7.0	263	803	1.22E+6	-
Effluent 2	7.5	92	163	3.54E+3	-
Effluent 2 after 5 mg/L chlorine	-	-	-	<100	-
Effluent 2 after 10 mg/L chlorine	-	-	-	<1	-



**Figure 7.** Removal of coliforms from effluent 1 with 10 to 30 mg/L of oxidant solution.

Table IV shows the characteristics of the effluents tested and the results after disinfection involving 30 minutes of contact time with chlorine concentrations ranging from 5

to 30 mg/L to obtain effluents with a concentration of thermotolerant coliforms of  $10^3$  MPN/100 mL or less.

The bactericidal power of the oxidant solution was demonstrated in Figures 7 and 8, was evaluated whether the solutions with the highest concentrations of chlorine can lead to the formation of organochlorines.

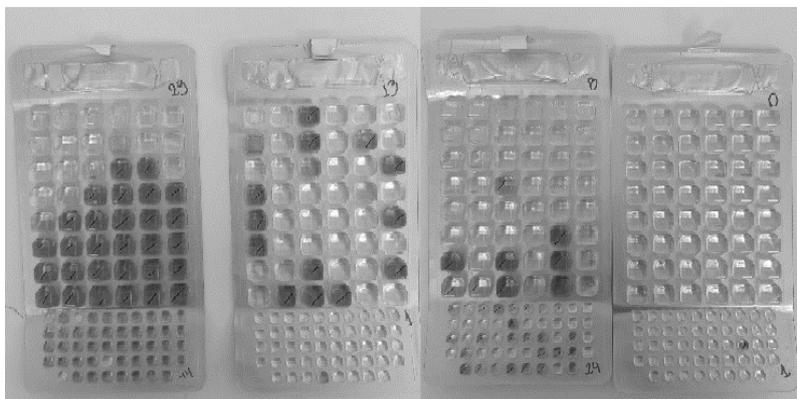


Figure 8. Removal of coliforms from effluent 2 with 5 to 10 mg/L of oxidant solution.

## 4. Discussion

### 4.1. Brine characterization.

Other studies on the characterization of brine conducted by Baydum and Sarubbo [16], Silva and Baydum [21], and Mahmud *et al.* [25] report similar characteristics as those presented in Table 2. The brine from the Noronha desalination plant has alkaline pH, mainly due to the high levels of calcium and magnesium. The brine's total hardness, sulfate, and chlorides had values tenfold higher than those reported by Matos [17] and above the maximum limits established by Brazilian standards [32, 33]. The chloride concentration in the samples was higher than 40000 mg/L. Seawater contains large quantities of various minerals, some rare and expensive in their land-based forms [22, 53]. These minerals in desalination brine can be reused to mitigate mineral scarcity to some extent and reduce the price of desalinated water significantly. The environmental impacts associated with brine disposal can be avoided as well. Desalination is one of the main sources of brine in the world. In addition to high salinity, brine may contain toxic substances, such as lead, zinc, and copper [31, 51].

The high hardness of seawater desalination brines may be a limiting factor to the generation of chlorine, as a thin limestone film consisting essentially of  $\text{CaCO}_3$  and  $\text{Mg}(\text{OH})_2$  forms on the surface of the cathode as a result of the increase in pH on the reaction surface of the electrode, as described by Kraft *et al.* [23, 24]. Alkali-earth metals pose a significant challenge to water treatment technologies and electrochemical processes due to their propensity to precipitate as metal hydroxides, which can deposit on membranes and/or electrodes, reducing their efficiency [25]. When conducting the present experiment, the decision was made not to perform pre-treatment to reduce hardness but rather to evaluate its effect on the generation of the oxidant solution and the formation of the precipitate.

### 4.2. Generation of oxidant solution.

Active chlorine and NaOCl contents of the oxidant solutions obtained with the brines were determined at the end of electrolysis. The highest mean active chlorine content was 2.27% and 3.61% m/m for the oxidant solutions obtained from brines 1 and 2, respectively. A

statistically significant difference ( $p < 0.05$ ) was found regarding the sodium hypochlorite generated by the two brines. Moreover, Tukey's test revealed no difference between the mean concentration of hypochlorite generated by brine 1 and commercial sodium hypochlorite with 2.5% m/m.

Figure 4 displays the average active chlorine and NaOCl in the oxidant solutions obtained from brines 1 and 2. On the real scale (verified in loco), the electrolysis units of the Pernambuco Water Company (COMPESA) produce an oxidant solution with an active chlorine content of 0.6% m/m from seawater with 1.69% m/m of chloride (i.e., 16900 mg/L) [50]. Solsona and Mendez [26] report that the NaOCl produced by electrolysis should have an active chlorine content of 0.1% to 0.6%. However, the experimental results show that the active chlorine content increases proportionally to the chloride content. For a concentrate from desalination equipment with 4.0% m/m of chloride, it was possible to produce an oxidant solution with about 2 to 3.5% of active chlorine after 24 h. Considering the production of 8 L of the oxidant solution from reject brine 1 and 2 with a chlorine concentration of 5.0 mg/L, for example, it is possible to disinfect an average of 29 to 35 m<sup>3</sup> of water. The alternative disinfectant solution produced in loco presented itself as a disinfectant agent capable of maintaining a free chlorine residual in water for a long period and at a small dose [47].

The pH in brine 1 slightly tended to increase over time, reaching a value close to 7. This may be explained by the occurrence of oxidation-reduction reactions and the formation of alkaline products, such as NaOCl. Different behavior was found in brine 2, with no major change, which may have been caused by fluctuations in the pH meter or the presence of acidic chemical species in the brine.

The temperature increased throughout the experiment, reaching close to 55 °C for both brines at the end of the experiment. A reduction in chlorine generation accompanied the increase in temperature. A higher temperature is associated with lower conductivity and therefore, more energy is needed to generate the same amount of chlorine. Normally, the temperature of the solution increases as a function of the varying current. According to Rabah [20], the electrolysis process should be carried out at room temperature, as the maximum concentration of NaOCl is generated at 25 °C. Brine 1 reached higher temperatures, likely due to its higher conductivity than brine 2. An approximately 18% reduction of the initial volume was found under the conditions of the experiment.

The mean change in electrical conductivity during the electrolysis was 66 mS/cm to 127 mS/cm for brine 1 and 99 mS/cm to 101 mS/cm for brine 2 in Table 2. Conductivity was stable throughout the electrolysis reaction with brine 2, whereas unstable behavior was found in the first hours of the reaction with brine 1, which only exhibited more stable behavior at the end.

For brine 1, total chlorine increased over time during the operation of the electrolytic cell, whereas more stable and higher concentrations were found with brine 2. This was associated with the higher concentration of salts in brine 2, as shown in Table 1. The oxidant solution generated from the desalination brines was transparent, as shown in Figure 5, with an apparent color below 2 uH, turbidity below 0, iron content below 0.1 mg/L, and manganese content below 0.06 mg/L.

The desalination of seawater is the main process for producing fresh water in many countries. Waste brine or concentrate rejects are leftovers of the desalination process and can have an adverse impact on the environment due to the high salinity. Previous authors [28] show an easy process for reducing the salinity of brine while also generating value-added products,

namely calcium and magnesium oxides. Waste brine contains sodium, chloride, calcium, and potassium ions in high concentrations while producing common salts such as NaCl, CaCl<sub>2</sub>, and MgCl<sub>2</sub> from brine can be economically profitable [53, 54]. An electrochemical system is used to precipitate inorganic salts available in seawater brine. The power applied reduces water to hydroxyl ions, which reduces the ionic species in the waste brine. With an applied power in the range of 2.5 to 4.0 V for 3 h, the total dissolved solids of the brine solution diminished from 47000 mg/L to 42000 mg/L.

Regarding the presence of salts, a slight increase (5%) in hardness and a 65% reduction in chloride occurred. Lucca [29] found that about 85% of the initial chloride of brine remained at the end of the electrolysis process. Matos *et al.* [17] produced an oxidant solution and reported that 75% of chloride remained. In the present study, only 35% of the chloride remained in the sodium hypochlorite generated after 24 hours, demonstrating efficiency and a high yield of conversion of the existing chloride. With both brines, the concentration of remaining chlorides at 24 h was lower than the chloride present in the commercial hypochlorite solution. Assuming a dosage of 5 mg/L of the oxidant solution generated from reject brine 2, for example, 23 mg/L of chloride and 22 mg/L of hardness would be added to treated water.

#### 4.3. Brine salts.

Turbidity was found throughout the experiment, and a small amount of white precipitate was formed, as shown in Figure 5. Based on Abdul-Wahab *et al.* [27], who studied problems associated with wastewater generated from the desalination process, salts of carbonates and hydroxides were produced during the experiments, which were deposited on the electrodes and electrolytic cell. Baydum and Asfora [16] observed the formation of precipitated salts in the oxidant solutions of all brines tested. Matos *et al.* [17] and Zhang *et al.* [52] indicated the presence of magnesium sulfate (CaSO<sub>4</sub>), calcium sulfate (CaSO<sub>4</sub>), sodium chloride (NaCl), magnesium chloride (MgCl<sub>2</sub>), and calcium chloride (CaCl<sub>2</sub>).

#### 4.4. Bactericidal power of the oxidant solution.

The coliform removal rate from effluents 1 and 2 (chlorine concentrations of 20 and 5 mg/L, respectively) was 99.99%. As effluent 1 had a COD of 640 mg/L, the high alkalinity has a buffering effect, leading to less effective when an acidic substance is added. Therefore, the decision was made to initiate the experiment with higher concentrations of the oxidant solution, and the complete inactivation of thermotolerant bacteria was achieved with four logarithmic cycles. Effluent 2 had a lower organic load, with a COD of 163 mg/L. It was, therefore, possible to eliminate the bacteria with three logarithmic cycles. These results prove the bactericidal power of the solutions, as shown in Figures 7 and 8.

Aussi *et al.* [11] found that the concentration of organochlorine compounds in chlorinated domestic effluents from secondary biological processes was not very significant; 15 mg/L of hypochlorite was added to an effluent with a COD of 15 mg/L, leading to the formation of 19 ug/L of trihalomethanes. In this experiment (Table 4), 10, 20, and 30 mg/L of hypochlorite were added to an effluent with a COD of 640 mg/L, leading to the formation of 287, 596, and 862 ug/L of organochlorine compounds (expressed in chloroform), respectively, all of which are below the limit of 1000 ug/L established in legislation for effluent disposal [32]. Devi and Dalai [42] observed that the presence of organic matter enhanced the formation of trihalomethanes (THMs).

Few studies have reported the generation of oxidant solutions from the waste of desalinated seawater, as can be seen in Table 5. Mota *et al.* [17] used brine from brackish groundwater desalination equipment in the state of Ceará, Brazil. Rabah and Alazaiza [20, 30] used brine from desalination equipment in the Gaza Strip. Baydum [16] and the present research project used brine from a seawater desalination plant on the Fernando de Noronha Archipelago.

**Table 5.** Studies for generation of oxidant solutions from desalination waste.

Sample	Chlorides	Anode	Cathode	Chlorine	Reaction Time	Reference
Groundwater desalination brines (wells)	1.7 x 10 <sup>3</sup> mg/L; 5.5 x 10 <sup>3</sup> mg/L and 10.2 x 10 <sup>3</sup> mg/L	Titanium/ruthenium	Titanium	0.10%; 0.24 % and 0.27 % m/m.	480 min	[17] *
Seawater desalination brines	3.7 x 10 <sup>4</sup> mg/L	Cuprum, graphite, steel and aluminium	Cuprum, graphite, steel and aluminium	1.9%	120 min	[20, 30] **
Seawater desalination brines	3.7 x 10 <sup>4</sup> mg/L	Titanium/steel	Titanium/steel	0.00008 %	60 min	[16] ***
Seawater desalination brines	4.06 x 10 <sup>4</sup> mg/L	Titanium	Titanium	3%	1440 min	Present work****

\* 30 V;

\*\*12 V, distance between electrodes: 5 to 40 mm; removal of hardness with Na(OH) before onset of experiment;

\*\*\* 30 V; distance between electrodes: 10 and 20 mm; without hardness removal;

\*\*\*\* 7 V; distance between electrodes: 3 mm; without hardness removal.

## 5. Conclusions

The present findings demonstrated stability in forming an oxidant solution from seawater after 6 h of electrolysis, with a maximum concentration of 3000 m/L in 24 h starting from an initial chloride concentration of 40000 mg/L. This feasibility study revealed that it is possible to obtain an oxidant solution from brine for water disinfection through electrolysis performed *in situ*. This process resulted in a 65% reduction in chloride in the oxidant solution, demonstrating the advantage of this process, as the brine was transformed into an oxidant solution that can be used for disinfection purposes. The disinfectant power was proven by the removal of coliforms. Future studies should investigate the possibility of using the oxidant solution for water disinfection for human use. The concentration of organochlorines in the chlorinated effluents with the sodium hypochlorite solution generated from brine was maintained below the upper limit established by current legislation. This study presents an alternative for using waste from desalination plants, minimizing the environmental impacts, especially regarding the salinization of soil and contamination of water. Future studies should investigate the potential of using the by-products of the electrolysis process (hydrogen and salts) for energy use on the archipelago.

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## Conflicts of Interest

The authors declare no conflict of interest.

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