

Application of Direct Lithium Extraction Technology to obtain Lithium Carbonate from Petroleum Formation Water

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Summary

This paper describes the results obtained through the application of the technology and experience implemented in the production of lithium in Salares from evaporites, in the waters of oil formation. After analyzing several base alternatives, the authors concluded that lithium carbonate can be produced on a pilot scale with the use of alumino-silicate base resins, which act selectively with the lithium present in the brine. Minería Positiva SRL developed all the industrial intellectual work and demonstrated an exclusive process for the production of lithium in these waters, constituting a unique case in Latin America and a pioneer in the world.

INTRODUCTION

The objective of this paper is to show the adaptation of the technology of direct extraction of lithium to the oil formation water from the water of the oil extraction process in the Northwest basin of Formosa, and to generate a study of the lithium production process.

The production of lithium from oil and gas production water has a bibliographic background (1), which establishes that lithium (Li) could be sustainably recovered from oil and gas production water through the use of Li recovery technologies such as adsorbents, membrane-based processes, and electrolysis-based systems.

A number of technologies have been tested that enable the recovery of Li from oil fields to provide large Li industries with more diverse and often geographically closer sources.

Although there are a large number of reports on oilfield brines, there are fewer publications on the use of oilfield

wastewater as a resource for obtaining Li.

The obtaining of lithium carbonate from petroleum formation water is a unique and unprecedented process in the industry in South America, which consists of the following stages:

- brine pumping and filtration,
- conditioning
- adsorption
- desorption or elution,
- product concentration using reverse osmosis and thermal evaporation,
- purification with ion exchange and polishing resins,
- Carbonation Reaction
- filtration and drying.

These will be developed in depth throughout this report.

To reach the final goal, the obtaining of lithium carbonate, it was necessary to carry out different tests evaluating the adsorption capacity of the resin, concentration stage, reaction times in

purification and to obtain lithium carbonation, in addition to the physicochemical parameters in all stages.

GENERAL ASPECTS

There are different ways to obtain Li_2CO_3 from continental brines in the Andes Mountains region (Argentina-Bolivia-Chile). But in each of them, the composition of the ion of interest (Li^+) and the contaminants that accompany it are different.

The importance lies in being able to see the differences between continental brines and well recovery waters, specifically, in Palmar Largo, where lithium concentrations are 10 (ten) times lower. The saline solutions are not saturated, allowing a certain margin of operation and water recovery.

Janecke's diagram shows, made with Figure 1, not only how saturated the brine is, but also the ratio of contaminants present, providing a different sequence of removal of these contaminants for each of the EST.

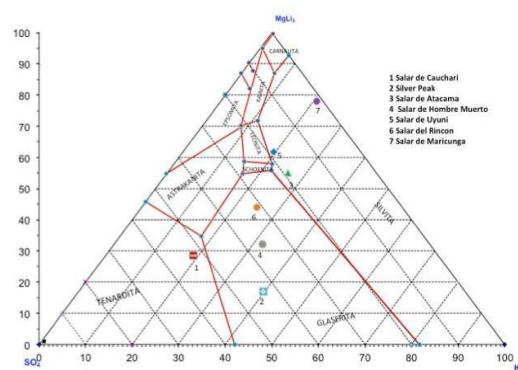


Figure 1 - Janecke diagram for different continental brines

As continental brines are saturated in NaCl , it is logical to remove it first through a process of concentration by removing water, for which solar energy is to date the most cost-effective.

In the case of the process for the Salar de Atacama (SQM and Rockwood Lithium), the initial brine is located in the Sylvinite zone (KCl), therefore this type of salts are obtained in the concentration stage through evaporation until the sulfate salt areas (schoenite, kainite, lithium sulfate and magnesium) are reached. which opens up the possibility of obtaining K_2SO_4 . Finally, the brine is concentrated until it reaches the area of carnallite and bischofite, to be saturated in LiCl as a concentrated brine for the carbonation process.

This difference in each of the brines increases the need to validate each proposed process through bench tests, thermodynamic models and the need to test them through pilot tests at the site where the plant will be located.

Board 1 - Composition of the different continental brines. Source: Maricunga Region III Lithium Project Technical Report, Chile, NI 43-101. For Li3Energy, 17 April 2012(22).

	Salar De Marikung (Chile)	Silver Peak (USA)	Salar de Atacama (Chile)	Dead Man (Argentina)	Salar de Cauchari (Argentina)	Salar del Rincón (Argentina)	Salar de Uyuni (Bolivia)
On	7.14	6.20	7.60	9.79	9.55	9.46	8.75
Towards	0.748	0.53	1.85	0.617	0.47	0.656	0.72
Li	0.104	0.023	0.150	0.062	0.052	0.033	0.035
Mg	0.69	0.03	0.96	0.085	0.131	0.303	0.65

Ca	1.035	0.02	0.031	0.053	0.034	0.059	0.046
SO4	0.06	0.71	1.65	0.853	1.62	1.015	0.85
Cl	16.06	10.06	16.04	15.80	14.86	16.06	15.69
HCO3	0.053	n.a	Traces	0.045	0.058	0.030	0.040
B	0.051	0.008	0.064	0.035	0.076	0.040	0.020
Density	1.200	n.a	1.223	1.205	1.216	1.220	1.211
Mg/Li	6.63	1.43	6.40	1.37	2.52	9.29	18.6
K/Li	7.19	23.04	12.33	9.95	9.04	20.12	20.57
SO4/Li	0.577	30.87	11.0	13.76	31.06	31.13	24.28
SO4/Mg	0.087	23.67	1.72	10.04	12.33	3.35	1.308
Ca/Li	9.95	0.87	0.21	0.86	0.65	1.79	1.314

PRELIMINARY STUDIES

Formation **water** is water that contains inorganic salts in solution, such as sodium, calcium, or bromides. Brine is commonly produced in conjunction with petroleum, and is used as a well control fluid during the completion and repair phases. These must be free of solids and not contain any particles that could clog or damage a productive formation, for this, they have a treatment prior to reinjection to both productive and shallow wells.

This is the same one that would be available to obtain lithium carbonate from the formation water.

Experience has so far shown progress on laboratory and pilot scales, and there are still no commercial productions. While a large number of venture capital companies have been advancing practical applications without success so far yet, but with great potential.

On the other hand, formation waters have lower concentrations compared to continental brines, but nevertheless have potential as a Li resource. There is no longer a need to build new wells, and oil producers benefit from the monetary flow generated by Li recovery from wastewater, which would otherwise be a financial burden.

The characteristics of the brines will depend on the type of reservoir, so it is important to understand the flow of available deposits: location, distance to the plant, location of the water treatment plant, flow rate of ADF generated per day (m³/day), sampling points and chemical composition: Lithium, density and concentration of other salts present (solid and dissolved phase).

For the present, three basic points were analyzed to evaluate the different technologies:

1. Flow of Available Grounds

The flow of water, which is the subject of this study and flows into the treatment system, comes from different oil production wells.

The wells are located in *the Northwest Basin, Formosa Province*, in different areas: *Palmar Largo area* that contains the Palmar deposit that is active and other smaller deposits that also contribute to production such as *Ramón Lista* (10 km), *El Potrillo* (108 km) plus a series of wells that also produce reaching a flow of around 3000 (2754) m³/day. It is important to note that the Ramón Lista and El Potrillo wells provide more oil than water.

In Palmar Largo there is the crude oil and water separation treatment plant and the *water treatment plant*, the water that comes out of this plant is not used for Secondary Recovery, but is injected into disposal wells, shallow reservoirs that are at a depth of 800 - 1000 meters.

There are also other areas: *the Surubí Area*, with two wells in production, around 1000 m³/day (879), and *the El Chivil Area*, which has a couple of wells in production, but its contribution is minimal. The Surubí Area provides production water, once the crude oil has been separated, to the Palmar treatment area.

In the water treatment plant, the water is left to rest for 24 - 48 hours and after this time, where larger solids are decanted, it is injected into the disposal wells through pumps.

It is important to note that, regardless of the area in question, the characteristics of the production waters tend to be similar. This could suggest that all the waters coming from the Palmar Area share these similarities. However, this observation also applies to the production waters of the Surubí and Chivil Area. Another significant feature is the temperature at which the produced water comes out of the wells. Despite the fact that the temperature decreases along its path to the point where the process is carried out, there is still energy available for its use.

2. Analysis of the Chemical Composition of Formation Water (ADF)

The purpose of this study is to determine the amount of lithium available in the water that is extracted along with crude oil and natural gas from the production wells of the formation, as well as to estimate the concentration of other

substances present, both in the solid phase and dissolved in the water.

The samples were taken at different points within each productive area of the deposit: Surubí, El Chivil and Palmar Largo. The analyses performed included:

➤ Lithium content

The Board 11 It shows the data obtained from the first five analyses carried out, where the lithium content of the sample is indicated, both in mg/l and in parts per million (ppm), and the density of the source formation water. The data are presented according to chronological order and sampling location. The first four analyses were carried out on particular samples within the Palmar Largo Production Area. For the fifth analysis, carried out by the Motter Laboratory, samples extracted from the seven active production wells of the Palmar Largo Area were taken, taken at the entrance of the manifold and a general sample at the exit, as well as samples from the Surubí and El Chivil Productive Areas.

The sixth analysis was carried out on samples taken from the representative sample points of the process, indicated in the Figure 16 in red as Sample 1: TK PURGE COLLECTOR, Sample 2: GENERAL WELL INJECTION COLLECTOR and Sample 3: SURUBI INLET PIPELINE TO PLANT.

Based on the results obtained, Board 10, a formation water density of 1.15 kg/l and a lithium concentration of 52 mg/L, corresponding to approximately 45 mg/L, were taken for the process calculations.

➤ **Content of other chemical species**

In addition to dissolved lithium, the content of other chemical species was found in the formation water, whose concentration values were obtained from the fifth and sixth analysis of samples, carried out by the Motter Laboratory of Formosa (

Board 12) and the Alex Stewart Laboratory respectively (

Board 13); the latter using the ICP (Inductively Coupled Plasma Mass Spectrometry) technique.

In both tables, the concentration values corresponding to the ions Na^+ , K^+ , Mg^{2+} , Ca^{2+} , Cl^- and SO_4^{2-} are highlighted, these are responsible for the high salinity of this water and, from the point of view of a classical process of concentration by evaporation, the first to precipitate in crystals of NaCl , KCl and CaSO_4 . Magnesium, on the other hand, has a great similarity in its chemical behavior with lithium, so its presence in a very high mg/Li ratio is inconvenient; for the data presented, this ratio is around 102:1 at the outlet of the wells, while in the water treatment plant it is 3.4:1 on average. Finally, a considerable presence of boron and smaller amounts of other ions can be observed, which for the purposes of the process can be considered negligible.

In general, the samples analyzed are slightly acidic ($\text{pH} < 7$), have very high hardness ($> 180 \text{ mg CaCO}_3/\text{l}$ of water) and turbidity is observed due to the presence of saline precipitates and silt-clay.

The Board 14 It shows the analyses, including calculations of the number of milliequivalent-grams per milliliter of sample (Meq/ml) of the aforementioned

ions, in order to get an idea of the balance of charges between cations and anions present. The difference recorded for the three samples is approximately 1%. This may be partly explained by the presence of other substances not listed in this report, either because their presence corresponds to trace amounts or because the method implemented does not detect them. The other reason is related to the errors inherent in the sample preparation procedure and the calibration of the measuring devices used.

➤ **Available Energy**

One of the salient features of the flow is its thermal load, which provides an additional advantage in terms of recovery, with possible applications in power generation or through heat exchanges due to the temperature of the solutions.

A daily availability of between 220,000 kcal and approximately 320,000 kcal has been observed, which is used for the selective adsorption process.

The efficiency of the studied process has been shown to keep the temperature close to the feed values, becoming a factor for substantial improvement. In addition, the Lithium Carbonate production reaction increases its efficiency at high temperatures due to the inverse solubility curve of the material.

3. Previous work, studies of alternatives

➤ **Brine Status**

Taking into account the sampling points:

- 1 M1: TK crude oil treatment purge manifold.
- 2 M2: General Well Injection Collector.

3 M3: Surubí Entrance Pipeline to the Plant.

And based on the ICP analyses carried out by the firm Alex Stewart, the ternary diagram for NaCl, KCl and H₂O was constructed, taking into account the saturation values of each of the salts individually and the double saturation value of these, thus defining the 4 (four) possible zones, the unsaturated zone and the three saturated zones, KCl plus saturated solution, KCl and NaCl plus saturated solution, and NaCl plus saturated solution.

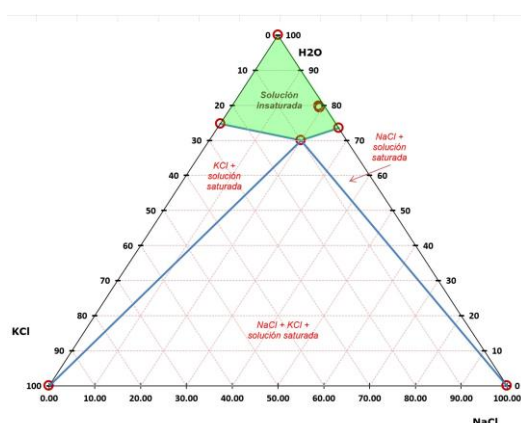


Figure 2 - Janecke diagram for brine from the Palmar Largo reservoir

The three points corresponding to the percentages (%) of NaCl, KCl, and H₂O of each of the samples (M1, M2, and M3) were plotted in the Janecke diagram. Because the concentrations of each of the ions considered are very similar, the three points are almost overlapping and are located in the unsaturated solution zone.

The brine available for the lithium production process is an unsaturated brine, as confirmed by the ternary analysis prepared specifically for it.

Unique conditions exist in the brines of the Northwest Formosa Basin. Each *brine is a thermodynamic and chemical*

system interacting with the medium to achieve acceptable efficiencies.

METHODOLOGY

To be a potential for the process, the brine must not only contain lithium in its composition, but must also be free of hydrocarbons (HC), total organic carbon (TOC) and suspended solids (SS). For this reason, the authors implemented a specific fleece **filtration system** for HC, vegetable activated carbon and diatom-containing stones before it enters the plant. The objective of this system is to ensure that the water used is of optimal quality, thus avoiding damage to resins, membranes and equipment.

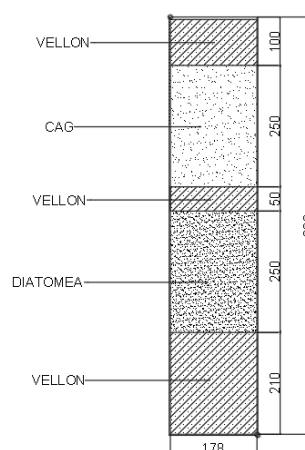


Figure 3 - Hydrocarbon Filter Distribution

The **selective adsorption (SA)** process is designed to selectively remove LiCl (Lithium Chloride) from a brine concentrated in NaCl (Brine), using a Chloro-Lithium-Aluminate (CLA) sorbent.

As sorbent materials in the process of extracting lithium from brines, polycrystalline hydrated alumina pellets based on hydrated alumina, such as crystalline gibbsite, bayerite, or aluminum chloride, are used. These pellets are morphologically altered by infusion within LiCl, LiOH, Li₂CO₃, or

another lithium source, in the absence of sodium chloride, creating specific sites of active lithium within the crystalline layers of the alumina. Infused alumina pellets have the general formula $\text{LiX} \cdot 2\text{Al}(\text{OH})_3$.

The sorbent selectively removes the LiCl from the brine and then the LiCl is desorbed from the sorbent using water containing approximately 50 ppm of Li (by weight) as LiCl .

The **adsorbent material** is a second-generation alumina-based resin, which has demonstrated high recovery efficiency according to metallurgical tests carried out in our laboratories. They have a wide range of Li content (50 -1000) mg of Li/L . They can be operated in a temperature range of 15°C to 90°C , which makes them operationally versatile. In addition, it has a varied granulometry, ranging from #14 to #40 according to ASTM standards, which allows a higher operating work flow rate to be obtained for lithium recovery in the plant. Additionally, it is PVC coated, which allows it to work in a wide pH range.

The adsorption capacity of the theoretical resin, measured in milligram of lithium per gram of resin, is 4.5 mg/g. During the process, eluted solutions are obtained with a reduction of 97.5% of initial Mg , without loss of lithium.

To carry out the adsorption stage, different operational alternatives were evaluated, varying the Bed Volume per hour (Bed Vol, BV/h), operating temperature and breakpoint.

The breakpoint is a limit value selected according to the needs of the process, where the operation stops. From a practical point of view, the volume of the breaking point is the most important piece of information, as it represents the

volume of fluid that can be treated by the column until the pre-specified breaking point is reached. This information is derived from experiments conducted in laboratory columns.

The parameters that were taken into account when carrying out this study are:

Adsorption

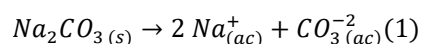
- Selected breakpoint: 45BV to 4BV/h.
- Volume of brine required (breakpoint): 3150 L. Recovery: 93%.
- Total charging time: $80/4 = 20$ hrs.
- Partial load time: $45/4 = 11:25$ hrs.

Elution

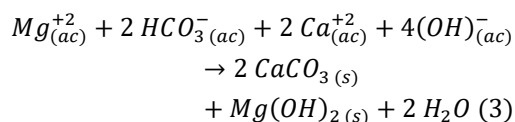
- Lithiated water supply: 9 BV to 4 BV/h.
- Volume of water required: 630 L.
- Partial download time: 2:25 hs.
- The adsorption/elution process works in a flooded chamber at 60°C .

The first stage of the carbonation process is the purification of the brine, a process known as **Polishing**, which consists of the low-temperature reaction of Sodium Carbonate (Na_2CO_3) with the magnesium and calcium present in the brine through the following chemical reactions:

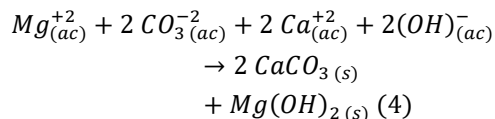
Soda Ash (Na_2CO_3) dissolves in water according to the following reaction, heated to 60°C :



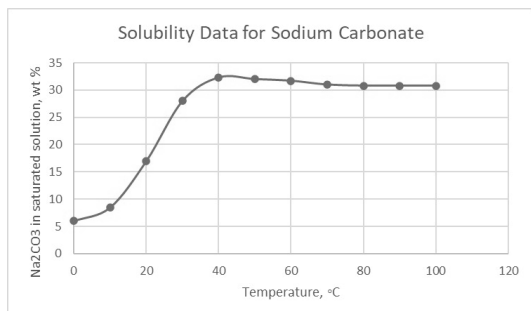
The solution is then sent to the Polishing Reactor, which contains the brine and is kept at 43°C , where the following chemical reactions occur:



Combining Equation (2) with Equation (3) yields:



The reaction is carried out at 43°C to prevent the precipitation of lithium, obtaining magnesium hydroxide and calcium carbonate in solid form, which are separated by filtration. The lithium-rich mother water resulting from the filtration is stored and subsequently conditioned for the carbonation reaction.

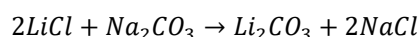


Graphic 1 - Sodium carbonate solubility curve

Parameters taken into account:

- Temperature
- Reaction Time
- Lithium Concentration
- Brine Volume

The reaction between a solution of lithium chloride (LiCl) and sodium carbonate (Na₂CO₃) results in the formation of sodium chloride (NaCl) and lithium carbonate (Li₂CO₃). The balanced chemical equation for this reaction is as follows:



In this reaction, the chloride ions (Cl⁻) in lithium chloride react with the sodium ions (Na⁺) in sodium carbonate, forming sodium chloride, commonly known as table salt. In addition, lithium ions (Li⁺) in

lithium chloride react with carbonate ions (CO₃²⁻) in sodium carbonate, forming lithium carbonate. This chemical reaction takes place in an aqueous solution, where the participating ions interact to form the corresponding products. A lithium carbonate reactor, also known as a carbonation reactor, is a piece of equipment used in the lithium carbonate production process.

Parameters taken into account:

- Temperature
- Reaction Time
- Lithium Concentration
- Sodium Concentration Carbonate
- Brine Volume

The development, research and analysis were carried out at the **Pilot Plant** - Lithium Optimization and Training Center (COCLI), after the installation, assembly and commissioning of the metallurgical and chemical laboratory carried out by the authors. In addition, we own the applied technology and own the intellectual property rights associated with it.

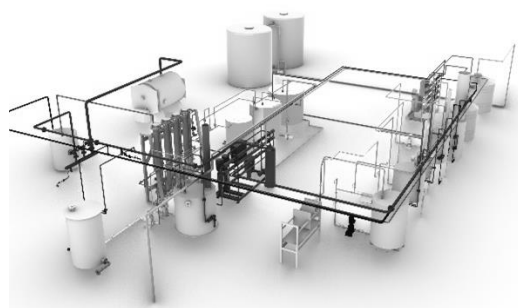


Figure 4 - Pilot Plant Diagram – Lithium Optimization and Training Center (COCLI)

LABORATORY-SCALE TESTING

Brine characterization

As a first step, the sampling points were defined in the water treatment plant of the palmar largo reservoir to carry out

the following determinations in the formation water (ADF):

- Total Solids
- Total Dissolved Solids
- PH
- Conductivity
- Lithium
- Sodium
- Boron

In the Board 17, you can see the results obtained from the different daily tests.

Removal of hydrocarbons and suspended solids from formation water

To carry out the adsorption test, it is essential to have a brine free of hydrocarbons and suspended solids. To do this, we proceeded to filter using a cylindrical separator funnel x 250ml filled with activated carbon and stones containing diatoms, separated between layers with sponges, with the sole purpose of containing the material.



Figure 5 - Laboratory filtration with Activated Carbon and Diatom Stones

Adsorption/Elution or desorption

Adsorption tests were carried out with previously filtered brine, varying operating temperature and bed vol (BV) per hour, in order to determine the parameters that best fit the process and then carry it out in the pilot plant.

- Total Load: 80 BV to 3 BV/hr.
- Partial load: 45 BV at 3 BV/hr and 4BV/h.
- Operating temperature: 60°C and 70°C
- Elution: 9 BV at 3 BV/hr and 4BV/h

Operational Parameters

Flow rate (BV/h)	3,0 – 4,0
Temperature (°C)	60 – 70
Column Type	Cylindrical separator funnel x250ml
Diameter (cm)	3,50
Height (cm)	9,50
BV (ml)	100
Amount of Resin (g)	80,1
ADF Volume (ml)	4500
ADF Agrega (BV)	45
Li Salmuera (mg/l)	50-60
Volume of H2O Li (ml)	900
H2O Li added (BV)	9
H2O Li (mg/l)	>50
Lithium Measurement Equipment	Turbospec e400

Board 2 - Laboratory adsorption/elution operational parameters

Two cycles at a speed of 3BV/h and two cycles at a speed of 4BV/h at a temperature of 60°C, consecutively, were tested using the same sample of formation water and the same batch of lithiated water for elution, represented in the

Graphic 1. Subsequently, three consecutive cycles were carried out increasing the operating temperature to 70°C and the speed to 4 BV/h, as shown in the Graphic 2.

According to the results of the cycles tested, the amount of lithium extracted from the resin ranges between 245 and 190 mg of lithium. The difference between them is in the amount charged and avoided per cycle. If there is no evidence of loss of resin efficiency, the curves vary plus and minus with respect to an average that remains constant.

Brine Polishing Reaction

The brine purification test for calcium and magnesium removal consisted of reacting 400 ml of the prepared brine from the concentrated brine ready for carbonatar. A dilution was carried out by taking 114 ml of concentrated brine and up to 400 ml with demineralized water. The resulting solution yielded the following results:

<i>pH</i>	<i>Conductivity</i>	<i>SDT</i>	<i>Li</i>
25°C	ms/cm2	g/lt	mg/lt
5,6	24	23	1990

The dissolution was necessary to obtain a brine similar to the one that would come out of the reverse osmosis bank. The estimated values of calcium and magnesium were calculated from theoretical data, as indicated in the Board 3.

	<i>Li ppm</i>	<i>As ppm</i>	<i>Mg ppm</i>
Q2	303	70	12
<i>EVAS factor.</i>	23	23	23
<i>Brine Conc.</i>	7000	1600	276
<i>dilution</i>	144/400	144/400	144/400
<i>Sim RO Output</i>	2000	456	79
<i>mg/400 ml</i>	800	182	31

Board 3 - Brine Parameters

In addition to the brine, a solution of sodium carbonate was prepared, weighing 530 mg and adding 20 ml of demineralized water. It was heated to a temperature of 60 °C, with constant agitation. Subsequently, the polishing reaction was carried out by mixing the brine and the sodium carbonate solution, stirring constantly for 30 minutes and keeping the temperature at 43 °C. Once the time has elapsed, the samples are filtered, dried and characterized.

The Board 21 – "REF-SAL-020" and "REF-SAL-021", shows the results obtained.

Carbonation Reaction

To carry out this test, it was necessary to prepare an artificial brine with the following characteristics:

<i>Parameters</i>	<i>Quantity</i>	<i>unit</i>
<i>Lithium</i>	8190	mg/l
<i>Sodium</i>	35574	mg/l
<i>TDS</i>	180	mg/l
<i>Conductivity</i>	185	ms/cm
<i>PH</i>	7,6	
<i>Volume</i>	410	MI

The artificial brine was heated in a beaker to 90°C.

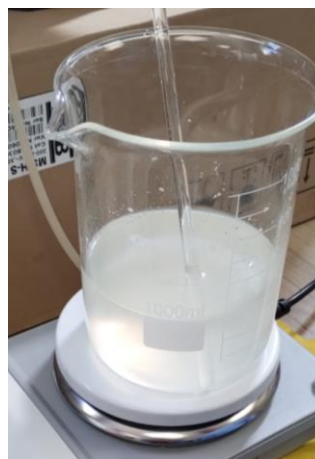


Figure 6 – Artificial brine

At the same time, a 28% w/w sodium carbonate solution was prepared at 70°C, which was then brought to a temperature of 90°C.

Once both solutions reached operating temperature, they were mixed under constant agitation at 90°C for two hours.



Figure 7 – Carbonation reaction

Subsequently, the mixture was filtered and the filtrate was placed in a stove at 105°C for 12 hours.

Board 18 It shows the results obtained in carbonation on a laboratory scale.

PILOT-SCALE TRIALS

Removal of hydrocarbons and suspended solids from formation water

To achieve the removal of HC and SS, the previously used filter was scaled up to a laboratory scale. In this process, the sponge used in the trial was replaced by **polypropylene microfiber fleece**. This material has the capacity to adsorb up to 20 times its weight in HC, with a hydraulic capacity of 45 m³/hr and a holding capacity to operate at 20 m³/hr. Combining it with activated carbon and diatomaceous stones, distributed according to Figure 3. They were placed in a **Bag Filter** (PFH1E.5.APT) of punched polyester with a porosity of 5 microns, with a maximum flow rate of 20m³/h (1cp) and a maximum working temperature of 70°C, as shown in the Figure 17.

The test carried out allowed us to know the behavior of the filter through

permanent sampling and to establish the optimal operating conditions, including pressure, flow, temperatures and useful life of the filter bag, that best suit the job.

- Flow rate required for feeding to the process, close to 1 m³/hr.
- Pressure between 0.1 - 0.2 kg/cm².
- Pressure and temperature drop.
- Two bag filters per operating cycle are required.

The samples filtered in the hydrocarbon filter had traces of paraffins and paraffin waxes, which could affect the efficiency of the adsorption column resin and reverse osmosis membranes. Therefore, a second filtration was carried out in the laboratory using filter paper, simulating the 5 micron cartridge filter that is installed preventively prior to the entry of the adsorption columns.



Figure 8 - Laboratory Filtration

When the sample was cold filtered, the result was crystal clear water, visibly free of solids, as can be seen in the Figure 8. However, when the brine is heated to 60°C to enter the adsorption column, it acquires a yellowish colour characteristic of the brine, as can be seen in the Figure 9.

This leads us to think about the presence of paraffins in the brine, as they are soluble at 60°C. When the brine is heated, the appearance of the

filtered water changes from crystal clear to cloudy.)



Figure 9 – Hot filtered brine before entering columns and cold filtered brine

Once the adsorption and elution tests were carried out on a laboratory scale, using formation water filtered in a hydrocarbon filter at the entrance of the plant and subsequently filtered in the laboratory, the exhausted brine and eluate were heated above 60°C in order to evaluate the presence of wax (paraffins). However, no change was observed.

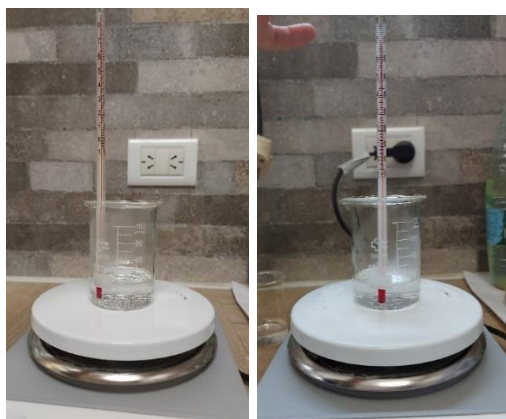


Figure 10 - Depleted Brine and Elute heated to >60°C

These are impregnated in the resin, as can be seen in the Figure 11.



Figure 11 – Resins before and after adsorption

As can be seen in Figure 12, both the filtering material (fleece) and the walls of the bag were covered with dense, oily, greenish-brown substance with a hydrocarbon odor. Different samples were taken for analysis and characterization.



Figure 12 - Filter after 26 hours of operation

Adsorption/Elution or desorption

Based on the results obtained in the laboratory, the HC and SS removal tests, as well as the brine characterization, we proceeded to operate the column in a pilot plant.

The pilot plant has four adsorption columns, each with a capacity of 70 liters. The adsorption test consisted of introducing the previously filtered brine from the long palm water plant, in the first instance to column No. 1. A single total load of 80BV was carried out at a speed of 4BV/h, which is equivalent to a

total of 5600 Liters in a period of 20 hours running.

Subsequently, partial elution was carried out. This consisted of passing 9BV at a speed of 4BV/h of lithiated water prepared with a lithium concentration of around 50ppm through column No. 1, which adds up to a total of 630 liters in 2 hours and 15 minutes. With this, a loading and unloading operation cycle is completed.

Then, partial charging cycles of 45BV to 4BV/h were continued, totaling 3150 liters in a period of 11 hours and 15 minutes running.

Elution was reduced to 8BV, keeping the velocity at 4BV/h Lithiated water prepared with a lithium concentration of around 50ppm was passed through the same column. This adds up to a total of 560 liters in 2 hours.

This adjustment will allow us to analyze the behavior of the resin, compare the results with those obtained in the Bench Test cycles in the Laboratory and study the adsorption-elution curves cycle after cycle, optimizing the process.

The *Graphic 3* and Board 19 represent the behavior of column No. 1 after the 15 cycles tested. Once evaluated, it will be Stability in resin efficiency parameters was observed, with no significant loss of efficiency. Therefore, All four columns were operated simultaneously. Obtaining the necessary eluate to carry out the evaporation and subsequent carbonation operation.

Thermal Evaporation

The Board 4 It represents the considerations taken for the design of the evaporator installed in the pilot plant.

Diameter Ø	m	1.2
<i>Height H</i>	m	1.4
<i>Base Area</i>	m ²	1.131
<i>Volume</i>	m ³	1.58
<i>Density</i>	kg/ltr	1.1
<i>Coil Diameter</i>	in	2
<i>Coil</i>	(OD m)	0.063
<i>Coil Length</i>	m	16
<i>Spiral length</i>	m	3.20
<i>Number of laps</i>	n	5.0
<i>H Serpentine</i>	m	0.472
<i>Height from floor</i>	m	0.10
<i>Minimum Liquid Level</i>	m	0.750
<i>Diameter Coil m</i>	m	1.02

Board 4: Evaporator Design Parameters

The evaporator must operate with the coils flooded at all times, for which the operating level of the evaporator must be greater than 0.6 meters measured from the bottom of the tank.

In the proposed design, the feed flow to the evaporator comes from the reverse osmosis bank, with a design flow rate of 227 liters/day. Since no TOC-free product brine is available, detailed results in *Board 20*, according to design parameters (< 0.3mg/l to enter RO), the test was carried out with concentrated brine directly from the absorption column.

➤ Evaporating Elute Analysis

The Board 15 and Board 16, present the latest analysis carried out on a sample of eluate sent and analysed in BHY's own and external laboratory

During the operation, various variables were measured and taken into account, including diesel consumption, evaporated volume per hour and temperatures. The following variables were controlled:

- Initial brine (Lt)
- Initial temperature (°C)
- Time to 100°C

- Diesel consumed (lt)
- Evaporated Vol. (lt)
- Liters Evaporated per hour (lt/h)
- Liters Evaporated per liters diesel

Brine Polishing Reaction

Starting from a concentrated brine, which has the following parameters:

Parameters	Quantity	unit
Lithium	8100	mg/l
Sodium	3835	mg/l
AC	1871	mg/l
Mg	321	mg/l
TDS	75,3	mg/l
Conductivity	71,3	cS/cm
pH	4,93	
Volume	450	Lt

Board 5: Parameters of the concentrated brine in the evaporator

It was conditioned up to 43°C.

For the preparation of Soda Ash, a 28% w/w solution was made from sodium carbonate and demineralized water, heating it until it reached 60°C.

Subsequently, both solutions reacted in the reactor for 30 minutes at 43°C. The resulting solution was then filtered using a filter press.

The filtered product was collected and sent back to the conditioning tank to carry out the carbonation stage. The cake retained in the filter was removed, dried, and stored for further analysis. Detailed results can be found in the Board 22, "REF-SAL-033", provided by the external laboratory Alex Stewart.

Carbonation Reaction

1st First Carbonation

The process to reach carbonation began with the entry of ADF previously filtered

through the HC Filter (Fleece, CAG and Stones with diatomea) into a single column. After analyzing the efficiency of this column, fifteen elutions were made with a volume of 5750 liters of eluate with approximately 140 g of Li per elution, which were sent to evaporation for concentration. After monitoring the operation and performance of this column, we proceeded to operate with the other 3 (three) remaining columns.

From the operation with all columns, it resulted in the following charge and discharge cycles per column: 18 (eighteen) cycles in column 1, 4 (four) cycles in column 2, 5 (five) cycles in column 3, and 4 (four) cycles in column 4. During all these cycles, approximately 12,710 liters of eluate had to be evaporated to reach the required concentration.

Once the volume and the appropriate concentration of more than 6000 ppm of Li was reached in the evaporator tank to carry out the carbonation process, the concentrated brine was conditioned and heated in the conditioning tank using steam coils.

The solution of Sodium Carbonate (ASH soda) and demineralized water was prepared simultaneously. Both liquids were heated to a temperature of 90 °C before being transferred to the carbonation reactor.

At the same time, the filter press was also conditioned by passing demineralized water at 90 °C. This operation is crucial, as it keeps the filter at a temperature similar to that of operation. Avoiding loss of Lithium Carbonate by dissolution, since the lower the temperature, the greater the dissolution.

In the reactor, with controlled agitation and keeping the temperature constant at

90 °C, the reaction was allowed to take place. Temperature control ensures the formation of Lithium Carbonate. Once the reaction is complete, the resulting solution passes through the filter press, in the filter dishes the Lithium Carbonate cake is obtained, while the filtrate or mother water is collected in another tank.

The final phase of the process is the harvesting of the Lithium Carbonate obtained, which is then dried to ensure its stability and purity.

➤ Operational Analysis for Carbonation

Parameters of concentrated brine:

Parameters	Quantity	unit
<i>Lithium</i>	7000	mg/l
<i>Sodium</i>	4031	mg/l
<i>TDS</i>	73,2	mg/l
<i>Conductivity</i>	67,1	cS/cm
<i>PH</i>	4,8	
<i>Volume</i>	450	Lt

Board 6: Parameters of the concentrated brine in the evaporator

The concentrated brine is conditioned to 90°C.

In the preparation of Soda Ash at 28% w/w, a solution was made from sodium carbonate and demineralized water at 70°C. Subsequently, the solution was heated to 90°C.

The resulting filtrate was stored in the mother water tank for further analysis and to form the corresponding mass balance.

The results are expressed in the Board 21. References:

Reference	Content
REF-SAL-018	Brine Conc. 1° carbonation with 7000 ppm
REF-SAL-019	Liquor product of 1° carbonation
REF-SAL-020	Brine conc. Pre-carbonation - Laboratory
REF-SAL-021	Pre-carbonation product liquor - Laboratory
REF-SAL-022	Lithium Carbonate (Solid)
REF-SAL-023	Suspension generated in evaporation

Board 7: References of samples sent to the external laboratory "Alex Stewart"

2nd Second Carbonation

To carry out a second carbonation, 14300 liters of eluates were required, destined to evaporate until reaching the appropriate concentration to carry out a pre-carbonation, in order to remove the impurities present in the product brine and subsequently carry out the carbonation.

Once the appropriate volume and concentration greater than 6000 ppm Li were reached to start the carbonation process, heating was carried out using steam coils. Simultaneously, the ASH soda solution and demineralized water were prepared. Both liquids were heated to a temperature of 90 °C, then transferred to the carbonation reactor.

As in the first carbonation, the filter press is conditioned by passing demineralized water at 90 °C. -. The carbonation reaction carried out with constant and controlled stirring and temperature.

Once the reaction was complete, the resulting solution was passed through the filter press and then washed with demineralized water at 90°C. In addition, vacuum was applied by suction with a pneumatic pump to remove the highest possible percentage of mother water retained in the Lithium Carbonate cake found in the Filter Press dishes.

The mother or filtered water is stored for further analysis.

In the final phase of the process, the Lithium Carbonate obtained was harvested, which was then subjected to a drying process in a laboratory oven. This step is essential to ensure the stability and purity of the final product.

➤ Operational Analysis for Carbonation

The Board 8 They present the parameters of the concentrated brine:

Parameters	Quantity	unit
Lithium	6900	mg/l
TDS	65,1	mg/l
Conductivity	60,7	cS/cm
PH	4,82	
Volume	430	Lt

Board 8: Brine parameters for carbonation

The Board 22 express the results. References:

Reference	Content
REF-SAL-030	Brine Conc. Pre-carbonation
REF-SAL-031	Brine Conc. Carbonation
REF-SAL-032	Carbonation liquor
REF-SAL-033	Polishing Product - Solid
REF-SAL-034	Pipe Product - Solid
REF-SAL-035	Lithium Carbonate - Solid

Board 9: References of samples sent to the external laboratory "Alex Stewart"

RESULTS

The results shown below are those obtained throughout this project, ranging from the characterization of virgin brine to the obtaining of lithium carbonate, the object of study.

Characterization of the brine of the palmar largo deposit at three sampling points:

Results	Determ.	Lithium (Li)		Density
	Unit Technique	mg/L ICP-OES	ppm Calculation	g/ml Pycnometry
TK PURGE MANIFOLD	Water	55	47	1,164
GENERAL WELL INJECTION MANIFOLD	Water	58	50	1,169
SURUBI INLET PIPELINE TO THE PLANT	Water	53	45	1,170

Board 10: Li Content in ADF

Detailed characterization of the brine confirmed the presence of lithium in the formation water of the palmar largo deposit. This finding was instrumental in initiating the development of visualization engineering, basic engineering, and extended basic engineering. In addition, relevant laboratory-scale studies were carried out to develop the necessary technology. Subsequently, the plant was designed, assembled, commissioned and commissioned.

The incorporation **of the hydrocarbon filter** to reduce the solids and hydrocarbon content in the brine prior to its entry into the pilot plant was a crucial step.



Figure 13: Comparison of filter with stones and activated carbon



Figure 14: ADF Filtered in Plant

However, as can be seen in the Board 23, the filter retains contaminants, but not one hundred percent (100%) and raises the possibility of contamination of the filter. Therefore, it is necessary to evaluate the useful life of the filter, the residence times of the fluid, the flow rate, the pressure and explore other alternatives, such as the use of activated carbon of vegetable origin, such as olive stone. These alternatives are currently in the testing stage and will be presented in detail at a later date.

Based on the different **adsorption/elution experiences at the laboratory level**, it is observed that the resin recovery factor is 4.94 mg Li per gram of resin for a flow of 2 BV/h. As the flow rate of brine to be operated increases (3 and 4 BV/h), the recovery factor decreases slightly to 4.13 and 3.83 respectively, although it still maintains a good performance in terms of lithium recovery percentage.

The results indicate that the resin recovery factor, with an average of 4.13 mg Li per gram of resin, is correlated with flow rates of 2 and 3 BV/h. As the flow rate increases, the factor decreases slightly by 16%. This is mainly attributed to the low concentration of lithium in the brine.

In addition, the results reveal that the resin exhibits selectivity for lithium ions, with the following order of preference $\text{Li}^+ > \text{B}^{3+} > \text{Mg}^{2+} > \text{Ca}^{2+}$.

Based on the experiences in the pilot plant, after 15 cycles tested in column No. 1, lithium extraction between 120 and 140 grams per cycle has been observed, with an average yield factor of 2.5 grams of lithium per gram of resin and a recovery of 80%.

It has been possible to reduce the charging time from 45BV to 40BV and the unloading time from 9BV to 7BV, thus optimizing the working times to meet the loading/unloading cycle in 12 hours.

After loading 600 bed volumes (BV) and 42,000 liters of ADF into Column 1, stability in the resin efficiency parameters has been observed, with no significant loss of efficiency.

After thorough analysis and continuous operation with a single column, it has been planned to operate with all four columns in parallel. Once Columns 2 to 4 were activated and loaded, simultaneous partial loading and unloading cycles were carried out with Column 1, producing approximately 1540 liters of product with a concentration of around 280 ppm per cycle. This product is sent to the evaporator tank to reach 6000 ppm, then it will be conditioned and proceed with carbonation.

To carry out the first carbonation, 450 liters of brine with a concentration greater than 6000 ppm were needed, for which 12700 liters of eluates were required. This made it possible to obtain an industrial grade Lithium Carbonate that exhibits a purity of 85.5%. This result is a positive indicator of the success of the process implemented by the authors.

Obtaining a second industrial-grade lithium carbonate was achieved by evaporating approximately 14300 liters

to reach the required concentration of 8000 ppm lithium. As part of a dedicated focus on the quality and consistency of the final product, the Polishing Stage was carried out prior to carbonation. This stage consisted of low-temperature pre-carbonation to remove contaminants such as Ca and Mn, which allowed 8.4% more purity to be obtained. The lithium carbonate obtained in this phase reveals a promising purity of 93.9%.

The Board 21 and Board 22, express the characterization of concentrated brine, mother liquor, lithium carbonate and impurities.

The Graphic 4 It represents the liters of ADF, elutes obtained, fuel consumption and average liters evaporated per hour needed to carry out the process.

In addition. Remaining in the later research stage, which will be explained later, purification by means of IX ion exchange resins for the removal of Ca, Mg, B and TOC from the product brine is contemplated. Brine concentration by osmosis banks will also be considered as part of this research process.



Figure 15: First Lithium Carbonate

CONCLUSIONS

Once this project has been carried out, the necessary and sufficient information is available to reach the following conclusions: The feasibility of producing

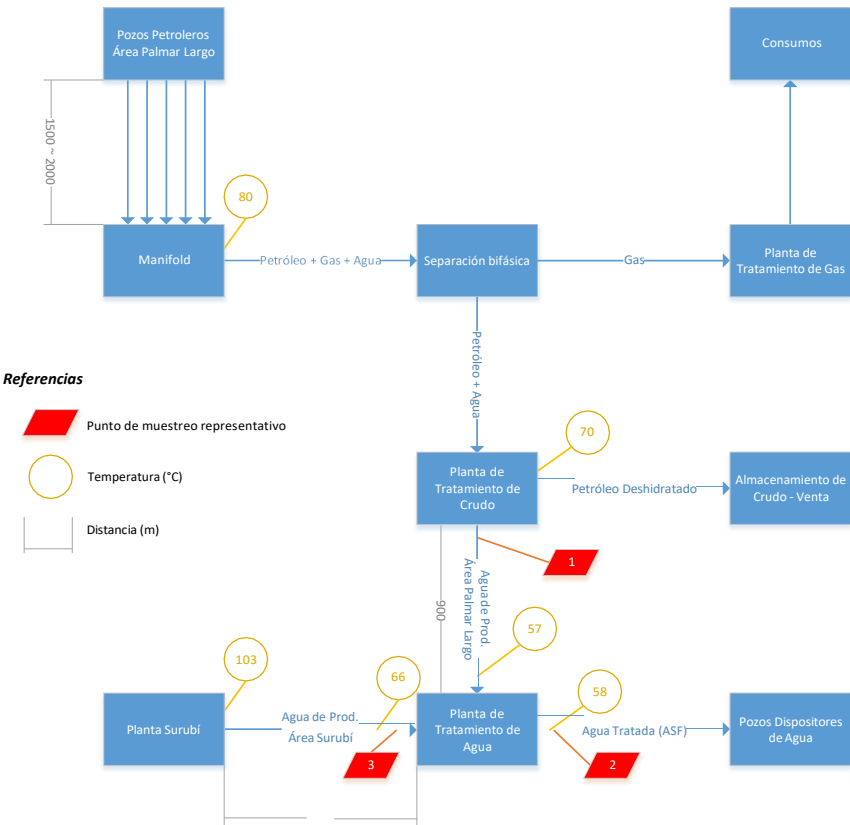
lithium carbonate from the brines of the Northwest Formosa basin has been validated through the tests and studies carried out herein. It has been demonstrated that it is possible to apply the technology and experiences implemented in the production of lithium in Salares from evaporites, to the waters of petroleum formation. Lithium carbonate has been obtained by LED with a purity of more than 85%, very satisfactory results in terms of the purity of the final product. It was also shown that the techniques implemented in the process for the removal of impurities were feasible, since it was possible to remove 8.4% of them, obtaining a second lithium carbonate with 93.9% purity. We believe that by incorporating product purification with IX and other technologies, it is possible to obtain a battery-grade lithium carbonate, adapted to the technical specifications of each customer. We emphasize that this technology is not only limited to the oil sector, but is applicable in other sectors of the industry. Every project is unique, but with the right research, studies and engineering, it is possible to adapt it. It is notable that, although the production of lithium carbonate from equivalent oil-forming water represents a relatively low amount, this project became a unique case in the country and in Latin America, prompting other companies to investigate the lithium content in their waters. We believe that Lithium is part of the new technical economic model that has at its base the need for energy storage and electromobility, making this project a unique case. Placing it in the high standards of the region and the world.

ANNEX

Board 11: Lithium content and density of formation water

CHRONOLOGICAL ORDER OF ANALYSES CARRIED OUT		1°			2°			3°			4°			5°		
		InLab			DR. Skymook			Lab. DR. Mutter			UNSa (INBEMI)			Lab. DR. Mutter		
		Cont. Lithium		Its.	Cont. Lithium		Its.	Cont. Lithium		Its.	Cont. Lithium		Its.	Cont. Lithium		Its.
Sample	Sampling Location	mg/l	ppm	kg/l	mg/l	ppm	kg/l	mg/l	ppm	kg/l	mg/l	ppm	kg/l	mg/l	ppm	kg/l
Area Surubi General														51	44,3	1,15
Area Chivil General														51,6	45,3	1,14
Area PL General	Manifold							50	43,48	1,15	51	44,3	1,15	47,7	42,2	1,13
	Purge TK Cutter										52	45,6	1,14			
<i>Pozo YPF. Fr.PL.x-1</i>														52,9	46,0	1,15
<i>Pozzo Yapf. Far.bridge.a.6h</i>														53,8	46,8	1,15
<i>YPF well. Fr.PL.a.9</i>														51,7	45,4	1,14
<i>Pozzo Yapf. Far.Bridge.A.12H</i>														55,6	48,3	1,15
<i>YPF well. Fr.PL.a.14</i>														52,5	46,1	1,14
<i>YPF well. Fr.PL.a.18</i>		104	90,43	1,15										51,1	45,2	1,13
<i>Well PP.Fr.RL.1001</i>					56	48,70	1,15							53,4	46,8	1,14
Average		104,0	90,4	1,15	56,0	48,7	1,15	50,0	43,5	1,15	51,5	45,0	1,15	52,1	45,6	1,14

Figure 16 : Block diagram of operations in Palmar Largo, sampling points



Board 12: Complete water analysis of the palmar largo reservoir (lab. Motter).

Punto de Extracción de la muestra	Color	Olor	Turbiedad (NTU)	pH	Dureza Total en CaCO ₃ (mg/l)	Calcio (mg/l)	Magnesio (mg/l)	Alcalinidad Total en CaCO ₃ (mg/l)	Sodio (mg/l)	Cloruros (mg/l)
Yacimiento PROA	Ambar Claro	No Característico	5,00	5,90	37500,00	5850,00	5567,00	900,00	> 1000000,00	200000,00
Yacimiento EL CHIVIL	Ambar Claro	No Característico	4,00	6,20	37000,00	5900,00	5416,00	810,00	> 1000000,00	205000,00
Yacimiento PALMAR LARGO	Ambar Claro	No Característico	6,00	5,90	36500,00	6100,00	5173,00	850,00	> 1000000,00	210000,00
Pozo YPF.Fr.PL.x-1	Ambar Claro	No Característico	5,00	6,40	36850,00	5950,00	5349,00	980,00	> 1000000,00	200000,00
Pozo YPF.Fr.PL.a.6H	Ambar Claro	No Característico	6,00	6,40	37000,00	6130,00	5276,00	1100,00	> 1000000,00	215000,00
Pozo YPF.Fr.PL.a.9	Ambar Claro	No Característico	5,00	6,40	37300,00	6100,00	5367,00	855,00	> 1000000,00	210000,00
Pozo YPF.Fr.PL.a.12H	Ambar Claro	No Característico	5,00	6,40	38000,00	6010,00	5471,00	900,00	> 1000000,00	205000,00
Pozo YPF.Fr.PL.a.14	Ambar Claro	No Característico	5,00	6,20	37500,00	6100,00	5537,00	1041,00	> 1000000,00	212500,00
Pozo YPF.Fr.PL.a.18	Ambar Claro	No Característico	4,00	6,20	36500,00	5950,00	5264,00	790,00	> 1000000,00	200000,00
Pozo PP.Fr.RL.1001	Ambar Claro	No Característico	5,00	8,40	37500,00	6010,00	5471,00	833,00	> 1000000,00	210000,00
Agua de pozo Uso industrial	Incoloro	Inodoro	2,00	5,81	1360,00	545,00	0,20	50,00	235,00	400,00

Board 13: Analysis of Palmar Largo Reclamation Water Alex Stewart NOA Laboratory

Punto de Extracción de la muestra	Sulfatos (mg/l)	Nitratos (mg/l)	Nitritos (mg/l)	Amonio (mg/l)	Solidos disueltos totales (mg/l)	Arsenico (mg/l)	Fluoruros (mg/l)	Litio (mg/l)	Potasio (mg/l)	Boro (mg/l)	Densidad (kg/l)	Observaciones
Yacimiento PROA	2150,00	9,00	< 0,05	< 0,10	> 3000000,00	0,50	9,00	51,00	9200,00	82,50	1,15	Succion Bomba Worthington
Yacimiento EL CHIVIL	2200,00	10,00	< 0,05	< 0,10	> 3000000,00	0,50	10,00	51,60	8650,00	80,00	1,14	Purga Tk - 5
Yacimiento PALMAR LARGO	2100,00	10,00	< 0,05	< 0,10	> 3000000,00	0,50	10,50	47,70	8900,00	113,00	1,13	Purga Tk - 8
Pozo YPF.Fr.PL.x-1	2675,00	11,00	< 0,05	< 0,10	> 3000000,00	0,50	10,50	52,90	10600,00	149,70	1,15	Manifold
Pozo YPF.Fr.PL.a.6H	2680,00	12,00	< 0,05	< 0,10	> 3000000,00	0,50	11,00	58,30	10900,00	134,60	1,15	Manifold
Pozo YPF.Fr.PL.a.9	2750,00	13,00	< 0,05	< 0,10	> 3000000,00	0,50	8,50	51,70	10000,00	153,00	1,14	Manifold
Pozo YPF.Fr.PL.a.12H	2175,00	9,00	< 0,05	< 0,10	> 3000000,00	0,50	12,00	55,60	10500,00	170,40	1,15	Manifold
Pozo YPF.Fr.PL.a.14	2300,00	12,00	< 0,05	< 0,10	> 3000000,00	0,50	9,50	52,50	11000,00	164,40	1,14	Manifold
Pozo YPF.Fr.PL.a.18	2100,00	11,00	< 0,05	< 0,10	> 3000000,00	0,50	9,00	51,10	10200,00	162,00	1,13	Manifold
Pozo PP.Fr.RL.1001	2250,00	10,00	< 0,05	< 0,10	> 3000000,00	0,50	9,50	53,40	10900,00	174,60	1,14	Manifold
Agua de pozo Uso industrial	1750,00	4,00	< 0,05	< 0,10	2428,00	0,05	4,00	0,13	< 0,10	2,58	1,00	Zona Sala de Compresion

Board 14: Analysis of Palmar Largo Reclamation Water Alex Stewart NOA Laboratory

Resultados	DETERM.	Sulfatos	Cloruros	B	Ba	Ca	Fe	K	Li	Mg	Mn	Na	Sr	Conductividad	Densidad	pH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	UNIDAD	SO ₄ ⁼	Cl ⁻	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	mS/cm	g/ml	Unidades de pH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	TECNICA	Gravimetria	Volumetria	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	Potenciometria	Picnometria	Potenciometria																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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COLECTOR PURGA TK	Agua	1556	145582	157	4,35	1138	5,44	7464	55	151	2,56	87097	117,9	224	1,164	5,7																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
COLECTOR GENERAL INYECCION POZOS	Agua	1696	150048	150	3,49	1278	<3.0	7548	58	179	3,54	89175	132,9	225	1,169	5,8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
DUCTO INGRESO SURUBI A PLANTA	Agua	1391	151488	123	8,47	1581	<3.0	7311	53	233	5,59	89542	162,9	227	1,170	6,3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Resultados	DETERM.	Sulfatos	Cloruros	B	Ca	K	Li	Mg	Mn	Na	Sr	Conductividad	Densidad	pH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
															UNIDAD	SO ₄ ⁼	Cl ⁻	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L

Board 15: Analysis of Eluted by lab. By BHY the 10/20/2023

Especie	Unidades	Muestra Ref-sal
pH	-	5.45
Alcalinidad Fenolftaleína	ppm CaCO3	0.0
Alcalinidad Total	ppm CaCO3	3.0
Alcalinidad Hidróxidos	ppm CaCO3	0.0
Dureza Total	ppm CaCO3	125
Dureza Cálcica	ppm CaCO3	79
Dureza Magnésica	ppm CaCO3	46
Cloruros	ppm Cl-	1,850.0
Sulfatos	ppm SO4	13.3
Sílice	ppm SiO2	47.00
Hierro	ppm Fe +2	3.68
Conductancia Específica	µmho/cm	5,370.0
Total de sólidos disueltos (T.D.S.)	ppm	4,417.00
Boro	ppm B	12.00
Manganeso	ppm Mn	0.039
Turbidez	NTU	13.14

Board 16: Analysis of Eluted by lab. BHY External - 10/27/2023

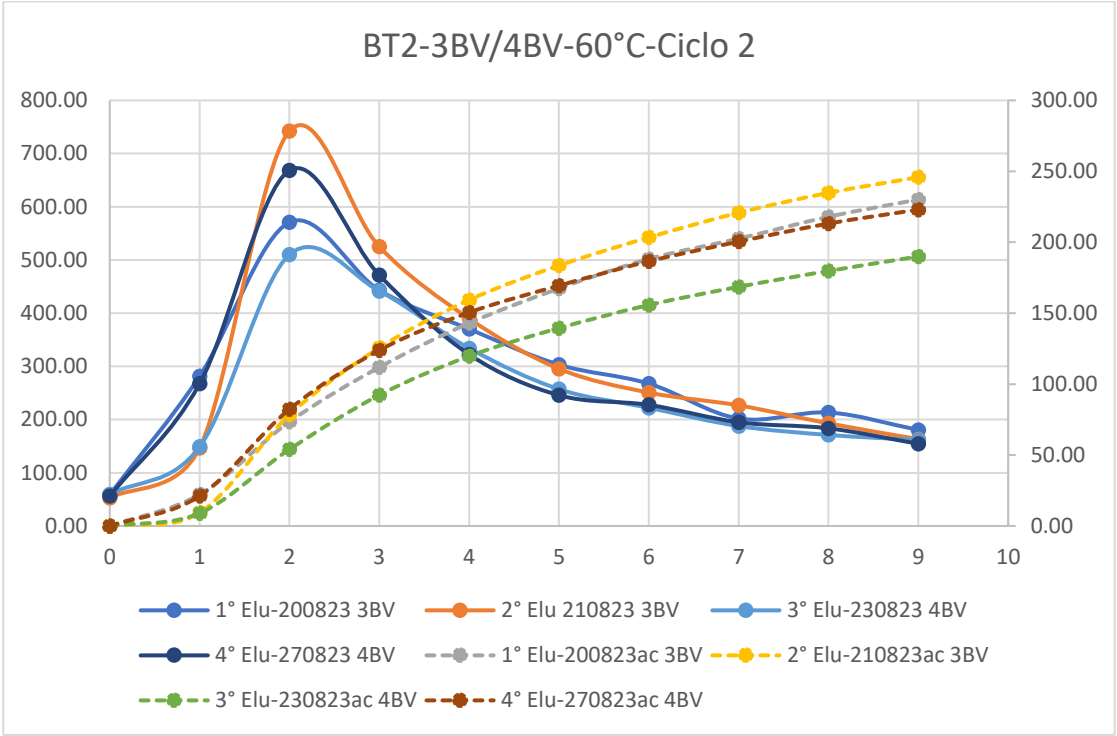
IDENTIFICACIÓN MUESTRA	DETERMINACIÓN	TECNICA	RESULTADO
MQ-28645-01 REF-SAL-013	COT mg/ litro (*)	Spectroquant Merck	15,8
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	4
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	< 1
	Litio mg/ litro (*)	Standard Methods 23st Ed 2017: 3120 B	285,20
	Sodio mg/ litro (*)	Standard Methods 23st Ed. 2017 3500 - Na+ B.	139,37
	Potasio mg/ litro (*)	Standard Methods 23st Ed. 2017 3500 - K+ B.	32,02

Board 17: Daily Analytics

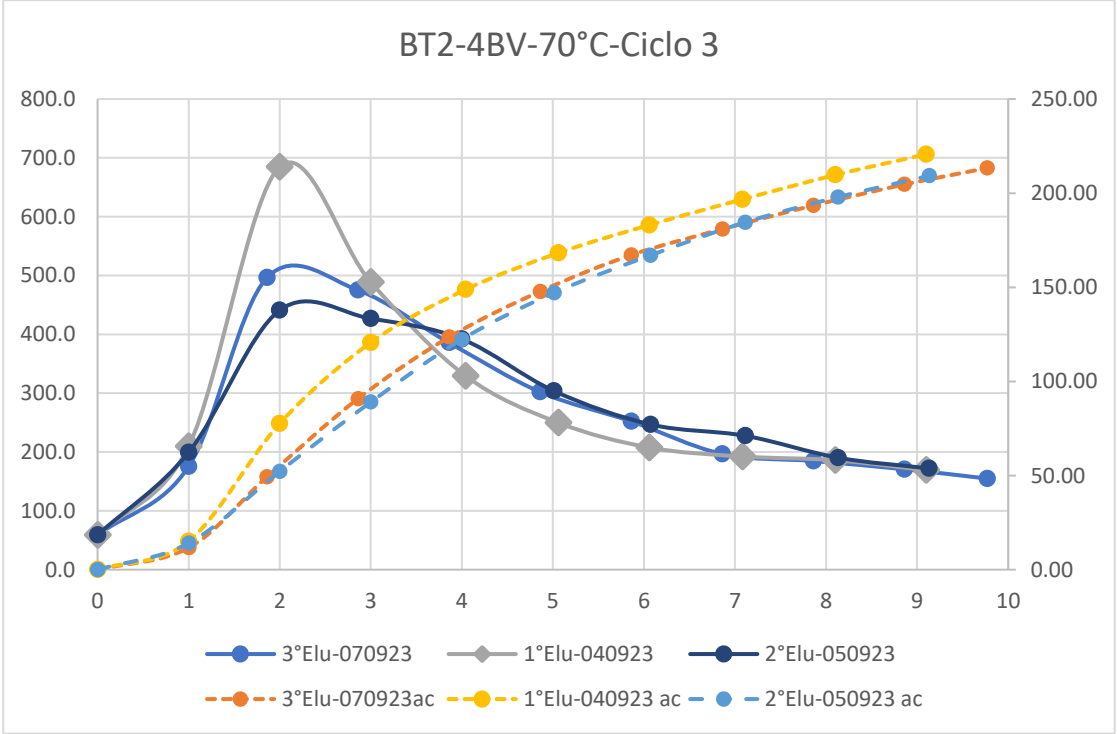
Day	Sample	T (°C)	pH	Cond. (ms)	Lithium (mg/L)	Sodium (mg/L)	Boron (mg/L)	ST (g/L)	SDT (g/L)	SS (g/L)
5/7	M1	59	6,10	322,4	65	88552	302	289	231	59
6/7	M2	60	5,92	328	62	87987	212	-	-	-
7/7	M3	55	5,58	313,6	60	88129	223	-	-	-
8/7	M4	55	5,82	308	60	87991	220	226	225	1
9/7	M5	52	5,86	282,4	55	87323	219	228	227	0
10/7	M6	55	5,96	314	55	88266	214	239	235	4
11/7	M7	55	6,02	308	-	-	-	232	231	2

ST=Total Solids; SDT=Total Dissolved Solids; SS=Settleable Solids

Graphic 1: Elution Curve at 3BV/4BV at 60°C laboratory scale



Graphic 2: Elution curve at 4BV at 70°C laboratory scale

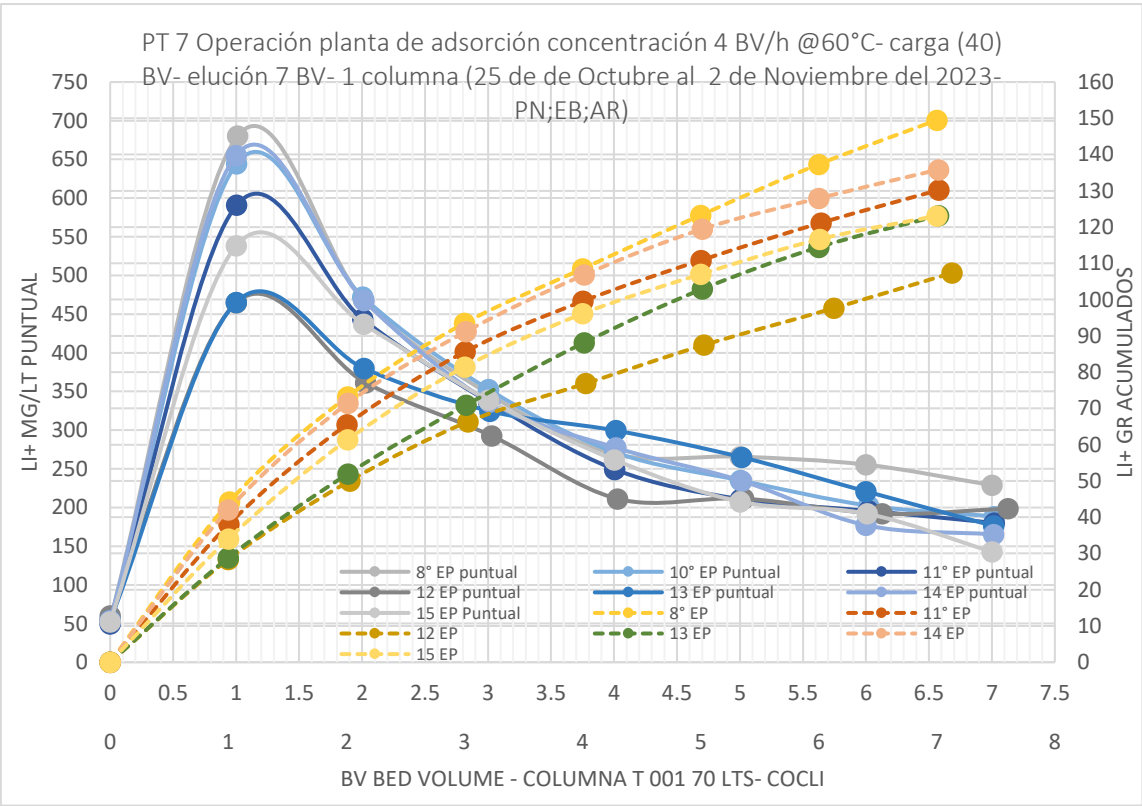


Board 18: Carbonation on a laboratory scale

	Solution	LiCl	Li	Na ₂ CO ₃	CO ₃	Li ₂ CO ₃
	ml	Gr	Gr	Gr	Gr	Gr
Test 1	410	20,59	3,40	27,66	15,66	17,95
Test 2	405	18,82	3,10	27,10	15,34	16,41
Test 3	420	19,35	3,19	26,90	15,23	16,87

	Li ₂ CO ₃	The Truth of the Madre	The Truth of the Madre	Li Precip	I precept them
	gr Obtained	mg/lt	Gr	mg/lt	Gr
Test 1	12,72	1765	0.86	2407	2,41
Test 2	12,17	1598	0.72	2302	2,30
Test 3	12,14	1676	0.75	2296	2,30

Graphic 3: Partial elutions Column N°1 4BV/h at 60°C



Board 19: Comparative data of the different elutions *

	EP3	EP4	EP5	EP6	EP7	EP8	EP10	EP11	EP12	EP13	EP14	EP15
FR	2,46	2,51	2,39	2,4	2,2	2,7	2,5	2,3	1,9	2,2	2,4	2,2
Recover y %	81%	87%	81%	79%	73%	86%	97%	90%	74%	84%	84%	81%
gr Li	138	140	134	135	122	149	141	130	107	123	136	123

* Elution EP9 is not covered in this section, but it is accounting within the column cycles. During this loading and unloading cycle, the operation was stopped during loading due to the state of ADF of power coming from the TK-30, for operational safety of the column, it had to be washed by circulating 2BV (140 liters) of lithiated water through it to prevent precipitation from being generated in the resin due to the characteristic of the water. This last part was carried out because it did not have a concrete time by REFSA personnel to improve the ADF and take care of the operability of the column.

Board 20: analysis of different eluates carried out in BHY's own and external laboratory

DETERMINACION	UNIDAD	SALMUERA PROPUESTA	SALMUERA 1 REF-SAL-005 / 6 / 7 / 8	SALMUERA 2 REF-SAL-013	SALMUERA 3 REF-SAL-024
Alcalinidad Total	ppm CO ₃ Ca	-	-	-	2,8
TDS	mg/l	12200,00	3948,50	4417,00	2488,00
pH	-	6,90	5,70	5,45	5,44
Temperatura de Agua	°C	20,00	20,00	20,00	20,00
Dureza Total	ppm CO ₃ Ca	177,90	295,11	125,0	22,0
Dureza Cálcica	ppm Ca ⁺²	31,00	95,50	79,0	13,0
Dureza Magnésica	ppm Mg ⁺²	24,40	13,75	46,0	9,0
Sodio	ppm Na ⁺	2760,00	480,75	139,37	58,28
Litio	ppm Li ⁺	708,00	302,00	285,20	172,00
Potasio	ppm K ⁺	63,00	62,00	32,02	17,21
Bario	ppm Ba ⁺	0,20	0,09	-	-
Hierro	ppm Fe ⁺²	1,00 (4)	2,90 (4)	3,68 (4)	1,46 (4)
Manganeso	ppm Mn ^{+2/+3}	1,90 (4)	1,56 (4)	0,039 (4)	0,077 (4)
Sulfatos	ppm SO ₄ ⁻²	-	40,25	13,3	-
Cloruros	ppm Cl ⁻	8397,00	2575,75	1850,0	1100,00
Boro	ppm B ⁻	34,00	22,75	12,00	4,30
Sílice	ppm SiO ₂	- (5)	- (5)	47,00 (5)	50,30 (5)
Conductividad	µS/cm	19600,00	7410,00	5370,00	3230,0
SDI		< 3 (1)	< 3 (1)	< 3 (1)	< 3 (1)
Turbiedad	NTU	< 1 (2)	< 1 (2)	13,14 < 1 (2)	5,51 < 1 (2)
Cloro Libre Residual	ppm Cl ₂	0 (3)	0 (3)	0 (3)	0 (3)
COT (Carbono Orgánico Total)	ppm	-	-	15,8	254,0
Hidrocarburos	ppm	-	-	4 (7)	< 1
Aceites y Grasas	ppm	-	-	< 1	-

Board 21: 1st First Lithium Carbonate, analyses carried out in an external laboratory "Alex Stewart"

			DET.	Sulfatos SO ₄ ^{=*}	Cloruros Cl ⁻ *	Carbonatos CO ₃ ^{=*}	B*	Ba*	Ca*	Fe*	K*	Li	Mg*
			UNIDAD	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			COD.AN.	LMCI22	0002NLMCI01	LMFQ16	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03
			TÉCNICA	Grav	Volum	Volum	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	10	10	10	1	0.01	2	0.3	2	1	1
			LS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA											
REF-SAL-018	AMBIENTAL	SALMUERA (LIQ.)	1051	46154	N.C	196	0.92	834	115.3	593	7042	139	
REF-SAL-019	AMBIENTAL	SALMUERA (LIQ.)	478	22767	5648	97	<0.20	<40	<6.0	273	1523	<20	
REF-SAL-020	AMBIENTAL	SALMUERA (LIQ.)	287	12612	N.C	56	<0.20	241	29.8	162	1963	39	
REF-SAL-021	AMBIENTAL	SALMUERA (LIQ.)	279	12389	101	56	<0.20	<40	<6.0	145	1925	35	
DUP	AMBIENTAL	SALMUERA (LIQ.)	281	12472	103	56	<0.20	<40	<6.0	149	1915	36	

			DET.	Mn*	Na*	Sr*
			UNIDAD	mg/L	mg/L	mg/L
			COD.AN.	LMMT03	LMMT03	LMMT03
			TÉCNICA	ICP-OES	ICP-OES	ICP-OES
			LC	0.01	2	0.5
			LS	-----	-----	-----
NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA				
REF-SAL-018	AMBIENTAL	SALMUERA (LIQ.)	7.26	4269	29.5	
REF-SAL-019	AMBIENTAL	SALMUERA (LIQ.)	<0.20	14104	<10.0	
REF-SAL-020	AMBIENTAL	SALMUERA (LIQ.)	2.03	1056	<10.0	
REF-SAL-021	AMBIENTAL	SALMUERA (LIQ.)	<0.20	1616	<10.0	
DUP	AMBIENTAL	SALMUERA (LIQ.)	<0.20	1638	<10.0	

NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA	DET.	Ni*	Pb*	S*	Si*	Sr*	Zn*
			UNIDAD	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			COD.AN.	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38
			TÉCNICA	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	3.00	8.40	6.00	6.00	0.09	0.60
			LS	-----	-----	-----	-----	-----	-----
REF-SAL-022	AMBIENTAL	CARBONATO DE LITIO		175.13	48.64	843.12	2890.35	985.88	7936.89
DUP	AMBIENTAL	CARBONATO DE LITIO		168.62	47.56	711.56	2838.75	974.00	7880.01

Board 22: 2nd Second Lithium Carbonate and Polishing, analyses carried out in an external laboratory "Alex Stewart"

NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA	DET.	Sulfatos SO4=*	Cloruros Cl ⁻ *	Carbonatos CO3=*	B*	Ba*	Ca*	Fe*	K*	Li	Mg*
			UNIDAD	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			COD.AN.	LMCI22	0002NLMCI01	LMFQ16	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03	LMMT03
			TÉCNICA	Grav	Volum	Volum	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	10	10	10	1	0.01	2	0.3	2	1	1
			LS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
REF-SAL-030	AMBIENTAL	SALMUERA (LIQ.)		118	49188	N.C	310	1.52	798	75.5	1126	7424	169
REF-SAL-031	AMBIENTAL	SALMUERA (LIQ.)		154	46431	458	274	<0.20	<40	<6.0	1036	6859	75
REF-SAL-032	AMBIENTAL	SALMUERA (LIQ.)		118	30849	5014	170	<0.20	<40	<6.0	698	1542	<20
DUP	AMBIENTAL	SALMUERA (LIQ.)		113	30468	4993	172	<0.20	<40	<6.0	704	1546	<20

NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA	DET.	CO3=*	Material Insoluble*	Humedad*	SO4=*	Cl ⁻ *	Al*	As*	B*	Ba*	Ca*
			UNIDAD	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			COD.AN.	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38
			TÉCNICA	Volum	Grav	Grav	Grav	Volum	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	1.00	100	0.1	100	10	6.00	10.50	0.90	0.30	2.10
			LS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
REF-SAL-035	AMBIENTAL	SOLIDO		79.13	1858	<0.1	168	14265	10.78	126.72	279.12	7.09	1198.82
DUP	AMBIENTAL	SOLIDO		79.25	1854	<0.1	186	14025	10.90	124.74	276.86	7.80	1196.73

NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA	DET.	Cd*	Co*	Cr*	Cu*	Fe*	K*	Li*	Mg*	Mn*	Na*
			UNIDAD	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg
			COD.AN.	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38
			TÉCNICA	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	0.30	0.60	1.20	0.90	1.20	45.00	1.00	6.00	0.30	6.00
			LS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
REF-SAL-035	AMBIENTAL	SOLIDO		<0.30	<0.60	<1.20	<0.90	45.72	271.44	17.86	1575.23	2.30	8654.83
DUP	AMBIENTAL	SOLIDO		<0.30	<0.60	<1.20	<0.90	45.16	279.88	17.76	1572.55	2.12	8690.99

NRO MUESTRA CLIENTE	ÁREA INTERNA	TIPO MUESTRA	DET.	Ni*	Pb*	S*	Si*	Sr*	Zn*
			UNIDAD	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			COD.AN.	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38	LMMT38
			TÉCNICA	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	3.00	8.40	6.00	6.00	0.09	0.60
			LS	-----	-----	-----	-----	-----	-----
REF-SAL-035	AMBIENTAL	SOLIDO		<3.00	<8.40	63.04	816.64	41.48	45.32
DUP	AMBIENTAL	SOLIDO		<3.00	<8.40	73.99	799.22	40.98	46.55

			DET.	B*	Ba*	Ca*	Fe*	K*	Li*	Mg*	Mn*	Na*	Sr*
			UNIDAD	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			COD.AN.	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S	LMMT03-S
			TÉCNICA	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES
			LC	1	0.01	2	0.3	2	1	1	0.01	2	0.5
			LS	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
NRO MUESTRA	CLIENTE	ÁREA INTERNA	TIPO MUESTRA										
REF-SAL-033	AMBIENTAL	SOLIDO	2278	325.49	168139	25080.5	3886	21163	17496	1185.64	20824	6511.4	
REF-SAL-034	AMBIENTAL	SOLIDO	542	15.59	1049	122216.6	12896	288	13353	1815.57	121560	128.1	
DUP	AMBIENTAL	SOLIDO	543	15.15	1060	125722.6	12981	292	13353	1786.23	122149	128.1	

Board 23: References and results of samples sent to an external laboratory "BHY", for determination of TOC, HC and Fats and Oils.

Reference	Content
REF-SAL-013	Eluted – Q2 – (18-10-23)
REF-SAL-014	Column Feeding (19-10-23)
REF-SAL-015	Brine Exhausted (19-10-23)
REF-SAL-016	Q1 (20-10-23)
REF-SAL-017	Virgin brine

IDENTIFICACIÓN MUESTRA	DETERMINACIÓN	TECNICA	RESULTADO
MQ-28645-01 REF-SAL-013	COT mg/ litro (*)	Spectroquant Merck	15,8
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	4
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	< 1
	Litio mg/ litro (*)	Standard Methods 23st Ed 2017: 3120 B	285,20
	Sodio mg/ litro (*)	Standard Methods 23st Ed. 2017 3500 - Na+ B.	139,37
	Potasio mg/ litro (*)	Standard Methods 23st Ed. 2017 3500 - K+ B.	32,02
MQ-28645-02 REF-SAL-014	COT mg/ litro (*)	Spectroquant Merck	880,0
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	24
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	36

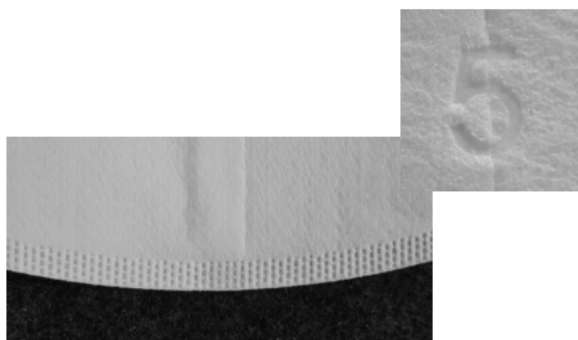
IDENTIFICACIÓN MUESTRA	DETERMINACIÓN	TECNICA	RESULTADO
MQ-28645-03 REF-SAL-015	COT mg/ litro (*)	Spectroquant Merck	248,0
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	3
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	18
MQ-28645-04 REF-SAL-016	COT mg/ litro (*)	Spectroquant Merck	258,0
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	< 1
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	14
MQ-28645-05 REF-SAL-017	COT mg/ litro (*)	Spectroquant Merck	1.160,0
	Hidrocarburos mg/ litro (*)	Standard Methods 23rd Ed 2017: 5520 F	12
	Sustancias Solubles en Éter Etilico mg/ litro (*)	Standard Methods 21st Ed 2005: 5220 B	< 1

Figure 17: Filter Bag – Data Sheet



Filtro Bolsa
PFH1E.5.APT

Diámetro:	178 mm
Longitud:	430 mm
Aro:	Plástico
Terminación:	100% soldada



Caudal máximo recomendado:	20 m ³ /hr (1 Cp)
Diferencial de presión inicial a 20 m ³ /hr:	< 0,1 bar.(1 Cp)
Grado de retención:	5 Micrones
Eficiencia:	> 75%
Diferencial de presión recomendado de cambio:	2 bar
Temperatura máxima de trabajo recomendado:	70°C

Medio filtrante:	Poliéster Punzonado – Salida flameada
Hilo:	N/C
Aro:	Polipropileno

Porosidad:	5 Micrones
Espesor:	2.5 mm.



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Graphic 4: Overview of ADF, Eluate and Consumption



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