

Ing. Silvestre Montes
King Lee Technologies



CAPACITACIÓN EN VIVO

SiO₂



Protege tus membranas de ósmosis inversa contra incrustaciones por **sílice**



1 Julio 2025



10:00 am CDMX

C^orbotecnia

Fuentes de agua



Pozo profundo



Superficial



Mar



Residual tratada



El sílice (SiO_2) en los ciclos de operación



Compuesto formado por silicio y oxígeno, presente en muchas fuentes de agua. Es el segundo elemento que más se encuentra en la corteza terrestre después del oxígeno

Reactiva

Coloidal

¿Cómo se mide?

partes por millón (ppm) o miligramos por litro (mg/L)

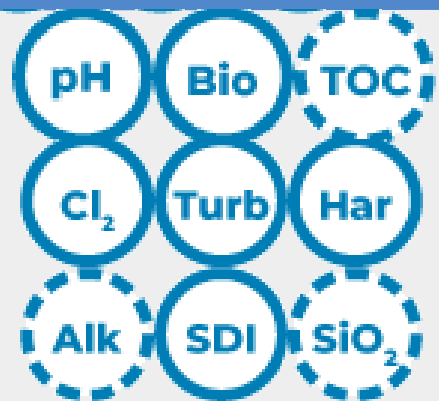
Rangos típicos

20 - 102 ppm

% nominal de rechazo en membranas TFC

| Ion | % Rechazo |
|-----------|-----------|
| Sílice | 92 - 95 |
| Silicatos | 90 - 98 |

Análisis fisicoquímico del agua, elementos clave a evaluar



1

Cationes

Dureza
Calcio
Magnesio
Sodio
Carbonatos
Hierro Aluminio
Manganeso
Bario

2

Aniones

Alcalinidad
Bicarbonatos
sulfatos,
Cloruros
Floruros
Nitratos
Fosfatos

3

Adicinales

Sílice
Temperatura
pH
COT
DBO
DQO
Conductividad
SDI
Sólidos disueltos

El pretratamiento químico en sistemas de Ósmosis Inversa



¿Por qué es importante?

- ✓ Previene incrustaciones y ensuciamiento
- ✓ Reduce el consumo de energía
- ✓ Prolonga la vida útil de las membranas
- ✓ Asegura una calidad estable del agua permeada

¿Y si no se controla el sílice?



Problemas que genera el Sílice



Incrustaciones irremovibles



Deterioro permanente de membranas



Costos altos por reemplazo y limpieza de membranas



Paros no programados del sistema



Pérdida de calidad del agua producto



Soluciones a través de:



Proyección Hidráulica



Proyección Química



Proyección Hidráulica



2025-06-24 12:39:11

v3.3.0.4

Project name: 1456 m3/día
Customer: 1
Username: Ing. Silvestre

Water type: 20250217_1456 m3di
Flux loss per year: 10.00%
Salt passage increase: 10.00%

Membrane age: 3
Safety factor: 1.4

Overall System

Total permeate flow: 1,456 m3/d
Raw water flow: 1,835 m3/d
Total concentrate flow: 379 m3/d
Overall recovery: 79.35 %

Water source: Waste Tertiary MF/UF (SDI<3)
Raw water TDS: 1,004.41 mg/L
Feed osmotic pressure: 6.4 psi
Concentrate osmotic pressure: 30.36 psi

Feed pressure: 101.03 psi (1P)

System - Pass1

Permeate flow: 1,456 m3/d
RO feed flow: 1,835 m3/d
Concentrate flow: 379 m3/d
Recovery: 79.35 %
Number of elements: 108
ERD type: None
Recirculation:

Average flux: 15.12 lmh
Water source: Waste Tertiary MF/UF (SDI<3)
Feed TDS: 1,004.41 mg/L
Feed osmotic pressure: 6.4 psi
Concentrate osmotic pressure: 30.36 psi
Pump efficiency: 80 %

Temperature: 25 °C
Average NDP: 60.09 psi
Specific energy: 0.3 kWh/m³
Feed pressure: 101.03 psi
Permeate TDS: 20.55 mg/L
Fouling factor: 0.73

| | # of vessels | # of elements | RO feed flow m3/d | Permeate flow m3/d | Conc. flow m3/d | RO feed pressure psi | Conc. pressure psi | Vessel DP psi | Boost pressure psi | Back pressure psi | Inter-stage pressure loss psi | Average flux lmh | Perm. TDS mg/L |
|---------|--------------|---------------|----------------------|-----------------------|--------------------|-------------------------|-----------------------|------------------|-----------------------|----------------------|----------------------------------|---------------------|-------------------|
| Stage 1 | 9 | 6 | 1,835 | 778.82 | 1,056.18 | 101.03 | 93.44 | 7.59 | 0 | 0 | 0 | 16.17 | 12.67 |
| Stage 2 | 6 | 6 | 1,056.18 | 482.88 | 573.3 | 93.44 | 89.47 | 3.97 | 0 | 0 | 0 | 15.04 | 20.15 |
| Stage 3 | 3 | 6 | 573.3 | 193.19 | 380.11 | 89.47 | 84.41 | 5.07 | 0 | 0 | 0 | 12.03 | 53.3 |

Proyección Hidráulica

Water Analysis - Pass 1

| Species | Raw water | Adjusted feed | Conc. | | | | Permeate | | | | |
|-------------|-----------|---------------|----------|----------|----------|-----------|----------|--------|--------|-----------|-------|
| | | | Stage1 | Stage2 | Stage3 | Composite | Stage1 | Stage2 | Stage3 | Composite | |
| Ammonium | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sodium | 61.91 | 61.91 | 105.94 | 192.20 | 285.15 | 285.15 | 2.21 | 3.52 | 9.30 | 3.59 | 3.59 |
| Potassium | 0.18 | 0.18 | 0.27 | 0.46 | 0.62 | 0.62 | 0.04 | 0.06 | 0.14 | 0.06 | 0.06 |
| Magnesium | 56.94 | 56.94 | 98.44 | 180.44 | 270.71 | 270.71 | 0.67 | 1.07 | 2.84 | 1.09 | 1.09 |
| Calcium | 93.40 | 93.40 | 162.21 | 298.72 | 450.34 | 450.34 | 0.09 | 0.13 | 0.39 | 0.14 | 0.14 |
| Strontium | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Barium | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fluoride | 0.02 | 0.02 | 0.03 | 0.06 | 0.09 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Chloride | 10.08 | 10.08 | 17.47 | 32.11 | 48.31 | 48.31 | 0.05 | 0.09 | 0.25 | 0.09 | 0.09 |
| Sulfate | 46.78 | 46.78 | 81.24 | 149.56 | 225.41 | 225.41 | 0.06 | 0.12 | 0.32 | 0.11 | 0.11 |
| Nitrate | 0.51 | 0.51 | 0.85 | 1.51 | 2.18 | 2.18 | 0.04 | 0.07 | 0.18 | 0.07 | 0.07 |
| Carbonate | 2.70 | 2.70 | 4.68 | 8.62 | 12.99 | 12.99 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 |
| Bicarbonate | 652.00 | 652.00 | 1,125.86 | 2,061.66 | 3,089.52 | 3,089.52 | 9.38 | 14.83 | 39.25 | 15.16 | 15.16 |
| Boron | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bromide | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Silica | 79.90 | 79.90 | 138.72 | 255.37 | 384.84 | 384.84 | 0.13 | 0.24 | 0.62 | 0.23 | 0.23 |
| CO2 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 | 16.46 |
| TDS | 1,004.41 | 1,004.41 | 1,735.71 | 3,180.70 | 4,770.16 | 4,770.16 | 12.67 | 20.15 | 53.30 | 20.55 | 20.55 |
| pH | 7.76 | 7.76 | 7.98 | 8.23 | 8.39 | 8.39 | 5.97 | 6.16 | 6.58 | 6.11 | 6.11 |

Proyección Hidráulica

Within Vessels - Pass1

| | Position | RO feed flow m3/d | Permeate flow m3/d | Flux lmh | Element recovery % | Element DP psi | Net driving pressure psi | Polarization | Feed TDS mg/L | Perm. TDS mg/L |
|------------------|----------|-------------------------|--------------------------|-------------|--------------------------|----------------------|--------------------------------|--------------|------------------|-------------------|
| Stage 1 | | | | | | | | | | |
| LG BW 400 R Dura | 1 | 203.89 | 15.36 | 17.22 | 7.53 | 1.75 | 92.86 | 1.10 | 1,004.41 | 8.92 |
| LG BW 400 R Dura | 2 | 188.53 | 14.97 | 16.78 | 7.94 | 1.54 | 90.58 | 1.11 | 1,085.73 | 10.09 |
| LG BW 400 R Dura | 3 | 173.57 | 14.60 | 16.37 | 8.41 | 1.34 | 88.40 | 1.11 | 1,178.76 | 11.47 |
| LG BW 400 R Dura | 4 | 158.97 | 14.23 | 15.96 | 8.95 | 1.15 | 86.29 | 1.12 | 1,286.27 | 13.16 |
| LG BW 400 R Dura | 5 | 144.74 | 13.88 | 15.56 | 9.59 | 0.98 | 84.18 | 1.13 | 1,411.90 | 15.26 |
| LG BW 400 R Dura | 6 | 130.86 | 13.51 | 15.15 | 10.32 | 0.83 | 82.02 | 1.14 | 1,560.51 | 17.92 |
| Stage 2 | | | | | | | | | | |
| LG MaxRO R | 1 | 176.03 | 14.50 | 16.26 | 8.24 | 0.94 | 80.12 | 1.12 | 1,738.72 | 12.70 |
| LG MaxRO R | 2 | 161.53 | 14.10 | 15.81 | 8.73 | 0.81 | 77.99 | 1.12 | 1,893.88 | 14.66 |
| LG MaxRO R | 3 | 147.43 | 13.69 | 15.35 | 9.28 | 0.70 | 75.75 | 1.13 | 2,073.93 | 17.11 |
| LG MaxRO R | 4 | 133.74 | 13.24 | 14.85 | 9.90 | 0.60 | 73.35 | 1.14 | 2,284.76 | 20.53 |
| LG MaxRO R | 5 | 120.50 | 12.75 | 14.30 | 10.58 | 0.50 | 70.70 | 1.15 | 2,534.01 | 25.67 |
| LG MaxRO R | 6 | 107.75 | 12.20 | 13.68 | 11.32 | 0.42 | 67.71 | 1.16 | 2,831.46 | 32.55 |
| Stage 3 | | | | | | | | | | |
| LG MaxRO R | 1 | 191.10 | 11.93 | 13.38 | 6.24 | 1.09 | 66.32 | 1.09 | 3,189.67 | 36.53 |
| LG MaxRO R | 2 | 179.17 | 11.47 | 12.86 | 6.40 | 0.98 | 63.75 | 1.09 | 3,400.18 | 42.08 |
| LG MaxRO R | 3 | 167.70 | 10.99 | 12.32 | 6.55 | 0.88 | 61.15 | 1.09 | 3,630.36 | 48.63 |
| LG MaxRO R | 4 | 156.71 | 10.51 | 11.78 | 6.70 | 0.79 | 58.49 | 1.09 | 3,882.25 | 56.40 |
| LG MaxRO R | 5 | 146.21 | 10.01 | 11.22 | 6.84 | 0.71 | 55.75 | 1.09 | 4,158.00 | 65.68 |
| LG MaxRO R | 6 | 136.20 | 9.49 | 10.64 | 6.97 | 0.63 | 52.92 | 1.09 | 4,459.68 | 76.84 |

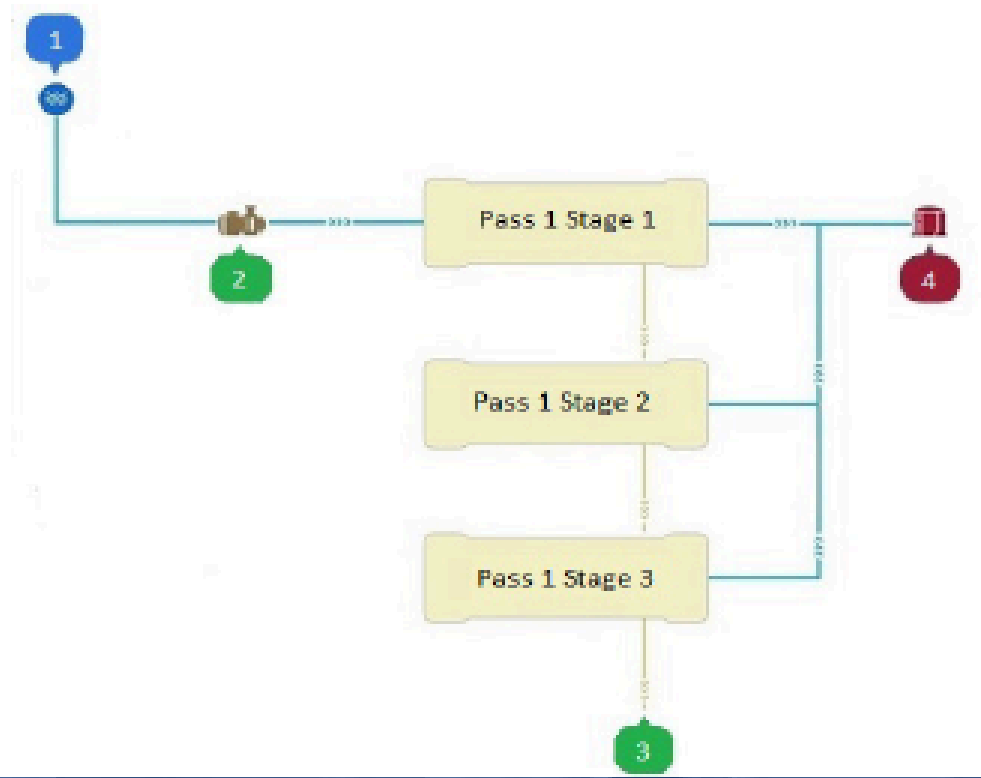
Proyección Hidráulica

Solubility - Pass1

| | Solubility calculation | |
|-------------------|------------------------|----------|
| | Feed | Conc. |
| LSI | 1 | 2.37 |
| CaSO4 | 1.05 % | 10.66 % |
| SrSO4 | 0 % | 0 % |
| BaSO4 | 0 % | 0 % |
| CaF2 | 0 % | 0.28 % |
| SiO2 | 62.61 % | 265.63 % |
| Stiff Davis Index | 0.61 | 1.78 |

Warnings - Pass1

Disclaimer: LG Chem Design is intended to be used by persons having the requisite technical skill, at their own discretion and risk. When using LG Chem Design, it is the user's responsibility to make provisions against fouling, scaling and chemical attacks, to account for piping and valve pressure losses, feed pump suction pressure and permeate backpressure. LG Chem shall not be liable for any error or miscalculation in results obtained by using LG Chem Design. Because use conditions and applicable laws may differ from one location to another and may change with time, users are responsible for determining whether products are appropriate for their use.



Proyección Química



Chemical Projection

Membrane Cleaning

Pump and Dilution



Project Information

FeedWater Input

Chemical Projection Output

Project Database

Project Information

Project Name

Organization & Contact Name

Date

Run By

Clear Data

[Download User Guide](#)

Feed Type

Total Flow Rate

Overall Recovery *

 %

Number of Trains

 Stages per Train

Operation Time

 hrs / day days / mo months / yr

Chemical Tank Size

Chemical Dilution

Membrane Manufacturer

Membrane Model

Membrane Type

Salt Rejection

Fouling Factor

Recirculation

Acid Injection



Proyección Química

Cations

| | | |
|-------------------------------|----------------------|---------------------------------------|
| Total Hardness * | <input type="text"/> | mg/L as CaCO ₃ |
| Calcium [Ca ²⁺] * | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Magnesium [Mg ²⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Sodium [Na ⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Potassium [K ⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Barium [Ba ²⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Strontium [Sr ²⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Iron [Fe ²⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Aluminium [Al ³⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Manganese [Mn ³⁺] | <input type="text"/> | mg/L <input type="button" value="v"/> |

Anions

| | | |
|---|----------------------|---------------------------------------|
| Total Alkalinity ** | <input type="text"/> | mg/L as CaCO ₃ |
| Bicarbonate [HCO ₃ ⁻] ** | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Sulfate [SO ₄ ²⁻] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Chloride [Cl ⁻] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Fluoride [F ⁻] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Nitrate [NO ₃ ⁻] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| O-Phosphate [PO ₄ ³⁻] | <input type="text"/> | mg/L <input type="button" value="v"/> |
| Silica [SiO ₂] | <input type="text"/> | mg/L <input type="button" value="v"/> |


Additional Information

| | | |
|-----------------|-----------------------------------|--|
| TOC | <input type="text"/> | mg/L |
| BOD | <input type="text"/> | mg/L |
| COD | <input type="text"/> | mg/L |
| Conductivity | <input type="text"/> | μs/cm <input type="button" value="v"/> |
| Temperature *** | <input type="text" value="25.0"/> | C <input type="button" value="v"/> |
| pH **** | <input type="text" value="7.0"/> | |
| SDI | <input type="text"/> | |
| Turbidity | <input type="text"/> | NTU |

PROJECT INFORMATION

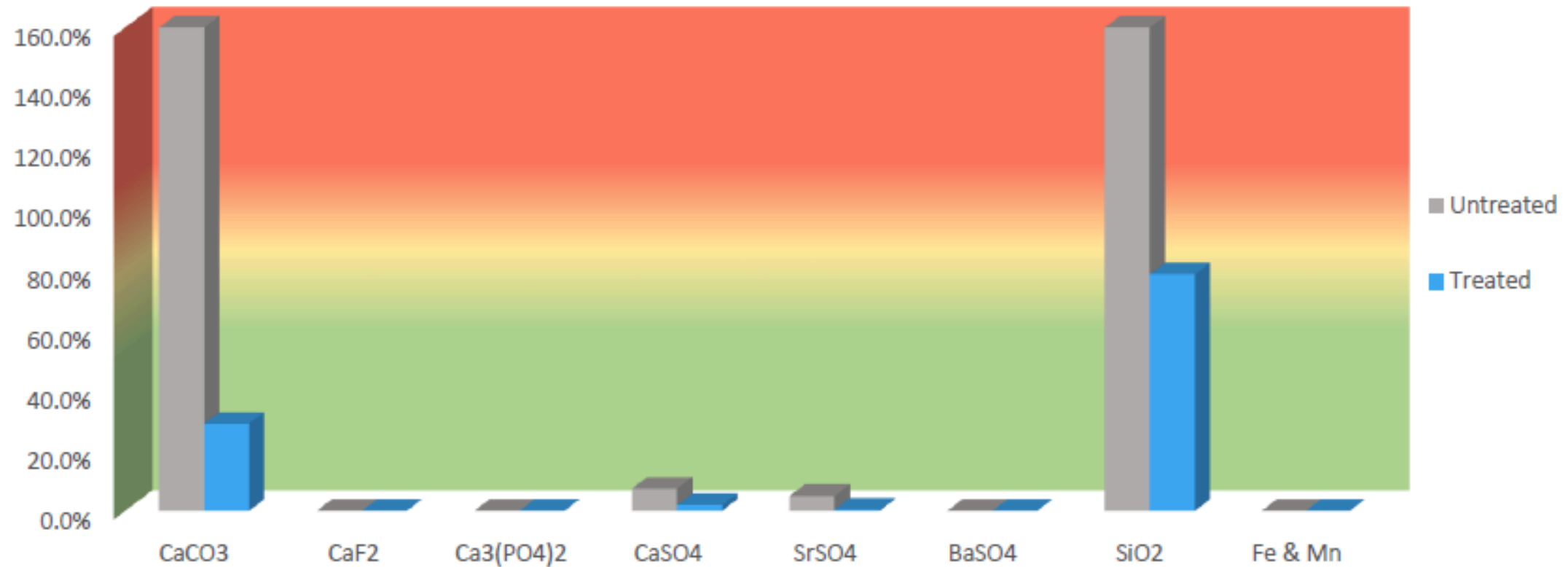
Recovery Rate: 67.0% **Feed Flow Rate:** 39.6 gpm **Feed Source:** Agua de pozo

| PROJECTED CHEMICAL DOSE* | |
|--------------------------|------------|
| Pretreat Plus® 0100 | @ 7.2 mg/L |

 The adjusted feed reflects an auto-balance of cations/anions. Feedwater may indicate the presence of colloidal silica. Consider Protec RO to inhibit colloidal silica fouling.

| UNTREATED SCALING POTENTIAL OVERVIEW | | |
|--------------------------------------|---|-----------|
| Calcium Carbonate | LSI / S&DSI | 1 / 0.7 |
| Calcium Fluoride | CaF ₂ | ▶ 0.00% |
| Calcium Phosphate | Ca ₃ (PO ₄) ₂ | ▶ 0.00% |
| Calcium Sulfate | CaSO ₄ | ▶ 7.40% |
| Strontium Sulfate | SrSO ₄ | ▶ 5.00% |
| Barium Sulfate | BaSO ₄ | ▶ 0.00% |
| Silica | SiO ₂ | ▶ 251.10% |
| Iron & Manganese | Fe & Mn | ▶ 0.00% |

% SCALING POTENTIAL



Resultados proyección química

ION CONCENTRATIONS

Ion concentrations are reported in mg/L unless specified otherwise.

| Parameters: | Raw Feed | Adjusted Feed | Concentrate | Permeate |
|--|----------|---------------|-------------|----------|
| Calcium [Ca ²⁺] | 50.0 | 50.0 | 150.9 | 0.4 |
| Magnesium [Mg ²⁺] | 38.0 | 38.0 | 114.7 | 0.3 |
| Sodium [Na ⁺] | 101.0 | 154.1 | 465.0 | 1.2 |
| Potassium [K ⁺] | 0.0 | 0.0 | 0.0 | 0.0 |
| Barium [Ba ²⁺] | 0.0 | 0.0 | 0.0 | 0.0 |
| Strontium [Sr ²⁺] | 0.5 | 0.5 | 1.6 | 0.0 |
| Iron [Fe ²⁺] | 0.0 | 0.0 | 0.0 | 0.0 |
| Aluminium [Al ³⁺] | 0.0 | 0.0 | 0.0 | 0.0 |
| Manganese [Mn ³⁺] | 0.0 | 0.0 | 0.0 | 0.0 |
| Anions: | | | | |
| Bicarbonate [HCO ₃ ⁻] | 363.6 | 363.6 | 1097.3 | 2.9 |
| Carbonate [CO ₃ ²⁻] | 0.0 | 0.0 | 0.0 | 0.0 |
| Sulfate [SO ₄ ⁻] | 113.0 | 113.0 | 341.1 | 0.9 |
| Chloride [Cl ⁻] | 79.0 | 79.0 | 238.4 | 0.6 |
| Fluoride [F ⁻] | 0.0 | 0.0 | 0.0 | 0.0 |
| Nitrate [NO ₃ ⁻] | 6.3 | 6.3 | 19.0 | 0.1 |
| O-Phosphate [PO ₄ ³⁻] | 0.1 | 0.1 | 0.3 | 0.0 |
| Silica [SiO ₂] | 104.0 | 104.0 | 313.9 | 0.8 |
| Other: | | | | |
| pH | 7.0 | 7.0 | 7.5 | 5.0 |
| TDS | 855.5 | 908.6 | 2428.3 | 7.3 |
| Temperature | 25 °C | | | |

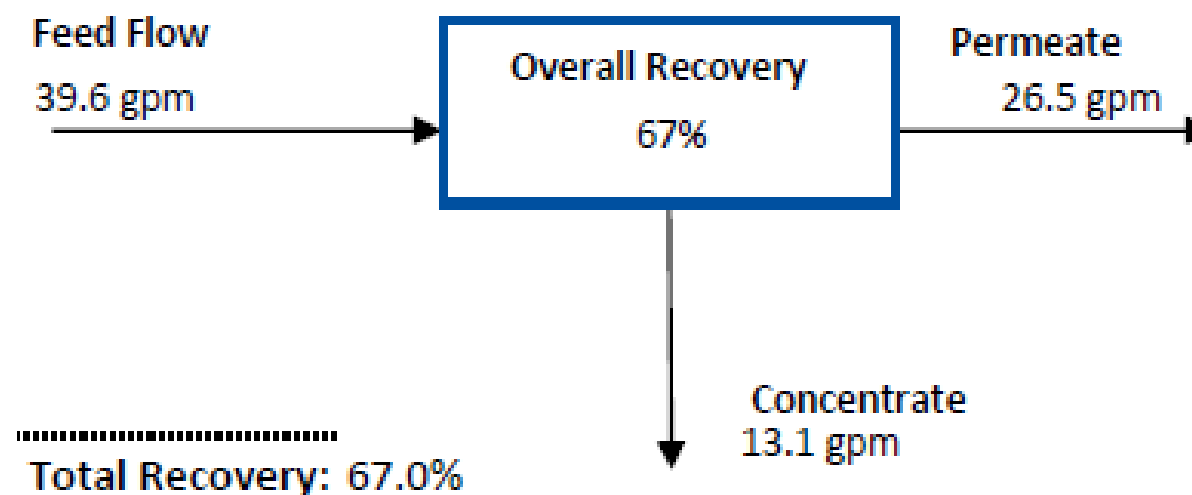
Resultados proyección química

Resultados proyección química

SYSTEM PARAMETERS

| | |
|-------------------------------|-------------------------------------|
| Membrane Manufacturer: | |
| Membrane Model: | BW 400 ES L |
| Membrane Type: | Brackish Water |
| Salt Rejection: | Monovalent: 99.6%, Divalent: 99.6%. |
| Fouling Factor: | 1.00 |
| Number of Trains: | 1 |
| Array: | |
| Feed Source Name: | Agua de pozo |

SYSTEM DYNAMICS



Total Usage*

Estimated Effective Dose @ 7.2 mg/L Pretreat Plus® 0100

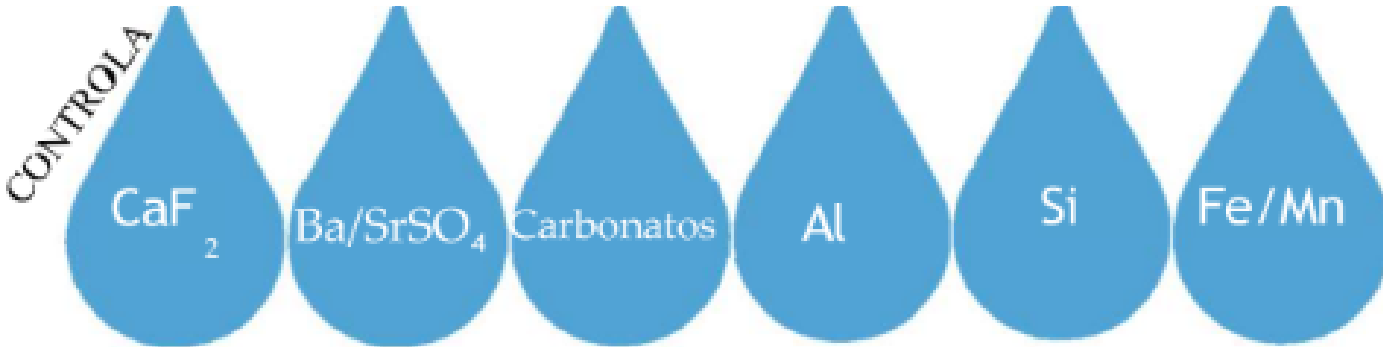
| | Daily | Monthly | Annually | Chemical |
|---|-------------|-------------|--------------|-----------|
| Antiscalant Injection Rate 1.02 mL/min: | 1.55 kg/day | 10.86 kg/mo | 130.35 kg/yr | Undiluted |
| | 1.46 L/day | 10.2 L/mo | 122.97 L/yr | |

Tratamiento preventivo

> **Pretreat Plus[®] 0100**

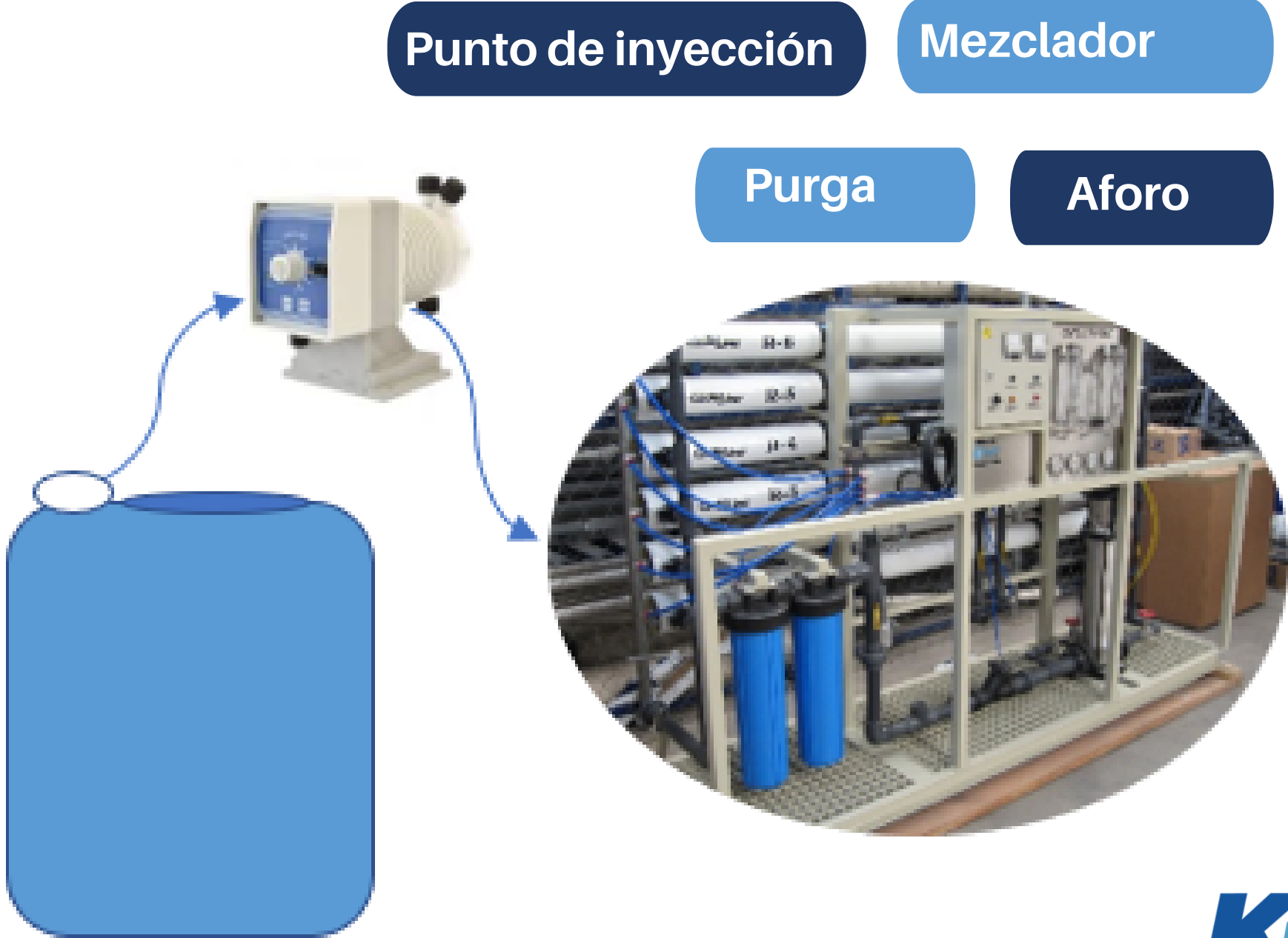
Anti-incrustante

De amplio espectro, formulado para evitar la incrustación prematura en las membranas



Dosis

Tasa de inyección



Bitácora de operación

 Tablero

 Datos de operación

 Registros de eventos 

 Perfiles de conductividad 

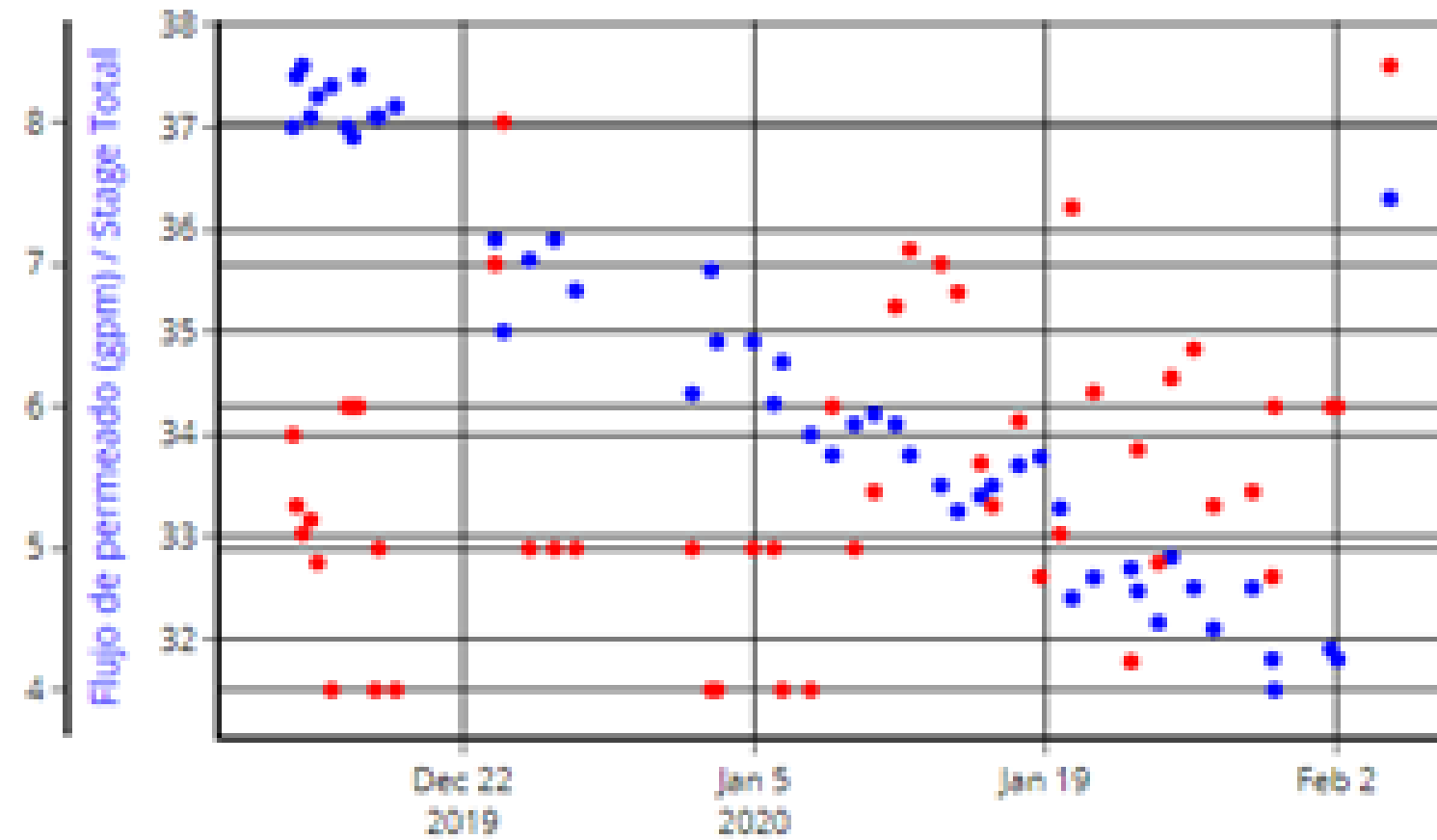
 Gráficos

 Proyectos 

 Recursos

 Ayuda

Conductividad de permeado ($\mu\text{S} / \text{cm}$) / Stage Total



Tratamiento correctivo



Limpieza química de membranas

Muy pronto...

Gracias por su atención

Para cualquier cotización y asesoría contáctanos:

Tel. +52 33 3834-0906

ventas@carbotech.com.mx

ingenieria@carbotech.com.mx

