Liquid Filtration for Chlor-Alkali Plants

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What are the 3 most important parameters in operating a chlor-alkali plant?

1. Brine Quality

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2. Brine Quality

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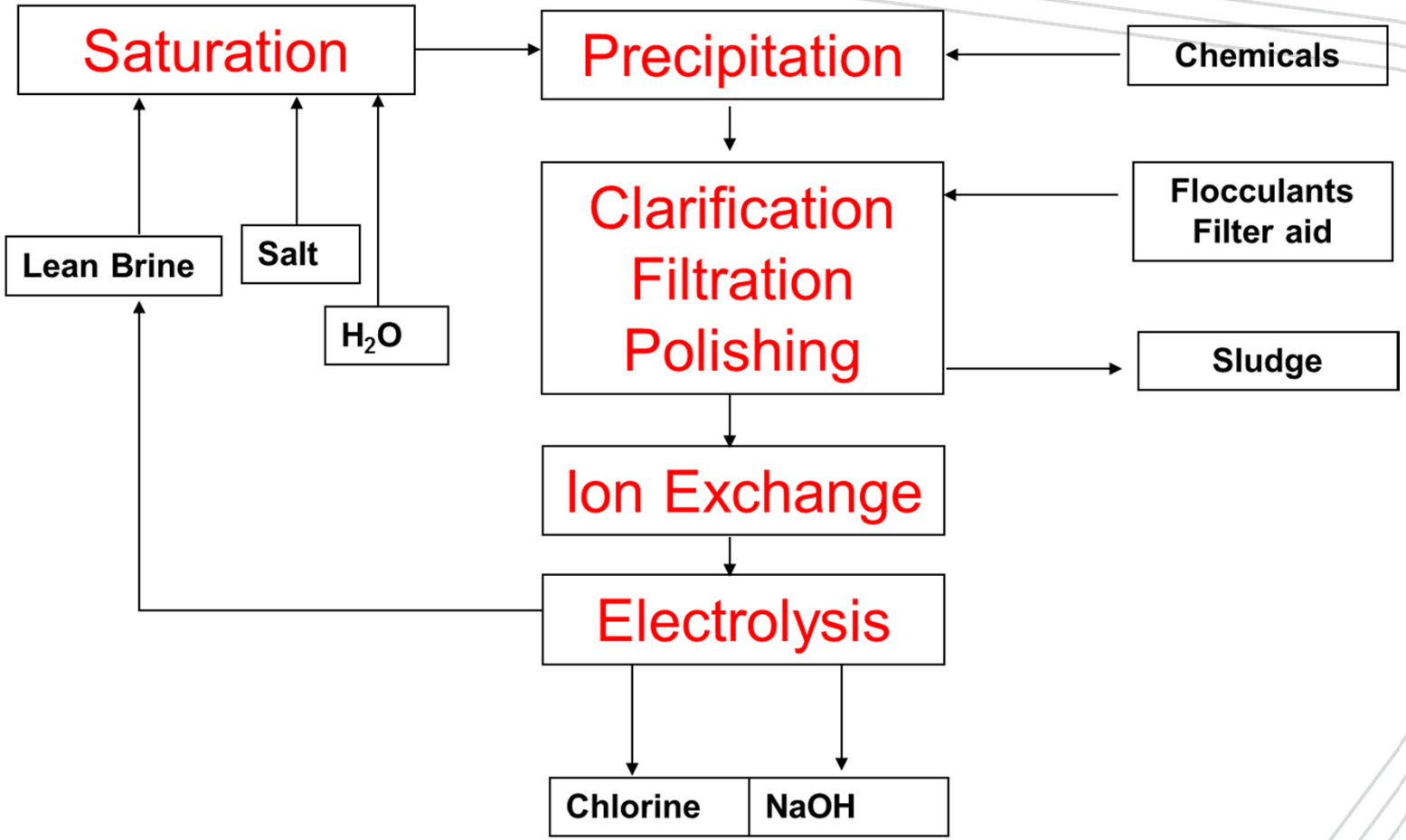
3. Brine Quality

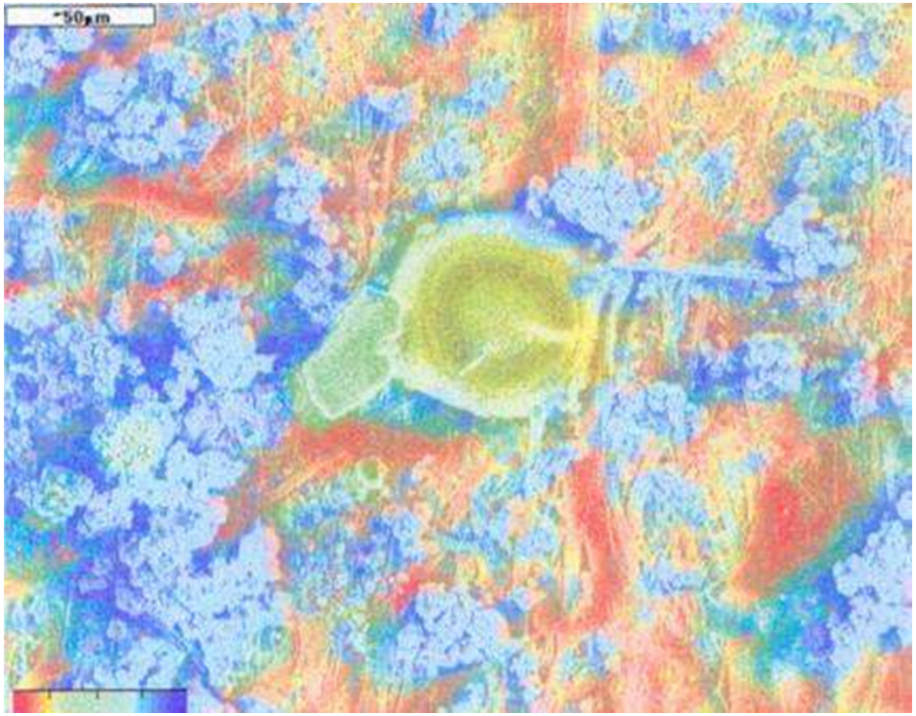
Agenda

- Overall brine treatment process and how it fits into chlor-alkali plant
- Salt impurities dissolved into brine
- Precipitation to remove impurities
- Removal of precipitants by filtration
- Benefits
- Experience

Typical Block-Flow Diagram for Membrane Process with Conventional Brine Treatment and Filtration



Salt impurities dissolved into brine



Brine sample filtered over an analysis membrane. Surface analysis using a combination of Scanning Electronic Microscopy and X-ray Fluorescence Spectroscopy

1. $CaSO_4$ = Blue, Ca precipitated as $CaCO_3$ (1 ppm to over 6,000 ppm)
2. $MgSO_4$ and $MgCl$ = Light Green, Mg precipitated as $Mg(OH)_2$ (1 ppm to over 600 ppm)
3. Silicates = Dark Green

Analysis membrane = Red (Nylon)

Also important at other customer sites:

4. $Fe(OH)_3$
5. $Al(OH)_3$
6. $BaSO_4$
7. HgS (amalgam process)
8. Strontium
9. Nickel
10. Organics

Dissolved salt impurities in brine reduced to:

Maximum impurity levels in feed to electrolyzers		
	Membrane cell room	Diaphragm cell room
sodium chloride	290-305 g/l	320 g/l
calcium and magnesium	20 ppb	5 ppm
sodium sulfate	7 ppm	5 ppm
silicon dioxide	5 ppm	0.5 ppm
aluminum	50 ppb	0.5 ppm
iron	0.5 ppm	0,3 ppm
mercury	0.01 ppm	1 ppm
heavy metals	0.05 ppm	0.05 ppm
flouride	1 ppm	1 ppm
iodine	0.4 ppm	
strontium	0.5 ppm	
barium	0.4 ppm	
TOC	1 ppm	1 ppm
pH	2.0 - 11.0	2.5-3.5

How to remove impurities – First using precipitation (chemicals and reactions)

Calcium and Magnesium reduction

- Na_2CO_3 (soda ash) + $CaSO_4$ => $CaCO_3$ + $2NaSO_4$ results in Ca removed down to 0.6 ppm

Particle size produced is about 2 microns in size

- 2NaOH (caustic) + $MgCl_2$ => $Mg(OH)_2$ + 2NaCl results in Mg removed down to single digits ppb

Particle size if flash precipitated can be as small as 0.1 micron in size

Silica reduction

- $MgCl_2$ + SiO_2 + 2NaOH => $(MgO)x(SiO_2)x*(H_2O)$ +2NaCl or Si removed by solids contact or evap

Sulfate reduction

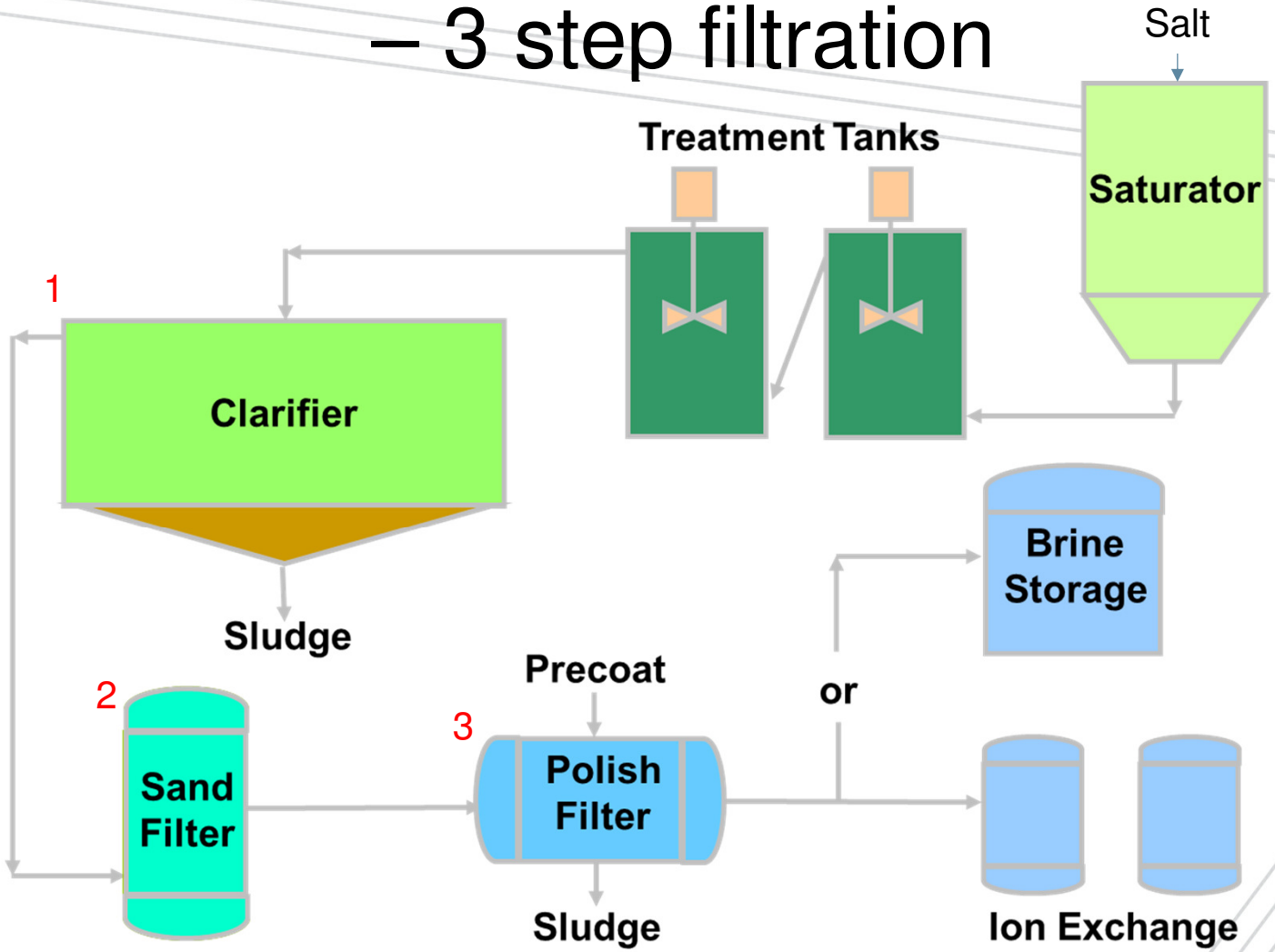
- $BaCO_3$ + $NaSO_4$ => $BaSO_4$ + Na_2CO_3 or brine purge or by RO

With brine wells, a Sulfate Solubility Inhibitor (SSI) can be added directly to the well to prevent the sulfate going into solution in the first place.

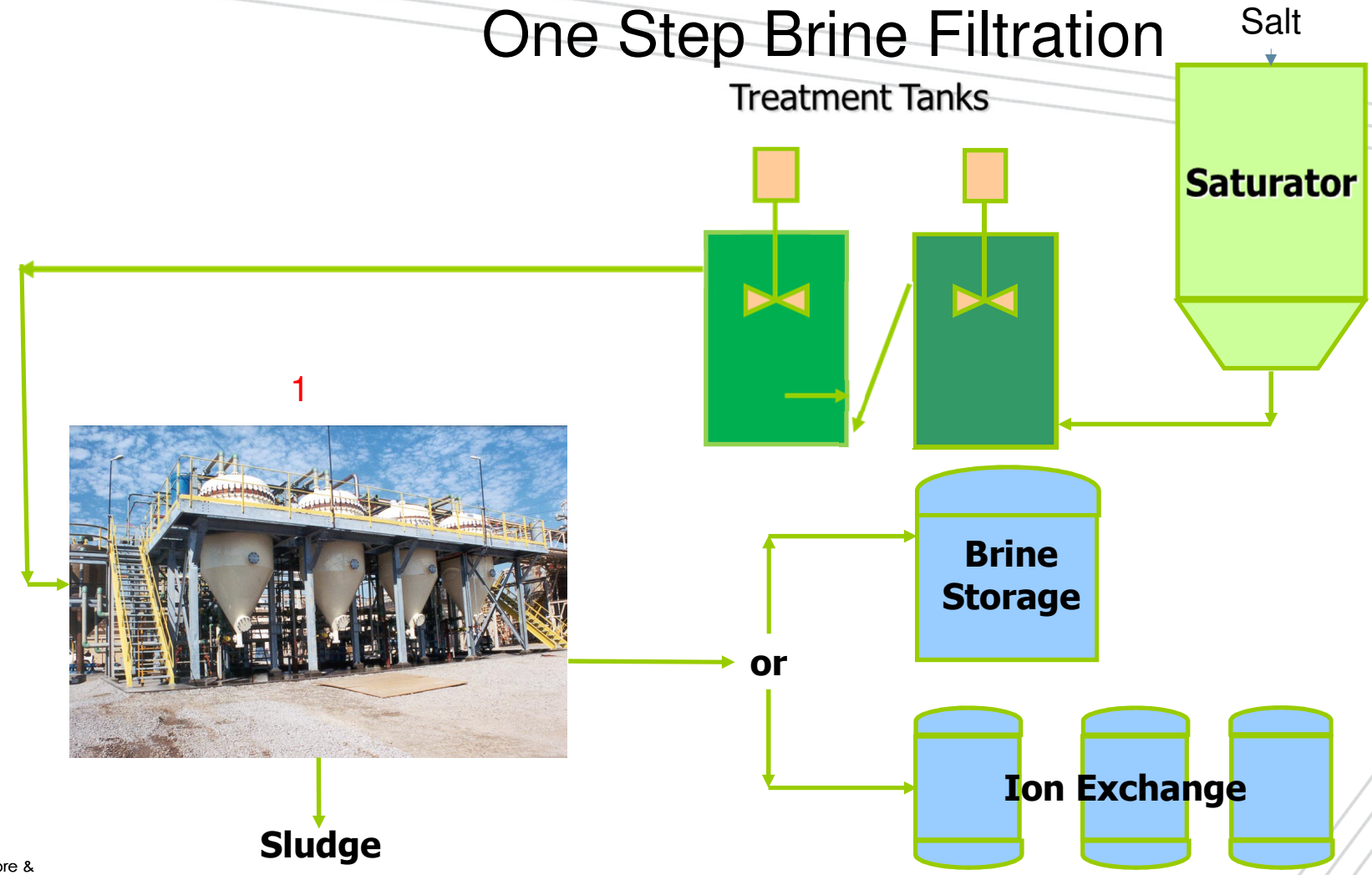
Further metal reduction

- An additional precipitation/coalgulation step to remove iron, aluminum at low pH using $FeCl_4$

Conventional brine treatment – after precipitation – 3 step filtration

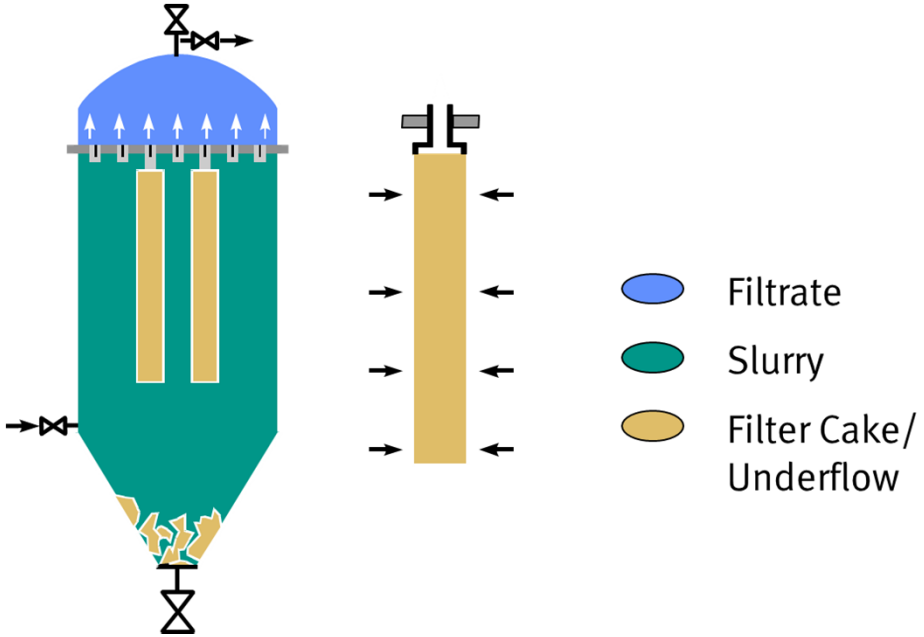


Brine Treatment and Purification with non-Precoat Filtration - One Step Brine Filtration

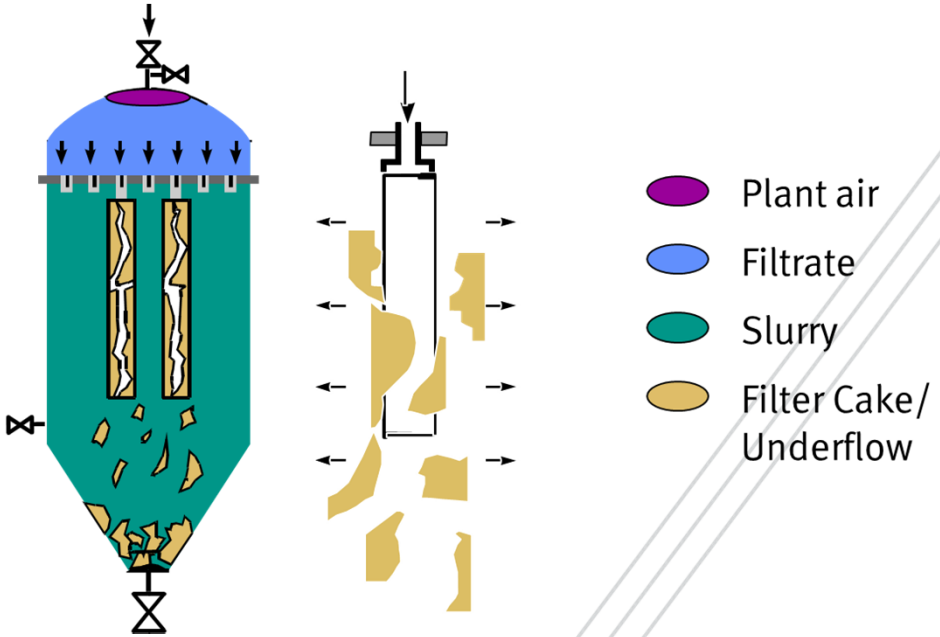


Tubular Back-Pulse Filter

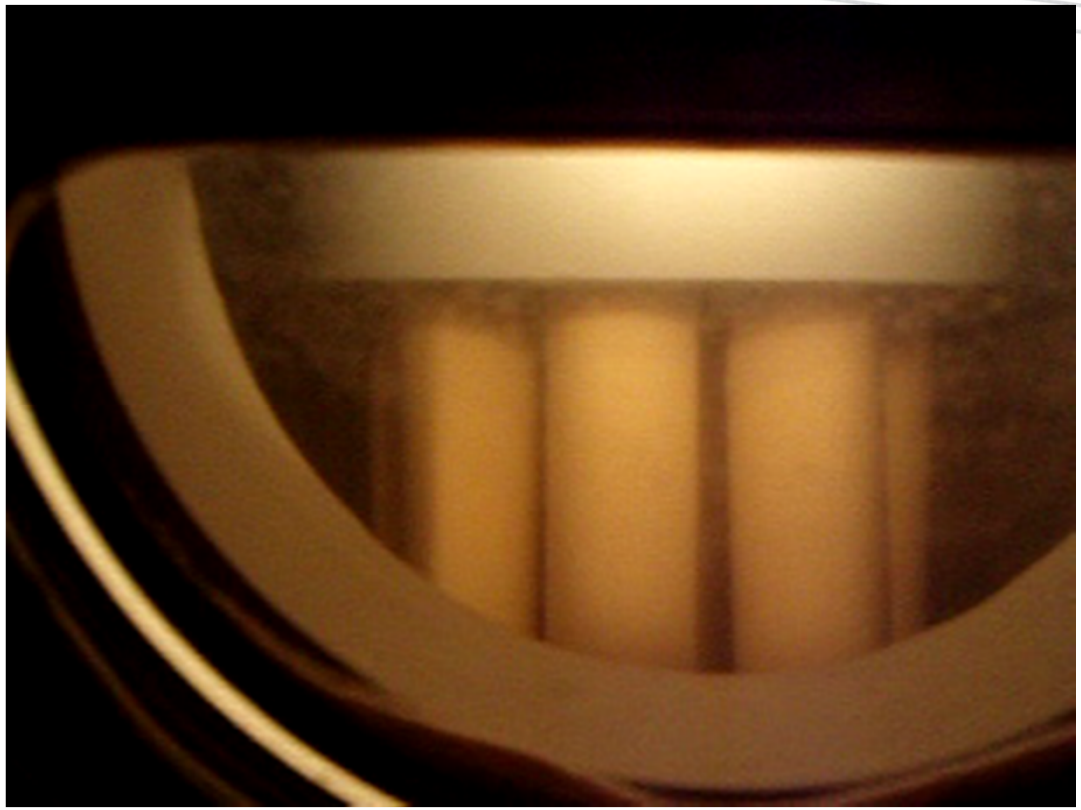
On-line Filtering



Back-Pulsing



Back-pulse of filter cake in brine slurry



Examples of GORE Filter Media

GORE Filter sleeve/sock

GORE Filter Tube Assembly – 2.5 times the filtration area of sleeve/sock

Benefits of GORE Back-Pulse Filters

- Reduces capital equipment costs by 50% and significantly reduces plant equipment footprint
- Fully automated
- No need for a standby filter
- Eliminates use of precoat and flocculants
- Higher solids concentration sludge, so if further dewatering is required, filter press is designed for solids loading, not hydraulic loading.
- Reduces 3 process steps down to 1
- Works with all different types of salt sources
- No longer have to handle sluice, as none is produced
- Quite often reduces chemical treatment costs, sometimes savings of over $1 million/year
- Eliminates power outage issues that precoat filters are sensitive to
- Eliminates issue of clarifier rolls due to large outdoor temperature swings
- Reduces amount of sludge produced, saving landfill costs or less contaminates sent back to the brine well
- Extends life of Ion Exchange Column resin and reduces cleaning frequency
- We have a value spread sheet that helps quantify the savings

Experience

- Experience with brine filtration in both Caustic Chlorine plants (also referred to as Chlor-Alkali plants), salt to Bleach, and Sodium Chlorate plants.
- Began developing the brine application back in the early 90's with our CPVC fluted support element dressed with our filter sleeve. Over 10 years ago, developed the GORE Filter Tube assembly to reduce size/quantity of filters required.
- Learned filtration flux rate dependent on impurities makeup. The higher the Ca to Mg ratio, the higher the flux rate. Some salts had an organic content – especially solar salts – which we initially avoided. Developed the optimum chemical precipitation reaction conditions for optimum filtration performance. Eventually solved the organic issue with Hygiene Wash (Patented).

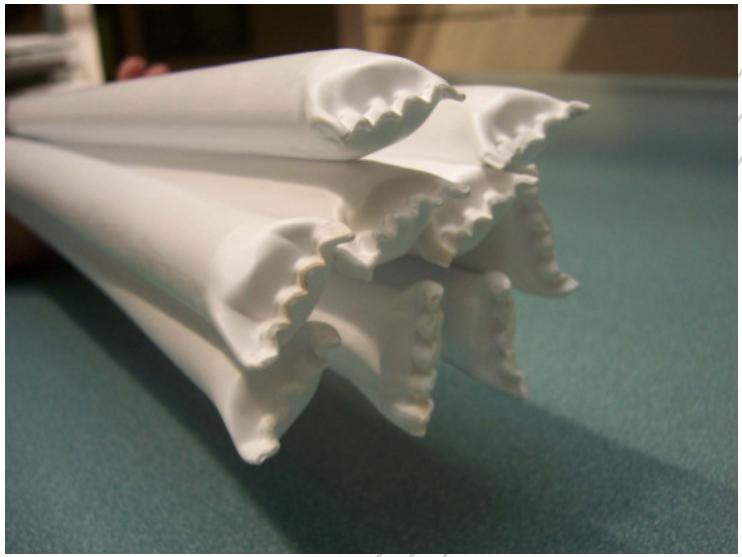
Installations

More than 100 commercial installations of GORE Filter Tube Assemblies or Fluted element with sleeve around the globe

Experience with various types of salt
Including vacuum salt, rock salt, solar salt
(Chilean, Indian, Mexican, Australian),
and well brine

Caustic Chlorine (C/A), salt to Bleach, & Sodium Chlorate Plants

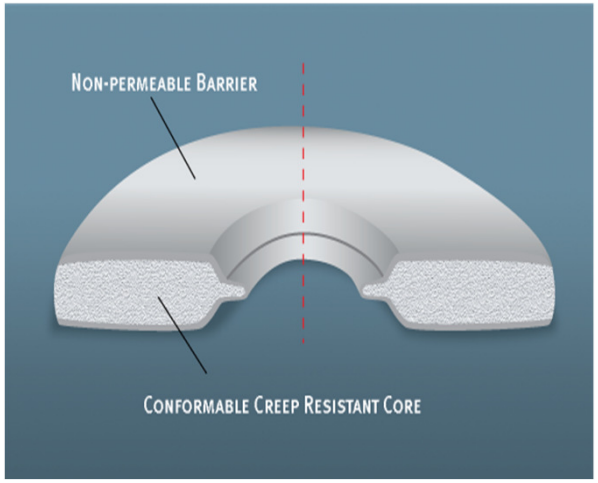
China – +95% of C/A plants use non-precoat technology. +95% use membrane electrolyzers. Solar and rock salt
Europe – mercury and membrane electrolyzers. Precoat technology prevalent. Majority use Vacuum salt.
Americas – diaphragm and membrane electrolyzers. Rock, well brine, and solar salt.



Our filtration technology is now coupled with the latest membrane electrolyzer technology, resulting in the most efficient chlor-alkali plant operation – located in China.

Gore Sealants for Chlor- Alkali

GORE® GR Sheet



GORE® Universal Pipe Gasket

GORE® Series Tape

GORE® Sealants for meeting the production challenges of corrosion, bolt load retention, leakage and overall reliability in Chlor- Alkali production