Sundyne®

Pumps & Compressors for Chlor-Alkali Applications

Sundyne Pumps | Sundyne Compressors | ANSIMAG Sealless Pumps | HMD Kontro Sealless Pumps | Marelli Bombas | PPI Diaphragm Compressors | SUNFLO®

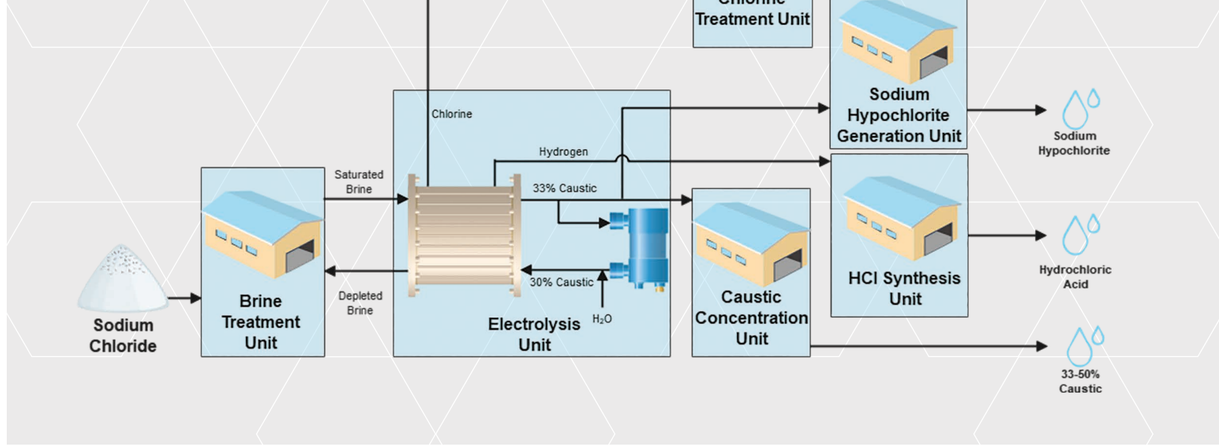
This process brief will generically apply to a sealless ANSI or ISO pump. Technical limitations may dictate the type of pump (for example, high temperatures limiting use of a plastic lined pump). However, many processes could use either sealed (Marelli), sealless metallic (HMD) or sealless plastic lined (Ansimag/ALI) pump. It is critical to understand the customer needs (price, lead-time, technology preference and the competitive environment) when proposing a pumping solution.

Chlor-Alkali Plant

The Chlor-Alkali Industry produces some of the highest volume basic chemicals used in the Chemical Process and other industries. Beginning with basic salt (sodium chloride) and water, the Chlor-Alkali process produces chlorine, sodium hydroxide and hydrogen (as a by-product). Both chlorine and sodium hydroxide have many industrial uses, including bleaching agents, disinfectants, insecticides, soaps and synthetic fibers. One of the most prominent uses of chlorine is to produce vinyl chloride, which is used to produce poly vinyl chloride (PVC). Chlorine can be difficult and expensive to store, so Chlor-Alkali plants are typically located close to where the chlorine is used.

In addition to producing chlorine and sodium hydroxide, a Chlor-Alkali plant may produce sodium hypochlorite and hydrochloric acid. A typical Chlor-Alkali plant consists of several operating units: Brine Treatment, Electrolysis, Chlorine Treatment, Sodium Hypochlorite Generation, Hydrogen Treatment, Hydrochloric Acid Synthesis and Caustic Concentration as shown in the following simplified process flow diagram:

Chlor-Alkali Plant Operating Units



Electrolysis is the predominant method used to convert salt and water into chlorine and sodium hydroxide. While three different electrolytic processes have been developed (Mercury Cell, Diaphragm Cell, Membrane Cell), the Membrane Cell process has emerged as the dominant technology due to its superior economic and environmental benefits and will be the focus of this brief.

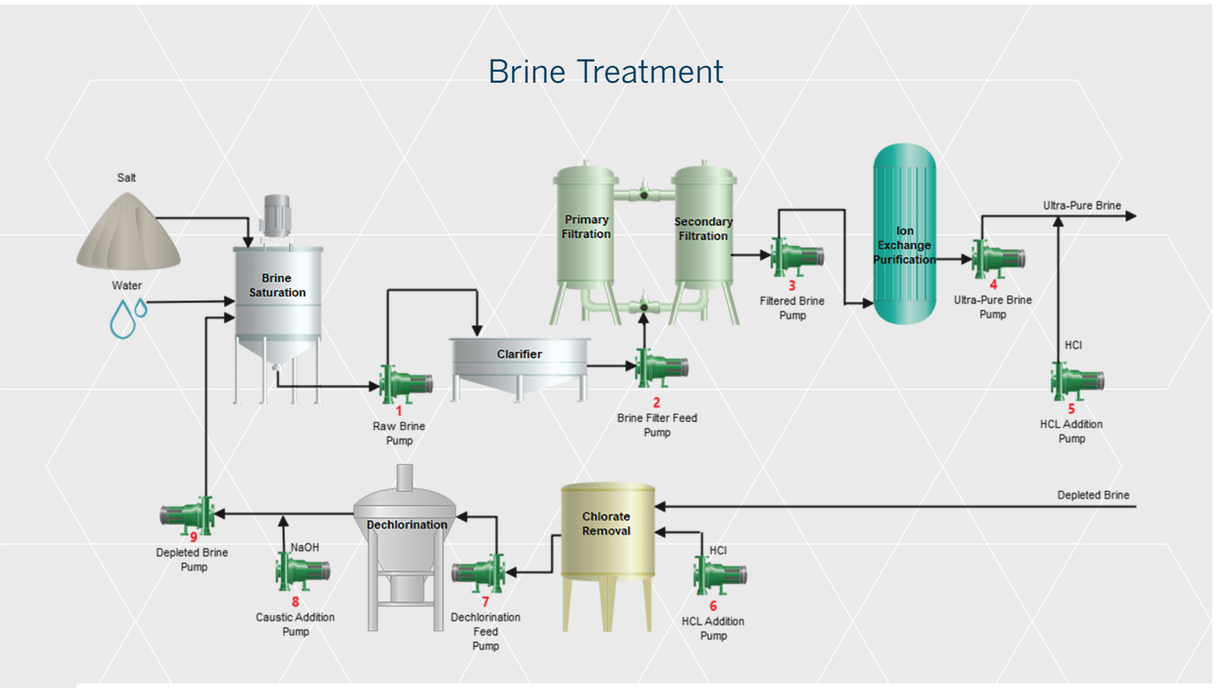
The Chlor-Alkali process is demanding on the equipment used. The liquid and gas streams are typically corrosive in nature and can be hazardous to the health & safety of plant personnel. Consequently, a Chlor-Alkali plant has a compelling need for the type of durable and reliable process equipment that Sundyne produces, most notably, sealless magnetic drive pumps (metallic and non-metallic). Please refer to Sundyne's Value Proposition document for specific feature/benefit information on these products.

In this process brief, each of the typical operating units will be discussed separately.

Brine Treatment

Salt (typically mined rock, evaporative or solar) is the primary feedstock for the brine treatment operation. However, any alternative source of salt (e.g., seawater) is acceptable. In the treatment process, salt is added to the Depleted Brine (Anolyte) coming from the Membrane Electrolysis unit. Note that prior to the salt being added to the depleted brine, the (chlorinated) depleted brine is treated with hydrochloric acid to remove any free chlorine. The salt feedstock is mixed with the dechlorinated depleted brine solution in the Saturation Tank to create the saturated (raw) brine solution.

Chemical reagents (such as soda ash, caustic soda and calcium chloride) are added to the saturated (raw) brine in a clarifier to force any impurities (such as magnesium, calcium, sulfate, iron, etc.) to precipitate out of the solution. The removal of impurities is a critical step as any impurities in the brine solution will act to shorten the life of the membrane in the electrolytic cell. After additional filtering, the saturated (purified) brine is further purified in an ion exchange vessel to produce ultra-pure brine. Hydrochloric acid may be added to the ultra-pure brine to reduce any excess chlorine ions before the ultra-pure brine is sent to the Membrane Electrolysis unit.



Pumps typically associated with the Brine Treatment unit include:

Ref#	Application	Pumped Liquid	Pump Type
1	Raw Brine Pump	Brine	ANSI/ISO
2	Brine Filter Feed Pump	Brine	ANSI/ISO
3	Filtered Brine Pump	Brine	ANSI/ISO
4	Ultra-Pure Brine Pump	Brine	ANSI/ISO
5	HCl Acid Addition Pump	Hydrochloric Acid	ANSI/ISO
6	HCl Acid Addition Pump	Hydrochloric Acid	ANSI/ISO
7	Declorination Feed Pump	Hydrochloric Acid	ANSI/ISO
8	Caustic Addition Pump	Sodium Hydroxide	ANSI/ISO
9	Depleted Brine Pump	Brine	ANSI/ISO

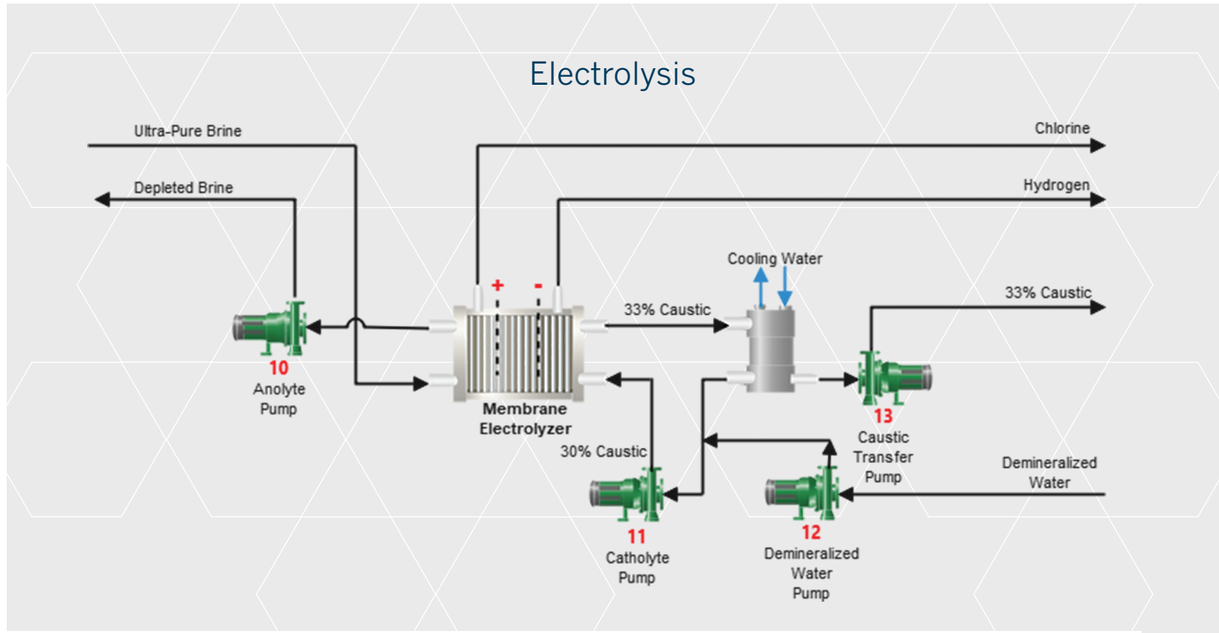
Electrolysis

The Electrolyzer is the heart of the Chlor-Alkali plant. While several electrolysis technologies exist, the membrane technology is the dominant technology because of its superior economic and environmental benefits. In the electrolyzer, two chemical reactions take place, one on each side of the non-permeable, ion-exchange membrane that divides the electrolyzer in two.

In the Anode section, the ultra-pure brine solution (from the Brine Treatment unit) is electrolyzed to produce chlorine gas at the anodes. After electrolysis, the chlorine gas exits the cell and is sent to the Chlorine Treatment unit. The depleted brine solution exits the cell and is returned to the Brine Treatment unit.

In the Cathode section, sodium ions (from the electrolysis of the brine in the Anode section) pass through the membrane and react with water in a dilute caustic soda solution at the cathode. As a result of this reaction, the concentration of the caustic soda solution is increased. Hydrogen gas is also produced by this reaction at the cathode and is widely considered as a by-product but can be used as an additional source of energy for the plant. *If the hydrogen is compressed, this could present an additional opportunity for a Sundyne PPI Compressor.*

After electrolysis, a portion of the concentrated caustic soda (catholyte) solution that exits the cell is sent to the Sodium Hypochlorite Generation unit, the Caustic Concentration unit and/or is prepared for commercial use. Water is added to balance the caustic soda solution, reducing its concentration, prior to being fed to the electrolyzer as a dilute caustic solution. The hydrogen gas produced exits the cell and is sent to the Hydrogen Treatment unit.



Pumps typically associated with the Membrane Electrolysis unit include:

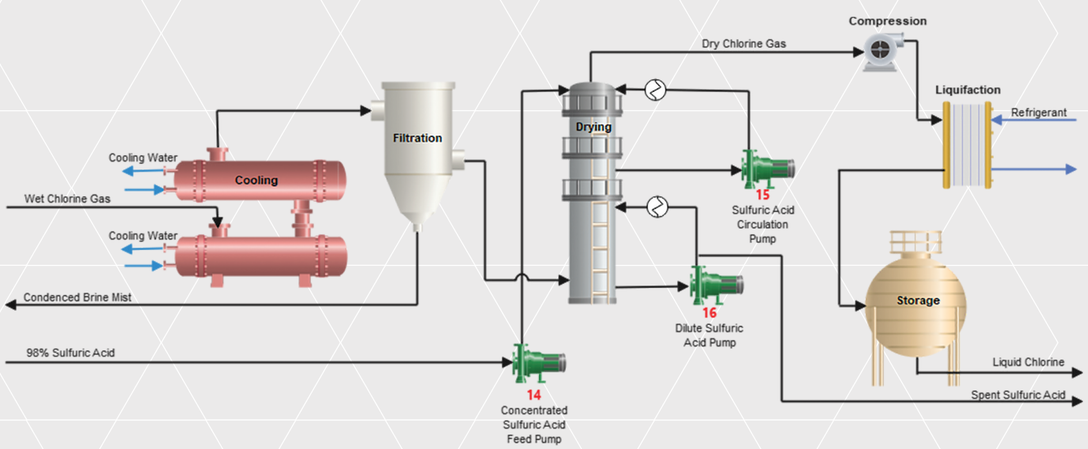
Ref#	Application	Pumped Liquid	Pump Type	Application Note
10	Anolyte Pump	Chlorinated Brine	ANSI/ISO	Highly Corrosive
11	Catholyte Pump	30% Sodium Hydroxide	ANSI/ISO	
12	Demin. Water Pump	Demineralized Water	ANSI/ISO	
13	Caustic Transfer Pump	33% Sodium Hydroxide	ANSI/ISO	

Chlorine Treatment

In the Chlorine Treatment unit, hot (wet) chlorine gas from the Electrolysis unit is treated in three steps prior to compression and liquefaction. The chlorine gas is:

1. Cooled in a series of heat exchangers;
2. Filtered to remove any brine mist that may have carried over from electrolysis;
3. Dried with sulfuric acid in a series of packed columns to remove any water.

Once dried, the dry chlorine gas is compressed and liquefied (cooled) for storage and transport. Because of the very unique manufacturing requirements for dry chlorine gas compression, this service is not an application for Sundyne Compressors.



Pumps typically associated with the Chlorine Treatment unit include:

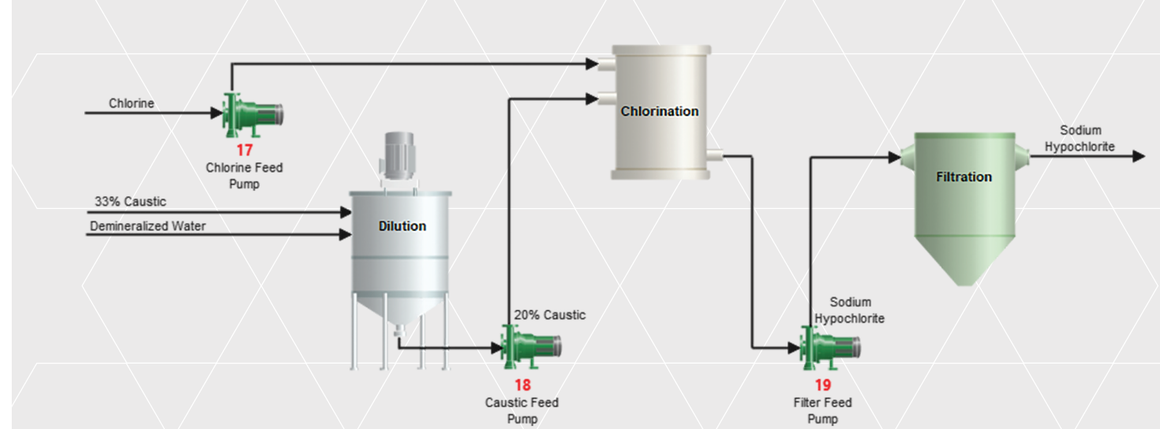
Ref#	Application	Pumped Liquid	Pump Type
14	Conc. Sulfuric Acid Pump	98% Sulfuric Acid	ANSI/ISO
15	Sulfuric Acid Circ. Pump	Sulfuric Acid	ANSI/ISO
16	Dilute Sulfuric Acid Pump	Dilute Sulfuric Acid	ANSI/ISO

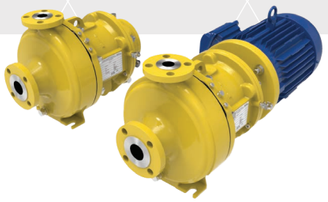
Sodium Hypochlorite Generation

The production of Sodium Hypochlorite can be performed in a batch or continuous process. Modern plants typically use the continuous process, which will be discussed here. The continuous process typically consists of 3 operations:

1. Caustic dilution;
2. Chlorination;
3. Filtration.

In the Caustic Dilution operation, sodium hydroxide (from the Electrolysis unit) is added to demineralized water to produce a dilute 20% caustic solution. In the chlorination operation, liquid chlorine (from the Chlorine Treatment unit) is reacted with the dilute sodium hydroxide in a packed tower to produce sodium hypochlorite. Any suspended impurities (such as sodium chlorate) are removed during a filtering operation. Once filtered, the sodium hypochlorite is cooled and prepared for commercial use.





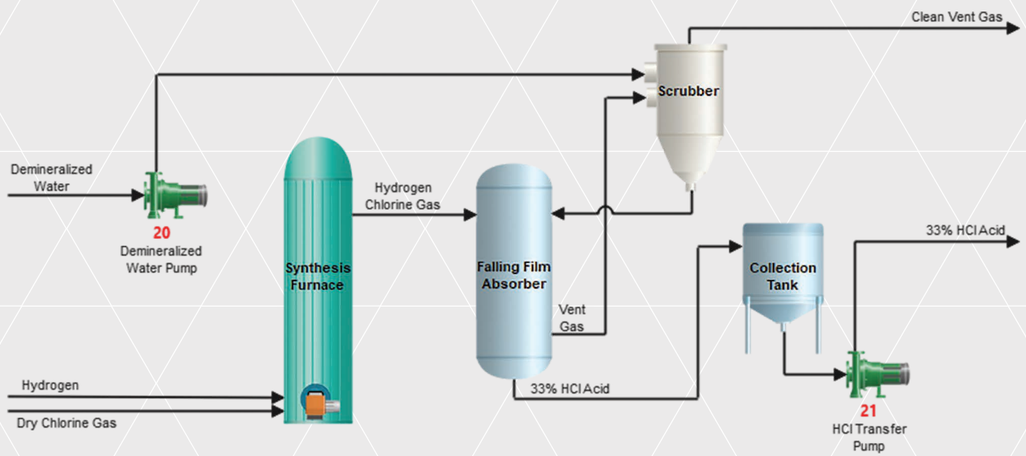
Pumps typically associated with the Sodium Hypochlorite Generation unit include:

Ref#	Application	Pumped Liquid	Pump Type	Application Note
17	Chlorine Feed Pump	Chlorine	ANSI/SO	Fluoropolymer Construction
18	Caustic Feed Pump	20% Sodium Hydroxide	ANSI/ISO	
19	Filter Feed Pump	Sodium Hypochlorite	ANSI/ISO	Fluoropolymer Construction

Hydrochloric Acid Synthesis

The Hydrogen produced in the Electrolysis unit (as a by-product of the Chlor-Alkali reaction) can be used either as a plant fuel source or as a raw material in the production of Hydrochloric Acid. To produce hydrochloric acid, hydrogen (after treatment) and dry chlorine gas (from the Chlorine Treatment unit) are fed into a synthesis furnace where hydrogen chlorine gas is produced. The hydrogen chlorine gas is subsequently fed to a (falling film) reactor, where it is absorbed into demineralized water to produce 33% hydrochloric acid. The hydrochloric acid flows by gravity into a storage tank that typically sits below the reactor. Vent gas left over from the combustion process is sent to a scrubber (packed tower) where any remaining hydrogen chloride gas is absorbed into demineralized water.

Hydrochloric Acid Synthesis



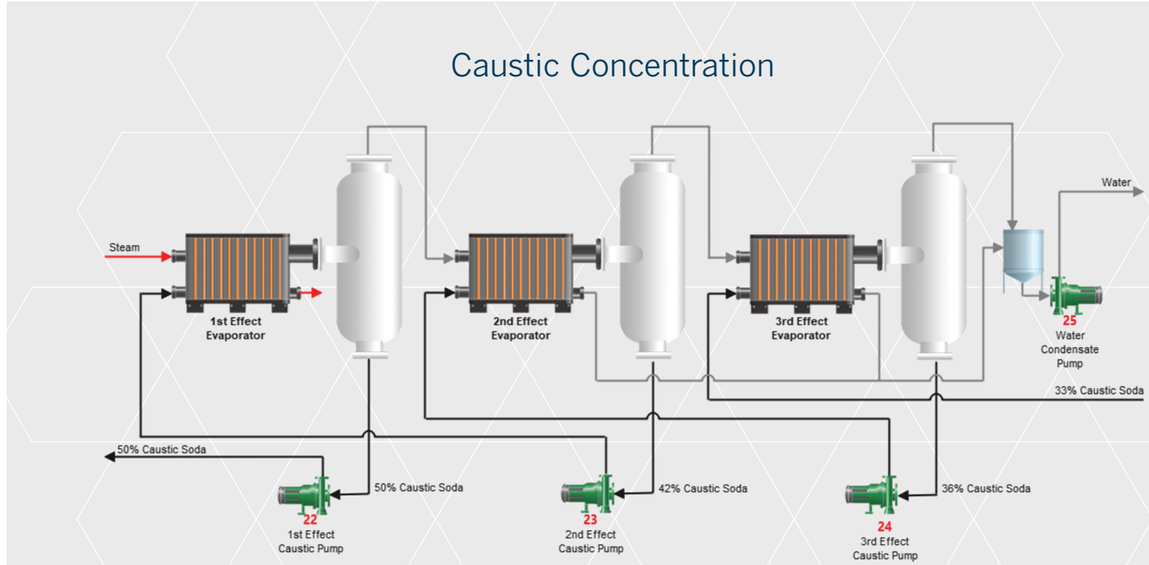
Pumps typically associated with the Hydrochloric Acid Synthesis unit include:

Ref#	Application	Pumped Liquid	Pump Type
20	Demineralized Water Pump	Demineralized Water	ANSI/ISO
21	HCl Transfer Pump	33% Hydrochloric Acid	ANSI/ISO

Caustic Concentration

Catholyte (32% Caustic Soda) coming from the Electrolysis can either be prepared for commercial use or further concentrated through an evaporation process. To produce concentrated (50%) caustic soda, 32% caustic soda (from the Electrolysis unit) is sent to a series of (three) multi-effect evaporators. The concentration of the caustic soda is gradually increased with each evaporation step to eventually produce a 50% caustic solution (lye).

Caustic Concentration



Pumps typically associated with the Caustic Concentration unit include:

Ref#	Application	Pumped Liquid	Pump Type	Application Note
22	1st Effect Caustic Pump	50% Caustic	ANSI/ISO	Operates Under Vacuum
23	2nd Effect Caustic Pump	2% Caustic	ANSI/ISO	Operates Under Vacuum
24	3rd Effect Caustic Pump	36% Caustic	ANSI/ISO	Operates Under Vacuum
25	Water Condensate Pump	Water	ANSI/ISO	

Criteria for Selecting Pumps Used in Chlor Alkali Units

Chlorine, Sodium Hypochlorite and Hydrochloric Acid are reactive elements that are toxic and corrosive. They should not be inhaled by plant personnel, even at low concentrations. Operators should consider the following requirements when selecting pumps for Chlor-Alkali production:

Worker Safety & Environmental Protection by Eliminating Leakage:

External emissions are one of the biggest issues relating to pumping equipment used in Chlor-Alkali production. Sealless pumps are typically used to move materials through each stage of production. Sealless pumps have no seals to replace, which means fewer (or no leaks) and no emissions.

Reliability via Superior Chemical Resistance:

Materials of construction for a pump's internals must be carefully considered. The harsh nature of Chlor-Alkali production can wreak havoc on a pumps internals. Many of the chemical catalysts used in the process (such as sulfuric acid to dry moist chlorine gas) add further demands on pump linings. A wide range of metallic and ETFE materials of construction should be available.

Simplified Maintenance:

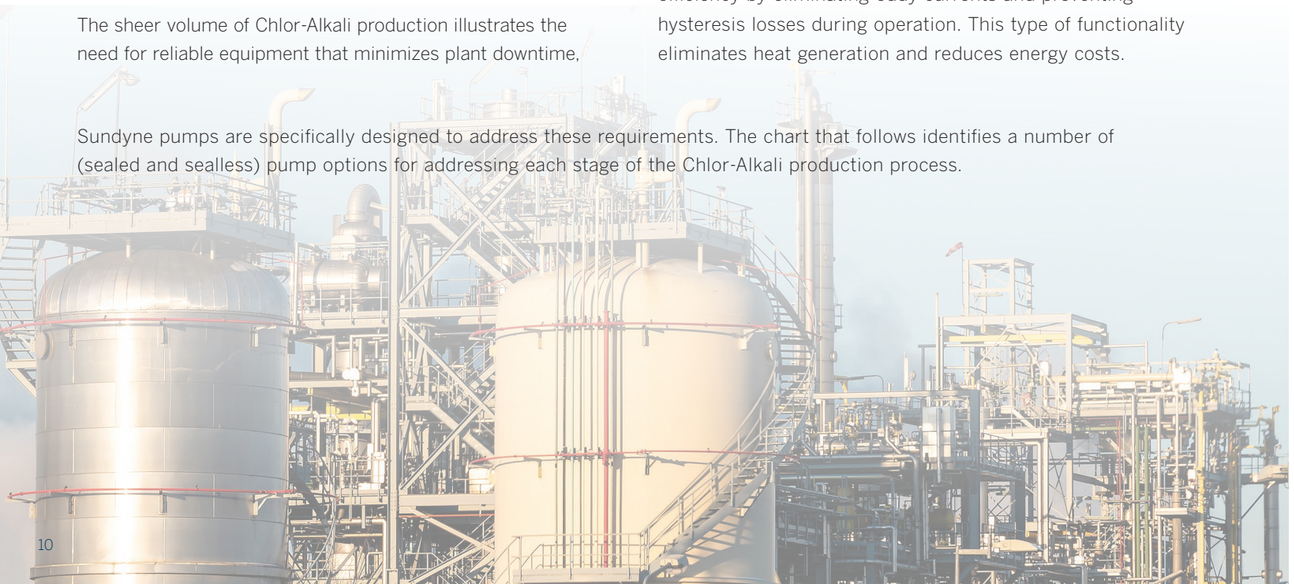
The sheer volume of Chlor-Alkali production illustrates the need for reliable equipment that minimizes plant downtime, as many plants producing these chemicals run operations around the clock.

The ability to streamline maintenance (and plan predictive maintenance activities) helps operators increase plant uptime. Sealless pumps eliminate the need for seal support systems, and they have fewer wetted parts, which minimizes maintenance costs and increases Mean Time between Maintenance (MBTM) intervals.

Energy Efficiency:

Electrolysis and Chlor-Alkali production are energy-intensive processes. Electricity can account for 40 to 50 percent of operating costs. In many cases, the ability to manage this expense determines the plant's profitability. Plants producing Chlor-Alkali should seek pumps with an efficient hydraulic envelop and low net positive suction head (NPSH) hydraulics. Small footprints are always preferred, not only to save space on the shop floor, but also to facilitate simple access for maintenance. And features such as a rear casing can bolster efficiency by eliminating eddy currents and preventing hysteresis losses during operation. This type of functionality eliminates heat generation and reduces energy costs.

Sundyne pumps are specifically designed to address these requirements. The chart that follows identifies a number of (sealed and sealless) pump options for addressing each stage of the Chlor-Alkali production process.



Chlor-Alkali Plant Pump Summary

						Sundyne Pumps		
Equip No	Unit	Application	Liquid	Pump Type	Construction[1]	ETFE Lined Mag Drive	Metallic Mag Drive	Metallic Sealed
1	Brine Treatment	Raw Brine Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
2	Brine Treatment	Brine Filter Feed Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
3	Brine Treatment	Filtered Brine Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
4	Brine Treatment	Ultra-Pure Brine Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
5	Brine Treatment	HCl Acid Addition Pump	Hydrochloric Acid	ANSI / ISO	ETFE	Ansimag K+/KI HMD Kontro ALI		
6	Brine Treatment	HCl Acid Addition Pump	Hydrochloric Acid	ANSI / ISO	ETFE	Ansimag K+/KI ,HMD Kontro ALI		
7	Brine Treatment	Declorination Feed Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
8	Brine Treatment	Caustic Addition Pump	Sodium Hydroxide	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
9	Brine Treatment	Depleted Brine Pump	Brine	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
10	Electrolysis	Anolyte Pump	Chlorinated Brine	ANSI / ISO	ETFE	Ansimag K+/KI HMD Kontro ALI		
11	Electrolysis	Catholyte Pump	30% Sodium Hydroxide	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
12	Electrolysis	Demineralized Water Pump	Demineralized Water	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
13	Electrolysis	Caustic Transfer Pump	33% Sodium Hydroxide	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
14	Chlorine Treatment	Concentrated Sulfuric Acid Pump	98% Sulfuric Acid	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
15	Chlorine Treatment	Sulfuric Acid Circulation Pump	Sulfuric Acid	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
16	Chlorine Treatment	Dilute Sulfuric Acid Pump	Dilute Sulfuric Acid	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
17	Sodium Hypochlorite Generation	Chlorine Feed Pump	Chlorine	ANSI / ISO	ETFE	Ansimag K+/KI HMD Kontro ALI		
18	Sodium Hypochlorite Generation	Caustic Feed Pump	20% Sodium Hydroxide	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
19	Sodium Hypochlorite Generation	Filter Feed Pump	Sodium Hypochlorite	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
20	Hydrochloric Acid Synthesis	Demineralized Water Pump	Demineralized Water	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO
21	Hydrochloric Acid Synthesis	HCl Transfer Pump	33% Hydrochloric Acid	ANSI / ISO	ETFE	Ansimag K+/KI HMD Kontro ALI		
22	Caustic Concentration	1st Effect Caustic Pump	42% Caustic	ANSI / ISO	316SS		HMD Kontro CSA/I	Marelli ISO
23	Caustic Concentration	2nd Effect Caustic Pump	36% Caustic	ANSI / ISO	316SS		HMD Kontro CSA/I	Marelli ISO
24	Caustic Concentration	3rd Effect Caustic Pump	32% Caustic	ANSI / ISO	316SS		HMD Kontro CSA/I	Marelli ISO
25	Caustic Concentration	Condensate Water Pump	Water	ANSI / ISO	ETFE / 316SS	Ansimag K+/KI HMD Kontro ALI	HMD Kontro CSA/I	Marelli ISO

[1] Construction materials referenced are a sample of the materials commonly specified in pump data sheets. Sundyne, LLC does not warrant the suitability of these (or any) materials in a particular service or application. Suitability is the sole responsibility of the purchaser and/or user.

When it comes to Chlor-Alkali applications, Sundyne is the **Safer, Better, Best** choice.

Safer for Operations
Better for the Environment
Best Total Lifecycle Value

For more information please visit www.sundyne.com and fill out the Contact Me form. A Sundyne representative will contact you.

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