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Chlor-Alkali: State of the Market 2020

Chlorine, sodium hydroxide, vinyl chloride and the rest are made possible through the chlor-alkali process, a chemical reaction.

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INTRODUCTION

For most people, the chlor-alkali process is most closely associated with the scent of clean pools and the chlorine found therein. But the chlor-alkali process is so much bigger than that: It is part of a well-established market, one of the world's largest chemical processing industries, and is poised for continued growth.

Globally, the chlor-alkali market was valued at $97 million in 2017 and is slated to grow at a CAGR of 5.1% through 2023. 360 Market Updates predicts that the market will increase, reaching a value of $131.1 million by the end of 2023.(1)

At a national level, more than 20,000 Americans are directly employed by the industry and another 245,000 are employed by chlor-alkali related industries.(2) As the demand for petrochemicals continues to rise, so does the significance of the chlor-alkali market.

THE BIG FIVE: WHAT'S THE BIG DEAL WITH THE CHLOR-ALKALI PROCESS

The chlor-alkali industry is responsible for producing five major chemicals:

- Chlorine
- Sodium hydroxide and potassium hydroxide
- Sodium hypochlorite
- Vinyl chloride monomer
- Hydrogen chloride

Each of these products is included in the chlor-alkali market, with all five chemicals used in various applications across the country.

1. Chlorine, arguably the most readily known of the five, is best celebrated for keeping pools sanitary and healthy. More importantly, it is also used to clean 98% of drinking water in the United States.

2. Sodium hydroxide and potassium hydroxide can be used interchangeably. The bulk of these chemicals are used to manufacture a wide range of items including detergent, aluminum products, and paper. Food-grade sodium hydroxide is used on German pretzels to give them a unique, crisp crust.

3. Sodium hypochlorite, more commonly known as bleach, can be found under bathroom sinks around the world. Before being made available for purchase, sodium hypochlorite is diluted in a liquid solution, resulting in the pungent household cleaner found in a bottle of bleach.

4. Vinyl chloride, or sometimes vinyl chloride monomer, is not a final product. On its own, it is an unstable and hazardous material that would pose a serious health risk. Instead, it is converted from a vinyl chloride monomer to a vinyl chloride polymer, or polyvinyl chloride, more commonly known as PVC. PVC plastic is the third-most produced synthetic plastic, with roughly 40 million tons made every year.

5. Hydrogen chloride is made when hydrogen is combined with the pure chlorine gas that is produced during the chlor-alkali process—a feat achieved when completing the reaction in the presence of a UV light. Most hydrogen chloride is used in the production of hydrochloric acid, an inorganic compound used in industrial processes.

Combined, these five chemicals are integral to a staggering amount of day-to-day life. Through the chlor-alkali process, we are provided with clean drinking water, paper, laundry detergent, bleach, PVC plastics, and various other products.

With all this at stake, it's easy to see why the chlor-alkali market is one to watch.

CHLOR-ALKALI

STATE OF THE MARKET IN 2020

The chlor-alkali industry produces five major chemicals used in a variety of applications.

CHLORINE

- Keeps swimming pools healthy by killing bacteria
- Used to disinfect 98% of drinking water in the U.S.
- Used in various industrial applications such as in the production of plastics, paper products, medicines, antiseptics, solvents and paints

SODIUM HYDROXIDE

- Used to manufacture disinfectant products
- Used in the manufacturing of pharmaceuticals and medicines from aspirin to cholesterol-reducing drugs
- Used in food processing applications such as curing foods and as an ingredient in food preservatives

SODIUM HYPOCHLORITE

- Extensively used as a bleaching agent in the textile, detergents, and paper and pulp industries
- In the petrochemical industry, it is used to refine petroleum products
- Used in food processing to sanitize food preparation equipment

VINYL CHLORIDE

- Used in the manufacture of polyvinyl chloride (PVC) pipes, wire coatings, vehicle upholstery, and plastic kitchen-ware
- Used in a variety of other applications including construction, health care, and electronics

HYDROGEN CHLORIDE

- Hydrogen chloride has many uses including cleaning, pickling, electroplating metals, tanning leather, refining, and in the production of many products such as hydrochloric acid

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QUICK CHEMISTRY: UNDERSTANDING THE PROCESS

Chlorine, sodium hydroxide, vinyl chloride and the rest are made possible through the chlor-alkali process, a chemical reaction. The process begins with sodium chloride—or salt, to the non-scientist—which is made into a salt-water solution called brine. The brine is charged with electricity, which forces the sodium and chloride to separate, resulting in sodium hydroxide, hydrogen, and chlorine. Using these byproducts, manufacturers can make sodium hydroxide, vinyl chloride, and hydrogen chloride.

ENERGETIC CHALLENGES

The chlor-alkali process requires a great deal of energy—the reaction itself is an electrolysis, meaning that… Producing these chemicals at a large scale consumes a lot of electricity, making energy prices one of the greatest expenses in the process, amounting to as much as 70% of the variable cost.(3)

Consequently, changes in the cost of electricity impact the cost of production and influence the future of the industry. If the cost of electricity continues to rise in Europe and North America, the chlor-alkali market is likely to migrate to other parts of the world where energy is cheaper.

Ironically, the chlor-alkali market plays a large role in the production and efficient use of energy. Wind turbine blades, insulation materials, and energy-saving LEDs are all products of the industry. Without the chlor-alkali industry, green-energy technology would come to a halt.

Reinventing the Process

Until recently, manufacturers struggled to control the chlor-alkali process. The reaction itself results in a byproduct of hydrogen and hydroxide ions, which need to be separated from the other elements to prevent further reactions. Historically, this has been accomplished through challenging and inefficient methods. In fact, the traditional methods involve either mercury or asbestos, making them not only inefficient, but hazardous.

But with the help of innovative technology, chemical plants are able to separate the unwanted leftovers using a semi-permeable fabric, or membrane, safely removing the unwanted ions. The chlor-alkali process is now cleaner, safer, and eco-friendlier.

Learn about the membrane from textechindustries.com

THE INDUSTRY

The chlor-alkali industry is broken down into three distinct business types. Each has its own set of data, including incident reports and market tracking.

- **Producers** are facilities that produce, ship, sell, or use chlorine internally when creating other products.
- **Sodium hypochlorite manufacturers** produce sodium hypochlorite by using chlorine that was produced outside of the facility.
- **Packagers** receive chlorine in bulk. Their task is to package the product into smaller containers for sale.

The Chlorine Institute publishes monthly statistics and production reports on producers and sodium hypochlorite manufacturers, which is available by online subscription. Euro Chlor has a similar program available for those interested in the European market.

A wide range of industries—from pharmaceuticals, to water treatment, to crop protection—depend on the chlor-alkali process, making it difficult to truly value the scope and power of the industry. A 2016 economic study found that chlor-alkali chemistry **saved consumers** in the U.S. and Canada more than **$421.5 billion annually**.(4) For example, there are available alternatives to the chlor-alkali

water treatment process, but many of these technologies require new systems to be constructed and the increase in cost would be passed on to consumers.

A FEW MAJOR PRODUCERS

The United States is home to several of the world's top producers, including(5):

- Axiall Corporation, A Westlake Company, Houston, TX
- Occidental Chemical Corporation, Houston, TX
- Olin Corporation, Clayton, MO

Outside of the U.S., some of the biggest producers are:

- AkzoNobel, Amsterdam, Netherlands
- Tata Chemicals, Mumbai, India
- Solvay S.A., Brussels, Belgium

REGULATIONS AND SAFETY

Because the chlor-alkali industry deals with some hazardous chemicals, producers, packagers, and manufactures follow market regulations created and enforced by governing entities.

Producers, Packagers, and Sodium Hypochlorite Manufacturers

The official governing agencies for plants, producers, packagers, and manufacturers in America are the Occupational Safety and Health Administration, the Environmental Protection Agency, and occasionally the Food and Drug Administration. Chlorine

What are Euro Chlor and the Chlorine Institute, anyway?

Euro Chlor and the Chlorine Institute are trade associations whose goal is to educate, support, and advocate for the chlor-alkali industry. They work to make the chlor-alkali industry safe, sustainable, and successful by self-regulating and sharing best practices.

As its name suggests, Euro Chlor is located in Europe and represents chemical companies across the continent. Any European-based chlor-alkali producer is welcome to join their community of 39 members.

The Chlorine Institute is based in the United States but welcomes members from outside its borders. Their 200 members are located in the U.S., Canada, Japan, Mexico, and additional international locations.

Both associations are globally respected and considered authorities on the chlor-alkali industry.(6, 7)

process plants in the U.S. generally look to the Chlorine Institute's informational pamphlets for compliance, which list preferred materials, construction features, and recommended safety guidelines.

Transporting

Because chlorine can be transported by boat, truck, pipe, or rail, transporting is regulated by a host of governing agencies in North America. These agencies include: The U.S. Department of Transportation, the Federal Railroad Administration, the American Association of Railroads, and the Pipeline and Hazardous Materials Safety Administration (PHMSA).

In Europe, the majority of chlorine is moved by pipeline, with rail and road amounting to little more than 5% of transportation. In contrast, more than two-thirds of American chlorine is used in the same manufacturing plant where it was produced—no need to transport at all. Roughly 21% of liquefied chlorine is transported by truck, rail, or barge.(8) There are about 22 miles of chlorine pipeline being regulated by PHMSA.

TRANSPORTATION CHALLENGES

In comparison with other hazardous chemicals, the incident rate for rail transportation of chlorine is low. In 2016, chlorine made up only 0.87% of all hazardous materials rail incidents.(9) There have been occasional train collisions and equipment failures that have resulted in chlorine exposure. In 2002, for example, a transfer hose ruptured, releasing 48,000 pounds of chlorine into the surrounding environment.

In 2016, a rail tank car ruptured, releasing 178,400 pounds of chlorine and prompting an investigation by the National Transportation Safety Board. Their inquiry concluded in February of 2019, resulting in new safety recommendations for chlorine transport. These recommendations include prohibiting use of tank cars not constructed of steel that meets the highest available fracture toughness specifications when transporting hazardous materials, as well as stricter maintenance guidelines.(10)

PETROCHEMICALS: A MARKET ON THE RISE

One-time-use plastics are on the way out, but the same doesn't hold true for durable performance plastics. These plastics perform well despite withstanding hundreds of uses and extreme conditions. They form daily objects like mobile phones and tablets, but also large-scale items like airplane parts and heavy machinery. Anyone who has been sick or hospitalized owes a debt of gratitude to performance plastics, as everything from incubators to joints for hip-replacements are created with these reliable materials.

There is also an argument for the environmental benefit of performance plastics. Because they are made to last, products and tools from performance plastics have a longer lifespan than other materials like wood or glass. They require less maintenance and repairs, which cuts down on carbon emissions. Additionally, these kinds of plastics are rarely wasted, as they can be recycled, ground up, and made into something new.(11)

What does any of this have to do with the chlor-alkali process?

Everything, as it turns out.

Dixon, A Transportation Ally

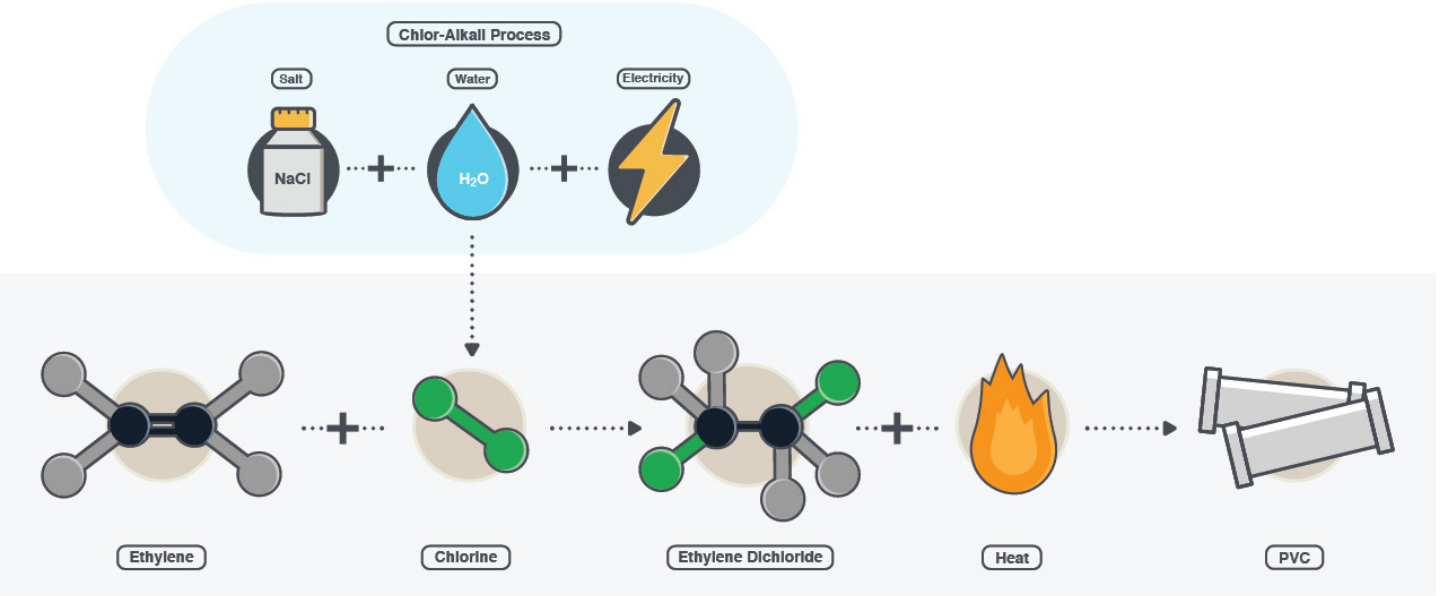
Dixon has provided the chemical processing industry with reliable, high-quality connections for various chemical needs for decades, and the chlor-alkali industry is no exception. Dixon's angle valve for chlorine rail cars has been trusted on North American railways for more than 15 years making it an ideal choice for the industry. Its bellows sealed valve helps eliminate unwanted emissions, preventing waste and harmful atmospheric conditions.

PETROCHEMICALS AND THE CHLOR-ALKALI PROCESS

Performance plastics are made from petrochemicals, which is a broad term for chemicals made from petroleum, fossil fuels, or sometimes renewable sources like corn or sugarcane. PVC plastic—or polyvinyl, number four on our list of chlor-alkali chemicals—is a petrochemical performance plastic.

PVC is made through a series of chemical reactions, one of which requires the chlor-alkali process. It starts with chlorine, which is reacted with ethylene. Ethylene, found in natural gas and crude oil, is what makes PVC a petrochemical.

Once the ethylene and chlorine have reacted to form dichloroethane, or ethylene dichloride, the ethylene dichloride is heated in a process called thermal cracking. This produces vinyl chloride monomer (number four on the list of chlor-alkali chemicals), which is then polymerized to form PVC.



CHANGES UNDERWAY

In 2015, PVC was the fifth most-produced plastic at 38 million tons.(12) Now, with experts predicting a change in the oil market, that number is expected to grow.

The International Energy Association expects the percentage of oil being used in transportation to peak in 2025.(13) After that, as more and more people switch to electric energy, that number will start to drop, and oil companies will shift their attention to petrochemicals. Indeed, they've already started.

Gulf states Louisiana and Texas have been approved to build 31 new petrochemical projects, and big oil companies like Shell have already invested in major petrochemical plants.(14, 15) Through a chemical process known as cracking, more hydrocarbons will be used to create ethylene and other petrochemicals instead of fuels, which will mean direct growth for the chlor-alkali industry—after all, you can't make PVC without chlorine and ethylene.

In 2019, the PVC market was estimated to be worth $41.4 billion. Growing at a rate of 3.8 percent CAGR until 2023(15), the PVC market shows no sign of slowing down, which is nothing but good news for the chlor-alkali industry.

OVERALL PREDICTION: GROWTH

All signs point to continued growth for the chlor-alkali market. As technology advances, so does the chlor-alkali industry: a reinvented membrane makes the chemical process safer and simpler, improved transportation equipment lowers accident risk, and increased supply of ethylene causes more demand for chlor-alkali products.

Chlor-alkali seems to have technology on its side.

No one can predict the future, but the chlor-alkali industry looks to be slated for steady growth for years to come, providing jobs, plastics, soaps, pharmaceuticals, clean water, and so much more for the world.

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