ADAO Chlor-Alkali Industry Report

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With Congress considering the Alan Reinstein Ban Asbestos Now Act of 2019 (S.717 and H.R.1603), focus has shifted to the chlor-alkali industry, which is the sole importer and user of raw asbestos in the United States. This report compiles publicly available information on the industry's asbestos imports, the role of asbestos in producing chlorine and caustic soda, the move away from the asbestos diaphragm process and growing adoption of membrane technology, the economic and energy benefits of the membrane process and the minimal environmental footprint of that process as compared to other asbestos and non-asbestos chlor-alkali production methods. This information demonstrates that the membrane process is widely deployed in the chlor-alkali industry in the US and globally, offers economic and energy advantages and is preferable environmentally.

Who imports and uses raw asbestos in the United States?

According to the U.S. Geological Survey (USGS), the chlor-alkali industry is the only sector currently importing and using raw asbestos, although a number of products containing asbestos continue to be imported into the U.S.

How much raw asbestos is imported annually by the chlor-alkali industry?

USGS reports that, in 2018, 750 tons of asbestos was imported into the U.S. by this industry.

Where is the raw asbestos used by the industry produced?

Asbestos is no longer mined in the U.S., Canada and other countries. According to USGS, the raw asbestos imported by the chlor-alkali industry has come predominantly from Brazil and, to a much lesser extent, Russia. However, Brazil is ceasing to mine asbestos, leaving Russia, Kazakhstan and China as the only sources of supply.

What products does the chlor-alkali industry produce?

Since the 19th century, the chlor-alkali industry has produced chlorine and caustic soda.

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How are chlorine and caustic soda produced?

The chlor-alkali process starts with brine, which is water with a high concentration of salt (sodium chloride), typically seawater or brackish water from underground sources. A powerful electrolytic reaction splits the sodium chloride in the brine into chlorine gas and sodium, and then reacts the sodium with water to form sodium hydroxide (the "alkali" part of the term, "chlor-alkali"), commonly known as caustic soda.

There are three primary electrolytic processes for producing chlorine and caustic soda: the diaphragm cell process, the mercury cell process, and the membrane cell process. The first two have been used for over 100 years and are the most harmful environmentally because of their use of asbestos and mercury. The membrane cell process does not use these hazardous chemicals and has a considerably smaller environmental footprint. This process was developed 60 years ago and has been deployed extensively in the last three decades.

Use of the mercury cell process has sharply declined in response to global concerns about the health and ecological impacts of mercury. The few remaining plants are expected to be shut down in the near future.

In some cases, plants using asbestos diaphragms have converted to non-asbestos diaphragms, which are less costly than membrane cells but lack the other benefits of the membrane technology.

How is chlorine used?

According to the industry, approximately 40 percent of chlorine produced in the United States is used to make polyvinyl chloride (PVC or vinyl), a plastic with numerous applications. Another 37 percent of chlorine produced in the US is used to produce basic organic chemicals needed for manufacturing, and solvents for metalworking, dry cleaning, and electronics. Other large uses include producing hydrochloric acid for various chemical processes and titanium dioxide, a white pigment. While perhaps best known for its role in assuring clean drinking water, only four percent of total chlorine production is used for this purpose. The amount of chlorine used by the pharmaceutical industry is likewise relatively small.

How much chlorine is produced in the United States?

According to the Chlorine Institute statistics, in 2017, the U.S. chlor-alkali industry produced 12.3 million short tons of chlorine and 13 million short tons of caustic soda (sodium hydroxide).

What are the annual sales revenues of the chlor-alkali industry?

The U.S. chlor-alkali industry reports annual sales of over $8 billion.

Is chlorine production increasing or decreasing?

U.S. production of chlorine has been declining for some time. According to the Chlorine Institute, production in the US peaked in 2000 at over 14.057 million metric short tons. In 2017, the industry produced 12.3 million short tons of chlorine, a decline of 12.5% from 2000.

How many chlor-alkali plants are there in the United States?

According to the Chlorine Institute, there are currently 44 operating chlorine plants in the United States.

How many chlor-alkali plants in the United States use asbestos diaphragms?

The Chlorine Institute identifies 15 US chlor-alkali plants currently using asbestos diaphragms. These plants are owned by four companies -- Occidental Chemical Corporation, Olin Corporation, SABIC and Westlake Chemical Corporation.

How many chlor-alkali plants in the United States do not use asbestos diaphragms?

According to the Chlorine Institute, there are 27 U.S. chlor-alkali plants using alternative methods of production. The membrane process is the most common non-asbestos technology; a small number of plants use non-asbestos diaphragm and mercury cell processes.

What percent of global chlorine production is based on asbestos diaphragm processes?

There is only one chlor-alkali plant in the European Union currently uses this technology and it plans to convert to non-asbestos diaphragms by 2025. Since 1983, at least 20 plants outside the U.S., with a combined 3 million tons per year capacity, have converted from asbestos diaphragms to other technologies.

What is the rate of conversion away from the asbestos diaphragm process in the US?

According to an analysis performed for EPA, as of mid-1985, seventy-seven percent of the U.S. industry's total chlorine capacity was in electrolytic cells equipped with asbestos diaphragms and 30 plants used the asbestos process. Since that time, chlorine production capacity using asbestos diaphragms has declined significantly and 50 percent of the plants using this process have closed or undergone conversion According to the Chlorine Institute, 28 membrane cell units have been constructed in the US, including at some plants that continue to use the asbestos diaphragm process. The earliest membrane units were built in the 1980s, with significant scale-up of the technology starting in the late 1990s through the present. The many conversions that have occurred have not impacted the price and supply of chlorine.

What are the benefits from switching from asbestos diaphragms to the membrane process?

According to a 2014 European Union (EU) report, "[t]he consumption of electrical energy of the membrane cell technique is the lowest and the amount of steam needed for concentration of the caustic solution is moderate, resulting in the lowest total energy consumption." As an example of energy savings, the report points to the INEOS ChlorVinyls plant (formerly Norsk Hydro) in Rafnes (Norway), where conversion to the membrane process led to a reduction in electricity consumption of almost 15% and in steam consumption of approximately 65%." Stein Raae, an industry analyst, notes how important energy savings are in the economics of chlor-alkali production. "Chlor-alkali production is hugely energy intensive -- one plant can consume as much electricity as a small country -- and power accounts for approximately 70% of chlor-alkali variable costs."

In support of Canada's recent decision to ban asbestos, it examined the costs and benefits of requiring the country's only chlor-alkali plant using the asbestos diaphragm process to convert to membrane technology. The Canadian analysis found that, after taking into account the costs of conversion and the energy savings of the membrane process, "it is expected that the chlor-alkali industry would see operating cost savings of approximately $287 million between 2026 and 2035, with total net cost savings of about $168 million over the time frame of analysis."

How much asbestos waste is generated at chlor-alkali plants using asbestos diaphragms?

Asbestos diaphragms and their parts are periodically replaced and disposed of as waste or refurbished. Several landfills receive asbestos waste from chlor-alkali plants. Additional waste from the asbestos diaphragm process is managed on site. Based on reports submitted for the Toxic Release Inventory (TRI) in 2017, total asbestos releases for 2017 were 20,556,023 pounds, the bulk of which (92.8%) were on-site land releases. Asbestos releases in earlier years were comparable in magnitude. Examination of TRI reports indicates that chlor-alkali plants accounted for a sizable portion of these releases.

Wastewater discharges from chlor-alkali production are also a source of asbestos waste. "A significant quantity of asbestos is present in the water released from a diaphragm cell plant, which originates from wash down and cell repair or cleaning. Asbestos from cell wash operations and precipitated solids from metal treatment generate a solid waste of 0.83 kilogram per ton (kg/t) of chlorine," noted Aziz et al in Waste Treatment in the Service and Utility Industries. "Filter cake" collected from wastewater is then sent to a landfill or managed on-site.

What are the health and environmental impacts of the membrane cell process?

Membranes are made from Polytetrafluoroethylene (PTFE) co-polymers and similar fluoropolymers. These polymers are high molecular weight solids that are stable and inert except under elevated temperatures. They are known for their high strength and non-reactivity. Because of these properties, membranes are non-toxic under expected workplace conditions. As a result of their chemical and thermal stability, they do not decompose or biodegrade during disposal or generate hazardous waste. The fluoropolymers used for electrolytic cells in the chlor-alkali industry have a broad range of established industrial applications.

According to DOE, "[m]embrane cells are the most environmentally benign of all the cell technologies." In its Environmental Guidelines for the Chlor-alkali Industry, the World Bank recommends that investors "give preference to the membrane process" based on its "economic and environmental advantages," the absence of hazardous waste and significantly lower wastewater generation.