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REVIEW

The chlor-alkali process: *Work in Progress*

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Abstract The chlor-alkali process has come a long way from the days of the diaphragm and mercury cell process to the present membrane cell process, with huge reduction in power consumption and hence its carbon footprint. Although there is reduction in the release of highly toxic mercury to the environment, there is increased release of less harmful substances such as chloride and chlorate because the membrane cell is less tolerant to contaminants, and hence requires higher purity brine. The technology providers have continued to improve upon the process to reduce power consumption and to reduce the plant's footprint. This review looks briefly at the three technologies and attempts to look at where we currently are at. All new chlor-alkali plants being built are of the membrane process. This review mentions some of the areas where improvements can be made to the membrane process.

Keywords Chlor-alkali · Chlorate · Membrane cell · Oxygen depolarised cathode

Introduction

The chlor-alkali industry generally refers to the industry that produces chlorine and sodium hydroxide (an alkali), hence the term chlor-alkali (Environment Canada 1989; IPPC 2011, Dec). The term chlor-alkali industry also includes the production of chlorine with potassium or lithium hydroxide. Sodium hydroxide is commonly known as caustic soda or just caustic.

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Chlorine and caustic soda are products that are widely used in industry. They are used in producing detergents, herbicides, pesticides, pharmaceuticals, plastics, and soaps (Bommaraju et al. 2007; Euro Chlor 2007). The single largest usage area for chlorine is in the manufacture of polyvinyl chloride (Euro Chlor 2007; IPPC 2001), while its largest use in inorganic chemicals is for the manufacture of titanium dioxide. In the polyvinyl chloride molecule, more than half its content by weight is from chlorine (Euro Chlor 2011c, Sept). The manufacture of some plastics such as polyurethanes and epoxy resins that do not contain chlorine in their molecule also requires chlorine in their process (Euro Chlor 2011c, Sept). The chlorine tree in Fig. 1 shows the various uses of chlorine (Euro Chlor 2011c, Sept).

Today, in organic chemicals manufacture, polyvinyl chloride (PVC) is the largest consumer of chlorine, while its largest use in inorganic chemicals is for the manufacture of titanium dioxide (Bommaraju et al. 2007). Its co-product from the chlor-alkali manufacturing process, sodium hydroxide also finds wide application in industry.

For the production of sodium hydroxide and chlorine, the raw material used is sodium chloride. Sodium chloride, also known as common salt, has the chemical formula NaCl and contains the elements sodium and chlorine. Sodium chloride crystals vary in color from colorless when pure to white or gray.

The solar evaporation method for producing salt (Varjian 2003) is possible in areas with warm climates and where there is a higher evaporation rate than precipitation rate (O'Brien et al. 2005a). In this process, the salt water is collected in shallow ponds. Energy in the form of heat from the sun is used to evaporate the water. The salt content of sea water is less than 3 %. As the water evaporates and the brine solution increases in concentration, the sodium chloride starts to precipitate. This precipitate is collected

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