Replacement of Asbestos in the Diaphragm Cell Process for Manufacture of Chlorine and Caustic Soda

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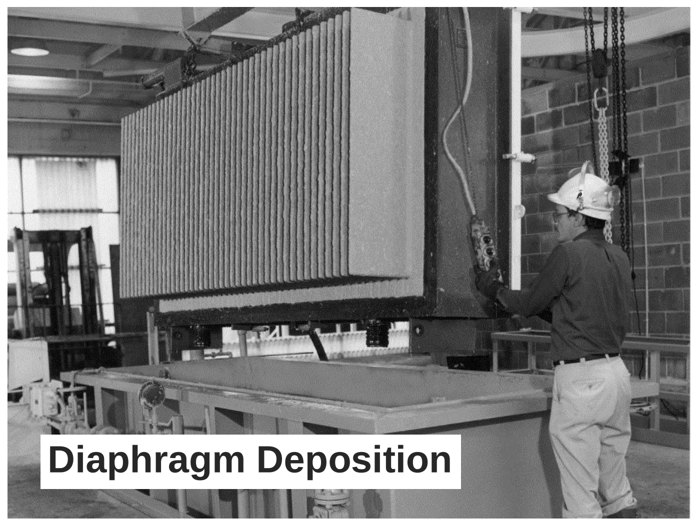
PPG has developed the Tephram® non-asbestos diaphragm for use in diaphragm electrolysis cells for the production of chlorine and caustic soda (NaOH). The Tephram diaphragm uses non-hazardous Teflon® fluoropolymer materials to replace asbestos. The Tephram diaphragm technology offers advantages in decreasing the complexity in handling raw materials (both asbestos itself and the corrosive chemicals used in asbestos diaphragm deposition) as well as in the disposal of asbestos materials at the end of their useful lives. Tephram diaphragms are easier to handle safely and are more environmentally friendly than asbestos diaphragms, and last much longer than asbestos diaphragms. At PPG's Lake Charles chlor-alkali complex an advantage in energy efficiency has been demonstrated. These advantages of greater durability and energy efficiency combine to reduce expenditure of cell renewal labor and consumption of both materials and energy. The impact of this technology is significant. The Chlor-alkali industry consumes approximately 1% of all the electric power generated in the United States. Domestically, diaphragm electrolysis cells account for about 54 million lbs/day of chlorine and 58 million lbs/day of caustic soda, or roughly 75% of U.S. chlorine and caustic soda production. These versatile basic chemicals are used as building blocks for the production of many products important to the U.S. economy, such as plastics, organic chemicals, aluminum, and titanium metals, coatings, refrigerants, safe drinking water, and pharmaceuticals.

Laboratory development of the Tephram diaphragm has been underway at PPG's Chemicals Technical Center (Monroeville, PA) for over 10 years. The first full conversion of a commercial diaphragm cell circuit to Tephram diaphragms was done at PPG's Natrium, West Virginia Plant in 1992. This 160 TPD diaphragm cell plant has operated exclusively with Tephram diaphragms since its conversion, marking its 10-year anniversary in 2002. Additional improvements to the Tephram diaphragm technology have been implemented regularly and full-scale demonstrations at PPG's Lake Charles, Louisiana Chlor-alkali complex were begun in 1996. At Lake Charles, an energy consumption advantage of about 3% over asbestos has been achieved. The conversion from asbestos to Tephram diaphragms was justified on the basis of reduced energy consumption, with health, safety, and environmental benefits as added bonuses.

Plant trials indicate that life of the diaphragm will be more than doubled with the Tephram diaphragm, with a 4-year average life expected. As of this writing (November, 2002), Tephram diaphragm cells are producing ~1700 ton/day of chlorine at the Lake Charles plant. Completion of this 1,800 ton/day conversion is expected by 2003. Further extension of the Tephram diaphragm to other cell designs is anticipated.

The Tephram diaphragm is mainly made of chemically inert Teflon fluoropolymer microfibers. These microfibers are made by pumping a fluoropolymer dispersion through a small orifice under very high shear conditions. The microfibers, along with wetting agents, thickeners, and other materials, are suspended in a water-based slurry. (A water-based slurry is much easier to handle safely than is the caustic-based slurry required with asbestos diaphragms.) The slurry is placed in a large tank and a diaphragm base mat is filtered onto the cathode structure by vacuum filtration. A photograph of Lake Charles' procedures for this diaphragm-forming step is shown in Figure 1. What is shown is one element of a 12-element PPG V-1244 bipolar electrolyzer. Each 12-element PPG V-1244 bipolar electrolyzer produces 25 T/day of chlorine.

Figure 1. Commercial Deposition of Diaphragm



The porosity of the diaphragm is controlled by the vacuum deposition of a topcoat (onto the base mat). This is deposited from a slurry of fine particulates following procedures similar to the deposition of the base mat. (In operation, porosity is further controlled with additives to the feed brine.) The deposition of Tephram is very similar to the deposition of asbestos, and, therefore, plant operations are minimally impacted by conversion to the new technology.

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