Emergency Chlorine Control System Protects Polycarbonate Production Facility

Bionomic Industries has successfully supplied air pollution control systems designed to mitigate the emergency release of pure chlorine gas generated by chlor-alkali processes utilizing brine membrane cell technology for the production of polycarbonate thermoplastic.

Polycarbonate is a strong, transparent thermoplastic commonly formed from bisphenol A (BPA) and phosgene (COCI2), a toxic gas generated onsite from chlorine (CI2). Chlorine and its derivatives, HCl, CIO2, NH2Cl, and TiCl4 are essential industrial products used in the preparation of bleaching agents, disinfectants, pesticides, refrigerants, and thermoplastics like polyvinyl chloride (PVC).

The chlor-alkali process is a commercial method for generating chlorine gas from an electrolytic cell containing a brine solution of sodium chloride (NaCl). Current is supplied to electrodes separated by an ion selective membrane which allows for the passage of sodium ions (Na+) but not chloride ions (Cl-). Chloride ions are oxidized at the positive electrode to form chlorine gas.

Chlorine gas causes irritation to the eyes, nose, and throat, and is potentially fatal depending on the concentration and duration of exposure. Bionomic Industries' air pollution control system is designed to remove normal process purge gases containing wet and dry chlorine, as well as concentrated chlorine released under emergency conditions.

Bionomic Industries developed a two-stage solution consisting of dual Series 6500 Model 24/30 Jet Ejector Venturi Scrubbers followed by a Series 5000 Model 60 Packed Tower constructed from ECTFE lined fiberglass and code certified in accordance with ASME Section X for Fiber-Reinforced Plastic Pressure Vessels.

Each scrubber stage sits upon a recycle tank pre-charged with sodium hydroxide (NaOH). Chlorine reacts with sodium hydroxide to produce sodium chloride (NaCl) and sodium hypochlorite (NaOCl). In response to increasing oxidation reduction potential, which is an indicator of an oxidant like sodium hypochlorite and chlorine absorption, sodium hydroxide is added proportionally, while an equal volume of solution is drained from the system to maintain a constant liquid level and sodium hypochlorite concentration.

The jet ejector venturi scrubbers, with high pressure PTFE spray nozzles, are fed by titanium centrifugal pumps which generate a constant vacuum on the upstream chlorine sources without the use of a fan or blower. The vacuum rating is a critical safety parameter, sensitive to changes in flow and pressure, designed to prevent chlorine gas exposure within the workspace. Gas flow is regulated by an automated damper-controlled reflux line connecting the second stage outlet to the first stage inlet. Liquid flow to the jet ejector venturi is regulated by control valves which recycle the additional flow capacity of the pumps, minus the system bleed rate, back to the tank through a mixing line.

Controls monitor and maintain equipment setpoints by modulating automatic valves, regulating the addition of process water, cooling water and caustic solution. Due to the criticality of the equipment, in the event of a system failure, or upon a low level or high ORP alarm, an emergency caustic supply valve opens and begins adding sodium hydroxide solution to the packed tower from an overhead storage tank. This emergency action allows sufficient time, if necessary, to shut down the upstream sources and prevent a chlorine release.

Bionomic Industries collaborated with the client's engineering team and third-party contractors in design review, hazard analysis, on-site integration and emission testing.

The Series 6500 Model 24/30 Jet Ejector Venturi Scrubbers and Series 5000 Model 60 Packed Tower were tested in accordance with EPA Method 26 for halogen emissions and achieved a chlorine removal efficiency exceeding 99.99%. Bionomic Industries Chlorine Emergency Scrubber System has operated within the design specifications and without incident for nearly a decade.

Design Conditions:

Flow Rate (ACFM):	5,700
Temperature (°F):	178
Inlet Pressure (in.WC):	-10
Chlorine Loading (lb/hr):	30,000
Duration (min):	15

Process Flow Diagram:

