# Ixom Botany ChlorAlkali Plant (CAP)

The ChlorAlkali Plant (CAP) produces chlorine and caustic soda using water, salt and electricity.

Hydrogen is a by-product of this process. The CAP consists of following main process areas:

- **Brine Treatment/Purification**
- **Brine Electrolysis**
- **Caustic Evaporation**
- **Chlorine Cooling, Drying and Compression**
- **Hydrogen Compression**
- **Effluent Treatment**
- **Emergency Chlorine Scrubber**

## Brine Treatment/Purification

Raw salt, stored on site, is dissolved in heated water in the lixator (pit where salt and water are mixed to make brine). Very high purity brine is necessary for the electrolysis process to protect the membranes. Impurities present in the salt, particularly calcium and magnesium compounds, are removed by chemical precipitation and filtration. Final purification is carried out in ion exchange columns.

## Brine Electrolysis

An electric current is passed through the brine solution with electrolysis taking place in bipolar membrane electrolysers, in series. Brine is circulated on one side of the membrane and caustic soda circulated on the other side. Chlorine gas is generated on the brine side and hydrogen gas generated on the caustic side.

Part of the weak brine is de-chlorinated and returned to the lixator in the brine treatment area where salt is added to increase the strength.

The reaction in the electrolysers involving the electrolytic separation of sodium chloride is as follows:

$$2\ NaCl_{(aq)} + 2H_20 \xrightarrow[\text{Current}]{\text{Electric}} 2NaOH_{(aq)} + Cl_{2\,(g)} + H_{2\,(g)}$$

## Caustic Evaporation

The majority of the caustic soda removed from the electrolysers is concentrated to 50%w/w for sale.

The remainder of the caustic soda at 32%w/w concentration is used within the plant for brine and water treatment, and for absorbing chlorine. Caustic is also diluted to 16% w/w for manufacturing of sodium hypochlorite.

# Chlorine Cooling, Drying and Compression

The wet chlorine gas produced in the electrolysers is cooled, dried, compressed and used on site in the manufacturing of hydrochloric acid, sodium hypochlorite and ferric chloride.

All chlorine produced on site is consumed on site in the product plants.

The principal sections of the chlorine handling system are cooling, drying, compression and sulphuric acid handling.

## Cooling

Chlorine cooling is achieved via passing wet chlorine gas through a shell and tube heat exchanger. As chlorine temperature decreases, moisture in the form of water vapour in wet gas condenses out. Dependent upon operational temperatures and production rates, the cooling medium is either site cooling water or a combination of this and chilled water supplied from a refrigeration unit.

## Drying

The drying system removes any moisture remaining in chlorine gas from the chlorine cooler. This system consists of two packed towers operating in series, primary and secondary. In these towers chlorine gas is contacted with sulphuric acid in counter current flow where moisture present in the gas stream is transferred to the sulphuric acid liquid stream.

## Compression

The chlorine compressor receives dry chlorine gas from the drying system and compresses the gas for use in the downstream products plants. The compressor is a rotary liquid ring compressor, which uses sulphuric acid as the sealing liquid.

## Sulphuric Acid Handling

The sulphuric acid handling system includes strong sulphuric acid supply and weak sulphuric acid disposal. The strong sulphuric acid tank supplies strong sulphuric acid for the chlorine drying towers and the chlorine compressor. Weak sulphuric acid from the drying towers is pumped to storage.

Liquid chlorine, manufactured at the Laverton plant in Melbourne, Victoria, is stored on site in 920 kg chlorine drums and 70 kg cylinders for distribution into local markets.

# Hydrogen Compression

The hydrogen produced in the electrolysers is cooled, compressed to approximately 50 kPag and then used for hydrochloric acid production. Surplus hydrogen is vented through a stack to the atmosphere.

# Effluent Treatment

## Alkaline Effluent System

Effluent from alkaline process area catchments drains to trenches which channel effluent to the alkaline effluent sump. From here, alkaline effluent is transferred to the alkaline effluent tank where it is mixed and neutralised using HCl and NaOH to achieve a pH in the range of 6.5 and 10.5.

As these neutralisation reactions have the potential to liberate chlorine gas under certain conditions, the alkaline effluent tank is operated under light suction, venting to the emergency chlorine scrubber (ECS) where any chlorine gas present is removed.

Treated alkaline effluent is discharged to the site effluent system.

### Acidic Effluent System

The acid effluent system is quite similar to the alkaline effluent system discussed above. Effluent from acid process areas drains to the acid effluent trench, then to the acid effluent pit from where it is pumped to the acid effluent tank.

The acid effluent tank is used to mix and neutralise effluent using HCl and NaOH to achieve a pH in the range of 6.5 and 10.5. Treated acid effluent is discharged to the site effluent system.

## Emergency Chlorine Scrubber (ECS) System

The emergency chlorine scrubber (ECS) uses extraction fans to collect gas from all the chlorine-containing plant vents. The gas is then scrubbed with caustic soda to remove chlorine producing sodium hypochlorite. The reaction is as follows:

$$2\ NaOH_{(aq)} + Cl_{2\ (g)} \rightarrow NaOCl_{(aq)} + NaCl_{(aq)} + H_2O$$

The ECS is a safety critical system designed to accommodate chlorine surges during plant upsets for 10 minutes minimum of full chlorine production. All vents containing chlorine pass to the ECS system. The concentration of chlorine in the exit gas from the ECS is monitored and alarmed.

Electrical power to the circulation pumps and extraction fans is backed up by emergency power from a stand-by emergency diesel generator. A nitrogen ejector that does not require power for operation further backs up the fans. A caustic gravity head tank that does not require power for its operation, further backs up the caustic pumps.