Feasibility Report

Conversion of Epichlorohydrin (ECH) Plant to Propylene Oxide (PO) Plant

Preamble

To effectively utilize the excess chlorine produced from TPL HCD, the Epichlorohydrin plant was set up in 1995. This is an upstream product of epoxy resins. This project was jointly promoted with M/s Ciba Geigy. The plant was in operation till March 2013.

The operations in the ECH plant in TPL have been suspended since the 1st of April, 2013, owing to high loss incurred mainly due to easy availability of cheap imports (ECH).

To effectively utilize the existing assets , the possibility of manufacturing propylene oxide which utilize the same raw material as ECH viz- Propylene , Chlorine and Lime was explored.

For Manufacturing Propylene Oxide Various Technologies are available like the POSM, POMTBE, direct oxidation , Hydrogen Peroxide and Chlorohydrin technology.

With the existing facility, Chlorohydrin technology is most suitable, as the process is similar to ECH manufacture.

DETAILS OF THE PROJECT

Manali Petrochemicals Limited is the only manufacturer of Propylene Oxide in India. They also manufacture the propylene oxide derivatives Propylene Glycol and Polyol. The domestic industry meets only about 50% of the Indian demand and the balance is being imported. The demand for this product is also increasing .Hence there is good market potential for these products.

AVAILABLITY OF RAW MATERIAL

The main raw materials for the manufacture of Propylene oxide from Propylene by the Chlorohydrin route are listed below

1. Propylene of purity around 95% (Min)
2. Chlorine of Purity 98%(Min)
3. Good Quality Lime with MgO content less than 1%

PROPYLENE

The key and major raw material propylene is available from the Fluid Catalytic Cracker of Chennai Petroleum Corporation Limited. The annual requirement of Propylene is about 13500 MTPA. The contractual quantity for ECH is about 6950 MTPA. The balance can be sourced from M/s CPCL or M/s HPCL.

CHLORINE

The other major raw material chlorine will be available from M/s TPL HCD. For the Propylene Oxide production level considered, about 60- 70 MTPD of chlorine is required.

Chlorine would be available as a gas at the battery limit.

LIME

Lime required for saponification of the chlorohydrin to Propylene oxide will have to be of high purity with minimum MgO content. The lime can be sourced indigenously or imported from Middle East or Far east Countries.

POWER

The total power requirement including onsite and offsite will be 1.3 MW. The existing TNEB Connection is 2600 KVA. To ensure continuous supply of power to critical systems, KVA DG set to ensure safe shutdown of the plant and systems.

WATER

The total requirement of water for the main plant and utilities would be approximately 1700 m3/Day.

PROCESS DESCRIPTION

Propylene oxide plant

The basic process is based on reaction of vapour phase propylene with a mixture of chlorine and water in liquid phase under controlled conditions followed by saponification of the chlorohydrin formed with lime.

The different sections of the plant are

a. Propylene Vapourisation Section

b. Chlorohydrination Section

c. Saponification section

d. Purification section

Propylene Vapouriser

Propylene in the form of liquid obtained from the bullet would be vapourised on the shell side of the vapouriser circulating the water on the tube side. The cold will be recovered in the water and the chilled water would be used in different section of the plant . The propylene so vapourised would be piped through a control valve to the Chlorohydrin reactor made of Titanium.

Chlorohydrination Section

Propylene , Chlorine and water are continuously introduced into the bottom of Chlorohydrin reactor where Chlorohydrination takes place as the bubbles of Propylene and chlorine pass up in the reactor. The reactions that are taking place in the reactor are exothermic in nature and the temperature will settle down without external heating or cooling due to enormous quantity of water that is under circulation in the reactor.

The Chlorohydrin solution thus obtained is overflowed from the reactor and sent to the saponification section.

Saponification Dection

A slightly excess solution in an aqueous slurry form is used to saponify the Propylene Chlorohydrin and to neutralize the byproduct hydrochloric acid in the circulating water.

The chlorohydrin solution leaving the reactor is mixed with the lime solution in a static mixer and is flowed into the saponifier tank where the propylene chlorohydrin is saponified and converted into propylene oxide. The formed propylene oxide is then steam stripped with live low pressure steam and is removed rapidly from the reaction zone and taken to a distillation section for further purification. The waste lime solution from the bottom of the saponifier alongwith Calcium chloride and sodium chloride formed in the reaction is sent through a hydrocyclone to remove the solid particles and the clear solution is sent through plate heat exchangers to recover the heat before discharging to effluent treatment section.

Purification Section

Distillate from the saponifier consists of Propylene Oxide and water with some chlorinated byproducts. It is fed into the propylene oxide column where the crude propylene oxide is further purified and obtained along with light-ends in the overhead condenser.

UTILITIES AND OFFSITES

The existing utilities and offsite of ECH will meet the requirement of proposed PO facility.

RAW WATER SYSTEM

Raw water is required for the following

a. Production of demineralized water for use in boiler for producing steam

b. As a make up to circulating cooling waters

c. Drinking water and sanitary purposes

d. As process water for preparation of milk of lime and for direct addition to the Propylene oxide plant

e. Service water for hose stations

f. Fire water make up

The total requirement of water is approximately 1700/day.

Three raw water pumps will be providing to supply the water to the various requirements mentioned above. A fire water tank of 2386 m3 capacity and raw water tank of 10673 m^3 is available. Fire water pump of Jockey pump 40 m3/hr, Electrical driven pump 610 m3/hr and diesel driven pump 410 m3/hr capacity at 100 m head will be run by an electric motor and the standby pump will be driven by diesel engine.

DEMINERALISED WATER PLANT

The water requirement for the boiler and the process will be of the order of 12 m3/hr. The existing DM plant of 60 m3/hr capacity is available and the same can be used.

COOLING WATER SYSTEM

The propylene oxide plant and the utilities require about 500 - 600 m3/hr of cooling water. He existing cooling tower circulation rate of 1500 m3/hr is more than sufficient.

STEAM SYSTEM

The requirement of steam for the propylene oxide plant is about 5 T/hr. Steam of medium pressure and low pressure is required.

The existing boiler produces 14 T/hr steam at 17 ksc (g).

COMPRESSED AIR SYSTEM

It is required to supply instrument air and plant air to different parts of the plant. The pressure of the compressed air main is 7 ksc (g). The existing instrument air compressor will supply the air to the proposed PO plant.

INERT GAS SYSTEM

Inert gas is required for blanketing the tanks and vessels , flushing of instruments , process lines etc.. The total quantity of nitrogen required will be about 50-60 M3/hr. It is proposed to draw this nitrogen from TPL LAB plant or by sourcing liquid Nitrogen.

EMERGENCY DIESEL GENERATOR SET

For the safe shutdown of the plant and for certain critical services emergency power will be supplied through a diesel generator set. The existing DG set 1450 KVA Capacity can be used for the same purposes.

OFFSITE STORAGE SYSTEM.

Storage for the following raw materials are available

a. Propylene - 982 m^3 (2 nos of 145 m^3 bullets & 2 nos of 346 m^3 bullets)

b. Quick Lime - 45 MT

It is proposed to modify the existing tanks to store propylene oxide.

FIRE WATER SYSTEM

A fire water tank capacity of 2386 m3 and raw water tank capacity of 10673 m^3 is available. Fire water pump of Jockey pump 40 m3/hr, Electrical driven pump 610 m3/hr and diesel driven pump 410 m3/hr capacity at 100 m head is available. Fire hydrant system and sprinkler system are available.

EFFLUENT TREATMENT PLANT

TPL – ECH is having well established effluent treatment plant.

Process effluent generated from Epichlorohydrin plant is pumped to primary clarifier where the effluent is concentrated at the bottom of the clarifier. The clarifier under flow is taken to the Rotary vacuum filter. The solids are dried on the cloth-using vacuum. The dry solids are scrapped by scrapper and discharge into trucks, which is used for land filling in low lying areas and brick manufacturing and cement industries.

The overflow from the clarifier flows to the cooling tower and cooled to 40ºC and pumped to series of Bio-Reactors. The COD is reduced from 2000 ppm to less than 250 pm and BOD is reduced from 400 ppm to less than 100 ppm using the bacteria and aeration process. Surface aerators are in operation to maintain the adequate dissolved oxygen level. Treated effluent after meeting the prescribed standard is pumped to the sea.

PLANT LAYOUT.

The Propylene oxide plant will be integrated with the existing ECH plant and some of the existing equipments of ECH will be used.

MARKET POTENTIAL

MPL is the only domestic manufacturer of Propylene Oxide. The Propylene Oxide is mostly consumed in-house to manufacture Propylene glycol and Polyether polyol.

There is good market potential for Propylene oxide and its derivatives Propylene glycol and Polyether polyol.

Current imports of Propylene oxide is about 20000 MTPA. Considering the domestic production , the total demand for Propylene Oxide is around 60000 MTPA.

Current Propylene Glycol imports is about 50000 MTPA and Polyol imports is more than 1 lakh tonne per annum.

The 15000 MTPA propylene oxide produced can be sold as such or used for making Polyols at MPL.

Propylene Glycol

Propylene Glycol is used for various applications in industries viz

1. Pharmaceuticals
2. Food Flavours and essences
3. Polyester resins

4. Perfumery compounds
5. Cosmetics
6. Cigarettes
7. Tooth paste
8. Pesticides

Of this, Pharmaceuticals , food flavours and essences and polyester resins manufacturing sectors account for a major share in the present consumption of Propylene Glycol in the country.

POLYOL

The polyols are broadly classified based on application as given below

1. Flexible Polyurethane foams
2. Rigid Polyurethane Foams
3. Semi-rigid Polyurethane foams
4. Miscellaneous applications

Flexible foams

Flexible foams are largely used for various household applications such as furniture cushions, beds, mattresses etc. Also, in automobiles, seat cushions, arm rests coverings etc. are made using flexible foams. In certain cases these are used as packaging material for high value items. Some of the miscellaneous applications include foam laminations, toys, novelties etc.

RIGID FOAMS

The specific thermal insulation characteristics of rigid PU foams are far superior to that of all other polymeric foams. The obvious advantage of polyurethane rigid foam is the lesser thickness required to achieve the same thermal efficiency as other materials.

Rigid Polyurethane foams are used as insulating materials in 1) Air Conditioning and Refrigeration industry (insulation of domestic refrigerators , air conditioners , water coolers , refrigerated vans etc) 2) Process Industries (Insulation of process equipments , pipelines , storage tanks etc) and c) Transportation Sector (Insulation of rail coaches , bus coaches , air craft , ships etc.)

SEMI – RIGID PU FOAM

Semi-rigid PU foams are used in the manufacture of steering wheels, scooters / motorcycles / bicycles / car seats, and arm rests, shoe soles etc.

MISCELLANEOUS APPLICATIONS

Polyol are also used in the manufacture of polyurethane elastomer, coatings, paints, adhesives / sealants, binders etc.

MANPOWER

The existing manpower at ECH facility instead of retrenching can be used for operating the PO plant.

FINANCIALS

The ECH plant cannot be directly used to manufacture PO without certain process and engineering modifications. At the same time, considering the tight market conditions and the tightening financials of MPL, it was important that the capital expenditure on the conversion be kept optimum. Hence it was decided to use certain equipment from MPL Plant I & II which are not in line as on date along with certain equipments at ECH. Using this equipment, the approximate capital expenditure required for the conversion is approximately INR 12.96 Crore which would yield a capacity of 15,000 MTPA of PO.

The viability of this project is as given below

The discounted cash flow model was made for a period of ten years starting 2014. The investment of INR 12.96 crore was considered in 2013. The Cost of Production was taken as the average of the previous 5 years using the specifications achieved by MPL along with TPL utilities and raw material costs

Financial Results

Investment (INR Crore)		12.96
NPV (INR Crore)		26.96
IRR		16%
Payback		5 years

Conclusions

Based on the numbers and the current market scenario, it seems to be a good option to convert the ECH facility into a PO plant. The fact that it is cheaper to produce Propylene Oxide instead of importing the same gives MPL a firm reason to go ahead with this project.

Considering all the above points as well as the financial returns, it is proposed that MPL goes ahead with this project to create a solid foothold across the country.

Annexure – 1

Proposed Propylene Oxide Production – Process Description.

Propylene oxide is produced utilising the chlorohydrin technology. In a titanium hollow vessel filled with water, chlorine is injected at the bottom, which immediately forms hypochlorous acid and propylene vapour is injected in this zone and it is converted to propylene chlorohydrin (PCH). By-product Dichloropropane is also produced in small quantities. Always excess of propylene is maintained in the reactor and hence the entire chlorine is converted into propylene chlorohydrin and dichloropropane. The un reacted propylene is recycled back to reactor.

The reactor operates at near atmospheric pressure and at around 55 to 60 °C. It is a simple vessel without any internals and no catalysts or any other additive are used in the reaction process. The reactor relies on good upward velocity provided by the circulating gas and incoming process water to move the produced chlorohydrin from the place of injection to maximize the production efficiency.

Propylene chlorohydrin overflows from the reactor and is pumped into a saponifier along with Milk of Lime. Saponifier is steam stripped from the bottom to remove the "PO" formed from the reaction zone. The PO along with the excess and entire quantity of DCP present in the reactor overflow enters a separation column where PO is removed as top product as it boils at 34 °C at atmospheric pressure and the high boiling DCP and water moves to the bottom of separation column. PO is condensed with chilled water and sent to the storage tank.

The DCP liquid and water enter the decanter where water is decanted and recycled back to the reactor. The DCP liquid is sent to the storage tank for marketing. Thus it could be seen that this process does not utilize equipment's like furnace, heaters nor use any catalytic reaction process. It does not produce any listed hazardous waste.

The Saponifier bottom waste water is pumped to a High rate Thickener after heat recovery where all unreacted inerts in the milk of lime are settled and sent to a rotary vacuum filter, the solid is washed and removed for disposal as a landfill or in the manufacture of low cost lime bricks.