PROJECT PRE-FEASIBILITY REPORT

for

Debottlenecking and Expansion of Existing Petrochemical Complex

at

Hazira Manufacturing Division

Reliance
Industries Limited

January 2015

1.0 Introduction

1.1 Background

The Petrochemical industry is vital to national growth. India is having 3.17 million square kilometres land mass and over 1.22 billion population and is one of the fastest growing economies in the world. It has well-developed Process Industry. Petrochemicals cover basic chemicals like Ethylene, Propylene, Benzene and Xylene. The other major components are the intermediates like Monoethylene Glycol (MEG), PAN and Linear Alkyl Benzene (LAB) etc., synthetic fibres like nylon, Polyester Staple Fibre (PSF) and Polyester Filament Yarn (PFY), polymers like Low Density Polyethylene (LDPE)/ High Density Poly Ethylene (HDPE), Poly Vinyl Chloride (PVC), polyester and Polyethylene Terephthalate (PET) etc. and synthetic rubbers like Styrene Butyl Rubber (SBR), Poly Butadiene Rubber (PBR). The sector has a significant growth potential. Although the current per capita consumption of petrochemicals products is low, the demand for the same is growing. The US consumption has reached saturation level, china's consumption above industry curve is basically export led. India has the advantage of high population and expected to maintain high economic growth. This should propel the India's consumption in polymer to new levels in coming year.

Global chemical market size was estimated at USD 3.9 trillion in 2013 and is expected to grow at 3-4% per annum over the next 5 years to reach USD 4.7 trillion by 2018. India currently accounts for approximately 3% of the world chemical market. The Indian chemical and petrochemical industry expanded in 2013 despite weakness in key export markets and subdued growth in the domestic market. The Indian chemical and petrochemical industry currently stands at USD 118 Bn and is expected to grow at a CAGR of 8% for the next five years. The share of this sector in the manufacturing GDP was 15% during 2012-13 and it accounted for ~9% of the total India's exports. Bulk chemicals form the largest sub-segment of Indian chemical industry with 40% market share whereas specialty chemicals with ~19% market share is the fastest growing segment. The current low per capita consumption across industries and segments and strong growth outlook for the key end use are the key growth drivers for this industry. To meet the increasing demand either the local production will have to ramp up or it will be met by imports. In the past decade, India didn't tap its manufacturing potential to the fullest which led to a surge in the chemical imports. Net imports have grown at ~20% between FY09 and FY13 where in the same period the domestic output has grown by ~4%.However, going forward, 'Make in India' could become the next big manufacturing growth story. The Government has set an ambitious plan of increasing the share of manufacturing in GDP from 16% to 25% by 2022.

Reliance Industries Ltd. (RIL), which is a pioneer in the petroleum and petrochemical sector, is organized in exploration and production of Oil & Gas, refining and marketing of petroleum products and manufacturing and marketing of petrochemicals, polymers, polyesters and polyester intermediates, intends to tap on this potential and intends to create global benchmarks in product quality and customer service with its multi-location, state-of-the-art and world-scale petrochemical plants. Hardly a wonder that some of the discerning and dominating global companies are Reliance customers today.

Some of the notable achievements of RIL are:

- Domestic Leadership in Petrochemicals
- World's Largest Producer of Polyester Fibre and Yarn
- Fifth largest producer of PP and PX in the world
- Eighth largest producer of PTA
- India's largest and world's eighth largest producer of MEG
- India's largest manufacturer of Synthetic Rubber

Reliance's philosophy of 'Growth is Life' has truly manifested itself in value creation opportunities for its myriad stakeholders, which include its valued customers. This growth has been achieved with state-of-the-art world scale projects and setting global benchmarks in product quality, standards and services.

Reliance's sites at Hazira, Vadodara and Dahej in Gujarat and Nagothane in Maharashtra are integrated with crackers. The Jamnagar site is integrated with the world class refinery, ensuring feedstock security at all the sites.

At Reliance our constant endeavor is to provide products and services that meet global standards. Based on our extensive interaction with the industry, we offer a wide range of grades for diverse applications across packaging, agriculture, automotive, housing, healthcare, water and gas transportation and consumer durables.

Superior technologies, strong focus on R&D, latest IT-enabled services to support supply chain management and the end-to-end solutions offered across the value chain reinforce our commitment to customer satisfaction.

Hazira Manufacturing Division (HMD) of RIL is located at village Mora, near Hazira in Chorasi Taluka of Surat District in the State of Gujarat. It is a multi-product, fully integrated complex manufacturing a wide range of petrochemicals, polymers, Polyesters and polyester intermediates. The complex comprises of a Naptha cracker feeding downstream petrochemical, fibre intermediates, and polyester plants.

The HMD complex of RIL was commissioned in 1991-92 to manufacture Mono-Ethylene Glycol, Vinyl Chloride Monomer (VCM), Poly Vinyl Chloride (PVC) and High Density Polyethylene (HDPE) along with utilities. Subsequently in later years, the Naphtha cracker, Purified Terepthalic Acid and Polypropylene plants were set up.

The integrated infrastructure facilities at HMD includes power plant, combined effluent treatment facilities, jetties, storage tanks, warehouses etc.

RIL HMD is now planning to expand its production capacities of various plants i.e. Cracker Plant, Ethylene (C2), Propylene (C3), C4 products (such as LPG, Butadiene, Butene 1, MTBE/Isobutylene, Butanediol, HIPB) etc., C5 derivatives and resins (C5 HCR resin, 72% DCPD, 85% DCPD, etc.), C6-C8, C9 and C9 resins, styrene, PBR, Polyester Plants (Polyester Staple Fibre + chips, Partially Oriented Yarn, PET), PP, PE, PVC etc. through the following technological upgradation processes by:

a. Optimization and debottlenecking of limiting equipment
b. Feed composition optimization.
c. Increase in operational time.
d. Change of hardware equipment.
e. Replacement of existing reactors and addition of parallel reactors etc.
f. Value addition of Product Slate by new processes / plants

The debottlenecking and expansion project will be implemented within the existing HMD petrochemical complex, as it has a close linkage to feedstock availability, product disposal and utilities within the petrochemical complex. Moreover, this will also provide advantage of the infrastructure already existing in the petrochemical complex for proposed expansion project.

The rationales behind the proposed debottlenecking and expansion project are:

a. Availability of requisite infrastructure facilities
b. Availability of land for the proposed expansion project within the premises of existing plant
c. Lower capital cost compared to the grass root project. This would save the capital cost resulting in lower cost or production and retention price.
d. The site is well connected with roads, railways and Tapi estuary.

e. Meeting the gap in demand and supply of petrochemicals in the country.

f. Due to the available infrastructure and associated utilities, the environmental impacts is also reduced.

g. Hazira Manufacturing Division (HMD) of RIL has a well-established Environmental Management System, which will also cover the debottlenecking and expansion project.

The Plot Plan is annexed as Annexure 1.

To assess the impacts, due to the proposed projects, RIL will engage a NABET accredited agency to conduct Environmental Impact Assessment (EIA) studies as per the requirements of the EIA Notification issued by the Ministry of Environment and Forest (MoEF) in 2006 and its various amendments. The EIA and RA reports will be based on the prevailing environmental quality data, identification, prediction and evaluation of the impacts incorporating existing and post-expansion cumulative operations, delineation of environmental management plan for mitigating adverse impacts and post-project monitoring programme.

The baseline data has been monitored for the period of 2013-14 for various environmental components i.e. Air, Noise, Water, Land, Biological and socio-economic environment along with the parameters of human interest.

1.2 Categorization of Proposed Debottlenecking and Expansion of Proposed Units

The categorization of the proposed project is done based on the EIA Notification dated 14th Sept. 2006 and its amendments.

a. Expansion Projects: The products from the Cracker C1-C9 plants involves processing of petroleum fractions & natural gas and / or reforming of aromatics, these projects are categorized under Sr. No. 5(c), **Category 'A'** project, as per the Schedule in the EIA Notification 2006**.**

b. Expansion Projects: The products from rubber plants, manmade fibres manufacturing plants and other petrochemical based plants where processes other than cracking & reformation are involved, these projects are categorized under Sr. No. 5 (d) and 5(e), **Category 'B'** project, as these plants are located in a notified industrial area/estate, as per the Schedule in the EIA Notification 2006.

However, as a part of the projects are categorized as Category 'A' and Category 'B' projects, RIL intends to approach MoEF, New Delhi to grant the Environmental Clearance for all the debottlenecking and expansion projects

2.0 Project Setting

2.1 Background

RIL HMD is located at Mora village near Hazira in Chorasi Taluka of Surat District and about 18 kms North-West of the Surat City in Gujarat State. The site location is such that Surat City lies on its East and estuarine region of Tapi River lies to its South; Arabian Sea is on the West and Bhatlai, Damka villages to its North. The project site is situated at latitude of 21^{o}09'30" to 21^{o}09'54" N and longitude of 72^{o}40'06" to 72^{o}40'36" E. The Bombay- Ahmedabad National Highway No. 8 passes close to Surat City which is well connected by Railway and Road network. There is a navigation channel available in the Tapi estuary from sea up to Magdalla port for transporting the raw material and finished products to the different industries along the Tapi river. Tapi River flows along the boundary of the site and joins the Arabian Sea near Dumas village. The proposed expansion will be carried out within the existing RIL HMD premises, which is located in the Hazira Industrial Area.

The summer begins in early March and lasts till June. April and May are the hottest months, the average maximum temperature being 40°C(104 °F). Monsoon begins in late June and the city receives about 1,200 mm of rain by the end of September, with the average maximum being 32°C (90°F) during those months. October and November see the retreat of the monsoon and a return of high temperatures till late November. Winter starts in December and ends in late February, with average temperatures of around 23°C (73 °F), and little rain. Very often heavy monsoon rain brings floods in the Tapi basin area.

The expansion of the petrochemical plants is proposed by RIL within the RIL HMD, which is located in the Notified Industrial Area (Hazira) of Gujarat Industrial Development Corporation (GIDC).

Presently, the following major industrial installations exist in the vicinity of the RIL-HMD complex.

- Larsen & Toubro Ltd. (L&T)
- Essar Group of Companies
- Adani Hazira Port
- Shell India
- Magdalla Port
- Krishak Bharati Cooperative Ltd. (KRIBHCO)
- Gujarat State Energy Generation Ltd. (GSEG)

- National Thermal Power Corporation (NTPC)
- Oil and Natural Gas Corporation (ONGC)

There are no hills, national parks, forests or sanctuaries in this area and there is no wild life.

2.2 Connectivity

Road connectivity to Hazira is provided by the National Highway No. 8 (NH-8), which runs from Delhi to Mumbai via Ahmedabad. At present four lanes NH-6 connects Hazira region to the main trunk line.

In terms of rail connectivity, Hazira is located approx. 43 kms from the Mumbai-Delhi railway line via Vadodara.

Surat is the nearest airport

2.3 Reconnaissance

The geographical location of the site is such that Surat city is in the eastern direction, while Tapi River is in South-East direction, Arabian Sea is towards West, while Bhatlai and Damka villages are in the North direction. The proposed site has no potential of agriculture. There is a wide variation in rainfall in the study area with an annual average 1200 mm. The site is situated at 21^{0}09'30" to 21^{0}09'54" North Latitude, 72^{0}40'06" to 72^{0}40'36" East Longitude.

2.4 Climate and Rainfall

The study area has a tropical savanna climate, moderated strongly by the Arabian Sea. The annual mean air temperature was 27.7°C. The annual mean humidity is recorded as 62%.

The summer begins in early March and lasts till June. April and May are the hottest months, the average maximum temperature being 40°C(104 °F). Monsoon begins in late June and the city receives about 1,200 mm of rain by the end of September, with the average maximum being 32°C (90°F) during those months. October and November see the retreat of the monsoon and a return of high temperatures till late November. Winter starts in December and ends in late February, with average temperatures of around 23 °C (73 °F), and little rain. Very often heavy monsoon rain brings floods in the Tapi basin area.

2.5 Soil Type

The major class of soil in the study area is clayey black (vertisol). The soil in the region is suitable for growth of cotton and tur. However farmers in the recent past have been growing cereals, jowar, cash crop and sugarcane. Few locations in the region fall under water-logged category due to poor soil infiltration, hence the soil fertility is poor.

2.6 Demographic Features of Hazira

The demographic features of Hazira region is presented below:

- Hazira Notified Area : 13,000 acres
- Mega Industries : 15+
- Employees : 13,000 +
- Workers : 38,000 +
- Total Vehicle Movement : 10,000 +
- Village Population : approx. 30,000 (Mora, Hazira, Kawas, Icchapore, Limla, Bhatpor, Damka, Bhatlai, Suvali).

2.7 Water Supply

Water supply to the industrial units are supplied by Singanpore weir.

2.8 Employment Generation

Since the project involve only de-bottlenecking and optimisation of existing petrochemical complex, there is no increase in direct and indirect employment. For new plant like MEG-4, Styrene, C5, the direct employee will be adjusted from the existing man power. However indirect employment will increase during construction of the above mentioned new projects.

3.0 Project Description

3.1 Background

RIL is presently processing naphtha for production of downstream petrochemical products. The existing petrochemical complex has necessary offsite and other infrastructure facilities.

The existing petrochemical complex has been granted ISO 14001 certification since the year 1999 for its Environmental Management System.

The existing complex has facilities for effluent treatment and disposal. The plant is having efficient sophisticated laboratory and instruments for monitoring of emissions, effluents and analysing solid and hazardous wastes.

The product slate for the existing plants and after the debottlenecking / expansion of the existing plants is presented in **Table 3.1**. The raw material required for the existing and after debottlenecking / expansion plants is presented in **Table 3.2**. The plot plan shows the manufacturing facilities, storage facilities, supporting and other auxiliary facilities alongwith the location of the proposed expansion units within the complex. The general plot plan for the plant area is shown in **Fig. 3.1**.

The process details of existing plant units are described below:

3.2 Process Description for Cracker

The cracker plant process can be subdivided in two sections viz. Cracking & Aromatics Recovery

Cracking section:

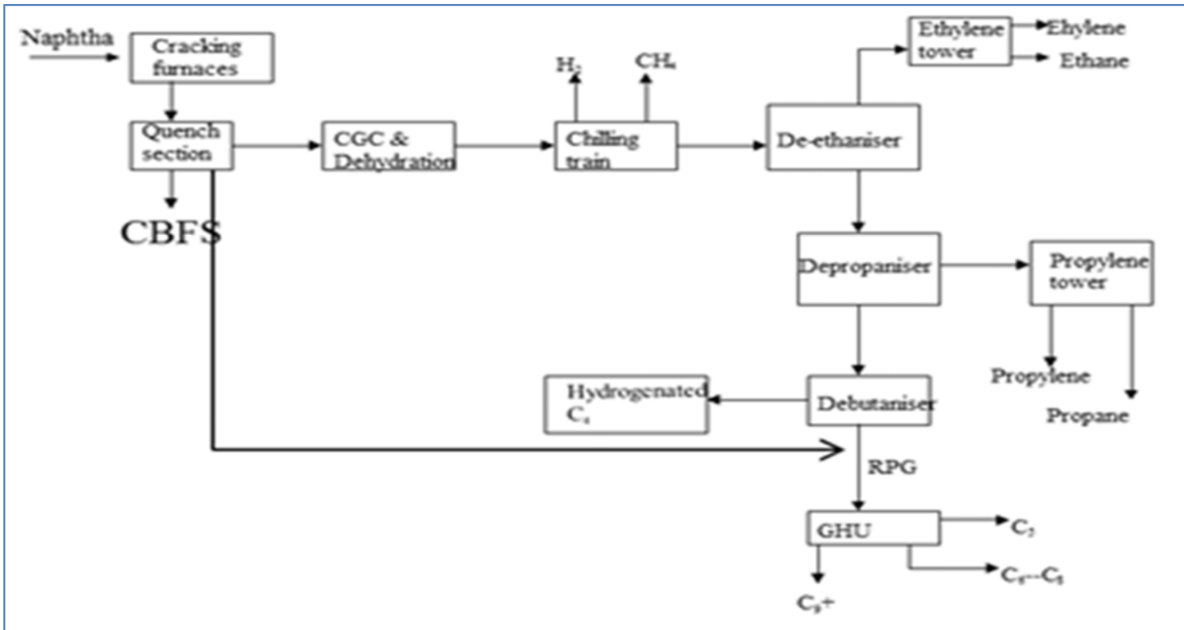
The cracking section consist of cracking furnaces, heat recovery section, primary fractionation, product separation & recovery section supported by cascade refrigeration system and fuel handling system.

In the cracking furnaces, Naphtha/ NGL is cracked to get lighter hydrocarbons. Recycle pyrolysis furnace is provided to crack ethane/ propane rich recycle streams. The hot lighter hydrocarbons from furnaces are cooled in waste heat recovery exchangers where high pressure steam is generated. Those cooled hydrocarbon is fed to the quench section to separate out fuel oil, gasoline and lighter components using quench oil and quench water as quench media. The quenched cracked gas is compressed in centrifugal compressor to facilitate recovery of products in the downstream equipment. Before the final stage of compression, the cracked gas is treated with caustic solution to remove acidic gases e.g. CO_2, H_2S etc.

The cracked gas is dehydrated in dryers to remove moisture content and chilled, prior to feeding to demethaniser where methane rich stream is recovered to use it as fuel in the furnace.

The demethaniser bottom product is sent to deethaniser. The overhead product is C2 hydrocarbon and bottom product is C3 and heavier hydrocarbons. The C2 hydrocarbon is fed to ethylene tower after removing acetylene where ethylene product is recovered from top, bottom ethane is recycled to the furnace. The bottom stream of deethanizer is fed to depropaniser and propylene stripper/ rectifier respectively to recover propylene in the top section of propylene rectifier and the bottom stream which is propane rich is recycled to furnace. Bottom of depropaniser is sent to Butadiene Unit. The Butadiene Unit produces a mixed C4 distillate product and raw pyrolysis gasoline as bottoms. Thus produced Ethylene & Propylene are used for the captive consumption.

Raw pyrolysis gasoline is hydrogenated in 2 stage GHU before feeding to aromatic plant. C5 rich and C9 rich stream is recovered from GHU by distillation. C6-C8 stream is sent to Aromatics Recovery Section.



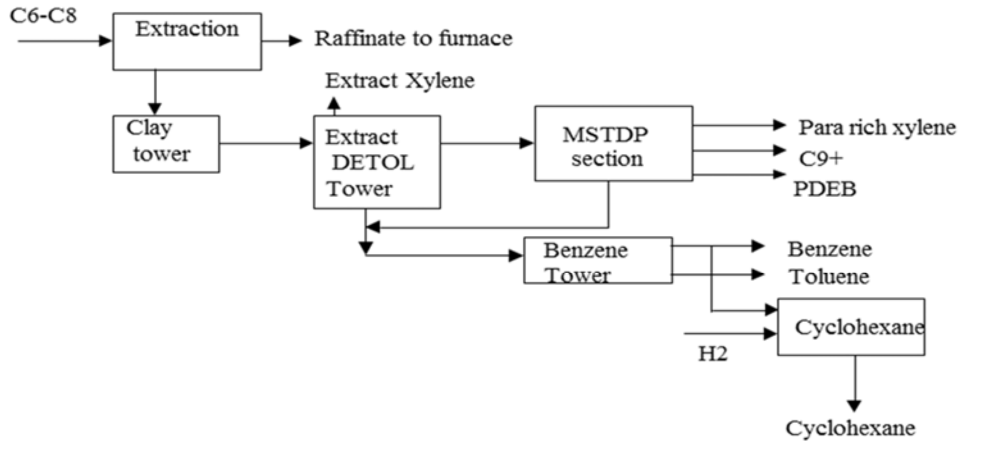
BLOCK FLOW DIAGRAM - CRACKER PROCESS

Aromatic Recovery Section:

The section is designed to process C6-C8 cut of the cracking section for the recovery of Benzene, Toluene, and Xylene.

The aromatics section consists of Extraction Section, Purification Section & Selective Toluene Dis Proponiation (MSTDP) Section/ PDEB section.

In the extraction section the aromatics & non aromatics streams are separated out by Extraction with solvent. Nonaromatic stream is (called Raffinate) sent back to cracking unit for co cracking with fresh Naphtha. Recovered aromatics stream is fed to the clay tower for removal of the colour. The stream then is fractionated in Extract Detol Column where Benzene and Toluene are separated from Xylene. The top product stream of this column is fed to the Benzene column for the separation of Benzene & Toluene. The Toluene is further processed in MSTDP section it is converted to Benzene and Xylene. This section is used for production of PDEB from mix Xylene. Part of Benzene is hydrogenated in two stage fixed reactor in the presence of Nickel Catalyst.



BLOCK FLOW DIAGRAM - AROMATICS RECOVERY PROCESS

Proposed debottlenecking activities:

- Considering multiple feed e.g. Propane, Ethane, n Butane and Naphtha
- Optimisation and debottlenecking of limiting equipments
- Addition of parallel equipment in case required

Process Description for Para Di Ethyl Benzene Plant

Aromatics section of the Cracker plant produces Benzene, Tolune & Xylenes. Mixed xylenes can be either sold or reprocessed in the existing set up of Aromatics plant to produce a value added product – PDEB.

A mixture of Ethylene and Mixed xylenes is preheated and reacted (at 325^0C temp. & 4 Kg/cm^2 pressure in presence of super selective catalyst). Hydrogen acts as a carrier gas during the reaction. Reactor bottom is taken to an accumulator (V 301) through a series of condensers. From V –301 top, hydrogen is recovered and sent to Fuel gas pool. V –301 bottom is taken to column C 205.

C – 205 top stream (consisting of unreacted Mixed xylenes) is recycled as reactor feed. C –205 bottoms (PDEB & heavies) are passed through clay tower (V – 303 N) and taken to column C 203.

C – 203 top is recovered as PDEB product and the bottoms are recovered as CBFS (Carbon Black Feed Stock).

PDEB is a value added product produced in place of mixed xylenes. The PDEB plant capacity will be increased by addition of a column.

Cyclohexane Process Description:

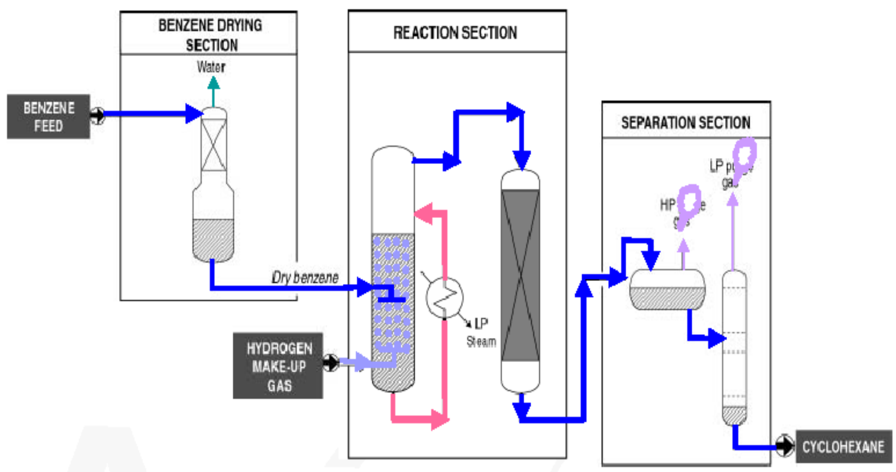
Cyclohexane plant is divided in to Feed section, Reaction section and separation section. Feed section is provided to remove water from Benzene feed so that water controlled less than 100 ppm, It consist of Benzene dryer and associated LP steam reboiler and condenser. Benzene with less than 100 ppm moisture is fed to reaction section. Benzene from Dryer bottoms is preheated against Finishing Reactor effluent in Benzene Preheater. Hot benzene is then routed to the Liquid Phase Reactor. In the Liquid Phase Reactor, benzene is mixed with Hydrogen. In the Liquid Phase Reactor, bulk of the benzene hydrogenation is achieved (approx. 99%) at temp of 215^oC and reactor pressure of 23.7 Kg/cm^2g.

As the benzene hydrogenation reaction is highly exothermic, heat of reaction is removed in a pump around circulation through a steam generating exchanger. The Pump around Pumps are operated in parallel and circulate the reactor content through the Pump around Cooler where heat is eliminated by the generation of low pressure steam.

Soluble catalyst is injected in the pump around system at the outlet of the Pump around Cooler for reaction requirement. The vapour leaving Liquid Phase Reactor then moves through the fixed catalyst bed in the Finishing Reactor where the last traces of benzene are converted to cyclohexane. The vapour effluent is cooled and condensed in three exchangers, the Boiler Feed Water Preheater, the Benzene Preheater and the Hydrogen Preheater. Condensation of the effluent is further maximized in the Effluent Cooler.

Seperation section

The excess of hydrogen and light ends are separated from the liquid in the H.P. Separator. The liquid further sent to LP separator for separating remaining Hydrogen and light end and product cyclohexane sent to storage



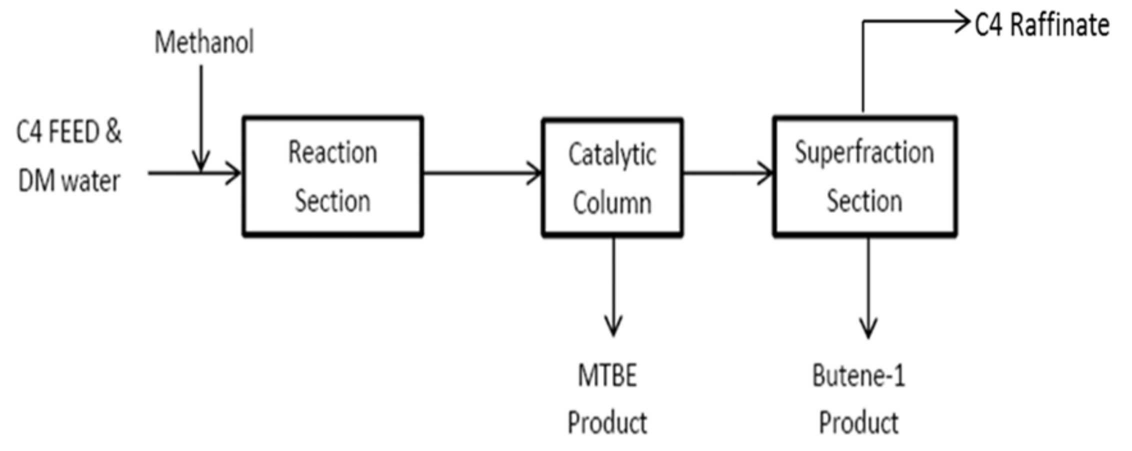
BLOCK FLOW DIAGRAM FOR CYCLOHEXANE PLANT

3.3 Cracker Byproduct Upgradation: Process Description for manufacturing Butene -1 and Methyl Tertiary Butyl Ether (MTBE)

C4 stream (mixture of isobutylene (42%), Butene-1 (32%), n-butane, trans-butene, cis-butene, isobutene) from Cracker plant is washed to remove the impurities and sent to reaction section. Methanol is purified for removal of dissolved oxygen and added to the reaction. The reaction takes place in two stage reactors. Main reactor is an expanded bed reactor with an up flow whereas finishing reactor is a fixed bed reactor with down flow.

Reaction is followed by catalytic fractionation.

In catalytic fractionation section, residual conversion takes place to produce MTBE and also MTBE and C4 cut are separated. C4 cut and excess methanol are recovered as liquid distillate and MTBE as bottom product. Excess methanol is recovered by water washing of C4 raffinate and the raffinate is then sent for fractionation through coalesce. In fractionation section, the C_4 raffinate is first splitted into n-butane and butene-2 rich cut and butene-1 and isobutene cut by the C_4 splitter columns. The Butene-1 rich stream is then obtained by distillation in the de isobutanizer. C4 Raffinate is stored and recycled to Cracker for cracking as well as sold as fuel.



BLOCK FLOW DIAGRAM FOR MTBE/ BUETENE - 1 PROCESS

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments
- Feed composition optimisation

A Process Description for manufacturing Butadiene

The mix C4 feed to the Butadiene Unit from Cracker Plant.

Butadiene Plant is divided in to sections, viz. Extraction, Purification & Solvent Recovery.

Extraction section

C4 mix feed is fed to No. 1 EDC (extractive distillation column) (upper) along with solvent, comprising of ACN (Acetonitrile), Ethanol and water to extract out 1,3 BD (butadiene) from the feed to the bottom. After washing with water Butanes and Butenes are transferred to OSBL.

1,3 BD as side cut vapor from No.1 EDC (lower) is fed to the bottom of the No. 02 EDC which separates ethyl acetylene and vinyl acetylene. Methyl acetylene comes overhead together with Butadiene and C5 heavies sent to the Purification section for further purification.

Purification Section

No.2 EDC overhead are sent to the Tailing Column, which separates 1, 2 - BD, cis—butene-2 and C-5 hydrocarbon to column bottom. These heavies are then sent to sphere via

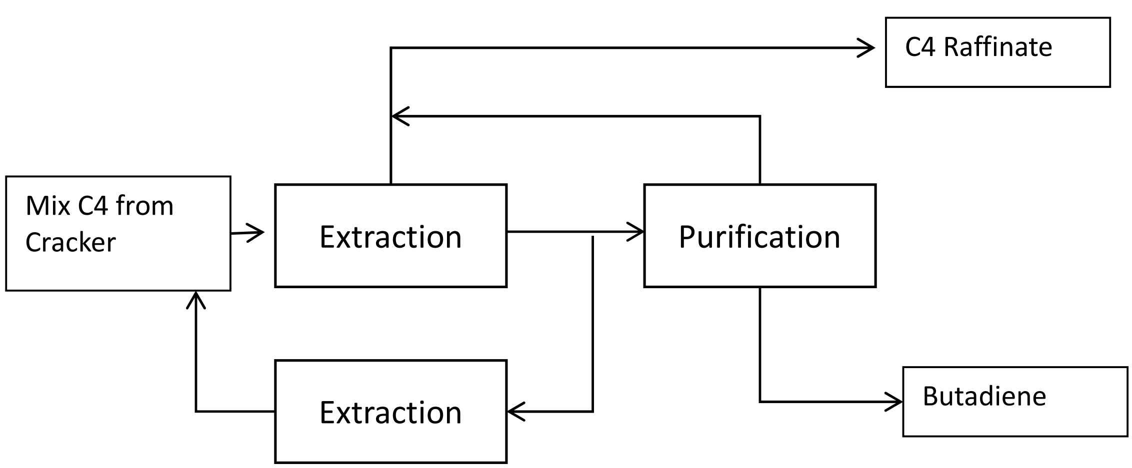
BB Washer. All of the heat required is supplied from the lean solvent. 1, 3 -BD along with Methyl acetylene (MA) are fed to Topping column where MA is removed to Column overhead.

The bottoms of the No. 1 EDC (lower) sent to the Solvent Stripper to separate the remaining hydrocarbon from the solvent back to the No.1 EDC. Vapor containing a small amount of impurities such as ethyl acetylene, vinyl acetylene and 1, 2 –BD is separated from the side of the stripper. It is diluted for Butene rich stream and sent for hydrogenation in Cracker plant after washing.

Solvent Recovery Section

For the solvent recovery from various wash water streams and reflux drum boots from EDC and Tailing/Topping Column Solvent Recovery Section is recovered from the overhead of the SRC and fed back to the system. Some water from the bottom of SRC is sent to BB Washer/SSC Washer as wash water and remainder is taken out of the process and sent to the ISBL OWS (oily water sewer) pit and then pumped in to the cracker OWS pit.

The Stripper Column bottom pump feeds the solvent circuit in the plant. An extensive heat recovery system has been designed around the solvent circuit to optimize the energy consumption of the plant. The solvent is finally cooled to 50°C and fed to EDC (U) and EDC No. 2.



Block Flow Diagram – Butadiene Recovery Process

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments

B Process Description for manufacturing of Proposed C5 Products & its derivatives

The brief process descriptions are as follows:

i) C5 Splitter

The C5 splitter plant separates cis/trans 1,3 pentadiene “Pips”, CPD & DCPD, and Isoprene out of the crude C5 stream from the cracker. This extraction can be accomplished by the use of extractive distillation with a number of solvents, with input from the customer.

The proposed C5 Plant includes the following sections:

- CPD Dimerization
- PIPs Recovery
- DCDP Recovery
- Isoprene Recovery
- Solvent Regeneration

CPD Dimerization

C5 feed at controlled temperature is fed to dimerization reactor before distillation. In the reactor, cyclopentadiene “CPD” dimerizations to di-cyclopentadiene “DCPD”. After dimerization the product is directed to the C5 splitter column, where Isoprene and lights Fraction is removed as the overhead product. The main purpose of this splitter column is to separate the Isoprene, Isopentane and most mono-olefins from CPD, DCPD, Cyclopentane, Piperylenes and C6+.

PIP’s Recovery

The bottom product of the C5 splitter is sent to the Raw PIPs column. The overhead of this column is rich in Piperylenes. The cooled product is fed to the PIPs finishing column. 60% Piperylene is produced by the PIP’s finishing column. This product is directed to the storage after cooling. The bottom product of the PIP’s finishing column is combined with the bottom product of the Raw Isoprene column of the Isoprene section and the bottom product of the C5 splitter column and returned to the Raw PIPs column. The Piperylenes product can be used as a feed of the Resin unit.

DCPD Recovery

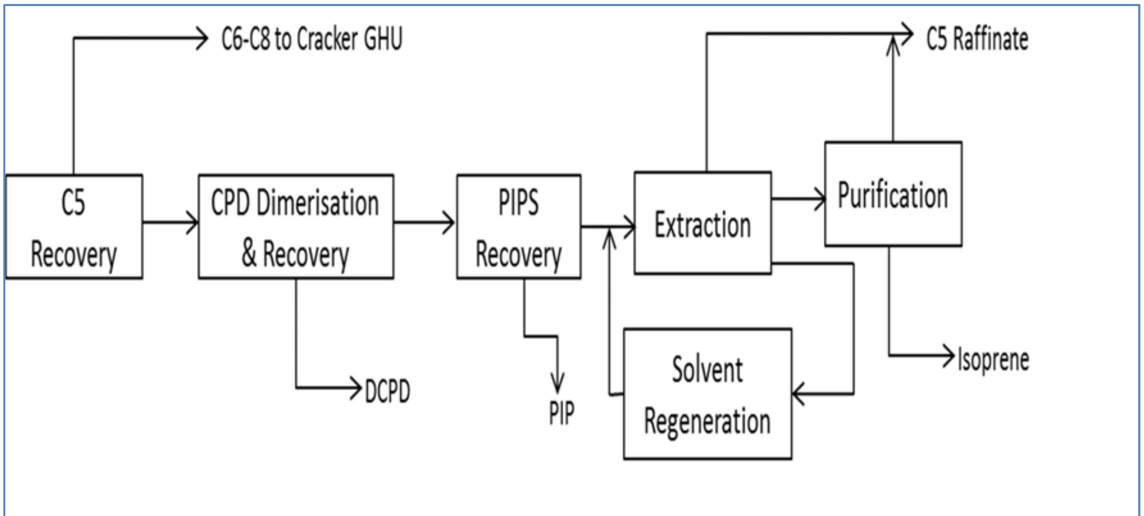
The bottom product of the Raw PIPs column is directed to the 1st DCPD column. This column is operated under vacuum. A C5-C6 fraction is produced on the top of this column and concentrated 70 % DCPD product is carried out of the bottom for HCR production. 85% can be produced by processing in an additional column. 70% DCPD product can be directed to the Resin unit or to DCPD columns #2 and #3 for production of higher quality DCPD. The 2nd DCPD column is removes light products of dimerization; the bottoms of the DCPD column contain co-dimers, trimers and other heavier components.

Isoprene Recovery

The C5 fraction containing Isoprene, Isopentane and mono-olefins is combined with the overhead of the PIPs finishing column, is heated and enters the first isoprene extractive distillation column EDC. In this first EDC, Isoprene and other dienes are extracted by the solvent to the bottom, while paraffins and olefins come out from the top as a raffinate. Solvent with a polymerization inhibitor is used for this process. The raffinate is directed to the storage. The bottom of the EDC bottom product is pumped to the first solvent recovery column where the Isoprene with dienes is removed with the overhead product as an extract. Lean solvent from the bottom is returned to the EDC through the range of heat exchangers. Extract is directed to the Raw Isoprene column for the heavy products separation. The Raw Isoprene column removes the rest of heavy dienes in the bottoms. Any polymers formed are removed in the bottoms. 98% Isoprene is removed as the overhead product of the Raw Isoprene column from where pure Isoprene is recovered by extractive distillation.

Solvent Regeneration

A small part of the lean solvent of both extractive distillation stages is directed to the solvent regeneration. The solvent regeneration is performed in the solvent regenerator, which is operated under vacuum and in the Solvent finishing column. Heavy products of polymerization are removed in the solvent regenerator. The Solvent finishing column is provided to remove water and the rest of alkynes and other hydrocarbons.



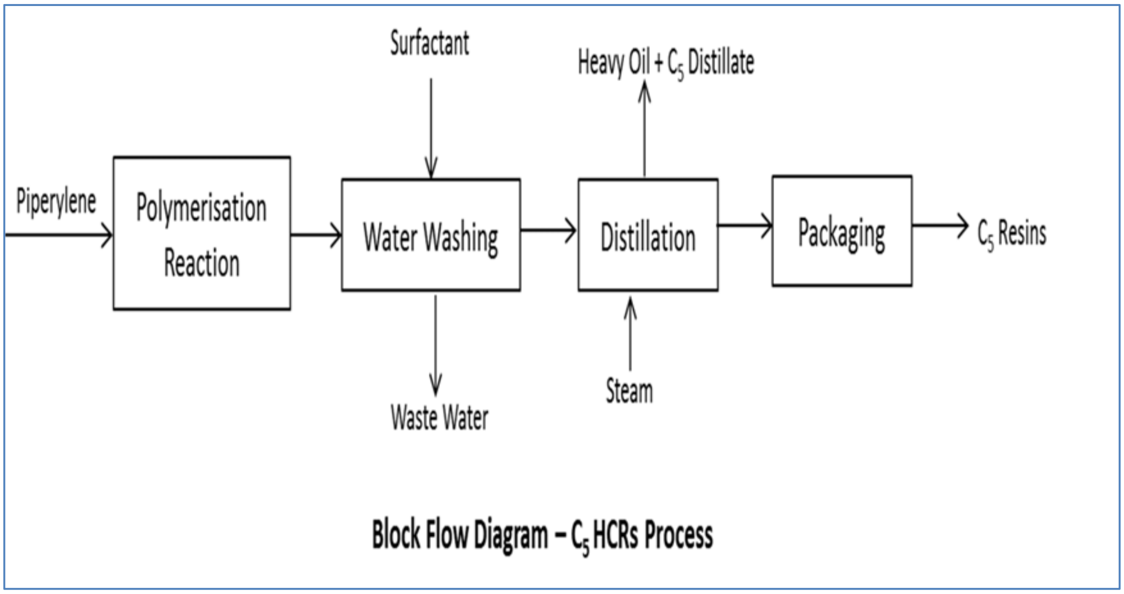
Block Flow Diagram – C5 Recovery Process

ii) C_5 HCRs Plant

Aliphatic resin unit includes several distinct sections:

- Reaction section, where the piperylene polymerization takes place by Friedel Craft reaction.
- Distillation section, where the unreacted material is separated from the finished resins.
- Pastilation and packaging section, where the finish product is converted from liquid form into solid chips and packed in 1-ton or 25 kg bags.

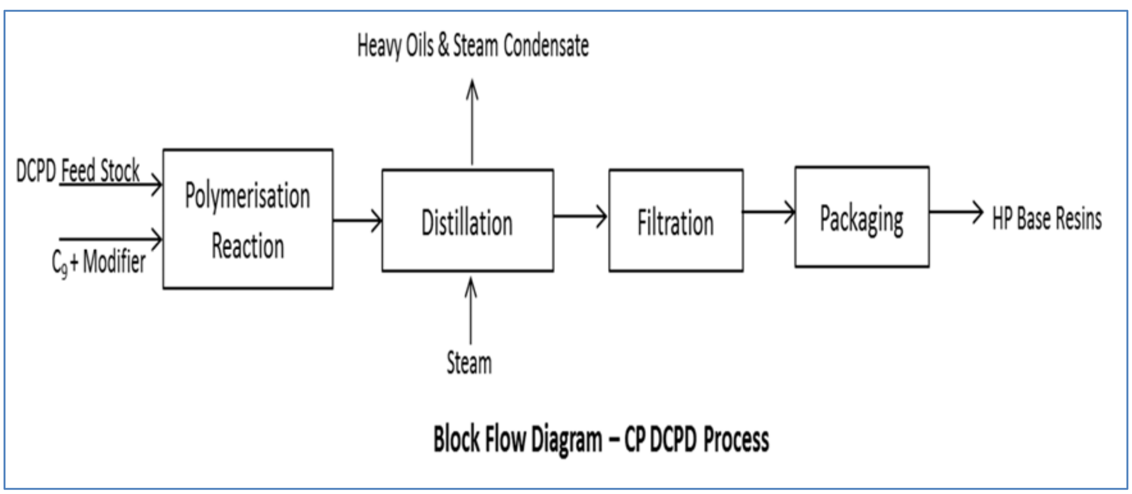
The reaction section operates in batch operating mode, while the rest of the plant is designed for continuous operation.



Heat Poly (HP) DCPD resin unit includes:

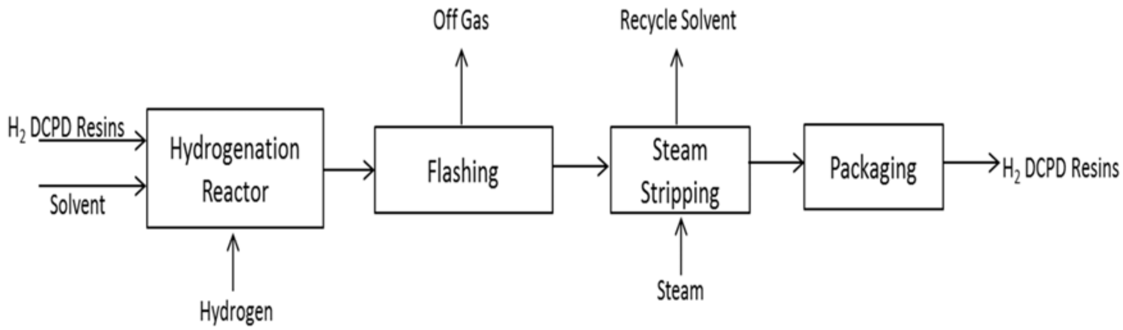
- Reaction/separation section, where the HP polymerization takes place and the unreacted material is separated from the resin product under vacuum by steam stripping.
- Pastillation and packaging section, where the finished product is converted from its liquid form into solid chips and packed in 1-ton or 25 pound bags.

The reaction/separation section operates in batch mode, while the pastillation/packaging section is designed for continuous operation. The DCPD raw material represents around 50% wt of HP DCPD base resin formulation, while the remaining 50% wt are C9 hydrocarbons and another hydrocarbon-type modifier. The entire HP DCPD resin unit operates in batch operation mode with a cycle length of ~40 hours.



d. H_2 DCPD HCRs

The hydrogenated HCR plant operates by blending molten HP resin together with a solvent. This solution is then mixed with hydrogen and sent to the hydrogenation reactor where the hydrogenation reaction takes place at high pressure and temperature. After the completion of the reaction, the reactor effluent is depressurized through several flashes, where excess of the off gas is removed. The remaining reactor effluent is fed to the steam stripping column, where the solvent is recovered at the top and recycled back to the process. The separated resin recovered at the bottom. The operation is assisted by direct injection of live steam. The final resin product is sent to the pastillation and packaging system (flakes or pastilles) to be ready for storage in the warehouse.



Block Flow Diagram – H_2 DCPD Process

Under proposed expansion activities new C5 product derivatives and resin plant will be installed.

3.4 Process description for manufacturing of Butanediol

Butanediol is manufactured using Linde process. The manufacturing process consist of two steps:

1) Ethynalation Step
2) Hydrogenation Step

<u>Ethynalation Step</u>

$HC \equiv CH$	+	HCHO	$\rightarrow$	$H-C \equiv C-CH_2OH$
acetylene		formaldehyde		propargyl alcohol
$H-C \equiv C-CH_2OH$	+	HCHO	$\rightarrow$	$HOCH_2-C \equiv C-CH_2OH$
propargyl alcohol		formaldehyde		Butadinol

In this step acetylene and formaldehyde is fed to reactor at the temperature 90°C & pressure 1.3 bar. The intermediate compound propargyl alcohol is produced which is again reacted with formaldehyde to give butyne-diol.

<u>Hydrogenation Step</u>

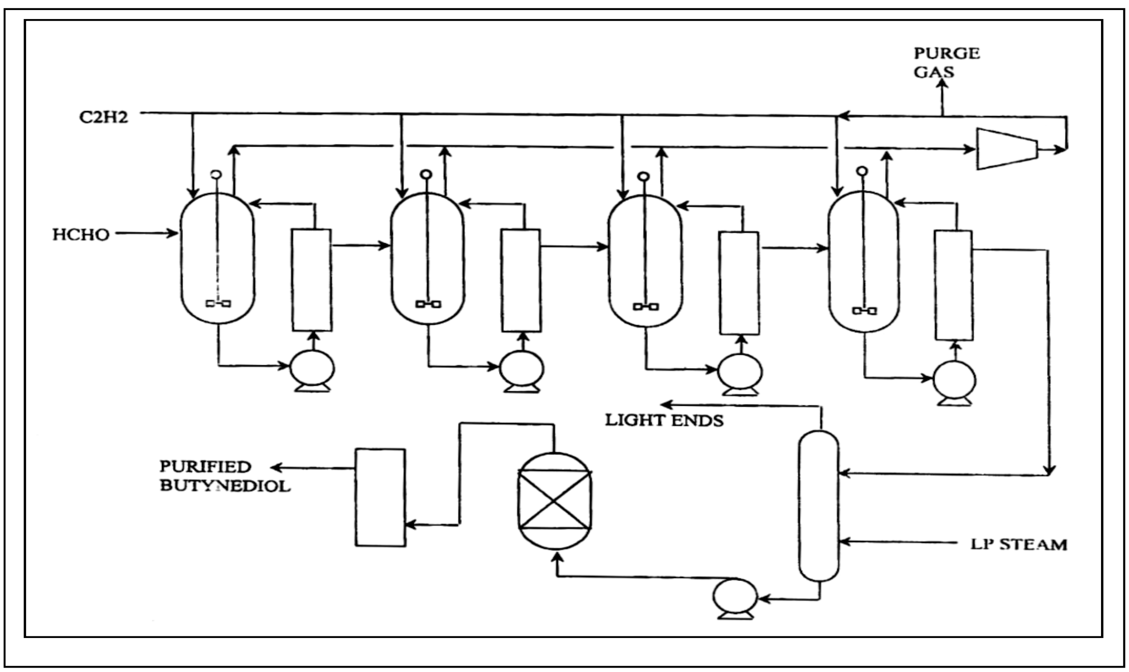
$$HOCH_2-C \equiv C-CH_2OH \quad + \quad H_2 \rightarrow \quad HOCH_2\text{-}CH=CH-CH_2OH$$

butadinol hydrogen 1-4 butadinol

$$HOCH_2\text{-}CH=CH-CH_2OH \quad + \quad H_2 \rightarrow \quad HOCH_2\ (CH_2)\ 2\ CH_2OH$$

butadinol hydrogen 1-4 butadinol

In this step the hydrogenation is carried out in two hydrogenators. Butadinol is treated with hydrogen at the temperature 70°C and pressure of 25 bar to get the product 1-4 butadinol the same reaction is carried out in second hydrogenator at the temperature of 150°C and pressure 25 bar.



Block Flow Diagram for Butanediol

3.5 Process Description for manufacturing of Polybutadiene Rubber (PBR):

Polybutadiene rubber is produced by solution polymerization of Butadiene monomer. Normal heptane and toluene is used as solvents. Three component based Zigler-Nata catalysts system is employed (Tri alkyl aluminium, Nickel naphthenate and Boron trifluoride) to carry out polymerization reaction to produce nickel based Butadiene Rubber so that high stereo specificity is achieved. The plant will have potential to produce neodium based Butadiene rubber.

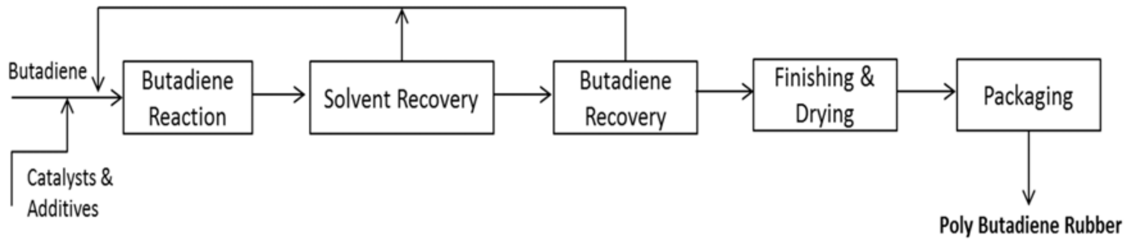
Exothermic heat of polymerization is removed by liquid ammonia boiling at subzero temperature inside reactor jackets. Four stirred tank reactors are used in series to achieve Butadiene conversion to the tune of 90%. The rubber solution so obtained is stabilized by addition of antioxidant at reactor outlet and stored in homogenization tanks. Subsequently the solution is flashed (stripped) with hot water and steam to precipitate rubber in hot condensate. Solvent so evaporated is sent for purification in distillation towers from where they are recycled to reactors. From solvent purification section, high boiler bottoms is recovered as by product and sold. The rubber crumbs precipitated in hot water is sent to rubber drying /finishing section where they are dewatered thru series of mechanical equipment (shaker screen, expeller and expander etc.) and dried to meet volatile matter specification. The dried crumbs obtained, are then pressed into 35 kgs. Bales in a baler machine and wrapped by LDPE films in a film wrapper. They are then packed in paper bags and stored in metal crates in the warehouse for dispatch. Rubber bales, due to their cold flow properties get deshaped under pressure. Hence metal crates are used for storing of rubber bales. Fine rubber particles which come out during equipment cleaning are processed in slop stripper and recovered as PBR scrap

Butadiene polymerization reaction is highly sensitive to moisture and other impurities present in monomer as well as in solvents and special care is required to be taken to operate purification and other operating systems to run within very close tolerances with respect to process parameters.

The PBR plant is recently commissioned however during detail designing it is found that by doing optimisation and debottlenecking of certain equipment, plant will produce more output.

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipment



Block Flow Diagram – PBR Process

3.6 Process Description for Manufacturing of Styrene Butadiene Rubber (SBR)

Styrene Butadiene Rubber (E-SBR) is manufactured by emulsion polymerization technology. Main Raw materials are Styrene and Butadiene. Styrene and Butadiene are charged in emulsifier along with soap, water and other ingredients. This emulsified solution is charged in series of agitated reactors along with catalyst and modifier. The reaction is exothermic and is controlled at 5-10 deg. C with the help of Ammonia circulating in coils inside the reactors. The reaction is carried out up to 60-65 % conversion, which gives optimum properties in rubber. At this conversion reaction is terminated by addition of shortstop. The Product is called Latex.

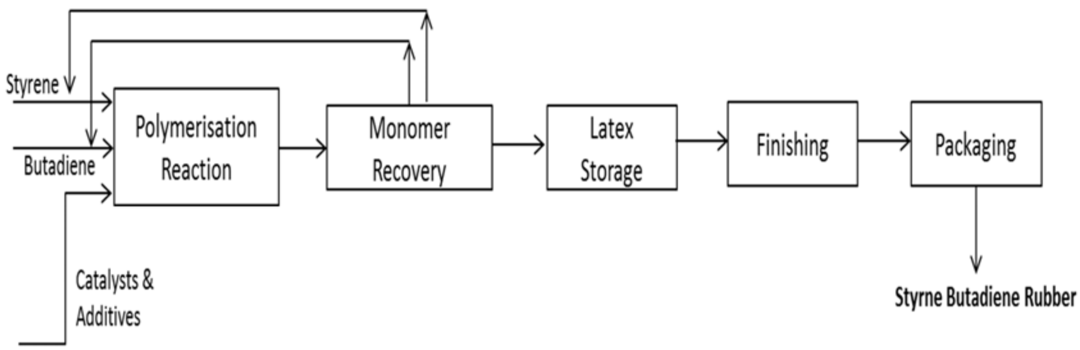
The unconverted Butadiene is recovered by pressure and vacuum flashing. It is condensed and recycled to the system. The unconverted Styrene is recovered by stripping and subsequent condensation and recycled back after purification. Toluene is used as solvent for BD purification. Toluene is also useful for online cleaning of reactors. During purification, heavies are separated out from unconverted Butadiene and styrene and stored in vessels and finally sold. Stripped latex is stored in tanks (and blended if required to achieve proper physical properties) and sent to finishing lines for conversion into rubber.

Antioxidant is added to Latex and Latex is coagulated with the help of Salt and Sulfuric Acid. Rubber crumbs obtained in coagulation are filtered and washed with water. These crumbs contain 50% moisture. These crumbs are then passed through an expeller to reduce the water content to about 10 %. Dewatered crumbs are shredded and further dried in a Tunnel Dryer. Dried rubber crumbs are baled in Baler, passed through a metal detector and finally shrink wrapped before packing in paper bags or cartons. Fine rubber also gets accumulated in the equipments during the process cycle in different sections of the plant due to stickiness in nature, and are recovered during cleaning of equipments. These rubbers are collected as SBR scrap and sold.

The SBR plant is recently commissioned however during detail designing it is found that by doing optimisation and debottlenecking of certain equipments, plant will produce more output.

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments.



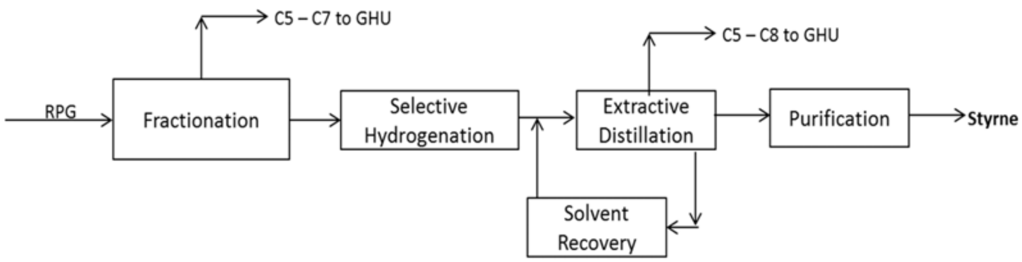
Block Flow Diagram – SBR Process

3.7 Process Description for Manufacturing of Styrene

The Styrene manufacturing unit includes a pre-fractionation section plus the extractive distillation section, producing high-purity styrene. C8 pre fractionation stream is fed to PA selective Hydrogenation section to remove Phenyl Acetylene (PA). Hydrotreated C8 cut is sent to extractive distillation column wherein styrene is selectively extracted at the bottom and the top is collected as raffinate. The bottom stream is sent for solvent recovery.

The styrene product recovered from the Solvent recovery section is sent to dryer section for removal of moisture and colour treatment. After the drying and chemical treatment, styrene extract is sent to Styrene Finishing Column. The finished product is sent for storage.

This plant is proposed as a new plant.



Block Flow Diagram – Styrene Process

3.8 Process Description for Manufacturing of Poly Vinyl Chloride (PVC)

PVC Process is divided into two sections viz. VCM & PVC.

VCM Section:

The Vinyl Chloride Monomer (VCM) process where Dichloroethane (EDC) is thermally cracked to VCM and HCl. VCM is recovered as high purity monomer stored in carbon steel spheres and used in polymerization of all grades of PVC without any purification. The by-product HCl is recovered as gaseous, high purity anhydrous HCl at a pressure suitable for direct feed to the Oxychlorination process.

The Oxychlorination process combines by-product HCl with ethylene to produce EDC, which, after purification by conventional distillation, is fed to the VCM furnaces. Oxy reaction takes place in a fluid bed of catalyst, which consists of principally Cupric Chloride impregnated upon a fluid support. Air or Oxygen can be used as the source of Oxygen for Chemical reaction.

In direct chlorination process, ethylene and chlorine are allowed to react to produce EDC. The required chlorine is obtained from the chlorine storage facility located within the complex. The purification of EDC is common to both oxychlorinator produced EDC and Chlorinator produced EDC.

PVC Section:

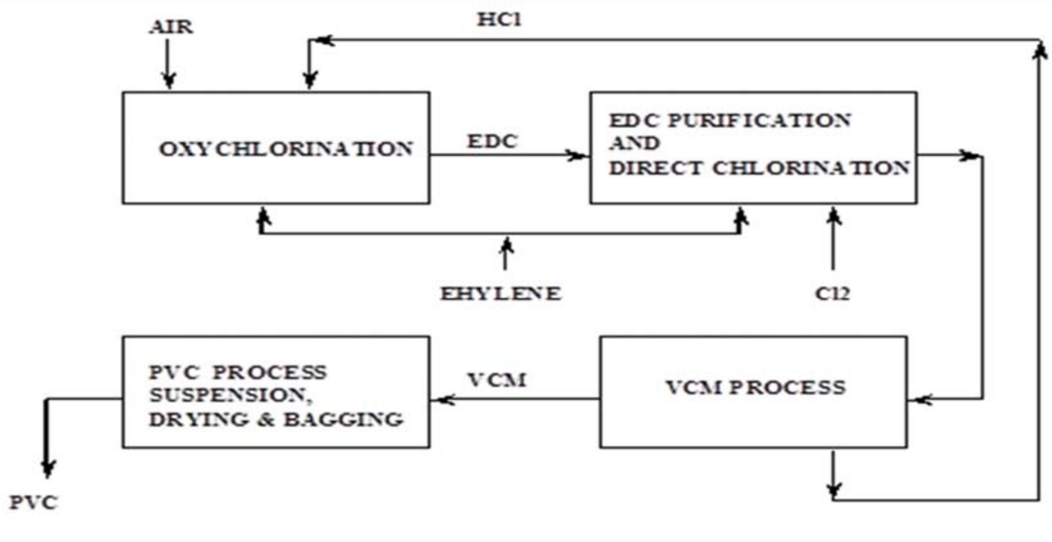
The PVC suspension process consists of the following operating areas:

- Additives preparation and charging
- Polymerization
- Slurry stripping and bending
- Resin drying
- Monomer recovery

Demineralized water, VCM, emulsifiers, buffer and catalyst(s) are added in the amounts and sequence specified by the recipe for a given product. Suspension polymerization is conducted by dispersing the monomer in the water phase by agitation. Cooling water is regulated automatically in order to maintain the appropriate reaction temperature when desired conversion is reached, short stop is injected to terminate the reaction. The charge is transferred to the stripping column fed tank for recovery of a portion of the unreacted monomers. The recovered monomer is returned to the recovered VCM tank and used for further polymerization. The stripped slurry from the bottom of the column is transferred to blend tanks. The blend tanks provide the slurry feed for the rotary drier.

The polymer slurry particles formed are large enough (about 140 microns) to allow centrifuge before drying. The dewatered slurry is fed into the drier in the form of wet cake. The wet cake is dried by heated air and pulled through the rotary drier with the air by the main exhaust blower. Drier resin is separated from the air by the primary cyclone and wet scrubber. PVC particles are passed over the screens to remove any large particles. Resin is conveyed to the check silos by the conveying system and any remaining fine resin particles in the air steam are scrubbed in the secondary collector. Most of the scrubber outlet slurry is transferred back to the blend tanks.

Centrate from centrifuge is directed to an interceptor pit where PVC fines settle down by gravity and are recovered as Wet Resins. Overflow from interceptor pit is sent to ETP where using centrifuge remaining PVC fines are separated and recovered as wet resins.



BLOCK FLOW DIAGRAM - PVC PROCESS

It is proposed to augment the capacity of existing PVC plant by making changes in the plant hardware.

Proposed debottlenecking activities:

- Addition of furnace for EDC Cracking.
- Replace reactor with larger capacity for oxychlorination.
- Optimisation and debottlenecking of limiting equipment in both VCM and PVC process.

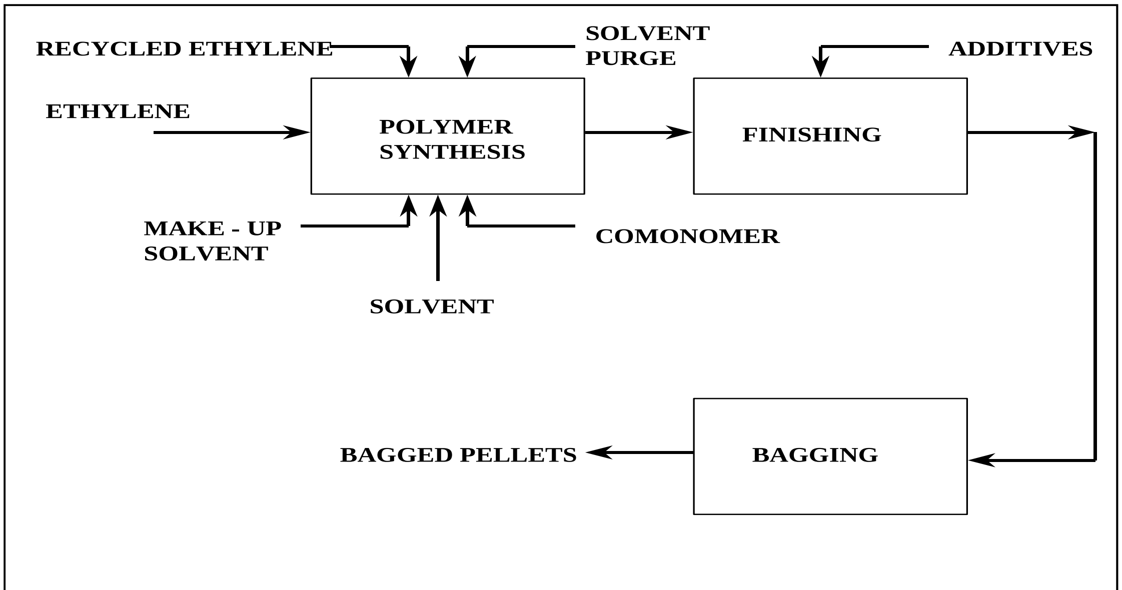
3.9 Process Description for Manufacturing of Polyethylene

The reactor is fed a carefully controlled mixture of ethylene and co-monomer in a cyclohexane solvent. The reaction takes place entirely in the liquid phase with catalyst and chain transfer agent being injected at strategic points in the reactor system.

Following the reaction stage, catalyst is removed from the polymer solution, and unreacted ethylene, co-monomer if used, and cyclohexane is flashed off and recycled. The polymer is extruded into pellets, stripped off any residual hydrocarbons, dried and packed.

Catalyst is removed from the polymer by adsorption into a fixed bed of alumina. The process produces a purer polyethylene product meeting the most stringent FDA regulations on heavy metal residues.

Additive requirements are relatively small with a resultant low cost for the additives system. Detailed process flow sheet is enclosed.



BLOCK FLOW DIAGRAM - PE (I&II) PROCESS

Presently, there are two PE plants in RIL, Hazira. Under proposed expansion activities, the capacity of the existing PE plants will be augmented by making several changes in the plant hardware.

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments.

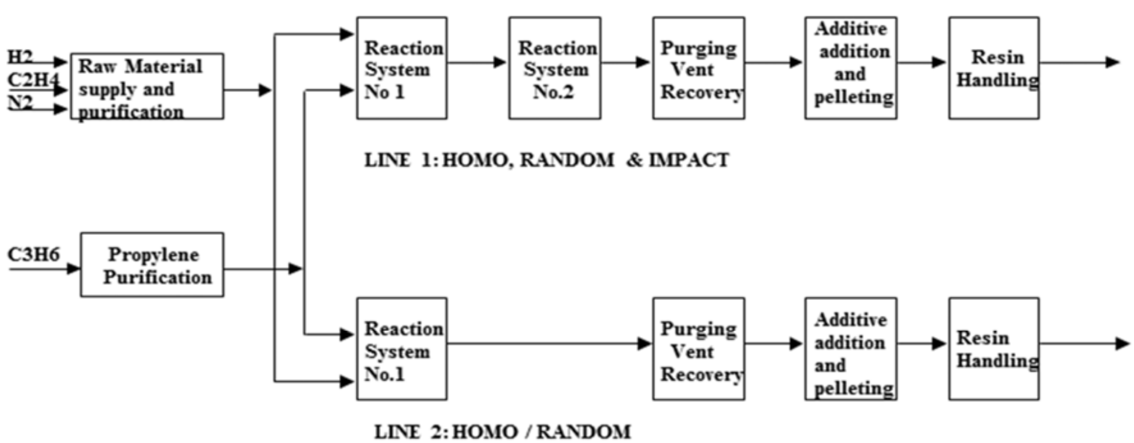
3.10 Process Description for Manufacturing of Polypropylene

Reactor feed streams (Propylene, Ethylene, Hydrogen & Nitrogen) are purified to the desired levels before feeding into reactor for polymerisation.

Homopolymer: Propylene polymerisation to polypropylene is initiated by Ziegler Natta catalyst or Relcat catalyst in presence of hydrogen in a fluidised bed reactor no 1 to form Homo polymer Resin.

Random Copolymer: Polymerisation of Ethylene and Propylene to Polypropylene is initiated by Zeigler Natta catalyst or Relcat catalyst in presence of hydrogen in a fluidised bed reactor no 1 to form Random Copolymer Resin.

Impact Copolymer: Polymerisation of Propylene to Homopolymer Resin is initiated by Zeigler Natta catalyst or Relcat catalyst in presence of hydrogen in a fluidised bed reactor no 1. The resin from Reactor no 1 is fed to Reactor no 2, wherein further polymerisation in presence of Ethylene, Propylene and Hydrogen is initiated with the help of residual catalyst of Reactor no 1 to form Impact Copolymer Resin.



Block Flow Diagram – PP Process

At a time only one type of resin can be produced per line. The resin is then sent to resin degassing and unreacted monomers are sent to vent recovery and then recycled back to reactors after separation. The Relcat catalyst is prepared in a catalyst preparation facility.

The degassed resin is sent to finishing section wherein additives are added to stabilise the resin and extrude it to pellets of uniform size and sold in 25 Kg. bags/ bulk tankages.

3.11 Process Description for Manufacturing of Mono Ethylene Glycol (MEG) and Ethylene Oxide

Fresh ethylene, recycle gas and oxygen are thoroughly mixed, preheated and passed through EO reactor consisting of large number of tubes filled with silver containing catalyst, where ethylene is converted by partial oxidation into Ethylene Oxide at elevated temperature and pressure.

The reaction product gas is scrubbed with neutralising liquid to remove acidic compounds and further cooled in EO absorber by counter current contact with water, which absorbs Ethylene Oxide and forms a dilute aqueous solution of Ethylene Oxide.

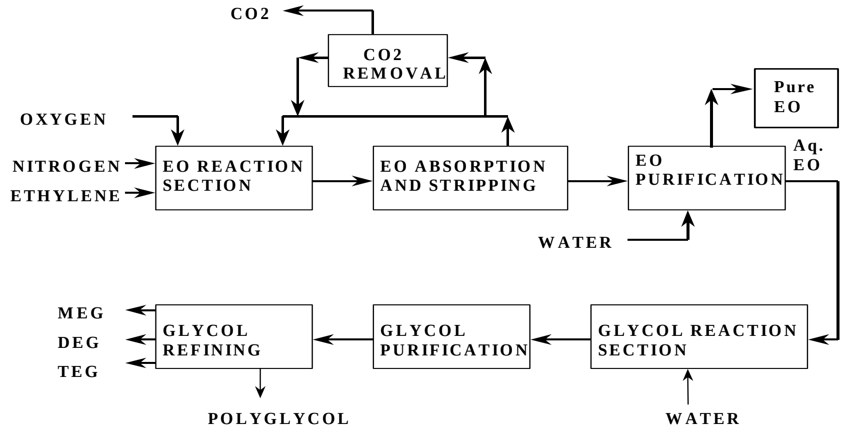
The gas after scrubbing and absorption of Ethylene Oxide is recycled back to the reactor via a recycle gas compressor. A slip stream is taken to CO2 removal section for removal of carbon dioxide formed in the reactor. This is achieved by absorption in hot potassium carbonate solution, which is regenerated in CO2 stripper. Dilute aqueous solution of Ethylene Oxide in water enters Ethylene Oxide stripper where Ethylene Oxide is stripped off. The lean solution after stripping of Ethylene Oxide is cooled and returned to Ethylene Oxide absorber. Ethylene Oxide from stripper are cooled, condensed and purified by passing through lights ends columns which removes lighter fractions. Purified Ethylene Oxide mixture is heated, mixed with additional water and passed through tubular Glycol reactor. The reaction takes place in liquid phase under elevated temperatures and pressure. The conversion is almost complete and the glycol water mixture is sent for evaporation.

In evaporation section, water is separated from glycol mixture in a triple effect evaporator with subsequent vacuum column.

Crude glycol mixture evaporation section is separated into various fractions viz. Mono Ethylene Glycol, Di Ethylene Glycol, Tri Ethylene Glycol & Tetra Ethylene glycols in a series of distillation columns. These products are cooled, stored and subsequently sent to offsite tankages.

Pure EO is distilled from Aq. EO to produce high purity EO which is stored in refrigerated vessels for dispatch. Raw materials are received from the associated tank farm.

The products are stored in the associated tanks farms and dispatched / loaded from there. There is also captive consumption of these products.



BLOCK FLOW DIAGRAM – MEG (I, II & III) PROCESS

Presently, there are three MEG plants in RIL, Hazira. Under proposed expansion activities, the capacity of the existing MEG plants will be augmented and a new MEG plant will also be installed.

Proposed debottlenecking activities:

- Increasing size of reactor and/or provide parallel reactor
- Optimisation and debottlenecking of limiting equipments
- Installation of Pure EO column
- New EO/ EG Plant

3.12 Process Description for Manufacturing of Purified Terephthalic Acid

The plant is divided in to two sections viz. Oxidation & Purification Sections.

Oxidation Section:

The Oxidation Plant consists of three main sections: Reaction, Product Recovery and Solvent Recovery.

In the Reaction Section Paraxylene feed stock is mixed with acetic acid solvent and catalyst solution. The combined stream is fed to the reactor where it is reacted with oxygen of air. The major portion of the terephthalic acid produced in the exothermic reaction is precipitated to form slurry in the reactor.

In the product Recovery section, reactor product is de-pressured and cooled in a series of three crystallizing vessels. Precipitated Terephthalic acid product is recovered by continuous filtration incorporating a solvent wash stage. Residual acetic acid in the filter cake is then removed in a continuous drier. The resultant product is conveyed to intermediate storage on the Purification Plant.

In the Solvent Recovery Section, impure solvent, recovered from the Reaction and Product Recovery Sections, is processed to remove the water of reaction, catalyst and unwanted reaction byproducts. The recovered solvent is fractionated to purify acetic acid suitable for re-use in the plant. The unwanted byproducts are stripped of acetic acid solvent and the aqueous concentrated residue slurry is dispatched for thermal oxidation or flaker.

The Oxidation Plant is designed for completely continuous operation. An important feature of the plant is the facility to return most of the filtered solvent to the Reaction Section, giving a catalyst recycle and thereby reducing the demand for fresh catalyst and solvent.

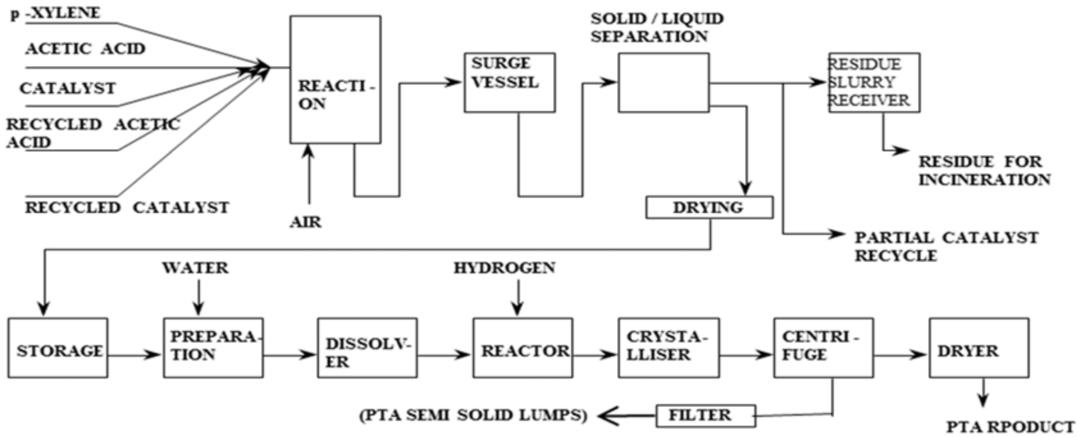
Purge stream is sent to catalyst recovery unit where catalyst is also recovered by precipitation and centrifuging to recycle to reactor.

Slip stream of solvent containing high methyl acetate is taken to convert methyl acetate back to acetic acid and recycle as solvent.

Purification Section:

The terephthalic acid (TA) product from the Oxidation Plant contains a small quantity of impurities which must be removed before the material can be used in the manufacture of polyester products, particularly bottles and film. This is achieved in the Purification Plant by selective catalytic hydrogenation of an aqueous solution of impurities saturated with hydrogen at elevated temperature and pressure. The purified terephthalic acid is subsequently crystallized and recovered by employing solid / liquid separation and drying steps.

The principal impurity 4 carboxy benzaldehyde (4 CBA) is an oxidation intermediate, which is hydrogenated to para-toluic acid. The para-toluic acid, being more soluble in water, remains in aqueous solution during the subsequent crystallization and product recovery stages.



BLOCK FLOW DIAGRAM - PTA (I, II & III) PROCESS

Proposed debottlenecking activities:

- Enriching air to increase production rate
- Optimisation and debottlenecking of limiting equipments and addition of pressure centrifuge

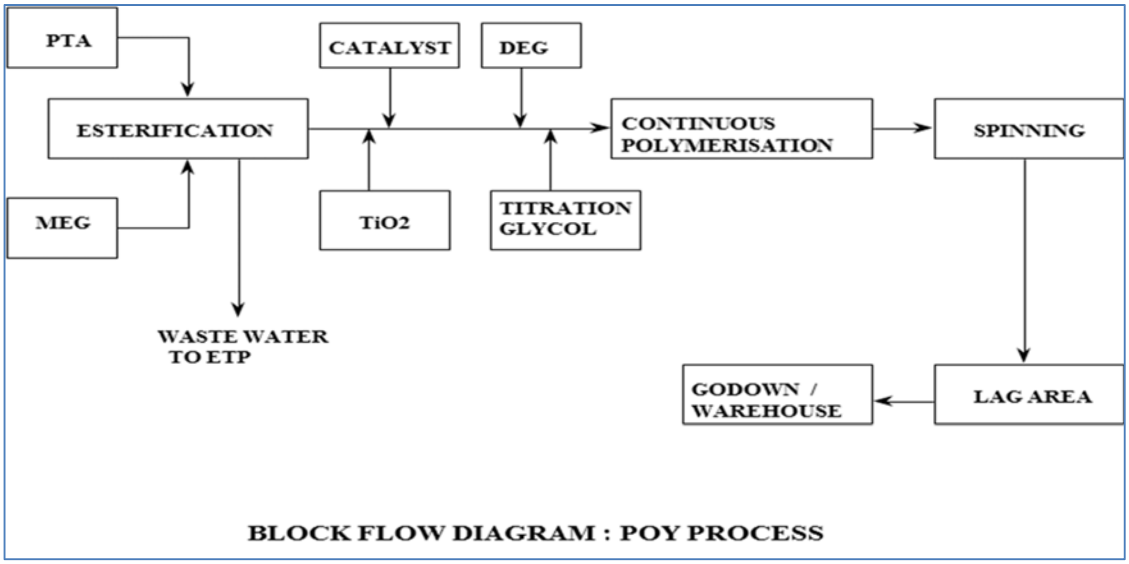
3.13 Process Description for Manufacturing of Polyester Products

3.13.1 Process Description for Manufacturing of Partially Oriented Yarn (POY)

Pure Terephthalic Acid (PTA) and Monoethylene Glycol (MEG) are mixed to produce Oligomer and water in the Esterification section. The oligomer is then pumped to polymerisation section after addition of chemicals namely catalyst, TiO_2, DEG & Glycol. The oligomer is converted into polymer through polymerisation reaction and is sent to spinning for converting it into Partially Oriented Yarn. The water generated in the process is sent to Effluent Treatment Plant.

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments

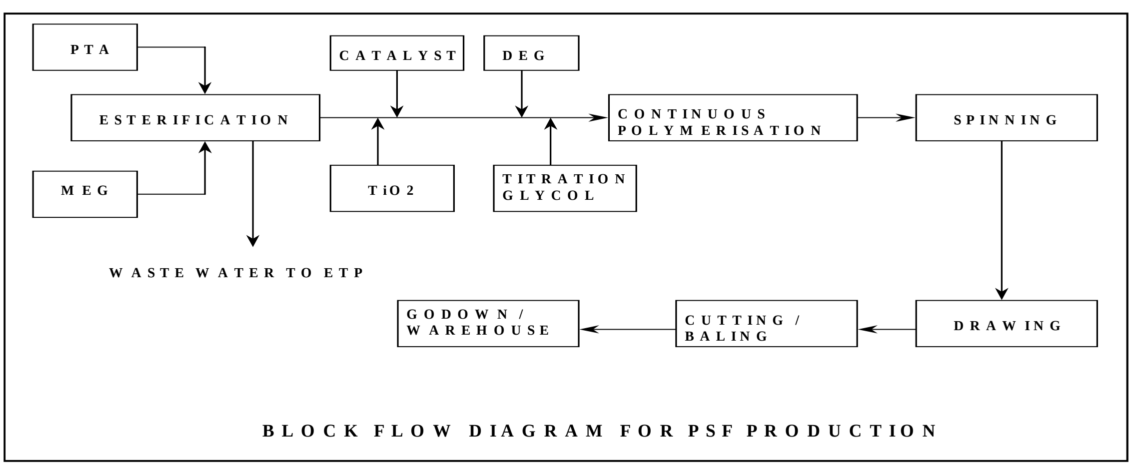


3.13.2 Process Description for Manufacturing of Polyester Staple Fibre (PSF)

Pure Terephthalic Acid (PTA) and Mono ethylene Glycol (MEG) are mixed to produce Oligomer and water in the Esterification section. The oligomer is then pumped to polymerisation section after addition of chemicals namely catalyst, TiO2, DEG & Glycol. The oligomer is converted to polymer through polymerisation reaction and is sent to spinning and the spin product is sent for drawing after which it is baled and cut. After cutting, the product is sent to warehouse. The waste water generated in the process is sent to Central Effluent Treatment Plant - II.

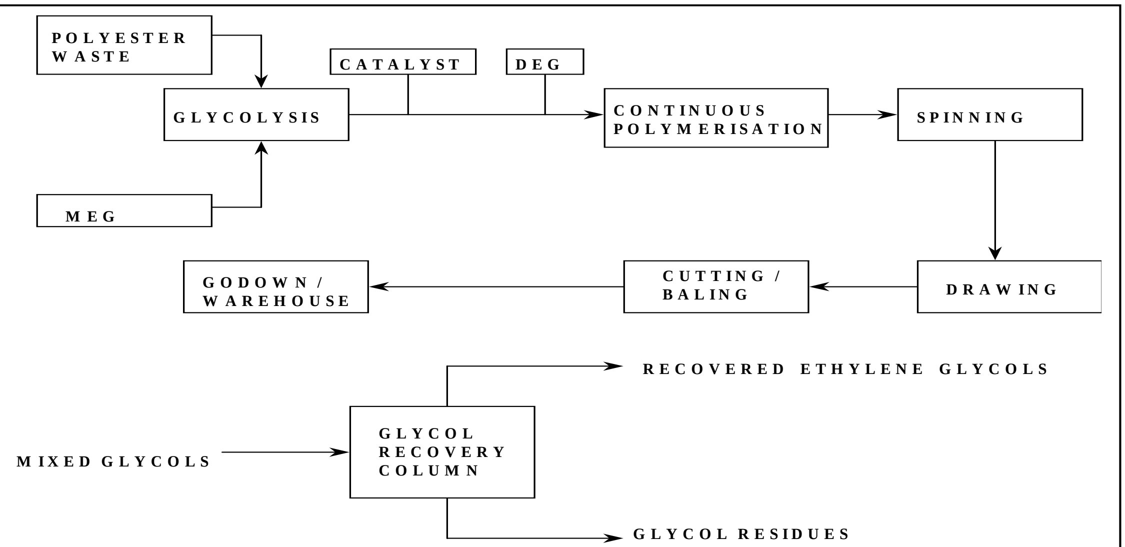
Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments
- Addition of new polymérisation and downstream units



3.13.3 Process Description for Manufacturing of Polyester Staple Fibre Fill (PSFF)

Polymer waste (Hard waste and Soft waste) and Monoethylene Glycol (MEG) are mixed to produce Oligomer and water in the Esterification section. The oligomer is then pumped to polymerisation section after addition of chemicals namely catalyst, TiO2, DEG & Glycol. The oligomer is converted to polymer through polymerisation reaction and sent to spinning and spin product is sent for drawing after which it is baled and cut. After cutting, the product is sent to warehouse. The waste water generated in the process is sent to Central Effluent Treatment Plant - II. In Glycol recovery column, Ethylene Glycols are recovered from top as Product and Glycol Residues are obtained from the bottom as by product.

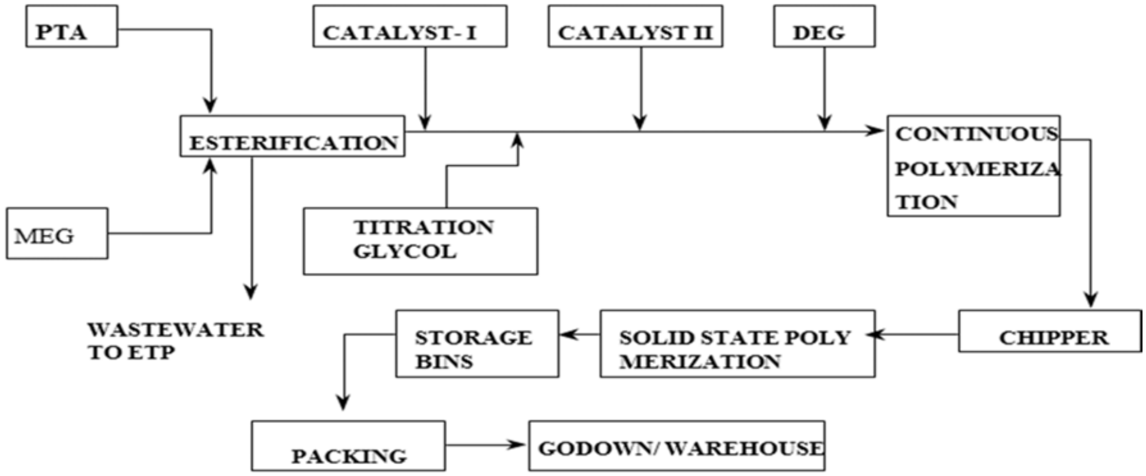


BLOCK DIAGRAM FOR PSFF PRODUCTION

3.13.4 Process Description for Manufacture of Polyethylene Terephthalate (PET)

Pure Terephthalic Acid (PTA) and Mono Ethylene Glycol (MEG) are mixed to produce oligomer and water in the esterification section. The oligomer is then pumped to polymerisation section after addition of chemicals namely catalyst, TiO_2, DEG & Glycol. The oligomer converted into polymer through polymerisation reaction and is sent to chippers for making polyester chips. The waste water generated in the process is sent to Central Effluent Treatment Plant - II.

The polymer chips are post polymerized in the “Solid State Polymerization” section. The chips are packed in polypropylene bags in an automatic chips bagging system.



BLOCK FLOW DIAGRAM FOR PET CHIPS PROCESS

Proposed debottlenecking activities:

- Optimisation and debottlenecking of limiting equipments

3.14 Process Description for Captive Power Plant (CPP)

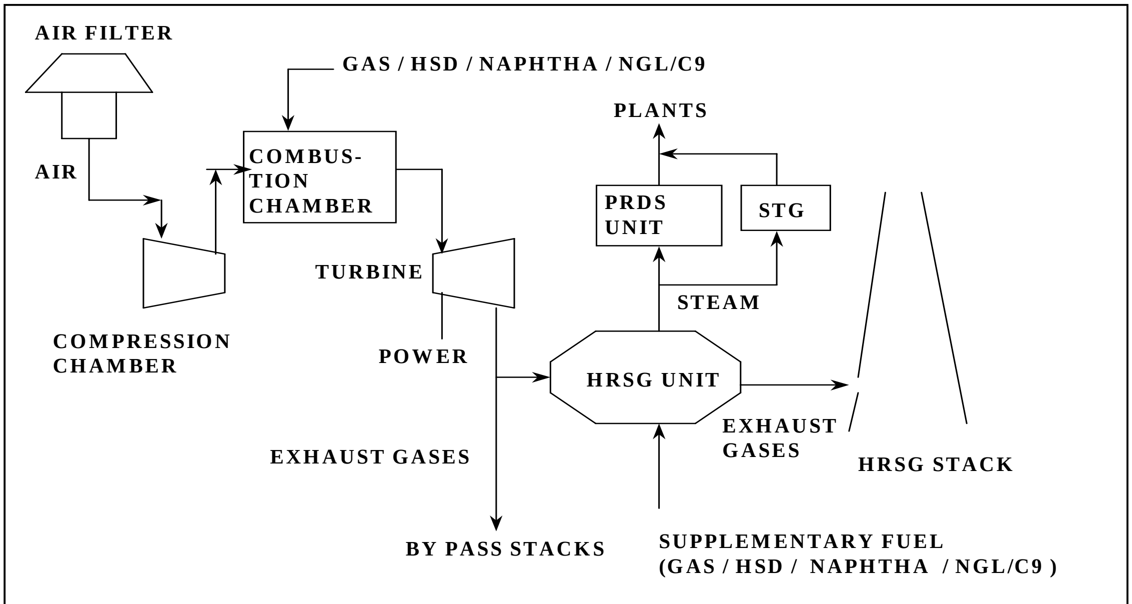
Gas Turbine:

Axial flow compressor which is driven by turbine sucks air through self cleaning type air filters. The compressed air is sent to combustion chambers. In combustion chambers, fuel (Natural Gas/HSD or NGL/Naphtha or HFHSD) is added and products of combustion are allowed to expand through 3 stage impulse turbine. Turbine rotor is coupled with a generator. The flue gas, which is comes out of turbines can be sent out through by-pass stack if the HRSG boiler is not in operation. Otherwise, the flue gas, which is having a temp. of 550 Deg.C. at base load of the machine and rich in O_2 content is used for generation of steam and sent out through boiler stack.

Heat Recovery Steam Generator:

Turbine exhaust is taken to boiler through duct where supplementary firing is given in the furnace zone. The hot gases heat the water in water tubes, and gets exhausted to atmosphere through the boiler stack. D.M. water is sent to deaerator through make-up water heater and preheater. From deaerator water at high pressure is pumped to the boiler drums with the help of BFWP. Down comers from the drum take water down to water wall, where heat is absorbed. The mixture of water and steam goes upto drum where steam is separated from water.

The saturated steam from the drums goes to primary super heater and from there to secondary super heater after getting injected spray water in desuper heater. This steam at the outset of boiler is at a high pressure and temperature. For meeting the process steam demand, high pressure steam is passed through PRDS where pressure reduction takes place as per demand. A part of High Pressure steam is used for generating additional power through Steam Turbine Generator (STG)



BLOCK FLOW DIAGRAM - CPP PROCESS

3.15 Manufacturing Process Description for Relpipe -2 Plant

RELPIPE-2 is a continuous process where resin is fed to an Extruder and extruded in to ducts and pipes. The basic process for production of duct or pipe manufacturing in RELPIPE-2 plant consists of the following activities.

- Resin feeding system to Extruder.
- Extruder operation to produce Duct or pipe.
- Duct Draw off and Pipe rolling.
- Scrap resin grinding operation.
- Utility area

Resin feeding system to Extruder

PE resin received from truck will be unloaded in to raw material hoppers of respective Extruder lines. Resin for the Main Extruder and the Inner layer extruder are fed into different hoppers. For both the extruders resin from the hoppers is continuously feed in to mixing hopper. In mixing hopper master batch resin and base resin is blended and fed in to Buffer hopper. From gravimetric hopper mixer resin is fed in to connected extruder.

Extrusion of duct or pipes:

Mixed resin from gravimetric hopper is fed in to electrically heated extruder. Molten polymer is extruded through die and then draws off in to vacuum cooling tank. In vacuum cooling tank vacuum is maintained to avoid pipe deformation. In vacuum cooling tank, cooling water is used to cool the hot extrude to form pipe or duct of the required size and strength. Single ducts are further clubbed together and passed through a sheathing extruder to product multi-way ducts.

Duct Draw off and Pipe rolling

Cooled Pipe/duct from vacuum cooling tank is passed through subsequent cooling operation similar to vacuum cooling tank. After series of cooling tank operation printing done as for product identification. After printing pipe is passes through haul-off pipe and where dimension of manufactured pipe is confirmed and send to coiler for rolling. After rolling of required length, the product is cut. The coils are strapped for ease of handling and to prevent un coiling. For large diameter pipes the product is supplied in straight lengths instead of coils

Scrap resin grinding operation for recycle.

Rejected and damaged ducts or pipes are cut in to medium sized chips and send to shredder, where it will be grinded into small pieces for recycle.

Utilities:

Utilities consist of Chiller unit, Cooling tower and associated pumps. This system supplies chilled water required for cooling the duct or pipe extruded.

Table 3.1: Product Slate for the HMD Complex

Sr. No.	Plant	Product	Existing Capacity MTPA	Increased Capacity MTPA	Final Capacity MTPA
1.	Cracker				
		Ethylene (C2)	9,00,000	1,00,000	10,00,000
		Propylene (C3)	4,38,000	62,000	5,00,000
		C4 products			
		LPG & HTPB	2,46,000	0	2,46,000
		Butadiene	1,40,000	70,000	2,10,000
		Butene 1	35,000	45,000	80,000
		MTBE / Isobutylene	85,000	1,15,000	2,00,000
		Butanediol*	43,000	0	43,000
		C5 Derivatives and resins	1,15,000		1,15,000
		C5 HCR Resin		28,375	28,375
		72% DCPD		13,500	13,500
		85% DCPD		35,500	35,500
		Heavy Oil		23,500	23,500
		HP DCPD Resin		24,875	24,875
		Hydrogenated HP DCPD Resin		25,500	25,500
		Isoprene		26,125	26,125
		Piperylenes		33,375	33,375
		Internal recycle to Furnace		1,00,000	1,00,000
		C6-C8			
		Cyclohexane	3,84,000	0	80,000
		C6-C8 Raffinate/Internal recycle to furnace			3,04,000
		Benzene	2,82,000	3,000	2,85,000
		Toluene	2,36,400	0	2,36,400
		Mixed xylene	1,98,000	0	1,98,000
		Para Di Ethyl Benzene	700	9,300	10,000
		C9 & C9 Resins	30,528	69,472	1,00,000
		Fuel Oil (CBFS)	93,600	36,400	1,30,000
		Styrene*	24,000	6,000	30,000
		SBR	1,50,000	50,000	2,00,000
		SBR (wet)	480	0	480
		Acetylene Recovery*	14,000	0	14,000
		PBR	40,000	20,000	60,000
		Hi Boiler	420	210	630
		PBR (wet)	120	60	180

Sr. No.	Plant	Product	Existing Capacity MTPA	Increased Capacity MTPA	Final Capacity MTPA
2.	Poly Vinyl Chloride (PVC)	Poly Vinyl Chloride (PVC)	3,50,000	50,000	4,00,000
		HCl	50,100	7,160	57,260
		By product Solvent	7,000	1,000	8,000
		Wet resin	8,965	1,285	10,250
3.	Mono Ethylene Glycol (MEG)	Mono Ethylene Glycol	6,00,000	1,20,000	7,20,000
		Ethylene Oxide	54,560	65,440	1,20,000
		HGR	56,500	21,500	78,000
		CO_2	60,000	0	72,000
4.	Purified Terephthalic Acid (PTA)	Purified Terephthalic Acid	33,00,000	0	33,00,000
		Methyl Acetate	16460	13702	30162
		PTA (Semi Solid Lumps)	5100	4228	9328
		Crude Benzoic Acid Mix	28800	24000	52800
		PTA Sweeping	620	502	1122
5.	Polyester	Polyester Staple Fibre + Chips	4,20,000	1,20,000	5,40,000
		Fibre Fill	1,00,000	0	1,00,000
		Partially Oriented Yarn	4,20,000	70,000	4,90,000
		Poly Ethylene Terephthalate	5,20,000	0	5,20,000
		Recovered EG	4310	0	4310
		Glycol Residues	4310	0	4310
		PET Chips	360	0	360
6.	Polyethylene	Polyethylene	5,00,000	50,000	5,50,000
7.	Polypropylene & FCP	Poly Propylene	5,00,000	0	5,00,000
		PP Catalyst	300	0	300
		Plant sweep/Poly waste/Machine waste	54,000	0	54,000
		TIO_2 Dry	1080	0	1080
		TIO_2 Wet	2520	0	2520
8	REL Pipe	HDPE pipes	1,21,000	0	1,21,000
9.	CPP	Power	380 MW gas based	0	380 MW gas based

***** Plants that were given Environmental Clearance (EC) in 2005, these plants are not yet established. However, they are proposed to be set up.

Table 3.2: List of Raw materials for the HMD Complex

Sr. No.	Plant	Raw material	Existing Quantity (KTPA)	Proposed Quantity Post expansion (KTPA)
1	Cracker	Naphtha	2745	2822
		Ethane	0	700
		Propane	0	500
		Butane	0	500
2	Poly Vinyl Chloride (PVC)	Ethylene	185	185
		Chlorine	281	281
		Ethylene dichloride	313	313
3	Mono Ethylene Glycol (MEG)	Ethylene	337	495
		Oxygen	408	490
4	Purified Terephthalic Acid (PTA)	Paraxylene	1440	1440
		Acetic acid	180	180
5	Polyester	PTA	1166	1262
		MEG	478	493
6	Poly Ethylene (PE)	Ethylene	511	541
		Cyclohexane	9	9.2
		Butene 1	30	32.3
7	Polypropylene (PP)	Propylene	502	502
		Ethylene	27	27
		Chlorobenzene	1.5	1.5
		Benzoyl chloride	0.06	0.06
		$TiCl_4$	4	4
		Ethyl benzoate	0.5	0.5
		Pentane	1	1
8	Relpipe	HDPE	79	79
		Silicon master batch	0.4	0.4
9	CPP	Natural gas /fuel gas	0.2	0.2
		HSD	89	89
		Naphtha/NGL/C9	962	962

4.0 Environmental Impacts

4.1 Air Environment

The major air pollutants from a petrochemical complex are PM, SO_2, NO_x and hydrocarbons (HCs/VOCs). Out of which, PM, SO_2, and NOx are emitted continuously from stacks (point sources) associated with fuel combustion as well as process units. Besides small quantities of Cl_2, HCl, CO and HC will be released from process stacks. The major sources of hydrocarbons releaseare through evaporation losses from storage tanks and uncontrolled escapes from process units (fugitive emissions) i.e. by process vents, leakages from pumps, valves and also from incidental spillages. These are categorised as area sources because they are distributed over an area in storage tank farm and process units. Apart from impact due to point and fugitive sources, the air environment will also get affected by automobile exhaust emissions at the project-site due to movement of vehicles for transportation of raw material and marketable products as well as for conveyance of employees.

Emissions from Existing Units

The major stack emission sources in the existing petrochemicals complex are from Heat Recovery Steam Generators (HRSG) in the captive power plant, vapourisers in polyester complex, fresh feed furnaces in cracker plants and Combination of fuel i.e. natural gas, HSD, C9, naphtha, Retrol Cracker gas, biogas, LSHS etc. are used in the existing petrochemicals complex. Waste process gaseous streams are vented after complete burning through flare stacks.

The stack emission monitoring is carried out by GPCB and the monitoring results indicate that air emissions from the process/vent stacks comply with the standards of GPCB.

Emissions from Proposed Units

In the proposed debottlenecking and expansion project, PM, NO_x and SO_2 will be major air pollutants from fuel burning units as combination of fuel will be used. Fuels proposed to be used will include natural gas, HSD, C9, naphtha, Retrol Cracker gas, biogas, LSHS etc. However, the details of the fuels used currently and after debottlenecking and expansion projects are given in **Table 4.1.**

The emissions from the existing units and from the after debottlenecking and new units along with stack parameters are presented in **Table 4.2**.

Table 4.1: Details of Fuel Consumption

Sr. No.	Plant / Product	Type of fuel used	Fuel requirement (Before Expansion)	Fuel Requirement (After Expansion)
1	Cracker Plant	Natural Gas	Natural Gas: 53.436 T/hr	Natural Gas: 60 T/hr
2	Poly Vinyl Chloride (PVC)	Natural Gas	Natural Gas: 7529 Nm^3/hr (VCM) Natural Gas: 430 sm^3/hr (PVC)	Natural Gas: 7529 Nm^3/hr (VCM) Natural Gas: 430 sm^3/hr (PVC)
4	PTA Plant	Gas, Fuel Oil, LSHS slurry / Auxiliary Fuel Natural Gas	Gas: 675 kg/hr FO/LSHS: 600kg/hr NG: 390 kg/hr Slurry: 3000 kg/hr	Gas: 900 kg/hr FO/LSHS: 800 kg/hr NG: 520 kg/hr Slurry: 4000 kg/hr
5	Polyester Plant	FO / LSHS / CG / Biogas/Gas/RG/PVG	Gas/CG:8700sm^3/hr Gas:12150 sm^3/hr FO/LSHS: 6900 kg/hr FO/HSD: 2850 kg/hr FO:6900 kg/hr Rec gas: 10800 kg/hr Biogas, Rec gas & PVG: 6000sm^3/hr Biogas & PVG: 6000sm^3/hr	Gas/CG:8700sm^3/hr Gas:12150 sm^3/hr FO/LSHS: 6900 kg/hr FO/HSD: 2850 kg/hr FO:6900 kg/hr Rec gas: 10800 kg/hr Biogas, Rec gas & PVG: 7200sm^3/hr Biogas & PVG: 8000 sm^3/hr
6	PE	Natural Gas, Waste Grease	Natural Gas: 3.12 Mt / hr Waste Grease: 0.5 MT/hr	Natural Gas: 3.12 Mt / hr Waste Grease: 1 MT/hr
7	Polypropylene	Gas	200kg/hr	200kg/hr
8	CPP	Natural Gas / HSD / HSD / Naphtha / Retrol / Cracker Gas	Gas: 145.665 Ksm^3 / hr HSD: 30.25 MT/hr HSD/Naphtha: 105.875 MT/hr Cracker Gas / C9: 54Kl/hr	Gas: 145.665 Ksm^3 / hr HSD: 30.25 MT/hr HSD/Naphtha: 105.875 MT/hr Cracker Gas / C9: 54Kl/hr
9	ETP	Bio gas (dryer)	258 sm^3 / hr	258 sm^3 / hr
10	ETP hazardous Waste incinerator	Fuel gas	Fuel Gas: 140 sm^3/hr	Fuel Gas: 140 sm^3/hr

Table. 4.2: Details of Stack Emissions of existing plant and after Debottlenecking and Expansion at HMD

Sr. No.	Plant	Stack Height (m)	Emission rate (mg/Nm^3)						
			PM	SO_2 (ppm)	NO_X	CO	HCl	Cl_2	HC
1	**Cracker Plant**								
	Boilers/Furnaces/Heaters/Incinerators								
	Fresh Feed Furnace H110	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H120	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H130	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H140	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H150	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H160	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H170	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H180	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H190	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H192	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H194	34	150	100	150	-	-	-	-
	Fresh Feed Furnace H196	34	150	100	150	-	-	-	-
	Recycle Feed Furnace H111	30.1	150	100	150	-	-	-	-
	Recycle Feed Furnace H121	30.1	150	100	150	-	-	-	-
	Recycle Feed Furnace H131	30.1	150	100	150	-	-	-	-
	Gas Hydrogenation Unit H710	30	150	100	150	-	-	-	-
	Gas Hydrogenation Unit H740	30	150	100	150	-	-	-	-
	PDEB Plant								
	Reactor Feed Heater (H-301)	30	150	100	150	-	-	-	-
2	**Styrene Plant (Proposed)**	50	150	100	150	-	-	-	-
3	**PBR Plant**	20	150	100	150	-	-	-	-

Sr. No.	Plant	Stack Height (m)	Emission rate (mg/Nm^3)						
			PM	SO_2 (ppm)	NO_X	CO	HCl	Cl_2	HC
4	**REL (HDPE) Pipes Plant**			-	-	-	-	-	-
	Process Vents								
	Unloading Hopper	5	150						
6	**PVC Plant**								
	Boilers/Furnaces/Heaters/Incinerators								
	VCM Incinerator	30	50	-	-	-	20	09	-
	EDC Cracking Furnace A	50	50	-	-	-	20	09	15
	EDC Cracking Furnace B	50	50	-	-	-	20	09	15
	EDC Cracking Furnace C	50	50	-	-	-	20	09	15
	Process Vents								
	PVC Dryers 1	35.5	150	-	-	-	-	-	
	PVC Dryers 2	35.5	150	-	-	-	-	-	
	Chlorine Destruction Unit	30	-	-	-	-	-	9	
6	**Mono Ethylene Glycol Plants**								
	Process Vents								
	CO_2 Stripper 1	32	50	-	-	150	-	-	-
	CO_2 Stripper 2	32	50	-	-	150	-	-	-
	CO_2 Stripper 3	32	50	-	-	150	-	-	-
	CO_2 Stripper 4 (Proposed)	32	50	-	-	150			
	Vent Absorber 1	26.5	-	-	-	-	-	-	15
	Vent Absorber 2	26.5	-	-	-	-	-	-	15
	Vent Absorber 3	26.5	-	-	-	-	-	-	15
	Vent Absorber 4 (Proposed)	26.5	-	-	-	-	-	-	15

Sr. No.	Plant	Stack Height (m)	Emission rate (mg/Nm³)						
			PM	SO_2 (ppm)	NO_X	CO	HCl	Cl_2	HC
7	**PTA Plants**								
	Boilers/Furnaces/Heaters/Incinerators								
	Incinerator 1	31.4	150	100	150	-	20	9	-
	Incinerator 2	31.4	150	100	150	-	20	9	-
	Incinerator 3	40	150	100	150	-	20	9	-
	Incinerator 4	40	150	100	150	-	20	9	-
	Process Vents								
	Vent Scrubber 1	30	150	40 mg/Nm³	25	-	-	-	-
	Vent Scrubber 2	30	150	40 mg/Nm³	25	-	-	-	-
	Vent Scrubber 3	26	150	40 mg/Nm³	25	-	-	-	-
	Vent Scrubber 4	26	150	40 mg/Nm³	25	-	-	-	-
	Turbine Expander 1	60	150	40 mg/Nm³	25	-	-	-	-
	Turbine Expander 2	60	150	40 mg/Nm³	25	-	-	-	-
	Turbine Expander 3	48	150	40 mg/Nm³	25	-	-	-	-
	Turbine Expander 4	48	150	40 mg/Nm³	25	-	-	-	-
	Atmospheric Absorber 1	45.5	150	40 mg/Nm³	25	-	-	-	-
	Atmospheric Absorber 2	45.5	150	40 mg/Nm³	25	-	-	-	-
	Atmospheric Absorber 3	39	150	40 mg/Nm³	25	-	-	-	-
	Atmospheric Absorber 4	39	150	40 mg/Nm³	25	-	-	-	-
8	**Polyester Complex**								
	Boilers/Furnaces/Heaters/Incinerators								
	DTA Vaporiser 1	56	150	100	150	-	-	-	-
	DTA Vaporiser 2	56	150	100	150	-	-	-	-
	DTA Vaporiser 3	56	150	100	150	-	-	-	-
	DTA Vaporiser 4	56	150	100	150	-	-	-	-
	DTA Vaporiser 5	56	150	100	150	-	-	-	-

Sr. No.	Plant	Stack Height (m)	Emission rate (mg/Nm^3)						
			PM	SO_2 (ppm)	NO_X	CO	HCl	Cl_2	HC
	DTA Vaporiser 6	56	150	100	150	-	-	-	-
	DTA Vaporiser A	60	150	100	150	-	-	-	-
	DTA Vaporiser B	60	150	100	150	-	-	-	-
	DTA Vaporiser C	60	150	100	150	-	-	-	-
	Heater 1	56	150	100	150	-	-	-	-
	Heater 2	56	150	100	150	-	-	-	-
	Heater 3	56	150	100	150	-	-	-	-
	Heater A	60	150	100	150	-	-	-	-
	Heater B	60	150	100	150	-	-	-	-
	Heater C	60	150	100	150	-	-	-	-
9	**Polyethylene Plants**								
	Boilers/Furnaces/Heaters/Incinerators								
	DTA Vaporiser AX/BX	31	150	100	150	-	-	-	-
	DTA Vaporiser CX	31	150	100	150	-	-	-	-
	Process Vents								
	Alumina Handling Plant	5	150	-	-	-	-	-	-
10	**Polypropylene Plants**								
	Boilers/Furnaces/Heaters/Incinerators								
	Rotary Kiln	15	150	100	150	-	-	-	-
	Process Vents								
	Vent Absorber		-	-	-	-	20	-	-
11	**Power Plant (Gas Based)**								
	Boilers/Furnaces/Heaters/Incinerators								
	Auxiliary Boiler	60	150	100	50 ppm				

Sr. No.	Plant	Stack Height (m)	Emission rate (mg/Nm^3)						
			PM	SO_2 (ppm)	NO_X	CO	HCl	Cl_2	HC
	HRSG 1	60	90	100	50 ppm	-	-	-	-
	HRSG 2	60	90	100	50 ppm	-	-	-	-
	HRSG 3	60	90	100	50 ppm	-	-	-	-
	HRSG 4	60	90	100	50 ppm	-	-	-	-
	HRSG 5	60	90	100	50 ppm	-	-	-	-
	HRSG 6	60	90	100	50 ppm	-	-	-	-
	HRSG 7	60	90	100	50 ppm	-	-	-	-
	HRSG 8	60	90	100	50 ppm	-	-	-	-
	HRSG 9	60	90	100	50 ppm	-	-	-	-
	GT By-pass – I to IX	30	150	100	50 ppm	-	-	-	-
12	**ETP**								
	Boilers/Furnaces/Heaters/Incinerators								
	Hazardous Waste Incinerator	30	150	100	150				
	Process Stacks								
	Sludge Dryer	30	150	-	-	-	-	-	-
13	**Flare Stacks**								
	VCM Flare stack	80							
	HT Flare Stack	80							
	PP Flare Stack	100							
	Flare stack for catalyst preparation facility	45							
	Cracker Flare stack	115							
	Ethylene Terminal Flare Stack	30							
	SBR Vents (6 nos)								

4.2 Noise Environment

There will be few additional equipments that are likely to be added, changed or modified due to the debottlenecking and expansion projects. Manufacturers/Suppliers of major noise generating machines/equipments like air compressors, feeder pumps, boilers etc. shall be instructed to make required design modifications wherever possible before supply and installation to mitigate the noise generation and to comply national / international regulatory norms w.r.t. noise generation for individual units. It will be ensured that low noise equipment are procured wherever feasible. Acoustic laggings and silencers, sound proofing/ glass panelling etc. will be provided at critical operating locations.

4.3 Water Environment

The projected water requirement for the petrochemicals complex after debottlenecking and expansion is 1,60,347 m^3/day. The increase in consumption anticipated is 21,059 m^3/day in comparison with the existing water requirement. The post-project water balance is presented in **Table 4.3**. Reliance Industries Limited has taken the permission for withdrawal up to 35 MGD of water. The water requirement for the proposed project will be met from already approved allocation by Govt. of Gujarat. Hence, no additional water is required for drawl beyond 35 MGD.

Table 4.3: Existing and Post Project Water Balance

Sr. No.	Source	Existing (13-14)		After Proposed expansion	
		Input m^3/d	Output m^3/d	Input m^3/day	Output m^3/d
1.	Process water including plant operations, boiler, washing etc.	66,543	52,794	76,992	54,018
2.	Cooling water makeup	62,030	14237	71,193	17,696
3.	Domestic	920	736	920	736
4.	Fire water/construction	9,795	-	11,242	-
5.	Quantity of Effluent Recycle to cooling tower as a make-up.		-11,163		-11,163
	Total	**1,39,288**	**56,604**	**1,60,347**	**61,287**

4.3.1 Effluent Treatment Plant

After all possible efforts for recovery, reduction & recycling of process wastes, it becomes essential to go for the "END OF THE PIPE TREATMENT" for the process effluents before discharging them outside premises. RIL has installed state-of-the-art treatment facilities for the treatment of wastewater prior to discharge into water receiving bodies.

The treatment plant is designed on the following philosophy:

- Treatment of entire domestic effluent along with the process effluent.
- Recycle of treated effluent with the maximum extent possible.
- Adoption of advanced and state-of-the art Technology for the wastewater treatment to achieve cost effective treatment
- Stream wise treatment of wastewater.
- Guard Ponds / Holding Tanks for storing influents during plant upset and treated effluent, if not meeting norms. Above off-spec effluents are further treated before discharge, to ensure 100% statutory Compliance.

Effluent streams are divided into two parts:

A) Low TDS containing streams: LTDS streams are streams containing TDS less than 500 ppm.

B) High TDS containing streams: HTDS streams are streams containing TDS more than 500 ppm.

A. LTDS Stream Process Description

The entire effluent from POY, PSF, PFF, MEG-I/II/III, PE-I/II, PP, PVC, Butadiene is low TDS containing effluent and part of effluent from PBR and SBR is low TDS.

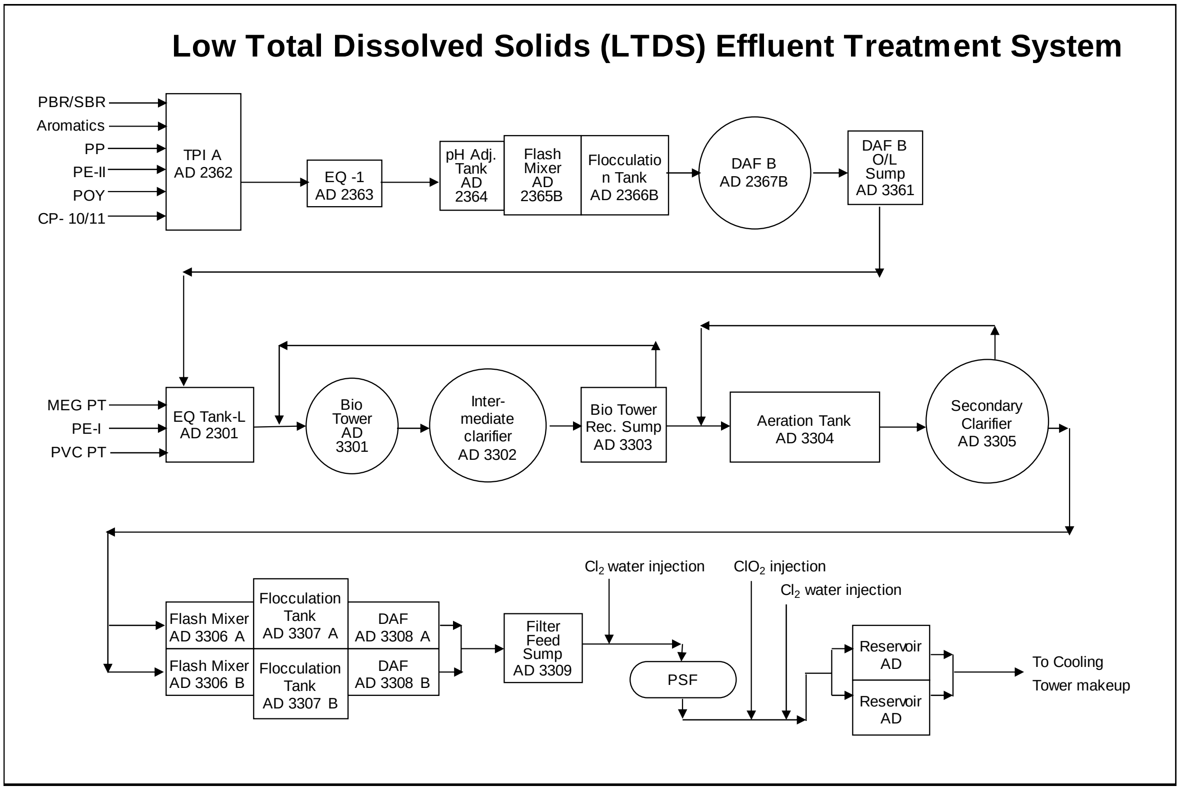
The LTDS effluent treatment unit is consisting of primary, secondary & tertiary treatment facilities.

Primary treatment facility consist of TPI (Tilted Plate Interceptor)-for the removal of free oil, Equalisation Tank, Flash Mixer, Flocculator followed by the DAF (Dissolved Air Floatation) for the removal of emulsified oil.

The secondary treatment is a combination of the attached growth and suspended growth system consisting of Equalization Tank, Bio Tower (1nos), Aeration Tank (1 nos.) and Secondary Clarifier.

The tertiary treatment facility consists of DAF, clarified water sump, Chlorination, Pressure sand filters (5 nos), activated carbon filters (5 nos) and Reservoirs (2 Nos).

Finally treated LTDS effluent is collected in Reservoirs (2 Nos). After quality check the treated LTDS effluent is pumped to the various Cooling Towers as make up water.



B. HTDS Stream Process Description

The High TDS containing effluent further segregated based on the oil content and termed as oily streams and non-oily streams.

The effluent from Cracker, Aromatics, Tank Farm, Terminal, CPF, Butene-1, MTBE, remaining effluent of PBR and SBR (i.e. Excluding LTDS streams) are High TDS streams.

The HTDS treatment unit consists of primary, secondary treatment facilities.

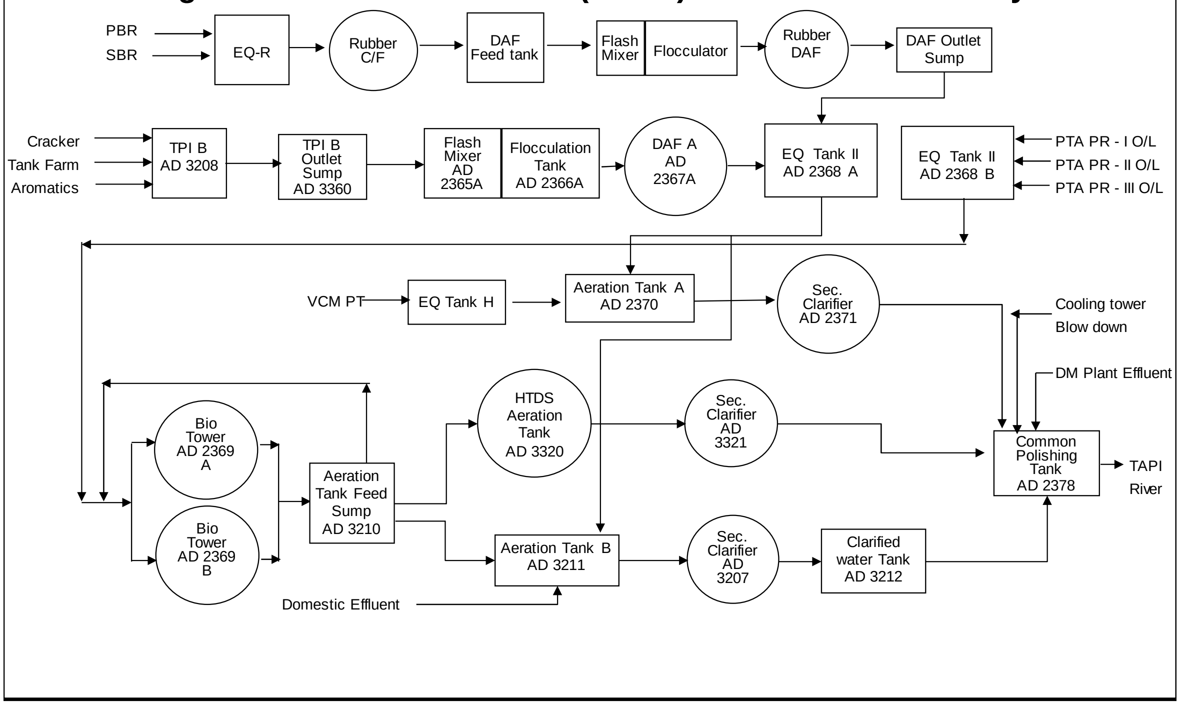
Primary treatment facility consists of TPI (Tilted Plate Interceptor) for the removal of free oil, flocculator followed by the DAF (Dissolved Air Floatation) for the removal of emulsified oil.

The secondary treatment is a combination of the attached growth and suspended growth system consisting of Equalization Tank (3 Nos.), Bio Tower (2 Nos.), Aeration Tank (3 Nos.) and Secondary Clarifiers (3 Nos).

In the Common Polishing pond DO level is raised by means of surface aerator. The effluent from this unit is discharged to the estuary Zone of Tapi River through close pipeline with diffuser at end. The design capacity of the multiport diffuser is approx. 96,000m^3/day which has adeqaute spare capcity to handle the debottlenecking and expansion proposed. Since the treated wastewater would be discharged through multiport diffuser into the sea, impact on water environment is not envisaged due to dilution potential available in the estuary.

At ETP two guard ponds are also available to store off spec treated effluent and provision is also available to take this effluent back to the system for re-treatment.

High Total Dissolved Solids (HTDS) Effluent Treatment System



4.4 Land Environment

No additional land is required for the proposed Debottlenecking and expansion projects, as there is enough land for expansion in the existing complex. As the HMD complex area falls within the GIDC industrial estate of Hazira, there will be no change in the land use pattern due to the proposed project.

There will be marginal increase in the quantity of hazardous waste generation, due to proposed project. The industry has efficient hazardous waste management practices, which is in compliance to the Hazardous Waste (Management & Handling) Amendment Rules, 2003.

The list of hazardous waste which would be generated, quantity of generation, treatment and disposal is represented in **Table 4.4**.

Table 4.4: Hazardous Waste / Solid Waste Management

Sr. No	Type of hazardous waste	Schedule I/II Process No.	HW generated before expansion	HW generated after expansion	Treatment and Disposal
1	Coke (VCM Plant)	1.1	35 MT/year	40 MT/year	Collection, storage, transportation and disposal by selling to coke processors / disposal at TSDF / Incineration / co-processing with cement industries
	Coke (Cracker Plant)	1.1	60 MT/yr	67 MT/yr	Collection, storage, transportation and disposal by selling to coke processors / disposal at TSDF / Incineration / co-processing with cement industries
2	Organic Residues	1.4	300 MT/yr	375 MT/yr	Collection, storage, transportation and disposal by incineration / co-processing with cement industries
3	Spent Molecular Sieves	1.7	170 MT/yr	170 MT/yr	Collection, storage, transportation and disposal by selling to an offsite recycler / reprocessor having valid CCA of this board or landfilling
4	Spent Catalyst from plants namely: PVC, PTA, MEG, Cracker, PP, PET etc.	1.7	908 MT/yr	1141 MT/yr	The waste will be sold to offsite reprocessors having valid consents of concerned State Pollution Control Board or sent for secured landfill at BEIL, Ankleshwar
5	Slop oil from wastewater plant / waste oil	1.8	1003 MT/yr	1254 MT/yr	The waste will be sold to an offsite recyclers / reprocessors approved by (registered with) MoEF having valid consents of concerned State Pollution Control Board

Sr. No	Type of hazardous waste	Schedule I/II Process No.	HW generated before expansion	HW generated after expansion	Treatment and Disposal
6	Chemical Sludge from Wastewater treatment	34.3	370 MT/yr	463 MT/yr	Collection, storage, transportation and disposal at TSDF site, BEIL, Ankleshwar.
7	Used/Spent Oil	5.1	188 MT/yr	235 MT/yr	The waste will be sold to an offsite recycler / reprocessor approved by (registered with) MoEF having valid consents of GPCB.
8	Acid residue & alkaline residue	12.1 & 12.2	As & when generated	As & when generated	The waste will be treated in Central ETP facility
9	Spent Solvent	20.2	25 MT/yr	29 MT/yr	Collection, storage, transportation and disposal by selling or the waste will be treated in ETP
10	Distillation residues	20.3	140 MT/yr	154 MT/yr	Collection, storage, transportation and disposal by selling to approved reprocessors
11	Chemical containing residue from decontamination and disposal	33.1	As & when generated	As & when generated	Collection, storage, transportation and disposal after treatment in ETP
12	Discarded containers and barrels	33.3	As & when generated	As & when generated	Collection, storage, transportation and selling of decontaminated drums / containers to a vendor having valid CCA of the board or; Containers which cannot be decontaminated by unit to authorised decontamination facility having valid CCA of the board.
13	Spent Carbon	35.3	100 MT/yr	125 MT/yr	Collection, storage, transportation and disposal by selling or co-processing with cement industries
14	Incineration Ash – PTA	36.2	700 MT/yr	1300 MT/yr	Collection, storage, transportation and disposal by selling to an offsite approved recyclers/reprocessors

Sr. No	Type of hazardous waste	Schedule I/II Process No.	HW generated before expansion	HW generated after expansion	Treatment and Disposal
					having valid CCA of the board
15	Incineration Ash from HW incinerator		25 MT/yr	25 MT/yr	Collection, storage, transportation and disposal at TSDF
16	Battery acid / electrolyte	36.6	As & when generated	As & when generated	The waste will be neutralised using alkaline effluent stream (DM plant effluent) and sent to ETP. The existing ETP has adequate capacity (qualitative and quantitative) to treat such waste without exceeding the treated effluent quality norms stipulated by GPCB.
17	TiO_2 slurry	A1	80 MT/yr	83 MT/yr	The waste will be sold to an offsite reprocessor having a valid consent of GPCB
18	Spent Nickel Cadmium batteries	A4	50 MT/yr	62 MT/yr	The waste will be sold to an offsite reprocessor having valid consent of GPCB
19	Mercury bearing waste	A6	As & when generated	As & when generated	Collection, storage, transporation and disposal by selling to an offsite reprocessor having valid CCA of GPCB and / or; TSDF of BEIL, Ankleshwar after treatment
20	Spent lead acid batteries and other lead containing waste such as resin	B4	150 MT/yr	188 MT/yr	Collection, storage, transportation and disposal by selling to CPCB registered recycler / reprocessor
21	Asbestos containing waste	B21	200 kg/yr	200 kg/yr	The waste will be collected in leak proof drums and land filling
22	Degraded Downtherm	C8	60 MT/yr	62 MT/yr	The waste will be sold to offsite reprocessor having a valid consent of GPCB

23	Zinc Oxide	C14	20 MT/yr	24 Mt/yr	The waste will be sold off to an off sire reprocessor having valid authorization of concerned SPCB.
24	Process Waste (Ethylene Bottom Dry (EBC) Waste	22.3	2400 MT/yr	2400 MT/yr	Collection, storage, transportation of EDC waste (bottom) by dedicated tanker from Hazira to M/s RIL Dahej for incineration at M/s RIL Dahej.
25	Organic Residue (from RIL Dahej)*		15 MT/yr	15 MT/yr	Receive, storage and disposal by incineration in HMD's hazardous waste incinerator
26	E waste		30 MT/yr	37 MT/yr	Collection, storage, transportation and disposal by selling to CPCB registered recycler / reprocessor
27	Rubber Waste (Rubber gel and Popcorn Polymers) from SBR & PBR	1.1	65 MT/yr	130 MT/yr	Collection, storage, transportation and disposal by selling to an off site recycler / reprocessor / Incinerator / co-processing having valid CCA of GPCB or; Incineration
28	Rubber Waste (Rubber gel and Popcorn Polymers) from styrene plant	1.1	-	150 MT/yr	Collection, storage, transportation and disposal by selling to an off site recycler / reprocessor / Incinerator / co-processing having valid CCA of GPCB or; Incineration
29	Rubber Waste (Rubber gel and Popcorn Polymers) from C5 derivatives	1.1	-	150 MT/yr	Collection, storage, transportation and disposal by selling to an off site recycler / reprocessor / Incinerator / co-processing having valid CCA of GPCB or; Incineration

For temporary storage of hazardous waste at site, a 3000 m^2 paved area with sheds, liner and leachate collection system is available. There is adequate vacant space available to store the wastes from the proposed activity .For final disposal of hazardous waste, Reliance Industries Limited is a permanent member of GPCB approved TSDF facility – Bharuch Enviro Infrastructure Limited (BEIL), Ankleshwar.

4.5 Socio-economic Environment

There will be some indirect jobs and business opportunities to the local people such as daily wage laborers, transporters and raw material suppliers. The project would increase and generate opportunities for ancillary and auxiliary business at the local and regional levels.

5.0 Project Schedule and Cost estimate

As the project mainly involves debottlenecking and optimisation of limiting equipments, the total time required for completion of this project is 12 months. For new plants viz MEG, C5 and Styrene, the expected project completion time period is 24 months.

Estimated cost for the proposed expansion project is Rs. 2100 crores.