Pre-Feasibility Report

for

Expansion of NCU, MEG, HDPE & PP Units

and

Catalyst Manufacturing unit

JUNE 2016
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INTRODUCTION

Indian Oil Corporation Ltd. (IOCL) intends to expand the Naphtha Cracker Unit including associated units from the current 800 KTA ethylene @ 8000 hr/yr to 947 KTA ethylene (including ethylene from OSBL recycle streams) @8000 hr/yr. CBI Lummus is the licensor of the plant. Part of this expansion is to consider additional feed from an ethane/ethylene recovery unit. Downstream of NCU, associated units, MEG unit and polymer plants exist.

The petrochemical complex consists of the following existing plants & related utilities which are in operation.

- Naphtha Cracker Unit (NCU) including associated units
- High Density Polyethylene (HDPE) Unit
- Swing (LLDPE/HDPE) Unit
- Ethylene Glycol (EG) Plant
- Polypropylene (PP) Unit
- Utilities including Captive Power Plant

IOCL is currently planning expansions of its production capacities for NCU, MEG, HDPE and PP plant.

Proposed Expansion Capacities

<table>
<thead>
<tr>
<th>Plant</th>
<th>Existing (KTA)</th>
<th>Proposed (KTA)</th>
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<tbody>
<tr>
<td>NCU (in terms of ethylene)</td>
<td>800</td>
<td>947</td>
</tr>
<tr>
<td>MEG (in terms of product)</td>
<td>300</td>
<td>425</td>
</tr>
<tr>
<td>HDPE (in terms of product)</td>
<td>300</td>
<td>351</td>
</tr>
<tr>
<td>PP (in terms of product)</td>
<td>600</td>
<td>780</td>
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</table>

IOC also intends to setup a Catalyst plant for production of FCC (Fluidized Catalytic Cracker) additives and hydro-treating (DHDS/DHDT) Diesel Hydro De-Sulfurisation/ Diesel Hydro Treater catalyst which will be situated in current PNC complex.
Indian Oil Corporation Ltd. (IOCL) is proposing to expand the existing units which includes NCU, MEG, HDPE and PP. Also IOCL is proposing to put up a catalyst manufacturing plant. The existing complex is spread over 306 HA hectares and there is sufficient vacant space to accommodate these proposed expansion projects.

**Proposed Projects Justification**

India, with a population exceeding 1.2 billion, and a large and steadily growing middle class with rising disposable income, is forecast to be among the world's five largest consumer markets by 2025. Polymer consumption is closely linked to GDP growth and India is the major economy with the second-fastest growth rate after China. In the competitive scenario of petrochemical business, profitability of petrochemical complex depends on cost of production of olefins. It is observed that cost of production of olefins decrease with increase in capacity. It appears from the market study, that Domestic demand is expected to grow leading to substantial gap in supply/demand. In view of the above, we should seize the opportunity of NCU, MEG, HDPE and PP revamp at present for production of additional olefins to penetrate the deficit market for improving margin.

The following feature also justifies the PNC complex as the best alternative as regards to the project site, infrastructure, connectivity and market potential:

- The products manufactured meets market specification.
- Adequate safety systems are in design to handle to any operational upset.
- Availability of the required land for the proposed expansion.
- Availability of infrastructure facilities
- Availability of Electric Power through captive power plant.
- Environmental management:

Existing plants already have robust management systems for quality, environment and occupational health and safety which are certified against the standards ISO 9001, ISO 14001 and OHSAS 18001 respectively.

- The wastewater from proposed projects will be treated in the existing ETP.
- Greenbelt development: There exists a well-established greenbelt area, which is adequate for attenuation of air emissions and noise levels.
IOC R&D over the years has developed significant expertise in FCC catalysts & additives as well as DHDS and DHDT catalysts. These formulations are currently commercially offered through SCIL (Sud Chemie India Ltd) by a licensing agreement. Considering IOC R&D’s proven capability/ expertise and as a strategic initiative IOCL has decided to put-up a catalyst manufacturing plant on its own for captive consumption.

**PROJECT AREA**

- Area within Fencing = 306 HA
- Green Belt = 55 HA
- Area within Compound Wall = 251 HA
- Pet coke Area = 40HA
- Balance Area for PNCP = 211 HA

**FUTURE EXPANSION AREA**

Total Area within Fencing = 102.5 HA (253 ACRE)

**PROJECT COST**

Estimated Project cost : 1500 Cr

**PROCESS DESCRIPTION**

**Naphtha Cracker Unit :**

Naphtha Cracker Unit is the mother unit of the entire complex. The associated units with NCU at Panipat is C4 hydrogenation, Pyrolysis gasoline hydrogenation unit, Butadiene extraction unit and Benzene extraction unit. In NCU, low aromatic naphtha cracks into lighter hydrocarbons in cracking heaters, which are then individually separated by fractionation to produce mainly polymer grade ethylene and polymer grade propylene. It also produces hydrogen, methane off gasses, pyrolysis fuel oil and other products like raw mix C4, raw pyrolysis gasoline that are further processed in Associated Units. Ethane and propane, produced in the process, are recycled back to cracking heaters.

Naphtha feed is received from storage tanks outside battery limits, filtered and mixed with hydrogenated C4, C5 and C6 recycle streams, prior to being sent to the liquid cracking heaters. All the SRT heaters operate using fuel gas only. The primary fuel gas is methane rich off gas produced in the naphtha cracker unit. Make-up/ back-up fuel is C3/C4 LPG supplied from adjacent refinery or RLNG vapor.

In the Gasoline Fractionator, the cracked effluent gases are further cooled, pyrolysis fuel oil (PFO) is separated as a bottoms product, a side stream product-pyrolysis gas oil (PGO) is withdrawn from the
Fractionator, gasoline and lighter materials are taken as an overhead vapor. Pyrolysis fuel oil product is mixed with heavy C9+ cut from the return tower of the Pyrolysis Gasoline Hydrogenation unit and is cooled prior to being sent to OSBL storage. A side stream product withdrawn from the Fractionator is sent to the PGO Stripper where it is steam stabilized. A portion of the stabilized PGO is filtered and used as purge oil for instruments, the rest is blended with fuel oil and cooled before being sent to OSBL storage.

Overhead vapor from the Gasoline Fractionator is cooled and partially condensed in the Quench Tower. The overhead vapor from the Quench Tower is sent to the Charge Gas Compressor. Recycle streams from downstream swing PE plant, HDPE plant and PP plant and off spec ethylene vapors from HP ethylene storage as well as internal recycle streams of the naphtha cracker are also reprocessed in the Charge Gas Compressor system. The quench tower overhead vapors are compressed in a five-stage centrifugal compressor with interstage cooling and is dried in a two bed molecular sieve drying system. The dry charge gas is progressively chilled against the process and propylene and ethylene refrigeration.

The condensed liquids from the charge gas chilling train along with the vent gas from ethylene fractionation and propylene fractionation, and light gas recycle from PP plant are sent to the appropriate feed locations of the demethanizer. Here, the residual gas is hydrogen of approximately 75 mol% purity. The hydrogen rich stream is further upgraded to 95+ mol% purity in an adiabatic heat exchange system. The raw hydrogen generated is used in the two primary processing steps: Methanation of CO in hydrogen to methane and water, as CO is a catalyst poison and in Drying of hydrogen; required for the hydrogenation reactors water is a poison to these catalysts.

Provision for reprocessing off spec ethylene is also provided in the demethanizer. Reflux to this tower is provided by an open loop refrigeration system which utilizes a motor driven centrifugal compressor. The demethanizer bottoms product feeds the deethanizer which also processes FCC dry gas C2s and FCC C3 streams received from Panipat refinery. Acetylene is removed from the net deethanizer overhead product by selective hydrogenation to ethylene and ethane, which is sent to Ethylene Fractionator. The ethylene products handled are: One stream is chilled and delivered to low pressure OSBL cryogenic storage. MP ethylene, HP Ethylene & Ethane.

The purpose of the depropaniser is to make a sharp separation between C3 components and heavier components in the Deethanizer bottoms and condensate stripper bottoms. Methyl acetylene and propadiene contained in the depropanizer overhead are removed by selective hydrogenation to Propylene and Propane in a single bed reactor. The net C3 product is sent to Propylene Fractionator where Polymer grade propylene is the distillate with bottom product containing primarily Propane.

The bottom product from the depropanizer flows to the debutanizer where the C4s product is separated. The debutanizer net overhead product, consisting of mixed C4s is pumped to the butadiene extraction unit, C4 hydrogenation unit, or to OSBL storage for further processing. The bottom product is combined with gasoline from Gasoline stripper bottom to make up the total raw pyrolysis gasoline product and is sent to the Pyrolysis gasoline hydrogenation unit.

Butadiene extraction unit recovers 1,3 butadiene from the raw mixed C4 stream produced in the NCU. BD raffinate is sent to hydrogenation unit.
C4 hydrogenation unit is designed to fully hydrogenate Butadiene raffinate in normal operation. Hydrogenated C4s is recycled to the NCU cracking heaters. In alternate operation, when BDEU is not operating, C4HU will process raw C4 mix. Butadiene and a portion of Butenes are hydrogenated in this mode of the operation.

Pyrolysis Gasoline Hydrogenation Unit processes raw pyrolysis gasoline from NCU in a two stage hydrotreating unit to produce C6-C8 heart cut that is sent to Benzene extraction Unit for benzene recovery, a fully hydrogenated C5 cut that is recycled to the cracking heaters and a partially hydrogenated c9+ product.

**Proposed Modification:**

Panipat Refinery Delayed Coker unit (DCU) and Fluidized Catalytic Cracking (FCC) units off gases are presently routed to Refinery Fuel gas, contain useful Ethylene, Ethane, Propylene & Propane which can be recovered and sent to Naphtha cracker unit. In this project, integration of ERU (ethylene recovery unit) with the existing system will take place and by this cracker capacity will be augmented. To support this capacity enhancement, modifications / additions in exchangers, pumps, vessels, column internals is being done. One furnace will be added in this project.

**Block Flow Diagram:**

![Block Flow Diagram](image_url)
Mono Ethyl Glycol Unit:

IOCL has installed a MEG unit at Panipat Naphtha Cracker Complex, having a capacity to produce 300KTA fiber grade MEG. DEG and TEG are also produced from the unit.

In the process ethylene is partially oxidized by oxygen in the presence of silver catalyst to make ethylene oxide (EO) in an exothermic reaction. The EO produced in the reactor is recovered by lean cycle water from reactor affluent stream in high pressure scrubber column and then it is again separated from rich cycle water by steam stripping in stripper. Then EO rich gaseous stream is absorbed with recycle water in low pressure reabsorber. Then 10 wt. % EO is hydrolyzed in glycol reactor at an elevated temperature and pressure by adiabatic, non-catalytic reaction to form MEG, DEG and TEG. So formed dilute glycol is concentrated in series of seven forward feed evaporators to form Crude glycol and then distilled in MEG, DEG and TEG column respectively to produce fiber grade MEG as products and DEG, TEG and HG as by-products.

Proposed Modification:

Modifications proposed are based on a review of plant hydraulic load data, as-built equipment efficiency, preliminary process calculations and computer simulations performed by SD. To achieve the mentioned capacities, several equipments shall undergo some modifications; although no modifications have been envisaged in major equipments like recycle gas compressor and EO reactors. Some new equipments shall be added to the unit to cater to higher load. Few of the new equipments envisaged are:

1) Additional Oxygen filters – To cater to higher oxygen flow rate.
2) An ethylene recovery unit – To minimize ethylene loss from argon purge from cycle gas flow.
3) Regenerator trim condenser – To achieve design outlet temperature of 60 Deg.C
4) Cycle Water Exchanger – To avoid leakage
5) Cycle Water Chiller – For better absorption of EO in cycle water in the scrubber

High Density Polyethylene Unit (HDPE):

IOCL has installed a HDPE unit at Panipat Naphtha Cracker Complex based on M/s Lyondell Basell’s Hostalen technology, having a capacity to produce 300,000 MTPA HDPE.

HDPE is produced by continuous polymerization of monomer (Ethylene sourced from Naphtha Cracker unit) and co-monomer (Butene) in presence of catalyst, co-catalyst and solvent in reactors. After polymerization, the solvent is separated from the polymer by decanters. The solvent is sent to recovery section, wherein wax generated during polymerisation is separated from solvent and solvent is recycled
back to process. The polymer separated in the decanters is dried in Drying section and then sent to Extrusion section. The polymer is extruded in Extruder along with additives for stabilization of polymer. The polymer is stored and homogenized in silos and then sent for bagging and packaging.

**Proposed Modification:**

To achieve the mentioned capacities and to cater for higher load, several equipments shall undergo modifications and some new equipment shall also be added to the unit. Few of the equipments wherein addition/modification are envisaged:

1) Flash vessel
2) Dryer
3) Evaporator
4) Distillation Vessel

**Polypropylene Unit (PP):**

IOCL Panipat refinery & petrochemicals complex is operating two trains of PP unit (2 x 300,000 MTPA) based on M/s Lyondell Basell’s Spheripol technology.

PP is produced by continuous polymerization of monomer (Propylene sourced from Naphtha Cracker Unit) and co-monomer (Ethylene) in presence of catalyst, co-catalyst and selectivity control agent in reactors. After polymerization, the unconverted monomer is separated from polymer in recovery section and is recycled back to process. The polymer separated in the recovery section is dried in Drying section and then sent to Extrusion section. The polymer is extruded in Extruder along with additives for stabilization of polymer. The polymer is stored and homogenized in silos and then sent for bagging and packaging.

**Proposed Modification:**

To achieve the mentioned capacities and to cater for higher load, several equipments shall be added/modified. Few of the equipments wherein addition/modifyation are envisaged:

1) Recycle gas compressor
2) Loop reactor coolers and pumps
3) Teal pump
4) Water/organic separator
Catalyst Manufacturing Unit:

The plant is designed for manufacturing Fixed bed and Fluidized bed type catalyst systems used for refinery application. The plant shall be configured to manufacture 500 MTPA of ZSM-5 FCC catalyst additive and 1000 MTPA of DHDS/DHDT catalyst. This plant will also able to produce other FCC additives like Residue Upgradation Additive, CO-combustion promoter additive etc.

The plant shall also be designed to produce key ZSM-5 zeolite and gel alumina required for the manufacture of ZSM-5 additive and alumina support for manufacture of DHDS/DHDT catalyst & FCC additive/ catalyst. Other raw materials like fillers, silicates, hydrated alumina, and acids required are to be directly sourced from market.

SOCIAL BENEFITS

Social Benefits:

These projects, besides general economic desirability, would result in substantial socio-economic benefit to the country in general and more specifically to the region. The socio-economic benefits are described hereinafter.

Social Upliftment of the Region:

This area of the country is undergoing rapid industrialization. Setting up of these projects will be a boon to this region and will bound to improve living conditions and thereby result in further reduction of population below poverty line, which is one of the prime policy objectives of the Government. It is expected that by creation of vast employment potential and industrialization of the area poor/weaker section of the society will see an upliftment in their living conditions.

Employment Generation:

During Construction phase, projects will provide employment to persons, of which significant portion is expected to be drawn from the surrounding areas. On commissioning and achieving successful trial runs, these projects will provide direct employment to local persons and indirect employment in the form of contractors, workers, transporters etc.
ENVIRONMENTAL PROTECTION

Prevention of Air Pollution:

Emissions from the plant are minimized with the application of nitrogen blanketing for storage tanks, proper selection of pumps as per OSHA standard, proper selection of gaskets, etc.

Prevention of Water Pollution:

As for process waste water, it will be routed to the already existing Effluent treatment plant, which is installed so as to comply as per Haryana State Pollution Control Board (HSPCB) and Central Pollution Control Board (CPCB) guideline.

In order to prevent underground water pollution, the process area is paved with concrete. Oil, acid and rain water falling in the area is collected in a sump for further treatment. This waste water is discharged to the waste water treatment plant for treatment.

Prevention of Noise:

Noise level of working place will be controlled within the limit as specified in the HSPCB standard. In the case that some areas might not satisfy the said standard, suitable countermeasures, e.g. addition of noise insulation, use of PPE etc., will be applied in order to satisfy the said standard. Noise level at plant boundary fence will be controlled to satisfy noise criteria.