1.0 Introduction

Kochi Refinery, a unit of Bharat Petroleum Corporation Limited (BPCL-KR), is a 9.5 MMTPA Refinery located at Ambalamugal in Ernakulam District (Kerala), India. The Refinery was commissioned in 1966 with crude oil processing capacity of 2.5 Million Metric Tons per Annum (MMTPA). Through progressive revamps and addition of process units, the refining capacity has been augmented to present level of 9.5 MMTPA, incorporating advanced refining technologies.

1.1 During 2008-09, the refinery set out on a bottoms upgradation project and Environment clearance obtained for the project in Feb 2009. Subsequently,in view of the high demand growth of petroleum products projected in the coming years in the country and also to retain its profitability and competitiveness in the long run, BPCL-KR decided to carry out a Configuration Study and prepare a Pre-feasibility report (PFR) for an Integrated Refinery Expansion Project (IREP) with the help of Engineers India Limited (EIL) as Consultant. In addition to enhancement of refining capacity to 15.5 MMTPA, quality upgradation of autofuels to Euro-IV/ V norms and upgradation of refinery residue to value added products are envisaged as part of the project.

2.0 Proposed Process Configuration

The capacity expansion by 6.0 MMTPA will be facilitated by installing a new state of the art Crude distillation Unit of 10.5 MMTPA so as to replace the existing old 4.5 MMTPA CDU-1 which is not energy efficient. Associated process units like Delayed Coker Unit, FCCU, VGO HT, DHT Sulfur Recovery Unit (SRU), Hydrogen Generation Unit (HGU), Sour Water Stripper etc are included in the project. Propylene based downstream units are proposed in the configuration for utilizing the Propylene generated from FCC. Matching Utilities and Off-site facilities are also envisaged as part of the project.

2.1 The estimated cost of the project is around Rs.13,000 Crores.

Major process units proposed under the selected configuration are as follows:

Sl. No.	*Units*	*Capacity, MMTPA as per PFR**
1.0	Crude Distillation Unit	10.5
2.0	Delayed Coker Unit	3.84
3.0	VGO-HT	3.0
4.0	DHT	4.32
5.0	NHT/ISOM	0.8
6.0	FCC	2.2
7.0	Hydrogen Unit	0.09
8.0	Sulphur Recovery Unit	3 X 225 Tons/Day

Note:* Capacity of the down stream facilities may undergo minor change at the Detailed Feasibility Report stage.

2.1.1 Major Products

Sl No	Description	Quantity, TMTPA
	Products	
1.0	LPG	1153
2.0	Propylene / Propylene Derivatives	497
3.0	Naphtha	766
4.0	Euro-IV Gasoline (Domestic)	2145
5.0	ATF	600
6.0	Kerosene	272
7.0	Euro-IV Diesel	5250
8.0	Euro-V Diesel	1982
9.0	Bitumen	500
10.0	Sulphur	262
11.0	Coke	1195

2.2 Brief Description of the Major Process Units

2.2.1 Delayed Coker Unit (DCU)

The objective of this unit is to convert the Short Residue to value added products like Naphtha, LPG, HSD etc.

The feed to the Delayed Coker Unit is Vaccum Residue (VR) from Vaccum columns of all Crude Distillation units. Coker feed is successively preheated against product/ pump around stream and then flows into the bottom of the Coker fractionator. The feed is joined by the bottom liquid of the fractionator i.e recycle oil. The combined Coker feed and heavy recycle liquid are pumped from Coker fractionator to Coker heaters. The prime function of the heaters is to quickly heat the feed to the required reaction temperature while avoiding premature coke formation in the heater tubes. Heated liquid is fed to the coke drum, the hot feed cracks to form coke and cracked products. The cracked products leave from the top of the coke drum as a vapour stream to Coker fractionator. The Coker fractionator separates the coke drum effluent vapour into Coker Gas, LPG, Naphtha, Light Coker Gas Oil (LCGO), Heavy Coker Gas Oil (HCGO) and Coker Fuel Oil. Coker Gas is sent to Fuel Gas treatment unit and finally to the Fuel Gas header for use as internal fuel. LPG is sent to storage after treatment. Coker Naphtha, HCGO and Coker Diesel are sent to VGO-HT/DHT for treatment. Coke is transferred to Coke yard for sale.

2.2.2 Vaccum Gas Oil Hydro Treater (VGO-HT)

VGO Hydro treater shall treat Light Vaccum Gas Oil (LVGO), Heavy Vaccum Gas Oil (HVGO) from CDU/VDU and HCGO from DCU. The objective of this section is to hydrotreat the above streams which are feed stocks to FCC

The fresh feed along with Hydrogen after preheating through various exchangers is further heated to the reaction temperature in a furnace and then introduced into the reactor .After reaction, the effluent is routed to hot flash drum and the vapour is sent to cold flash drum. The bottoms from the hot flash drum and cold flash drum is sent to a fractionator and from their the products like LPG is routed to storage, Naphtha to Gasolene/ Naphtha pool and Diesel to Diesel pool. Hydrotreated VGO is sent to FCC.

2.2.3 Diesel Hydro Treater (DHT)

The objective of this unit is to hydrotreat the Diesel to remove the Sulphur content so as to meet Euro-IV norms.

A blend of straight run and cracked distillates from CDU/VDU and from Coker and FCC units are treated with Hydrogen to remove the Sulphur content. Hydrogen is fed to the reactor along with feed after preheating. Naphtha and Kerosene are separated in a column and routed to Naphtha and Kerosene/ Diesel/ ATF pool respectively. The treated diesel is sent to the Diesel pool.

2.2.4 Naptha Hydro Treater /Isomerisation (NHT/ISOM)

The objective of NHT unit is to treat the Naphtha to remove the Sulphur content and then feed to the Isomerisation unit to increase the Octane number so that the product can be sent to Gasoline Blending. This will increase the gasoline make of Euro-IV specification.

Part of the straight run light Naphtha is fed to the Naphtha Treater along with Hydrogen after preheating. Sulfur contained in the feed is converted to H_2S which is separated and sent to SRU. The treated Naphtha is sent to Isomerisation Unit where the C5/C6 feed is combined with Hydrogen and fed to the reactor. Isomerisation of Naphtha results in increased Octane number of the stream. The stabilized isomerate product is sent to Gasoline blending.

2.2.5 Fluidised Catalytic Cracking Unit (FCCU)

The objective of FCC is maximization of LPG with higher selectivity towards Propylene. FCC provides opportunity for establishing downstream petrochemical units based on Propylene.

The Hydrotreated VGO from VGO-HT is finely atomized and injected into the riser through feed injection nozzles over a dense catalyst phase. To achieve higher conversions, unit operates at higher severity with reactor temperature of 555 - 565 ^{o}C. The reaction mixture travels up through a riser where the cracking reactions take place and to a termination devise which disengages the catalyst from steam and product vapours. Reactor products, inerts, steam and minute amount of catalyst flow to the base of the main fractionator and are separated into various product streams.

The disengaged catalyst in the reactor is sent to an adjacent vessel where it is regenerated in 2 stages to remove the carbon present on the catalyst which is then recycled. A large wet gas compressor is required because of high amount of dry gas and LPG. The treated LPG is sent to Propylene recovery unit. Fuels Gas is routed to header for internal use after treatment. Light Cycle Oil (LCO) is sent to DHT unit. Heavy Naphtha is routed to Naphtha/ Diesel/ Gasoline pool after treatment.

3.0 Utility Requirements

Major utility requirements are air, nitrogen, raw water, power and fuel. The utility requirements and description of utility systems for various new process and auxiliary units, utility and offsite and infrastructure envisaged for the selected refinery configuration are explained in Chapter-9 of PFR. The total utility consumption of new units in the complex estimated based on EIL in-house data and are tabulated in Tables-9.1. Utilities such as Steam, Boiler Feed Water (BFW), Demineralised (DM) Water, Cooling Water, Compressed Air, etc. are generated internally.

The following utility systems are considered for the project:

1. Raw Water system
2. Cooling Water system
3. DM Water system
4. Compressed Air system
5. Nitrogen system
6. Steam, Power and BFW system
7. Condensate system
8. Internal Fuel Oil and Fuel Gas system

3.1 **Raw Water**: The raw water requirement shall be made available from the existing facility and shall be used as follows:

i) Cooling tower make up
ii) Process water
iii) DM Plant Feed
iv) Fire water system make up
v) Drinking Water System

Preliminary raw water distribution is shown in Chapter-9 page-3. Existing facilities will be used for receiving water from Periyar river.

3.2 Power Requirement

Post IREP, the total power requirement of the refinery would be around 105 MW. Power requirement of the new facilities shall be met by a combination of new and existing GT & STG and supplemented by purchase of power from grid.

4.0 Environmental Consideration:

4.1 In order to minimize the impact of the project on the environment, due attention is given for implementing effective pollution control measures. Highlights of the Environmental consideration discussed under Chapter-14 are given below:

- Low Sulphur fuels will be used.
- Sulphur recovery unit with minimum 99.8% efficiency will be installed.
- Possibility of providing a Tertiary Stage Separator in FCC is also being looked into so that particulate matter in stack emission Is within limits
- Heaters/ furnace will be provided with proven Low Nox burners to reduce Nitrogen Oxides (NOx).

- Use of LNG as fuel is being considered based on techno economic feasibility.

4.2 Total SO_2 emission from the refinery post IREP is expected to be within the existing permissible limit as stipulated by the state pollution control board. All efforts will be taken to minimize SOx and other emissions from the refinery during design stage itself.

4.3 To control fugitive emissions following measures will be taken:

- Minimum number of flanges, valves etc.
- High grade gasket materials.
- Usage of state-of-art low leakage valves preferably with bellow seals.
- Usage of pumps with mechanical seals.
- Provision of floating roof tanks.
- Provisions of double seal in some storage tanks.
- Provision of covering the oil-water separation units in ETP.
- Provision of seals in the drains and manholes.

4.4 A comprehensive wastewater management system shall be made available in the refinery to treat liquid effluent to meet the MINAS and State Pollution Control Board requirements for refinery. Oil effluent streams from process units and tank farm area are to be treated in the proposed process waste water treatment plant, floor wash and contaminated rain water shall be received through a separate pipeline and treated separately. . Separate treatment of spent caustic is envisaged. A separate sanitary waste treatment consisting of package unit is also envisaged. Treated waste water will be recycled within the refinery for process and utility requirements to the maximum extend and any excess treated waste water shall be used for gardening purpose.

4.5 Solid waste management generated in the refinery are spent catalyst, ETP sludges, general solid waste & tank bottoms. Some of the spent catalysts will be sent back to the original supplier for processing. The other catalysts are normally sent to a secured land fill.

Oily & Chemical sludge will be thickened in a thickener and thickened sludge will be dewatered in a centrifuge. The dewatered sludge will be sent to secured landfill.

General solid waste like waste refractory, spent insulation, decoking solid waste, spent charcoal etc. will be disposed off in a landfill.

Oil from the tank bottom sludge will be recovered to the maximum extent in a melting pit and the residue will be sent to secured land fill.