

Chapter 3 Operation of Processing Units

The Company plans refinery operations on the basis of demand for petroleum products, availability of required grade of crude oil as per designed parameters of processing units and refinery configuration. Yield pattern of the refinery depends upon the crude mix, refinery configuration, technology, finished product demand, production process optimisation and operating performance of various processing units.

Various factors such as deficiencies in planning for crude in consonance with the capacity of processing units, delayed commissioning, synchronisation of the commissioned units with other existing / new secondary processing units, operating below optimal capacity etc. adversely impacted the efficiency of the operation of the refinery units. Impact of such deficiencies in refining operations and Gross Refinery Margin (GRM) are discussed in succeeding paragraphs.

3.1 Crude planning and procurement

Crude is the main input that determines the yields and consequently the refinery configuration. Sulphur content in the crude determines the processing scheme and market value of the product. The planning and scheduling of crude oil is a critical task and accurate planning can result in substantial savings. A key issue for a refinery is, therefore, to identify and process optimal crude mix that maximizes profit margins. To find the right crude mix, the refinery has to take into account both processing and economic considerations. Main criterion for selection of crude by the Company is maximization of GRM. After selection of crude oils, the crude procurement and logistics departments have to secure the crudes and schedule them for delivery.

The Company imports nearly 85 *per cent* of crude through term contracts on annual basis from the foreign National Oil Companies at their Official Selling Price. The remaining quantity is sourced from indigenous suppliers and on spot basis.

The Company designed the Crude Distillation Units (CDUs) with a capacity of 15 MMTPA with the objective of processing 9.5 MMTPA (67 *per cent*) Arab Heavy Crude (High Sulphur Crude) and 5.5 MMTPA (33 *per cent*) Mumbai High Crude (Low Sulphur Crude). CDU-III was designed to process 'High TAN' crudes and the secondary processing units were accordingly designed to process feed from CDUs.

Audit observed that during the years 2011-12 and 2013-14 to 2015-16, the Company procured more high sulphur crude when the secondary processing units were not ready. Consequently, the Company could not produce high value products and maximise its revenue which is highlighted in the ensuing paragraphs.

The Company replied (November 2016) that Units were designed to process variety of crudes and processed crudes matching the availability of secondary processing facilities due to which the Company achieved highest distillate yield of 76 *per cent* in 2015-16. GRM was affected due to foreign exchange fluctuations and inventory losses.

In the Exit Conference (June 2017) with the Ministry, the Company agreed (June 2017) that secondary processing units were not ready; however it processed crude as the GRM was positive. The Ministry endorsed the reply of the Company.

The reply of the Company/Ministry may be seen in light of the fact that crude mix is very important factor for determining the product mix, distillate yield, Fuel & Loss and GRM. The Company though achieved the highest distillate yield of 76 *per cent* in 2015-16, it was less than the achievable yield of 83 *per cent* despite having a world class refinery. Further, the Company's GRM was 2.45, 2.67, -0.64 and 5.20 USD/BBL during the period 2012-13 to 2015-16 which was much below the targeted GRM of USD 10.82 per BBL as envisaged in the Phase III project. The Company did not restrict the crude procurement when secondary units of Phase III were not commissioned and operated. Thus, processing of excess crude saturated the existing secondary processing units resulting in non production of desired distillate yield.

3.2 Ineffective planning in operation of Crude Distillation Unit

Distillation is the start of the crude refining process, where the crude is separated into various fractions based on relative volatility and boiling point. Typical products of Crude Distillation Unit (CDU) are Off Gases, Naphtha, Kerosene, Light Gas Oil (LGO), Heavy Gas Oil (HGO) and Residue.

Audit found that the Company commissioned CDU III in March 2012. Various other secondary units under Phase III were commissioned from November 2012 to September 2014. However, the Company without taking into account the non-commissioning of the secondary processing units, procured crude commensurate with the processing capacity of all the units. This resulted in production of more High Speed Diesel (HSD), Vacuum Gas Oil (VGO), Naphtha, Aviations Turbine Fuel (ATF) and Fuel Oil (FO) during 2011-12 to

2014-15. Even after commissioning of all the secondary units, the Company continued production of low value products like FO and Naphtha in the year 2015-16. Audit noticed that during the period from 2011-12 to 2015-16, some of these products had to be exported at a price less than the domestic price. Even though cost in some of these cases was recovered, there was short revenue realisation to the tune of ₹ 2,774.52 crore. It was also noticed that for some of these products which were exported, the realisation was even below the cost of production which resulted in non recovery of cost to the tune of ₹ 1,666.86 crore (**Annexure III**). This affected the overall GRM.

The Company replied (November 2016) that loss of revenue on account of export be treated as a notional difference between export and domestic prices. It recorded positive operating margins and the sequential lag in commissioning of Phase III units was on account of non availability of stable power and steam.

In the Exit Conference (June 2017) with the Ministry, the Company again reiterated that it processed crude as the GRM was positive. The Ministry endorsed the reply of the Company.

The reply of the Company/Ministry has to be viewed in the light of the fact that the Company procured and processed crude without considering availability of secondary processing units and produced low value products. Further, though the Company had exported Vacuum Gas Oil (VGO) and earned revenue, it could not utilise the same in secondary processing units to convert it into value added product. The Company could not supply BS III and IV grade MS (2011-12 to 2014-15) and High Speed Diesel (HSD) (2011-12 to 2014-15) to the Oil Marketing Companies (OMCs) to meet domestic demand adequately. All these factors led to decrease in GRM from USD 5.60/BBL (2011-12) to USD (-) 0.64/BBL (2014-15).

3.3 Non synchronisation of revamped Hydrocracker units with PFCCU

Prior to Phase III expansion, the Company had two Hydrocracker Units (HCUs) which were designed for recycle mode of operation with 100 *per cent* conversion. HCUs are mainly used to produce middle distillates of low sulphur contents such as kerosene and diesel. Operation of HCU is affected by the factors like feed quality and quantity, mode of operation, catalyst type, maximization of certain product, catalyst cycle and hydrogen pressure. HCU produces VGO, Naphtha, kerosene and High Speed Diesel. The streams which are not cracked are called Unconverted Oil (UCO).

Under Phase III Expansion, both HCUs were revamped (HCU-1 in September 2011 and HCU-2 in May 2012) to convert the mode of operation from Recycle¹⁶ to Once Through¹⁷ Mode (54 per cent conversion rate) with design capacity of 1.6 and 1.7 MMTPA respectively, with the objective of processing Unconverted Oil (UCO) in Petrochemical Fluidized Catalytic Cracking Unit (PFCCU) which was also planned in Phase III. The process licensor, M/s UOP, had guaranteed that the revamped units performance would be at 54 per cent conversion rate with HC115 LT cracking catalyst and KF 848 hydro treating catalyst. Although, HCU-1 was revamped in September 2011, its catalyst was not changed from the existing HC215 to HC115 on the ground that HC215 had remaining life of one year and that the PFCCU was not ready. HCU-2 was revamped in May 2012 and its catalyst was changed from HC215 to HC115 on the assumption that PFCCU would be commissioned in second half of 2012. However, both the HCUs had to be operated under recycle mode for four years (2011-15) and it was only in 2015-16, the units operated under once-through mode.

A review of functioning of HCU-1 & 2 for the period 2011-12 to 2014-15 when the units continued to operate on recycle mode, revealed that there was under recovery of high value products and over recovery of low value products as compared to the standard yield under recycle mode which resulted in loss of revenue of ₹ 6,328.76 crore (**Annexure IV**). Further, operation of the units under recycle mode during the above period resulted in non-achievement of objective of the revamping.

The Company replied (November 2016) that actual yields are directionally in line with the design yields and agreed that conversion rates of both Hydrocrackers were high during the period. The catalyst change was delayed due to delay in commissioning of PFCCU that resulted in higher production of naphtha in 2012-13.

The reply of the Company may be seen in the light of fact that the purpose of revamp of HCUs was not achieved upto 2014-15 on account of non-conversion of VGO/UCO into value added product in PFCCU. Even with the same mode of operation, the standard yield could not be achieved which resulted in loss of revenue.

In the Exit Conference (June 2017) with the Ministry, it was stated by the Company that PFCCU did not come up due to delay in commissioning of CPP by BHEL which was agreed to by Ministry.

¹⁶ Under Recycle mode the feed will be reprocessed to ensure 100 per cent conversion of feed.

¹⁷ Under Once Through Mode, feed will be processed once and the remaining unconverted feed will be sent to PFCCU which produces Propylene and then to PPU which produced Poly Propylene, a high value product

3.4 Underutilization of Diesel Hydro Desulphurisation Treating Unit

Hydro treating is the process of removal of Sulphur, Nitrogen and metal impurities of the feed received from different units by treating with Hydrogen in the presence of catalyst. Diesel Hydro Treating Desulphurisation Unit (DHDT), with a capacity of 3700 TMT/PA was commissioned (November 2012) under Phase III expansion project. The unit produces BS III/IV grade HSD and low sulphur Naphtha and Kerosene. This unit was planned in addition to the Gas Oil Hydro Desulphurisation Unit¹⁸ (GOHDS) with a capacity of 1750.76 TMT/PA which was an existing unit.

The capacity utilisation of the DHDT and GOHDS for the three years ending 31 March 2016 was as follows:

Table 3.1: Capacity utilisation of DHDT and GOHDS

Year	DHDT		GOHDS	
	Feed processed (TMT)	Capacity Utilisation (%)	Feed processed (TMT)	Capacity Utilisation (%)
2013-14	1947.87	53	1213.56	69
2014-15	3149.15	85	623.41	36
2015-16	3379.04	91	1528.73	87

From the above, it could be seen that the capacity utilisation of DHDT was only 53 per cent during the year 2013-14. The utilisation though improved during 2014-15 and 2015-16, the same was below the installed capacity of the unit. In case of the GOHDS, the utilisation of the unit was below its installed capacity during the period from 2013-14 to 2015-2016.

Though, DHDT was commissioned with an intention of converting the entire HSD into BS III/IV, there were exports of lower grade HSD on spot tender basis even after commissioning of DHDT. Audit further observed that the export was made even when the demand of 653 TMT of BS III/IV HSD from domestic Oil Marketing Companies (OMCs) during 2013-14 and 2014-15 remained unfulfilled, as reflected in the following table:

¹⁸ Removes Sulphur from Light Gas Oil, Heavy Gas Oil and Vacuum Gas Oil.

Table 3.2: OMC demand of HSD and supply by MRPL**(Qty in TMT)**

Year	OMC Demand	Actual supply	Shortfall	Quantity exported
2013-14	4,750	4,338	412	710
2014-15	4,902	4,661	241	630
2015-16	5,543	5,547	-	-

The Company (November 2016) accepted that the unit was operated at lower capacity due to non-commissioning of units such as Delayed Coker Unit (DCU), Heavy Coker Gas Oil Hydrotreating Unit (CHTU) and PFCCU. The Company further stated that only desulphurised HSD was exported since July 2014.

In the Exit Conference (June 2017) with the Ministry, the Company informed that due to non-commissioning of CPP by BHEL, units which were to provide feed to DHDT could not be commissioned which resulted in underutilization of DHDT.

The reply may be seen in the light of the fact that the Company produced 17639 TMT of HSD during the period 2013-14 to 2015-16, which was more than the total HSD processed i.e. 10003.22 TMT through DHDT and GOHDS. Further, when the processing capacity and adequate domestic demand were available, the Company did not process and sell BS III/IV diesel. Thus, the Company did not achieve the main objective of converting entire diesel into BS III/IV as envisaged.

3.5 Non production of value added product from CHTU

Heavy Coker Gas Oil Hydro Treating Unit (CHTU) is a feed preparation unit for the PFCCU. The purpose of this unit was to produce low sulphur, low nitrogen hydro treated Heavy Coker Gas Oil (HCGO) for PFCCU. Fuel gas, Naphtha and Diesel were also to be produced from the CHTU. CHTU was commissioned in May 2014.

Against the input of 506 TMT in 2014-15, as per the design yield, the total output should have been 521 TMT. Similarly, in 2015-16, against the input of 741 TMT, the design yield should have been 762 TMT. However, the actual yield in 2014-15 and 2015-16 was 505 TMT and 741 TMT, respectively.

The Company's reply (November 2016) was silent about the reasons for short recovery of products during 2014-15 and 2015-16.

Ministry did not furnish any reply.

3.6 Commissioning and Operation of PFCCU

PFCCU was commissioned (August 2014) under Phase III expansion project to produce polymer grade Propylene, which was intended for processing into Polypropylene, a high value product, in the PPU. In case of non conversion, the Propylene from the plant would be diverted to LPG pool. PPU was commissioned on 17 June 2015.

3.6.1 Audit noticed that during commissioning of PFCCU, there was less flow in the unit due to which plant load could not be increased and the unit was commissioned bypassing the control valve. However, within a few days i.e. on 2 September 2014, the plant had to be shut down due to no flow through the bypass. The Company took 20 days (02 September 2014 to 21 September 2014) to repair the above defects which resulted in loss of production and consequent loss of revenue to the tune of ₹ 198.53 crore.

The Company replied (November 2016) that teething troubles were expected in commissioning a large process unit and the incident in PFCCU was a teething trouble which could occur to any complex system.

In the Exit Conference (June 2017) with the Ministry, Company stated that the repair work was completed in five days but it took another 15 days to restart the unit due to power failure which was attributable to the BHEL. Ministry's representative seconded the reply of the Company.

Audit observed that the problem was known to the Company before commissioning and therefore, it should have assessed the time required for rectifying the defects to ensure the effectiveness of the repair. In the absence of estimation of time, it could not be ensured that the Company took reasonable time to rectify the defect.

3.6.2 The designed yield of Propylene in PFCCU was 20.60 per cent of the feed. Audit observed that the total feed in PFCCU during the period from August 2014 to May 2015 was 6,96,922 MT which should have produced 1,43,566 MT of Propylene for conversion into Polypropylene in Poly Propylene Unit (PPU) against which only 3,951 MT of Propylene was produced in PFCCU. However, as the PPU was not ready, even this quantity had to be diverted to Liquefied Petroleum Gas (LPG) pool. Non production of Propylene as per the designed yield and its non conversion to Poly Propylene, a high value product, in the PPU resulted in loss of margin of ₹ 382.83 crore (**Annexure V A**).

The Company stated (November 2016) that as the PPU was commissioned in 2015, the entire propylene was sold as LPG.

Ministry did not furnish any reply.

3.6.3 Audit also noticed that post commissioning of PPU, propylene produced by PFCCU during June 2015 to March 2016 was 1,54,611 MT (10.93 *per cent* of 14,14,595 MT of feed) which was short by 1,36,791 MT compared to the design yield. The short recovery of Propylene during this period resulted in short production of Poly Propylene, a high value product to the tune of 136,244 MT and consequent loss of margin of ₹ 364.77 crore (**Annexure V B**). The Company replied (November 2016) that during 2015-16, PPU was in stabilisation mode and the entire feed to unit was limited to 156000 MT and due to continuous efforts, the propylene yield reached 19 *per cent* as against the design yield of 20.60 *per cent*. Further tuning for improving the yield was under progress.

However, the fact remains that as against the installed capacity of 4,40,000 MT per annum, only 1,56,149 MT was processed in PPU during the period from June 2015 to March 2016. This indicated that there was ample scope for production of Propylene in PFCCU which could have been further processed in PPU.

Ministry did not furnish any reply.

3.7 Commissioning and operation of PPU

PPU, which was to convert Propylene into Polypropylene, was commissioned in June 2015. The design yield of Polypropylene was estimated at 99.60 *per cent* of the feed.

3.7.1 After commissioning in June 2015, the unit had to be shut down for 16 days (11 July 2015 to 27 July 2015) on account of bagging issues. This resulted in loss of production of Polypropylene for 16 days and consequent loss of ₹ 28.57 crore¹⁹.

The Company replied (November 2016) that bagging unit broke down frequently during commissioning and various technical issues had caused down time of these machines.

Ministry did not furnish any reply.

3.7.2 Audit observed that out of 156,149 MT of feed that was processed by PPU during June 2015 to March 2016, the Company could recover 140,544 MT which was 90 *per cent* of the

¹⁹ 140,544 MT/244 days x 16 days x ₹ 31,005 (margin as per cost accounts)

feed as against 155,524 MT of design yield. Under-recovery of 14,980 MT of Polypropylene resulted in loss of ₹ 46.45 crore²⁰.

In reply, the Company stated (November 2016) that the lower yield could be attributed to operating at lower loads and lower sized carrier gas filter.

The reply is to be viewed against the fact that the reasons for lower yield were controllable in nature.

Ministry did not furnish any reply.

3.8 Commissioning and operation of DCU

Under Phase I and II, short residue (SR) produced in Crude Distillation Unit (CDU)/ Vacuum Distillation Unit (VDU) was processed in two Visbreaker Units²¹ (VBU) into Fuel Oil (FO) which was a low value product. Under Phase – III expansion project, the Company planned minimization of production of FO by processing the SR in the DCU. DCU was mechanically completed in December 2012 and commissioned in April 2014 at a cost of ₹ 1,057.57 crore as against the scheduled completion date of September 2011.

3.8.1 Due to the delay in commissioning (April 2014) of DCU, the SR was processed in the VBU and FO was produced during 2012-13 to 2013-14. Details of the FO produced and sold during these two years are given below:

Table 3.3: FO production and Sales

(Qty in TMT)

Year	Total Production	Sales		
		Domestic	Export	Total sales
2012-13	2113	128	1955	2083
2013-14	2281	89	2216	2305

It may be seen that the Company exported more FO which by itself reduced the sales realization by ₹1,459.89 crore during 2012-13 and 2013-14 as compared to the domestic realisation.

3.8.2 After commissioning, DCU was operated at 39 and 87 per cent of its capacity in 2014-15 and 2015-16, respectively. Further, change in operating parameters like temperature, pressure etc affected the yield of various products. Audit noticed that the actual yield of

²⁰ 14980 MT x ₹31,005 (margin as per cost accounts)

²¹ Upgrades short residue into lighter value added products.

Coke which is a low value product was 32.47 and 33 *per cent* during 2014-15 and 2015-16, respectively against the design yield of 29.66 *per cent*.

It was also observed that the Company continued to produce and sell FO during 2014-15 and 2015-16 as per details given below:

Table 3.4: FO production and Sales

(Qty in TMT)

Year	Total Production	Sales		
		Domestic	Export	Total sales
2014-15	1873	66	1731	1797
2015-16	604	90	630	720

The Company replied (November 2016) that, it processed more crude, produced and exported FO as the topping margin remained positive. As regards increase in Coke yield, the Company accepted the audit observation and stated that the Company is making continuous modifications to the operating conditions for reduction of coke and improving the yield of distillates.

The Company's reply is to be seen against the fact that, the Company could not achieve one the objectives of Phase III i.e. minimisation of FO production to increase the margin.

3.8.3 The DCU had faced problems with Wet Gas Compressor (WGC) while commissioning. The unit had to be shut down again for a period of 21 days (from 06 June 2014 to 24 June 2014 and from 12 January 2015 to 15 January 2015) after commissioning for carrying out maintenance work relating to WGC.

The Company stated (November 2016) that utilization of a new process unit was normally expected at 60 to 75 *per cent* and the availability of the unit was 71.20 percent in terms of number of days.

The Company's reply was not acceptable as the capacity utilisation of the unit in the year 2014-15 was only 39 percent.

In the Exit Conference (June 2017) with the Ministry, the Company stated that they were trying to improve the distillation yield by reducing coke formation. It was also stated that the yield of coke had improved to 30 *per cent* (2016-17) as against the norms of 29.66 percent. This was confirmed by the representative of Ministry also.

3.9 Non operation of the processing units for want of feed

The process units are interlinked based on the requirement of products. Non receipt of feed from one unit affects operation of another unit. Audit observed that, some of the units commissioned under Phase III expansion were to be shut down for want of feed.

Details of shutdown of units due to non- availability of feed were as follows:

Table 3.5: Units shut down due to non availability of feed

Sl. No.	Unit	Commissioned on	Year	Duration days	Brief reasons
1.	CHTU	May 2014	2014-15	11	No feed & Unit was shut down due to CDU-III shutdown
2.	DCU	April 2014	2014-15	12	Non availability of Vacuum Residue
3.	DHDT	November 2012	2015-16	10	Due to low stock Crude, CDU-I shutdown and non-availability of Hydrogen due to tripping of Hydrogen General Unit - 3

New units were shut down due to non availability of feed though the Company processed crude in excess of installed capacity of the refinery.

The Company replied (November 2016) that the above units were not available on account of non availability of feed from the concerned units due to operational constraints. Further, the DCU was shut down for 12 days due to excess production and evacuation of coke.

The fact remains that the above instances of shut down of units due to non-availability of feed points towards inadequate planning.

Ministry did not furnish any reply.

