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# Techno-economic Study of Petroleum Refinery Configurations for Ras Gharib Crude Oil

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**Abstract**

In the present study, for maximizing the refinery profit the optimization of selected refinery configurations, particularly the residue processing schemes were carried out. All selected configurations have "Zero Residue" and "Zero Fuel Oil" refinery producing Euro IV specification fuels. The desired products are LPG, gasoline, kerosene and diesel. Linear programming was employed to predict yield, product properties and utility consumptions and an optimizer was used on vary selected parameters to maximize the overall profit. Economic analysis like profit per barrel of crude, total capital investment and simple payback period has also been carried out.

**Keywords**: Techno-economic feasibility, Refinery configurations, Ras Gharib crude oil, Linear programming, Zero residue, Economic analysis, Simple payback.

## 1. Introduction

Presently Indian hydrocarbon industry is passing through a challenging phases to provide cleaner fuels as per the auto fuel policy. Since a petroleum refinery has to operate under various constraints like technical, economical social and political, therefore, process of planning a grassroot refinery has achieved an unparalleled significance in today's scenario. India's key advantages like cheaper capital, power and labor costs and strategic location provides a potential of becoming a refining hub of South Asia and South-East Asia. But, our refining industry needs to modify its crude processing schemes so as to provide cleaner fuels. However, the declining crude quality and the obvious advantages in processing opportunity crudes may require

refiners to process a large share of heavy crudes. In such a scenario, selection of refinery configurations optimum for processing heavy crudes will be the key to sustainability.

## 2. Configuration Studies

Six refinery configuration for Ras Gharib crude oil (API- 22, Sulfur- 1.7wt %) was selected with the aim of fulfilling the need of selected petroleum products in the country, confirming to the stringent environment regulations for five level of different refining capacities- 6, 12, 18, 24 and 30 MMTPA. Selected processing schemes basically differs in their residue processing options and in all configurations gasification unit is common, so as to achieve the target of "Zero Residue" and "Zero Fuel Oil Refinery". The variations in different configurations are shown in table 1 and the detailed configurations are given elsewhere.

Ras Gharib (API-22, Sulfur 1.7) give maximum yield for kerosene in configuration 3 and minimum for configuration 1, having residue hydrocracking unit (RHCU) and Delayed coker unit respectively. The yield for diesel is found maximum in configuration 6 having solvent deasphalting unit (SDA). Yield of LPG is maximum for configuration 1 having DCU. Maximum yield of Gasoline is found for configuration 2 which is having FCCU and RHCU unit both while for the same configuration yield of diesel is minimum. Yield of gasoline is very important for economical analysis as it is the highest value product considered in the present study. Product properties have been so selected so as to meet the EURO IV fuel specifications as sooner or later they are going to used throughout the country in a phased manner.

**Table 1:** Refinery configurations studied.

| Units | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **HCU** | X | | X | X | X | X |
| **DCU** | X | | | | | |
| **GOHTU** | | X | | | | |
| **RHCU** | | X | X | | | |
| **FCCU** | | X | | X | | |
| **NHT2** | | X | | X | | |
| **Alky** | | X | | X | | |
| **Cat. Poly.** | X | X | | X | | |
| **MHCU** | | | | | | |
| **SDA** | | | | X | | X |
| **Visbreaker** | | | | | X | |

**Table 2:** Product yields for different configurations.

| Products | Configurations | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **LPG % Vol.** | 5 | 4 | 4 | 3 | 3 | 3 |
| **Gasoline % Vol.** | 22 | 50 | 21 | 32 | 22 | 17 |
| **Kerosene % Vol.** | 12 | 13 | 17 | 13 | 15 | 13 |
| **Diesel % Vol.** | 61 | 33 | 58 | 52 | 60 | 67 |

## 3. Economic Analysis

Output of different crudes for all configurations has been studied and evaluated in term of profitability, investment and simple payback. Figure 1 shows net profit for different configurations and results of the study shows that refinery profit ranges from about $16 to $35 per barrel of crude depending upon throughput, and the configuration selected.

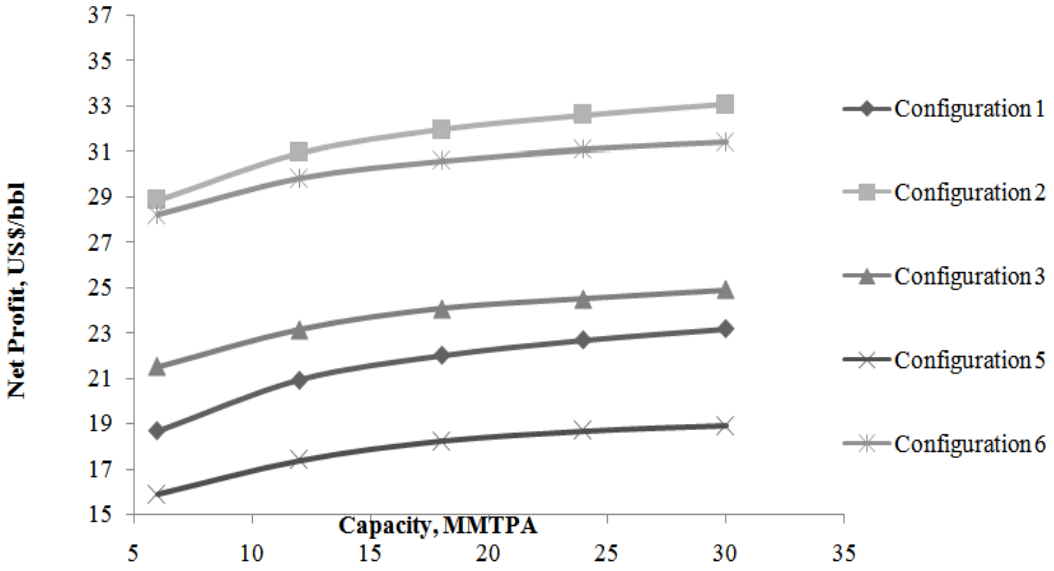


**Figure 1:** Variation of profits with refining capacity for different configurations.

It initially increases drastically for a grassroot refinery of size 6 MMTPA to 18 MMTPA but does not increases in the same proportion when refinery size varies from 18 to 30 MMTPA. The maximum value for net profit is observed for 30 MMTPA refinery and other factors like simple payback too favors refinery with larger capacity. Refinery of 30 MMTPA requires a capital investment of around Rs. 80,000 crores with a payback period of 5 years with a few exceptions. The simple payback is shown in figure 2.

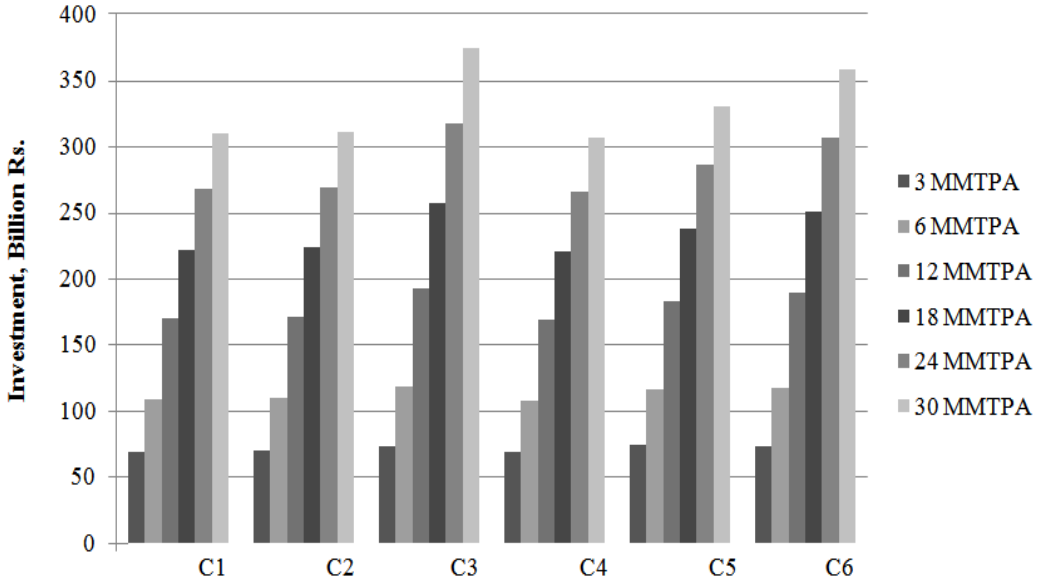


**Figure 2: Variation** of capital investment with capacity for all configurations.

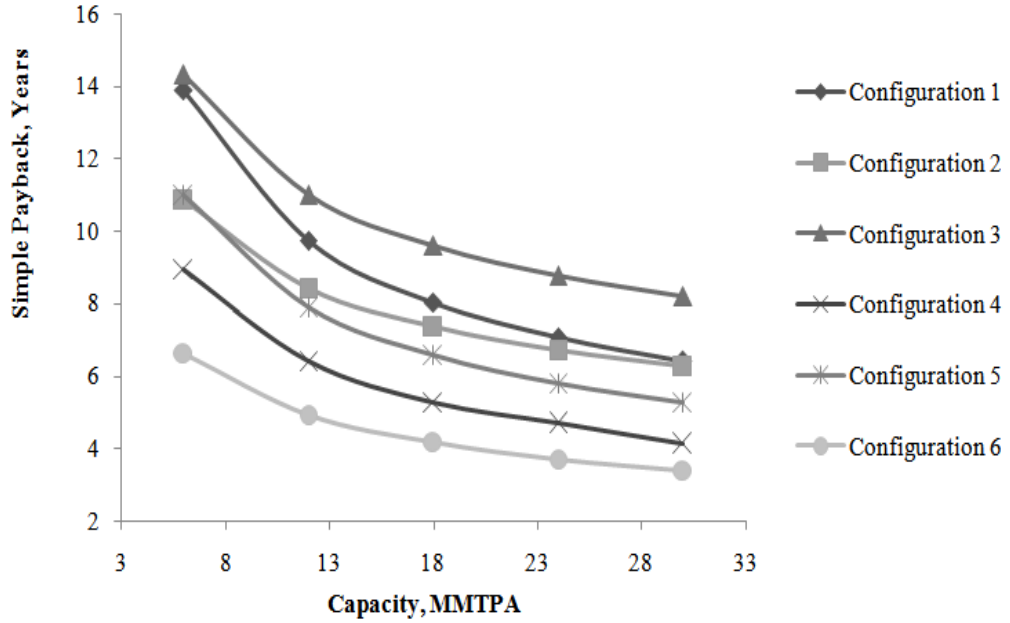


**Figure 3:** Variation of simple payback period with capacity for Ras Gharib.

## 4. Conclusion

Optimization of the refinery configurations for profit maximization does not give the yield pattern as required by the demand-supply scenario in the country and this is due to the fact that the petroleum product prices are not regulated properly. Therefore it is a policy matters and needs consideration at appropriate level. From the graph it can be observed that a 5 times increase in capacity (from 6 to 30 MMTPA), the investment

requirement increases 2-4 times, the payback period get halved and the increase in profit/bbl is approx 2 to 3 US$. Hence refinery with a large capacity in all points of views is a profitable venture.

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