FEASIBILITY STUDY FOR INSTALLATION OF A CONDENSATE FRACTIONATION PLANT AT KAILASHTILA GAS FIELD

By

Md. Nuruzzaman Khan

A Project Thesis
Submitted to the
Department of Industrial & Production Engineering
in Partial Fulfilment of the
Requirements for the Degree
of
Master of Advanced Engineering Management

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY
DHAKA, BANGLADESH

March 2011

The project thesis entitled as **Feasibility Study for Installation of a Condensate Fractionation Plant at Kailashtila Gas Field** submitted by Md. Nuruzzaman Khan, Student No. 100508124(P), Session- October 2005, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master in Advanced Engineering Management on March 30, 2011.

BOARD OF EXAMINERS

1.	Dr. Nikhil Ranjan Dhar Professor Department of Industrial & Production Engineering BUET, Dhaka	Chairman
2.	Dr. Kais Bin Zaman Assistant Professor Department of Industrial & Production Engineering BUET, Dhaka.	Member
3.	Dr. T. P. Bhowmick Professor Department of Mechanical Engineering KUET, Khulna.	Member (External)

Declaration

It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

Md. Nuruzzaman Khan

This work is dedicated to
All of the part-time graduate students of BUET

Table of Contents

List of Tables

List of Figures

ACRONYMS

A.V.: Account Value

bbl: Barrel

bbld: Barrel per Day

BCF: Billion Cubic Feet

BCR: Benefit Cost Ratio

BERC: Bangladesh Energy Regulatory Commission

BPC: Bangladesh Petroleum Corporation

CGR: Condensate Gas Raio

CNG: Compressed Natural Gas

EMRD: Energy and Mineral Resources Division, MPEMR, Govt. of Bangladesh.

EPC: Engineering, Procurement and Construction

ERL: Eastern Refinery Limited

F.C.: Foreign Currency

GIIP: Gas Initially In Place

HCU: HydroCarbon Unit, under Ministry of Power, Energy and Mineral Resources

HOBC: High Octane Blending Component

HSD: High Speed Diesel or Diesel

ICT: International Competitive Bidding

IOC: International Oil Company

IRR: Internal Rate of Return

JGF: Jalalabad Gas Field

KCFP: Kailashtila Condensate Fractionation Plant

KGF: Kailashtila Gas Field

KTL: same as KGF

L.C.: Local Currency

LC: Letter of Credit

LPG: Liquefied Petroleum Gas

MD: Managing director

MMCFD: Million Cubic Feet per Day

MMSCF: Million Standard Cubic Feet

MMSCFD: Million Standard Cubic Feet per Day

MPEMR: Ministry of Power, Energy and Mineral Resources, Govt. of Bangladesh.

MS: Motor Spirit or Petrol

MSTE: 'Molecular Sieve Turbo Expander' type gas processing plant

NBR: National Board of Revenue, Govt. of Bangladesh

NGL: Natural Gas Liquids

NOC: No Objection Certificate

NPV: Net Present Value

OGIIP: Original Gas Initially at Place

OTM: Open Tendering Method

P.V.: Primary Vale

PBP: Pay Back Period

Petrobangla: Bangladesh Oil, Gas and Mineral Corporation

PSI: Pre-Shipment Inspection

PW: Present Worth

RCFP: Rashidpur Condensate Fractionation Plant

RON: Research Octane Number

RPGCL: Rupantorito Prakritik Gas Company Limited

SCF: Standard Conversion Factor

SGFL: Sylhet Gas Fields Limited

SKO: Superior Kerosene Oil or Kerosene

SRL: Super Refinery Limited

VAT: Value Added Tax

Acknowledgement

At the very beginning I would like to express my sincere gratitude to the almighty Allah whose blessings made me capable of accomplishing this thesis work.

I am greatly indebted to my supervisor Dr. Nikhil Ranjan Dhar, Professor, Department of Industrial and Production Engineering, BUET for his constant guidance, cordial suggestion, dynamic instruction, help and care for the completion of the thesis work. He was so generous and merciful to take me under his supervision when my time for degree completion was about to an end.

I am thankful to the staff and personnel of the Department of Industrial and Production Engineering, Bangladesh University of Engineering and Technology, Dhaka as well as the concerned officers of Bangladesh Petroleum Corporation and Petrobangla for their co-operation.

My appreciation is extended to Sylhet Gas fields Limited Officials, especially my controlling Boss Engr. Abdul Quadir, DGM(Planning), Mr. Khawja Ahmed, GM(P&D) and Managing Director Engr. Md. Tofazzal Hossain, for their positive attitude and help to complete my thesis work. Special thanks and gratitude to my senior colleague Mr. Helal Uddin, Deputy Manager (P&M), SGFL for his inspiration, official sacrifice and help to prepare the base of the feasibility study. Thanks to Engr. Prianka-binte-Zama, Engr. Abdullah-al-Mamun, Engr. Abdullah-al-Masud, Engr. Shiplu, Lecturers of IPE and Engr. Mominul Islam and Engr. Maidul Islam Jewel, students of Shahid smrity Hall, BUET for their cordial assistance while writing this thesis report.

I am grateful to my family members, especially to my parents, mejo vaia Kamruzzaman, my wife Lutfunnahar and daughter Khadija-tul-Kubra for their inspiration and sacrifice due to my isolation from home to complete the thesis.

ABSTRACT

This project was designed to analyze the feasibility for installation of a Condensate fractionation plant at Kailashtila field to fractionate Condensate produced from Jalalabad gas field into petroleum products like Octane, Kerosene and Diesel. After the cessation of the feed stock of Jalalabad gas field, this plant may be used to fractionate the surplus Condensate of Kailashtila field and Bibiyana field.

This Report deals basically with the feasibility study and evaluation of the project: Installation of a Condensate Fractionation Plant at Kailashtila Gas Field. The main objective of the study focuses on feasibility analysis using both financial and economic appraisal including BCR(F), BCR(E), IRR(F), IRR(E), Discounted Pay Back Period to check the viability of the project.

Feasibility of proposed plant location is evaluated on the basis of site selection criteria. Plant Capacity is determined on the basis of raw materials supply and profitability. Products to be produced are Octane, Diesel and Kerosene is selected depending upon the property of raw materials and market demand. Fixed Capital Investment cost is determined by 'Ratio of plant capacities Power Factor' method on the basis of the cost of 2500 bbl/day capacity Rashidpur Condensate Fractionation Plant (RCFP) of SGFL in 2006. Plant operating costs, overheads and selling expenses are also taken from the similar costs of RCFP under operation from 2009.

Economic and Financial evaluation are performed on plant capacities of 750 bbl/day, 1250 bbl/day and 1500 bbl/day for most likely cases. Another option of 750 bbl/day capacity and pessimistic assumption are also evaluated.

Recommendations are made on conclusions and the findings of above mentioned evaluations.

Chapter-1

Introduction

1.1 Background

Energy is the prime mover of modern civilization. With the growth of GDP, the growth in energy demand is a common circumstance. To meet up the incremental energy demand, our most important mineral resource natural gas production is increasing day by day in Bangladesh. The daily average gas production in the Year 2009-10 was 1927 MMSCFD (million standard Cubic feet per day) which was 1751 MMSCFD in the previous year, and it was 1646 MMSCFD in the Year 2007-08 [1]. 'Condensate' is the liquefiable hydrocarbon associated with natural gas derived as by product while gas is processed in natural gas processing plants [2]. As the gas production is increasing, the associated condensate production is also increasing every year. In 2009-10 a total of 2,487,174 bbl of condensate was produced [1]. The daily average condensate production in 2009-10 was 6814 bbl/day and it is 12% more than the previous year.

Gas condensate can be fractionated in the fractionation plants to produce Petrol, Diesel, Kerosene, Octane and other hydrocarbon solvents [3]. In Bangladesh, existing condensate fractionation plants' total capacity is less than the total condensate production rate. As a result, Bangladesh needs to export gas condensate in the recent years which is the raw material of petroleum fuels [4]. On the contrary, Bangladesh is importing

substantial quantity of petroleum fuels e.g. Octane, diesel and Kerosene each year. In the last financial year (2009-10) Bangladesh exported a total of 551,070 bbl of gas condensate [4] while imports around 85,500 MT of Octane [5] which is equivalent to around (85,500×1000÷0.75÷159) = 716, 981 bbl. Corresponding Diesel and Kerosene import quantity was much higher than this [6]. Transportation and export of condensate is a troublesome job. It is rather convenient to transport finished petroleum products after fractionating the condensate at the vicinity of gas fields or at the terminal of condensate supply pipeline. It will also help to be self sufficient in fuel energy and save foreign currency and reduce the botherations of condensate export.

In Bangladesh, there are condensate fractionation plants in Haripur, Kailashtila, Titas and Bakhrabad gas fields to produce Petrol, Diesel and Kerosene [1]. All these plants are profitable enough and recently (August 2009) Sylhet Gas Fields Limited has started to fractionate at a bigger capacity (2500 bbl/day) at Rashidpur field using the condensate of Bibiyana field. This Rashidpur Condensate Fractionation Plant (RCFP) is producing Petrol, Diesel, Kerosene and Octane. This plant is also running with making good profits [7].

In this situation to meet up the demand of Octane, Diesel and Kerosene, effort may be made to fractionate the gas condensate by installing condensate fractionation plants. The second highest condensate producing field in Bangladesh is Jalalabad, now under operation of Chevron. The present (Dec 2010) condensate production rate of Jalalabad field is 1218 bbl/day [1]. Condensate from Jalalabad field comes to KTL zero point at Kailashtila field through Pipeline. Then it is transferred to Ashugonj via North-

South condensate pipeline or to private enterprises by tank lorry. Here feasibility study should be done for installation of a condensate fractionation plant at Kailashtila field.

1.2 Past History and Present Situation of Jalalabad Gas Field

Jalalabad Gas Field is now been being operated Chevron by Bangladesh Limited under PSC with Petrobangla. The field was discovered in the year 1989 by Scimiter Exploration Limited [8]. The reserve of this field was estimated by Unocal on Aug 1999, the then operator of the field and the field was also developed and brought into production by them [9]. The present (Feb,2011) daily average gas production rate from this field is @143 MMSCFD and about 1255 bbl/day of Condensate is produced as by-product [10].

Decision taken in a meeting chaired by Chairman of Petrobangla held on 23rd November 2004 at Petrobangla to install two Condensate fractionation plants by Sylhet Gas Fields Limited (SGFL), one at Rashidpur to fractionate the Condensate of Bibiyana gas field and another at Kailashtila to fractionate the Condensate of Jalalabad gas field [11]. Installation of Condensate fractionation plant at Rashidpur field (RPF) is going on under a separate project to fractionate the Condensate of Bibiyana gas field [7]. 1st phase of this project is completed in 2009 and it is fractionating 2500 bbl per day of Bibiyana condensate and producing around 1300 bbl of MS (Petrol), 850 bbl of Diesel and 350 bbl of kerosene per day [12]. The proposed project is to install a Condensate fractionation plant at Kailashtila field to fractionate Condensate of Jalalabad gas field. Condensate of Jalalabad field is purchased by Petrobangla under the “Condensate Purchase & Sales Agreement” (CPSA) in US dollar [13].

According to Finance ministry report “Towards Revamping Power and Energy Sector: A Road Map, June 2010, Finance Division”, gas production from Jalalabad field will be increased by more 250 MMSCFD after 2015 [14]. It is clear that, if the gas production rate is increased, then the associated condensate production rate is also increased. To utilize the additional quantity of condensate, we need additional capacity of fractionation plants.

1.3 Similar Types of Plants under Operation

Presently, Sylhet Gas Fields Ltd is operating 3 condensate fractionation plants at Haripur, Kailashtila and Rashidpur [7]. Moreover, RPGCL (Rupantorito Prakritik Gas Company Ltd), BGFCL (Bangladesh Gas Fields Company Ltd.), ERL (Eastern Refinery Ltd.) and private enterprise SRL (m/s Super Refinery Limited) are also fractionating condensate and producing Petrol, Diesel, Kerosene etc. in their own fractionation plants of various capacities.

1.4 Business Opportunity and Market

The price of raw material (condensate) and that of the products of a condensate fractionation plant are prefixed by the government and BERC (Bangladesh Energy Regulatory Commission) by gazette notification [15]. Reasonable margin is obtained by producing Petrol (MS), etc in the conventional fractionation plants. But in the recent years a large number of Petrol Engine vehicles being converted into CNG driven. So, the demand/consumption/ market of Petrol may be in decreasing trend. To overcome the marketing uncertainty, market survey and forecasting will be carried out in this project. If

the demand of Petrol is dissatisfactory, then Octane may be produced in the proposed plant instead of Petrol.

1.5 Financial and Economic Issue

By fractionating Condensate of Jalalabad gas field, petroleum products like Motor Spirit (MS)/Octane, Kerosene and Diesel will be produced whose market value is much higher than that of Condensate [15]. So, foreign currency will be saved instead of importing these end products.

1.6 Present Market and Demand Fixation

In the last few years (2005 to 2009) the use of MS is something reduced due to use of CNG in the vehicles [16]. But Bangladesh needs to import more than 70,000 metric tons of Octane even in those years [17]. Considering this it may be planned to produce Octane by increasing the Research Octane Number (RON) of the produced MS. By fractionating the Jalalabad condensate, the RON of the produced MS will be 82 [18]. By mixing/blending Octane booster with fractionated MS, the RON may be increased upto 95 which is the main specialty of Octane fuel [19]. So the import of Octane fuel of the country will be reduced substantially. EPC contractor of plant installation will be asked to make the necessary facilities to convert the fractionated MS into marketable quality of Octane depending upon market.

1.7 Scope of the Study

To fulfill the main objective the scope of the study includes:

Chapter 1 presents introduction and background of the study. **Chapter** 2 presents specific objectives of this work and also outline of the methodology which have been followed to draw effective results of the work.

Chapter 3 presents the technical feasibility analysis that includes the feasibility of the proposed plant location at Kailashtila. Availability of raw materials, selection of plant capacity, possible products from the available raw materials and selection of optimum product set for the proposed plant depending upon marketing opportunity are also determined in this chapter. Organizational and financial capability of the implementing agency, legal restriction and other issues are also presented in brief.

In **Chapter 4** market feasibility that means the production and demand situation of the products of the plant in Bangladesh has been studied.

Chapter 5 presents the determination of profitability by NPV, BCR, IRR, Payback Period etc. calculations. i.e. economic and financial analysis of the proposed project to find out feasibility of the proposed project by following appropriate methodology.

Chapter 6 provides the SWOT analysis that means the strength, weakness, opportunity and the threats of the project.

Finally, a summary of major contributions and recommendation for the future work is given in **Chapter 7** and references are provided at the end.

Chapter-2

Objectives and Methodology

2.1 Objectives of the Present Work

Natural gas condensate is a low-density mixture of hydrocarbon liquids that are present as gaseous components in the raw natural gas produced from many natural gas fields. The natural gas condensate contains hydrocarbons within the gasoline boiling range. In Bangladesh, the most important energy resource natural gas produced from underground reservoirs is processed in gas processing plants to meet the pipeline quality gas specifications. To get marketable products from the condensate, it is required to fractionate this by-product in the Condensate Fractionation Plants. To utilize the additional quantity of condensate, we need additional capacity of fractionation plants.The objectives of the present work are as follows:

i) To find out annual consumption of petrol, octane, diesel and kerosene in Bangladesh.

ii) To forecast market demand and local production of these products following proper methodology.

iii) To find the financial feasibility of the condensate fractionation plant by calculating Net Present Value (NPV), Payback Period, Benefit Cost Ratio (BCR), Internal Rate of Return (IRR) etc.

iv) To prepare recommendation on installation of a condensate fractionation plant at Kailashtila Gas Field.

The possible outcome of the thesis is a feasibility report including technical, economic, financial and marketing analysis and recommendation about the condensate fractionation plant installation.

2.2 Methodology

The methodology is as follows:

i) The data of petroleum products consumption, production rate, import, export etc. have been collected from Bangladesh Petroleum Corporation (BPC) and forecasted demand of petroleum products have been determined by Simple Moving Average (SMA) method.

ii) The analysis of technical feasibility including selection of plant capacity have been done by collecting of raw materials data (quantity, quality, sources etc.) from Hydro Carbon Unit, Energy Ministry and Petrobangla.

iii) Cost estimation and economic evaluation of the project have been done by the methodology presented by Valle-Riestra [20] and Peters and Klaus Timmerhaus [21].

iv) Plant installation cost and operating cost have been calculated on the basis of Rashidpur Condensate Fractionation Plant (RCFP) project of SGFL.

v) Financial feasibility of the condensate fractionation plant has been done by calculating Net Present Value (NPV), Discounted Payback Period, Benefit Cost Ratio (BCR), and Internal Rate of Return (IRR).

vi) Finally SWOT (Strength, Weakness, Opportunities and Threats) analysis has been done for understanding and decision-making for all sorts of situations in Kailashtila condensate fractionation plant.

Chapter-3

Technical Feasibility

3.1 Feasibility of the Proposed Plant Location at Kailashtila

The geographical location of the plant contributes a lot to the success of any chemical business venture. Utmost care and judgment is required for selecting the plant site, and many different factors must be considered while selecting the plant site. A suitable site must be found for a new project, and the site and equipment layout must be planned. Provision must be made for the ancillary buildings and services needed for plant operation; and for the environmentally acceptable disposal of effluent.

The Proposed plant location for Installation of a condensate fraction plant is near the existing MSTE plant of SGFL at Kailashtila, Location II. The location of gas fields in Bangladesh including Jalalabad and Kailashtila field, gas and condensate transmission lines are shown in Bangladesh map in Fig.3.1. The proposed plant site and layout are evaluated in the following sections based on site selection criteria mentioned in 'Plant Design and Economics for Chemical Engineers'-by Peters et al [21] and 'Design and Building of Process Plants'-some practical guidelines, by Dr. AKM.A. Quader [22].

The proposed plant location is at KTL Zero point near Kailashtila MSTE plant in Sylhet district is shown in Fig.3.2.

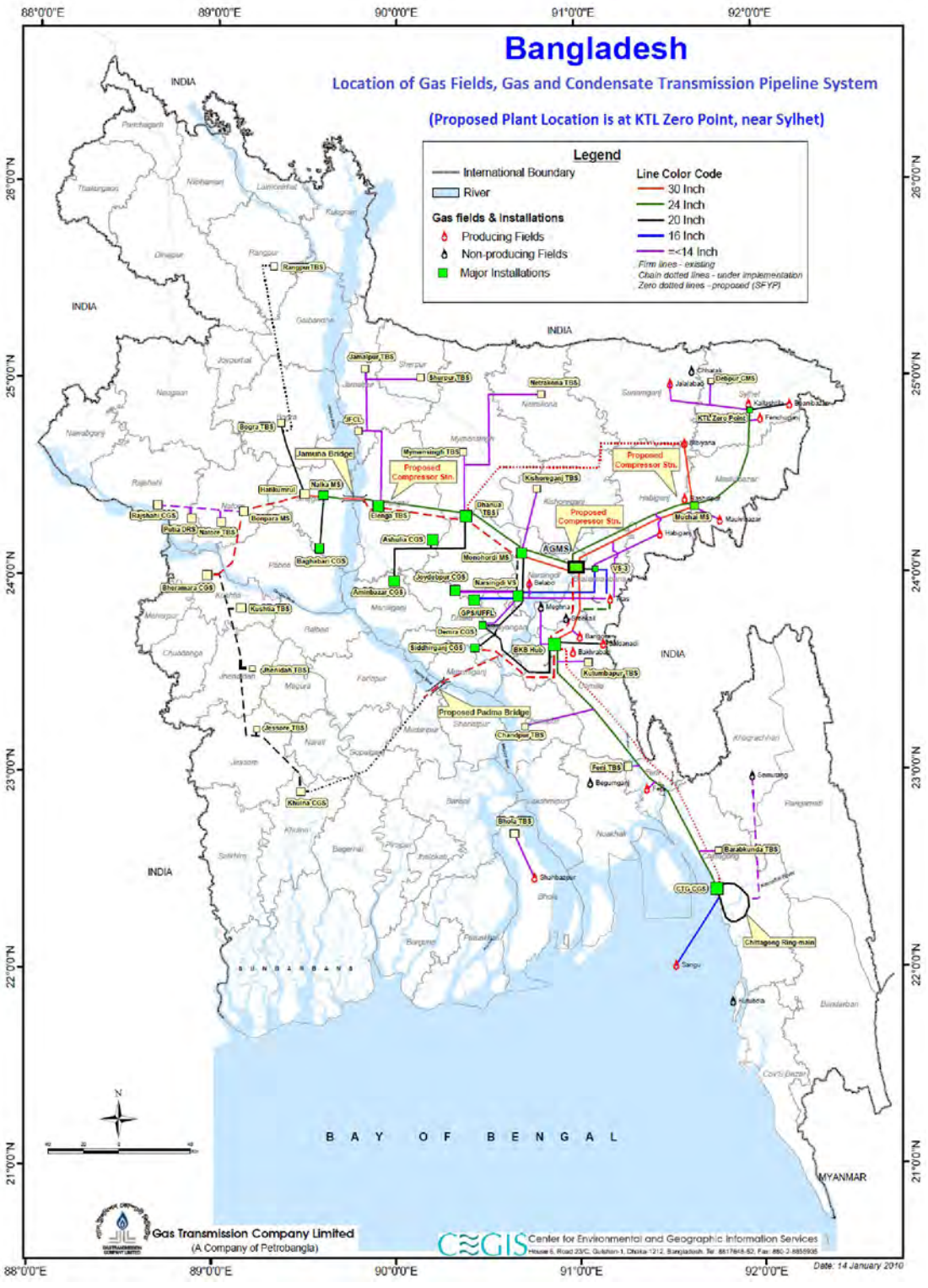

Fig.3.1: Bangladesh map showing Jalalabad and other Gas Fields, Gas and Condensate Transmission Pipeline System and Proposed Location for KCFP, near Sylhet.

Fig.3.2: Jalalabad Field and Proposed Plant Location at KTL Zero Point, Sylhet

3.1.1 Land Area

The proposed plant area is paddy field. Area can be acquired as per requirement depending upon selected plant capacity. No major infrastructure exists here. Photograph of aerial view of plant location is shown in Fig.3.3. The KCFP has easy access to water and road transport. Sylhet-Jokigonj highway runs through the front and the SURMA river runs through the back of the plant site as shown in Fig.3.3.

Fig.3.3: An aerial view of proposed plant location, ©Google

The land area used in the Rashidpur Condensate fractionation plant is 12.5 acres. Capacity of the plant is 3750 bbl/day. Here, tank farm area is 8.5 acres. Process plant area is 1.0 acre. Control room, Loading station, Office building, utilities and ancillary facilities 3.0 acres. On the basis of this, area requirement for plant capacity of 750 bbl/day is 6,25 acre. Area requirement for plant capacity of 1250 bbl/day is 7.25 acre. Area requirement for plant capacity 1500 bbl/day is 8.00 acre.

The land area around the proposed plant is almost farmland, cropland and few trees. No buildings or big installations are there in the west and north sides of the plant area. Therefore, area is available as per requirement depending upon the plant capacity. More land area can be acquired for further expansion of the plant.

3.1.2 Transportation

Raw materials, products and manpower transportation are very important issues in selection of plant location. Water, railroads, and highways are common means of transportation used by major industrial concerns. The kind and quantity of products and raw materials determine the most suitable type of transportation facilities. Careful attention should be given to local freight rates and existing railroad lines. The proximity to railroad centers and the possibility of canal, river, lake or ocean transport must be considered. Motor trucking facilities are widely used and can serve as a useful supplement to rail and water facilities. If possible, the plant site should have access to all three types of transportation and, certainly, at least two types should be available. There is usually a need for convenient air and rail transportation facilities between the plant and the company head quarters, and effective transportation facilities for the plant personnel are necessary.

At Kailashtila location II, i.e. at the proposed plant location, transportation facility of raw materials is already in done condition. The condensate of Jalalabad field comes here at their Scraper Unit (adjacent to the proposed plant location as shown in Fig.3.3) and pumped to North –South condensate pipeline or sold to the tank lorry/bowsers of private enterprise by the handling of SGFL.

Finished Products may be transported by tanker / bowser from the proposed plant location to the sales depots of petroleum marketing companies of BPC. Octane, Petrol and Diesel may directly be sent to the corresponding petrol pumps through the marketing companies. At present, condensate and finished products from Kailashtila-I and II are sold by tank lorry loading.

Office duty and Shift personnel may be taken lift & drop from residential area to plant area by SGFL bus in the similar roaster of adjacent MSTE plant of SGFL. The officers or workers living at other locations can reach to the proposed plant area very easily by public bus or other transport as the plant will be located by the side of Sylhet-Jokigonj highway.

Heavy equipment & plant materials may be transported by long trailers etc. by road. The Sylhet – Jokigonj highway runs by the side of the plant site. Moreover, the river Surma is very near to be used as convenient waterway for carrying heavy equipments, vessels etc.

Raw material octane booster and other necessary items may be transported by road, railway or by airplane. The Sylhet railway station is within 20 km and Osmani International airport is within 25 km from the proposed site.

3.1.3 Utility Supply

Availability of electricity, water, instrument air and other utilities are of very important considerations in plant site selection.

- **Fuel:** The fuel gas requirement for generator should be bought from Jalalabad Gas Transmission and Distribution Company as per govt. rule. The fuel for heater may be the vented off (C_4 and lighter) portion of raw material condensate. Both are available as the proposed plant location is at the vicinity of MSTE plant at Kailashtila-II.

- **Water:** Required cooling water and process water can be got easily from deep tube wells to be drilled under condensate fractionation plant installation project. Water treatment plant will be set up and run as per requirement.

- **Electricity:** The plant will have its own generator for captive electricity demand. Natural gas from MSTE plant or via gas Distribution Company can be supplied easily as generator fuel. Moreover, existing PDB electricity supply line and captive power system of adjacent MSTE plant will be an additional support if required.

- **Instrument air:** For pneumatic control system and for other concerned job, the necessary instrument air will require air purifier and instrument air compressor. The instrument air compressors and other power consuming equipments will run from the KCFP's own captive generators.

3.1.4 Climate

Climate of the proposed location is fairly good. Sufficient rain, sunlight, moderate wind flows are very common every year. Site elevation is not too high as to have adverse effect on barometric pressure. This area is free from cyclone and heavy storm. Neither snowdrop nor extreme high temperature is in the Sylhet area. So, the climate may be commented as excellent at our proposed location.

3.1.5 Waste Disposal

In recent years, many legal restrictions have been placed on the methods for disposing of waste materials from the process industries. The site selected for a plant should have adequate capacity and facilities for correct waste disposal. In choosing a plant site, the permissible tolerance levels for various methods of waste disposal should be considered carefully, and attention should be given to potential requirements for additional waste-treatment facilities. In our proposed plant, no significant waste or toxic material will be found. Oily water, sludge etc. may be burnt in the burn pit. Other wastes will be disposed off according to the recommendation of EMP (Environmental Mitigation Plan) study to be carried out under the Condensate Fractionation Plant Installation Project.

3.1.6 Labor Supply

The type and supply of labor available in the vicinity of a proposed plant site must be examined. Consideration should be given to prevailing pay scales, restrictions on number of hours worked per week, competing industries that can cause dissatisfaction or high turnover rates among the workers, and variations in the skill and productivity of the workers.

At present, SGFL is operating 3(three) more condensate fractionation plants of capacities varies from 72 bbl/day to 2500 bbl/day. Skilled and experience personnel from those plants may be partially transferred to the proposed plant and some new recruitment will fulfill the manpower requirement. Moreover in-site training of the plant personnel will be an integral part of the plant installation project.

3.1.7 Taxation and Legal Restrictions

State (NBR) and local (Union Parishad or Pouroshova) tax rates on property income, unemployment insurance, and similar items vary from one location to another. Similarly, local regulations on zoning, building codes, nuisance aspects, and transportation facilities can have a major influence on the final choice of a plant site. In fact, zoning difficulties and obtaining the many required permits can often be much more important in terms of cost and time delays than many of the factors discussed in the preceding sections. Our proposed plant location is near MSTE plant and it is outside busy residential area of Golapgonj pouroshova. Here, land tax will be reasonable and VAT rate on products is similar all around Bangladesh. The plant is supposed to get easily the BERC(Bangladesh Energy Regulatory Commission)'s license for petroleum production and storage, like other fractionation plants of SGFL.

3.1.8 Site Characteristics

The characteristics of the land at a proposed plant site should be examined carefully. The topography of land and the soil structure must be considered, since either or both may have a pronounced effect on construction costs. The cost of the land is important, as well as local building costs and living conditions. Future changes may make it desirable or necessary to expand the plant facilities. Therefore, even though no immediate expansion

is planned, a new plant should be constructed at a location where additional space is available. The proposed plant site is suitable enough to meet above criteria.

3.1.9 Flood & Fire Protection

Sylhet region is relatively high and at the upstream of the rivers like Surma, Kushiara etc. During heavy shower in the rainy season, temporary floods are occurred sometimes. Considering this, Land development work is included in the project implementation. The height of the land of adjacent MSTE plant and past experience will be very helpful in this regard.

The plant will be designed and constructed as per safety codes of refineries to prevent the possible fire hazards. SGFL personnel are trained and experienced enough to operate and maintain the plants safely and they have knowledge in firefighting as a regular basis rehearsal in plant sites.

3.1.10 Community Factors

The nature and facilities of a community can have an effect on the location of the plant. If minimum number of facilities for satisfactory living of plant personnel does not exist, it becomes a burden for the plant to subsidize such facilities. Cultural facilities of the community are important to sound growth. Facilities such as religious centers, libraries, schools, civic theatres, concert associations, and other similar groups do much to make a community progressive. The efficiency, character, and history of both state and local governments should be evaluated. The existence of low taxes is not in itself a favorable situation unless the community is already well developed and relatively free of debt.

SGFL personnel have a very good relationship with the local community, both the leaders and general people. The neighboring people well understand that, it is a state

owned company and the personnel working here for national interests. Moreover, a good number of neighboring people also are working in all installations of SGFL including MSTE, the proposed plant location. So, any expansion or growth of the company will make the local community happier.

3.1.11 Selection of The Plant Site

Depending upon the criteria and situation discussed in the above sections, the proposed plant location at Kailashtila-II can be considered as a suitable rather a best location for Installation of a Condensate Fractionation Plant.

3.1.12 Plant Layout and Plot Plan

Plant Layout and plot plan will include: Tank farm area, Fractionation tower and processing area, Heater, generator and other ancillary facilities, Plant control room, Administrative office, Loading station etc.

3.2 Availability of Raw Materials

The main raw material of the plant is condensate. Another is Octane Booster to produce Octane from fractionated by improving RON (Research Octane Number) as described in section 1.6 of this thesis report.

3.2.1 Condensate from Jalalabad Gas Field

The main raw material of the proposed plant is gas condensate. As condensate is a byproduct of natural gas, then the production of condensate is solely dependent on the production of natural gas from gas mines called as reservoirs [25]. The prime source of condensate for this project is from Jalalabad gas field. This field is under

operation of CHEVRON, an IOC. The reserve, production and future condensate prospect of this field presented below.

The Condensate-Gas ratio of Jalalabad field is around 8.5bbl/MMSCF [1]. The availability of condensate from this field can be presented in the subsequent sub-clauses.

- **Current Availability of Condensate from Jalalabad field**

Presently (Feb. 2011), Jalalabad field is producing around 142.7MMSCF of gas and 1255 bbl of condensate per day [10]. The daily average condensate production in the year 2009-10 was 1381 bbl [1]. In November 2010 it was 1124 bbl /day and in December 2010 it was 1218 bbl day [1]. The current availability can be considered as 1250 bbl/day. M/S Occidental Company, the then operator of this field, estimated the gas reserve in Aug 1999. Estimated gas reserve data is given in Table-3.1.

Table-3.1: Gas reserve of Jalalabad field as estimated in 1999 published by HCU [9]

	Proved reserve (BCF)	Probable reserve (BCF)	Possible reserve (BCF)
OGIIP	1038	4530	0
Recoverable Reserve (Recovery factor = 81%)	824	361	0
Recoverable reserve (2p) as per HCU 2001	879 BCF		

Proven, Probable and possible reserves are Reservoir Engineering terms. Recoverable reserve is the quantity of gas or oil that is possible to produce from the underground reservoirs.

Recoverable gas reserve of Jalalabad gas field is shown in the report of Hydrocarbon Unit of Petrobangla is 879 BCF [9], out of which 593 BCF gas is produced upto December 2010 [1]. The remaining recoverable gas reserve of this field is = 879 – 593 = 286 BCF and corresponding condensate reserve is = 286 * 8.5 = 2,431,000 bbl.

The proposed project is expected to be completed by June 2014. Then Condensate of Jalalabad gas field could be fractionated by the proposed plant for about 5 years (calculations are shown in the subsequent paragraphs). Afterwards the surplus Condensate of Kailashtila field and Bibiyana field will be fractionated through the proposed plant.

- **Future Trend of Condensate production from Jalalabad field**

Gas production from this field will be increased from this field. According to 'Towards Revamping Power and Energy Sector: A Road Map', June 2010, published by Ministry of Finance, Government of the People's Republic of Bangladesh, Para: 10.29, Table-16, The gas production of this field will be increased by additional 250 MMCFD after drilling of 3new wells depending upon the 3-D seismic survey results by 2015 [14]. The Condensate Gas Ratio (CGR) of this field is around 8.5 bbl/MMSCF. [Calculation: CGR= (Condensate Production in bbl ÷ Gas production in MMSCF) = (504226 bbl ÷ 59463.6 MMSCF) in Year 2009-10 = 8.48]. So, in 2015 the daily average gas production from Jalalabad field will be 140+250= 390 MMSCFD and corresponding condensate production will be (390×8.5) =3315 bbl/day.

- **Condensate Reserve/ Future Duration in Years**

The GIIP of this field was estimated as 1256 BCF and Recoverable reserve is 879 BCF [9], recovery factor is 81%. The cumulative gas production from this field since

inception to December 2010 is around 593 BCF [1]. Then the remaining recoverable gas reserve of this field should be 286 BCF (as on Dec. 2010). If the gas production rate remains the same as year 2009-10, (i.e., 59.46 BCF/year, the remaining reserve will be exhausted within subsequent 286÷59.46 = 4.8 years.

But this type of conclusion needs modification. Because the preliminary estimated reserve in 1999 proves to be increased, depending upon present production data and material balance calculations. After next 4.8 years (i.e., after 2015) the gas production from this field is expected to be more than 390 MMSCFD instead of being zero [14]. If 3-D seismic survey result on this field is positive, then the production will be increased. Otherwise the gas production will remain similar and the corresponding condensate production also. In this study, we will calculate the profitability if the plant is condemn as scrap material with zero value after 20 years of operation.

3.2.2 Condensate from other probable sources

In Bangladesh the most condensate enriched gas produces Beanibazar, Kailashtilla, Jalalabad and Bibiyana gas fields. The condensate gas ratios of these fields are 17.23bbl/MMSCF, 9.22bbl/MMSCF, 8.5bbl/MMSCF and 5.3bbl/MMSCF respectively [1]. These fields can be the other complementary sources of condensate. Information on these sources are presented bellow in brief. Proven gas reserve of Bibiyana is 4,121 BCF (Reserve estimated in Dec 2008 by m/s D&M) [8] and cumulative production upto December 2010 is 723 BCF [1], i.e., 17.54% of the total proved reserve. Gas production from this field is supposed to be = 700+200 = 900 MMSCFD by 2013 [14], and corresponding condensate production will be = 900*5.3 = 4770 bbl/day. But RCFP will consume 3750 bbl/day. So, additional 4770 – 3750 =

1020 bbl/day of condensate may be available to fractionate through the proposed fractionation plant if the condensate availability from Jalalabad field become reduced.

- **From Kailashtila Gas Field (KTL and MSTE)**

After completion of 2wells drilling and the production will be enhanced from Kailashtila field. Then from the two MSTE plants of KTL, produced NGL will be supplied to RPGCL and Condensate will be supplied to RPGCL, BPC and SRL and the surplus volume can be fractionated into value added Petroleum product, like MS/Octane, Diesel by installing the proposed new Condensate fractionation plant at Kailashtila.

After fractionation of Condensate from KTL and BBGF the products will be little bit different than that of Jalalabad. Fractionated products will be about 50% MS & 48% Diesel as now produced through existing Condensate fractionation plant at KTL. Fractionated MS will be converted into Octane by adding Octane booster (additives). EPC contractor will be requested to keep provision in the plant to fractionate the Condensate of KTL in the later phase of its life span.

- **Condensate from Bibiyana field**

After 2013, Bibiyana field will be able to supply additional quantity of 1020 bbl/day of condensate after fulfilling the total demand of RCFP as shown in the 1st paragraph of this section.

3.2.3 Octane Booster

Octane booster will be used to increase the Octane value (i.e., Research Octane Number or RON) of MS. The RON of the fractionated MS of Jalalabad field is 82, while

RON for Octane needs to be more than 95. The Octane Booster requirement to increase the RON from 82 to 95 is found as 4.5% of the volume of MS of 82 RON. Octane Booster can be procured from local supplier maintaining stringent quality requirements.

3.2.4 Comments

According to the 'Terms and conditions to give permission and issuance of NOC for import of condensate and installation of condensate fractionation plant in the private sector' prepared by Petrobangla and EMRD representatives of the Government of Bangladesh, dated 25/8/2008 clause no.3: "Condensate produced from different gas fields inside the country will be supplied to the fractionation plants already installed or to be installed in the govt. sector according to their demand. After fulfilling the demand of those plants, if there exists any surplus condensate, then that will be sold to the approved plant owner in the private sector through bidding" [26].

In the recent few years Bangladesh had to export raw condensate, because condensate production rate exceeded the existing condensate fractionation capacity in the country [4]. As the daily average condensate production rate is gradually increasing, Bangladesh needs more fractionation plants to process that condensate [1].

SGFL, being a state owned company, will get the preference to fractionate the condensate if it is financially viable for it.

3.2.5 Selection of Plant Capacity

Selection of plant capacity generally depends on (1) Market demand, (2) Raw materials availability, (3) Fund available for fixed capital investment and operating capital, (4) Financial and Economic Profitability analysis etc.

Market demand of the products to be produced and other factors will be analyzed in other sections of this thesis. Here, according to section-3.2.1, it is clear that, single source raw materials availability from Jalalabad field will be minimum 1250 bbl/day. Moreover, Bibiyana field will be able to supply a surplus quantity of 1020 bbl/day after fulfilling the 3750 bbl/day demand of Rashidpur Condensate Fractionation Plant as per section 3.2.2.

So, preliminarily it may be recommended for a plant capacity of 1250 bbl/day based on single source raw material. Market and economic evaluation in the subsequent chapters will help us to finalize the decision about plant capacity. Financial and economic evaluation for the plant capacities of 750 bbl/day, 1250 bbl/day and 1500 bbl/day are performed to realize the scenario.

3.3 Products Feasibility for the proposed Plant

3.3.1 Possible Products (From the Available Raw Materials)

Natural gas condensate is a low-density mixture of hydrocarbon liquids that are present as gaseous components in the raw natural gas produced from many natural gas fields. It condenses out of the raw gas if the temperature is reduced to below the hydrocarbon dew point temperature of the raw gas. The natural gas condensate is also referred to as simply condensate, or gas condensate, or sometimes natural gasoline because it contains hydrocarbons within the gasoline boiling range [2].

In Bangladesh, the most important energy resource Natural gas produced from underground reservoirs is processed in gas processing plants to meet the pipeline quality gas specifications. Normally water is removed from raw gas and Condensate is separated as by-product. Processed natural gas is mainly the combination of Methane(CH_4),

Ethane(C_2H_6), Propane(C_3H_8) and Butane(C_4H_{10}). Sometimes, Propane and Butane are extracted as LPG (Liquefied Petroleum Gas). Gas Condensate consists of liquid Hydrocarbons e.g., Pentane(C_5H_{12}), Hexane(C_6H_{14}), Heptanes and higher. To get marketable products like Petrol (or Motor Spirit, MS), Diesel (or Gas Oil), Kerosene etc. from the condensate, it is required to fractionate this by-product in the Condensate Fractionation Plants [3].

3.3.2 Products from the Condensate of Jalalabad Field

In 2005 from laboratory analysis of Condensate of Jalalabad field by ERL, it is observed that after fractionation, the products will be 66% off spec MS, 25% off spec Kerosene, 5% Diesel (off spec) and 4% will be vented out [18]. The summary of ERL analysis is given in Table-3.2.

Table-3.2: Fractions from Jalalabad condensate in 2005 as tested at ERL [18]

	Method: ASTM D 2892 (TBP Distillation)		Date: 11-06-2005
Sl.	**TBP cuts**	**Yield (% volume)**	**Comments**
a)	C_4 and Lighter	3.97	Vented out
b)	Gasoline, $C_5 - 150^0C$	66.15	Petrol/MS cut
c)	Kerosene, $150^0C - 250^0C$	24.88	Kerosene cut
d)	Gas Oil, 250^0C +	5.00	Diesel cut

Among the products in the above table, the fractionated MS or Gasoline (TBP cut, C_5–150^0C) meet all the standard properties of MS approved by BSTI except higher distillation temperature against 10% volume recovery (87^oC instead of 75^0C). Regarding the higher distillation temperature against 10% volume recovery this product considered as off spec. Fractionated Motor Spirit will be converted into Octane by adding Octane booster (additives).The 2nd product Kerosene will be off spec against smoke point. The 3rd product Diesel will be off spec Diesel in respect to density (0.88 kg/litre instead of 0.87 kg/litre). Since the 2nd and 3rd product will be off spec against BSTI standard, so the price of those

products is considered as same of Heavy Condensate for the income calculation in this project thesis.

By fractionating Condensate of Jalalabad gas field, petroleum products like Motor Spirit (MS)/Octane, Kerosene and Diesel will be produced whose market value is much higher than that of Condensate [15]. Moreover, foreign currency will be saved instead of importing these end products. Conceptual diagram of proposed condensate fractionation plant using feed from Jalalabad Gas Field (JGF) is presented in Fig.3.4.

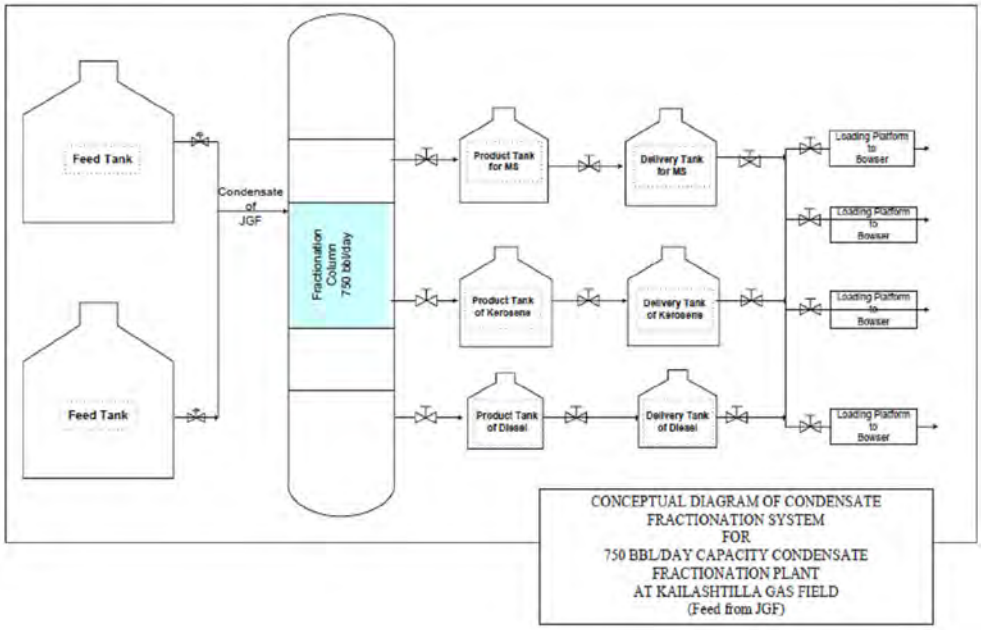

Fig.3.4: Conceptual diagram of proposed condensate fractionation plant using feed from Jalalabad Gas Field (JGF) [23]

The research octane number (RON) of the MS produced from fractionation of the Jalalabad condensate will be 82 [18]. By mixing/blending Octane booster the RON may be increased upto 95 which is the main specialty of Octane fuel [19]. So the need for import of Octane fuel of the country will be reduced substantially. So, option should be there in

the proposed plant to convert the fractionated MS into Octane. Schematic diagram of a condensate fractionation plant showing major units is presented in Fig.3.5.

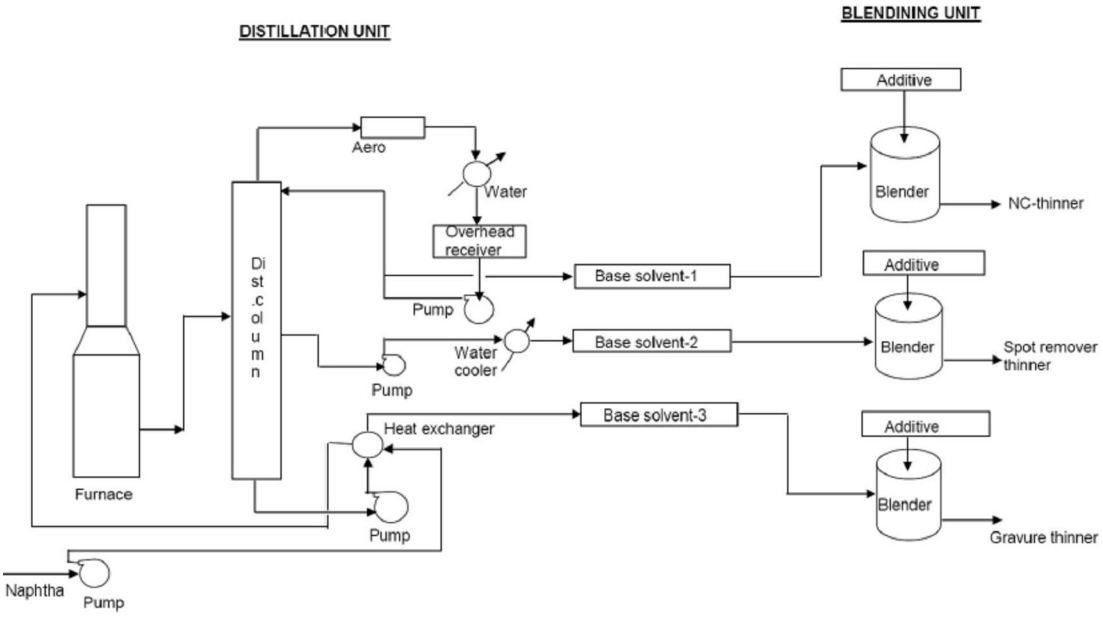

Fig.3.5: Schematic diagram of a condensate fractionation plant showing major units [24]

In December 2010, the laboratory analysis report of Jalalabad condensate shows that, about 71.95% of it contains naphtha or MS part, 22.75% Kerosene part and 1.25% Gas Oil or Diesel part, the rest 4.05% is C_4 & lighter i.e., LPG part [27] as presented in table 3.3.

Table-3.3: Fractions from Jalalabad condensate in December 2010

	Method: ASTM D 2892 (TBP Distillation)		Date: 30-12-2010
Sl.	**TBP cuts**	**Yield (% volume)**	**Comments**
a)	C_4 and Lighter	4.05	Vented out
b)	Gasoline/Naphtha, $C_5 - 150^0C$	71.95	Petrol/MS cut
c)	Kerosene, $150^0C - 250^0C$	22.75	Kerosene cut
d)	Gas Oil, 250^0C +	1.25	Diesel cut
e)	Fuel Oil, (RCO), 350^0C +	0	Residue

3.3.3 Products from the Condensate of Kailashtila and Bibiyana Field

In December 2010, the laboratory analysis report of Bibiyana condensate shows that, about 49.42% of it contains naphtha or MS part, 36.44% Kerosene part and 11.06% Gas Oil or Diesel part, the rest 3.08% is C_4 & lighter i.e., LPG part [27] as Table-3.4.

Table-3.4 Fractions from Bibiyana condensate in December 2010

	Method: ASTM D 2892 (TBP Distillation)		Date: 11-06-2005
Sl.	**TBP cuts**	**Yield (% volume)**	**Comments**
a)	C_4 and Lighter	3.08	Vented out
b)	Gasoline/Naphtha, $C_5 - 150^0C$	49.42	Petrol/MS cut
c)	Kerosene, $150^0C - 250^0C$	36.44	Kerosene cut
d)	Gas Oil, 250^0C +	11.06	Diesel cut
e)	Fuel Oil, (RCO), 350^0C +	0	Residue

Moreover, from the condensate of Kailashtila field, around 50% of MS and 48% of Diesel are being produced in the existing fractionation plant at KTL [7]. This ratio should be applicable in the future also.

3.3.4 Selection of Optimum Product Set for the Proposed Plant

Sylhet Gas Fields Limited is bound to sale its liquid petroleum products through the marketing companies of BPC at a reduced rate as per govt. rule. The prices of products and raw materials are presented in the following table-3.5 as per gazette notification dated March 9, 2009, Ministry of Power, Energy and Mineral Resources, Bangladesh.

Table-3.5: Price of Condensate and Products as per latest Govt. gazette dated 9-3-2009.

Sl. No.	Raw material or Product name	Price applicable for SGFL			Price to the End User
		Price/Liter before VAT	VAT/Liter	Price/Liter With VAT	Price/Liter (Variable & around)
1.	Condensate (Heavy)	28.58937	4.28841	32.87778	-
2.	Petrol/MS	57.84261	8.67639	66.51900	74.00000
3.	Octane	58.29532	8.74430	67.03962	77.00000
4.	Kerosene	34.59652	5.18948	39.78600	45.00000
5.	Diesel	34.24957	5.13743	39.38700	44.00000

3.3.5 Observation and Recommendation

Here, it is clear that the products of highest market price are Octane and MS; and the portion of MS in the Jalalabad condensate is as high as 71.95% (Table-3.3). So, in the proposed plant, it may be more convenient and profitable to produce highest ratio of MS or Octane. From the condensate of Jalalabad field, MS cut will be more than 70%. After cessation of production from Jalalabad field, the plant should have the option to fractionate the condensate from Bibiyana or Kailashtila field. Here, MS yield will be around 50%. The EPC contractor will be asked to make provision to use the plant with both raw materials and operating mode. So, the summary of the product selection can be proposed as Table-3.6.

Table-3.6: Products ratios in the proposed plant (in vol % of the variable raw materials)

Sl. No.	Name of the Products	Jalalabad Condensate	Bibiyana Condensate	Kailashtila Condensate
1.	Petro/MS	70%	50%	50%
2.	Kerosene	22%	36%	-
3.	Diesel	4%	11%	48%

In the case of Jalalabad Condensate as raw material, the products will be 70% MS/Petrol, 22% Kerosene and 4% diesel of the volume of raw materials fractionated. The 70% MS can be converted into Octane.

For the condensates of Bibiyana and Kailashtila fields, the products will be accordingly as presented in the above Table-3.6.

3.4 Organizational Capability of the Implementing Agency

The condensate fractionation plant project will be implemented by Sylhet Gas Fields Limited (SGFL) is a company of Petrobangla under Ministry of Power, Energy and Mineral Resources, Bangladesh.

SGFL's total number permanent employee is 611 (as per Dec'2010) among which 250 Officers and 361 Staffs. Majority of them are directly involved in gas processing and condensate fractionation activities under Operations Division. Recently (in December 2011) a new division named 'Liquid Petroleum and Marketing Division' is formed and approved by SGFL's board to work solely with liquid petroleum (mainly condensate) fractionation, handling, marketing activities including expansion of such business by installing and operating new fractionation plants if viable. SGFL's Organogram showing the divisions is presented in Fig.3.6.

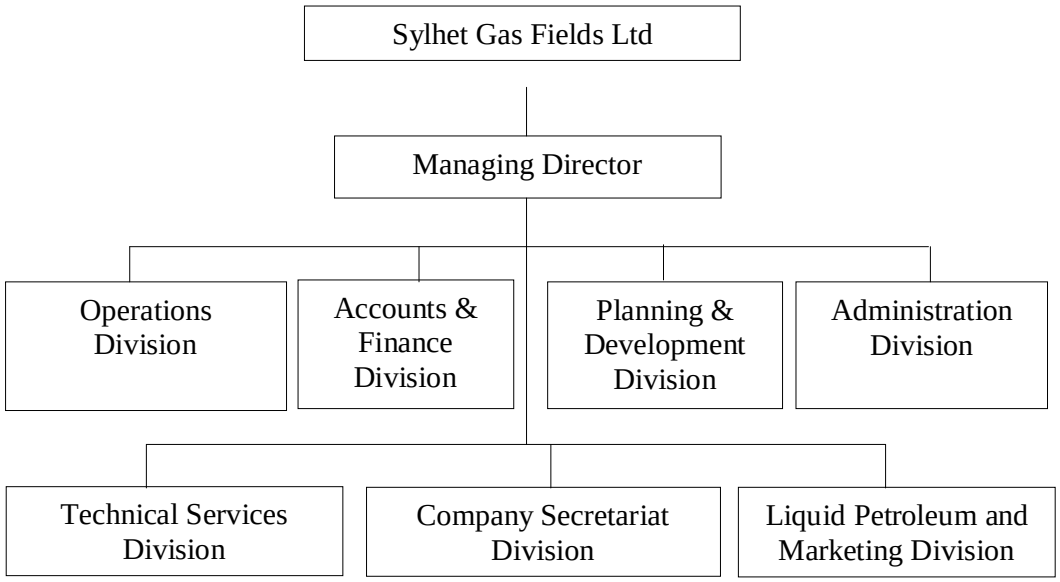

Fig.3.6: Organogram of Sylhet Gas Fields Limited

All the above mentioned divisions do their respective jobs. Here, the possible contribution of those to the implementation of KCFP (Kailashtila Condensate Fractionation Plant) will be discussed in brief:

3.4.1 Planning and Development (P&D) Division

Among its 3 Departments, Planning Department will start the main work of project planning, preliminary feasibility analysis etc. Then planning department will prepare DPP (Development Project Proposal) as per specified format and will perform the necessary activities for government's approval to implement the project. This Department of SGFL is efficient and experienced enough to carry out this job.

Another department under P&D division is 'Procurement department'. It is also well experienced in project oriented local and foreign procurement. Moreover several permanent Tender committees consisting multidisciplinary manpower headed by GMs are formed here to perform Procurement activities more efficiently.

3.4.2 Administration Division and human resource strength

It will provide right people to the right place to implement the project efficiently. SGFL has installed a 2500 bbl/day capacity condensate fractionation plant at Rashidpur Field using Bibiyana condensate as raw material. This plant is running well from August 2009. The second phase of the project to install another 1250 bbl/day condensate fractionation capacity plant is being installed. People are well experienced in fractionation plant installation in the recent period. Qualified and experienced GMs and DGMs successfully implemented RCFP without the help of consultant, are still in work at SGFL. Project should be started before they will have gone for LPR.

3.4.3 Other Divisions of SGFL those can help the KCFP implementation project

Liquid Petroleum and Marketing Division is working with condensate fractionation, marketing and expansion of related business and operation. The proposed KCFP installation project can get direct assistance from this division for successful implementation and can start earliest operations

Company secretariat Division will arrange necessary meetings of 'SGFL board of directors' as per necessary approval requirements of KCFP installation project.

Accounts and Finance Division: Beyond its routine work of manpower salary, pay and bill, cash and bank investment of funds, annual accounting, budgeting etc activities, SGFL's A&F division is well reputed to assist project related financing, payments and other jobs.

Technical Services Division will build and maintain infrastructural, transportation and logistic support to the KCFP project. The central store of TS division plays vital role during any project implementation by sheltering the newly procured materials and by providing old stored materials.

Operations Division has the highest inventory of manpower of all disciplines. It will release required expert people to work at KCFP project as per necessity. The present and ex-personnel worked under this division showed their efficiency and excellent performance while implementing 2500 bbl/day capacity RCFP without the help of foreign consultants.

3.5 Financial Capability of Implementing Agency

The financial strength of SGFL is satisfactory enough to implement KCFP project from its own resources. Net Current Asset of SGFL is Tk. 1,612,273,118 while Net Assets is Tk. 16,206,643,764 as on 30/06/2010. Liquidity and other financial parameters are also excellent. On the same date, SGFL had a fixed deposit of Tk. 8,869,116,416 i.e., FDR was more than Tk. 88691.16 Lakh.

In the past few years, SGFL has implemented several investment and development projects including drilling of new wells KTL-5,6, workover of old wells KTL-3,4, Syl-7 etc. with its own resources. The ongoing Rashidpur condensate fractionation plant (2^{nd} phase) and Kailashtila 2^{nd} MSTE plant installation projects are also self-financed projects of SGFL.

SGFL has completed all of those projects after contributing to the national exchequer by giving VAT, SD (supplementary duty), AIT etc. SGFL has a very good reputation as one of the largest VAT payer to the NBR (national board of revenue).

3.6 SGFL's Experience in Condensate Fractionation

SGFL has started to fractionate gas condensate into MS, Kerosene and Jet petrol in its own plant at Haripur since 1960s.

In 1984 another condensate fractionation plant started its operation to produce MS and Diesel at a capacity of 300 bbl/day at Kailashtila gas field.

In 2006-09: implementation of a condensate fractionation plant RCFP of 2500 bbl/day. And, presently, 2^{nd} phase of RCFP at a capacity of 1250 bbl/day is under implementation.

3.7 Legal and other issues

SGFL will get BERC license to fractionate condensate and store petroleum products, as it has 3(three) more condensate fractionation plant with BERC license. Environmental clearance will be possible as EMP study is included as a part of the KCFP project.

The other factors important to consider are discussed in details in Chapter-6: SWOT analysis of KCFP.

Chapter-4

Market Feasibility: Production and Demand Situation in Bangladesh

Before starting any business venture it is one of the most important considerations to find out the demand of the products to be produced. In fact it's the inception factor of any primitive business proposal. In the proposed condensate fractionation plant project, the products to be produced are Octane, Kerosene and Diesel. The demand of those products should be found out inside Bangladesh. Product exporting will not be encouraged here, though it is better to export value added fractionated products rather than raw condensate exporting. If there is available scope for MS or Petrol marketing in the future, then it will be more profitable for this proposed state owned fractionation plant instead of producing Octane [15].

4.1 Production Situation of Petroleum Products in Bangladesh

Eastern Refinery Limited is the only crude oil refining company in Bangladesh. It is the only source of finished petroleum products in Bangladesh. It can only supply 30 % of the total demand [28]. A small quantity of finished petroleum products are supplied by Petrobangla companies and private enterprises. The rest of the petroleum products

(Finished) is imported by Bangladesh Petroleum Corporation (BPC). The annual production of petroleum products at ERL in Metric Ton (MT) is shown in Table-4.1.

Table-4.1: Annual production of Petrol, Octane, Kerosene and Diesel at ERL (in MT) [28]

YEAR	MS(Petrol)	HOBC (Octane)	SKO	HSD
1999-00	76322	78192	321463	375104
2000-01	91480	68479	339540	333629
2001-02	101162	40134	306952	330448
2002-03	98374	40791	358745	379024
2003-04	78761	43287	338126	344507
2004-05	59625	39327	204864	396898
2005-06	75714	20932	311524	383085
2006-07	66046	13046	315229	335714
2007-08	67046	13439	262978	339131

From the table above, it is notable that, Octane (HOBC) production is remarkably decreasing at ERL.

4.2 Demand Situation of Petroleum Products in Bangladesh

We know that supply situation of petroleum products in Bangladesh is lower than the demand in Bangladesh. As a result we have to import finished petroleum products to meet the local demand. Annual demand of petroleum products is shown in Table-4.2 in the following [28]. Also graphical representation of annual demand of Kerosene and Diesel is shown Fig.4.1.

Table-4.2: Annual demand of MS, HOBC, SKO & HSD in Bangladesh (in MT) [28]

YEAR	MS	HOBC or Octane	SKO	HSD
1999-00	194378	75838	609402	1743251
2000-01	197046	98458	636098	1846239
2001-02	187787	120454	633755	1838266
2002-03	164446	140251	698486	1815159
2003-04	151337	145588	693638	2004402
2004-05	143965	142450	544478	2264843
2005-06	153340	126315	499207	2298677
2006-07	129549	95376	426357	2294223
2007-08	124823	90021	405101	2333597
2008-09	115381	78256	342703	2301269
2009-10	127000	85500		

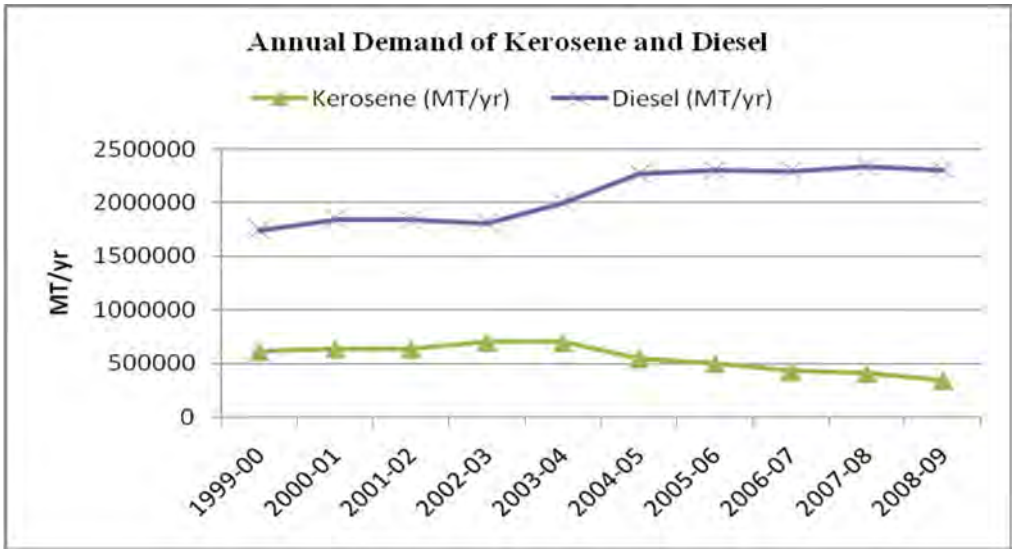

Fig.4.1: Annual demand of SKO(Kerosene) and HSD(Diesel) in Bangladesh

4.2.1 Demand of Octane

Demand and production of Octane (or HOBC) are presented in table-4.2 and table-4.1 above. The difference between demand and production is the annual shortfall and those are met up by importing finished products. The situation is presented in the following Table-4.3 and Fig.4.2.

Table-4.3: Difference in Demand and Production, or Need for Import of Octane

YEAR	Demand of Octane (MT/yr)	Production of Octane (MT/yr)	**Difference** or need for Import (MT/yr)	Need for Import in bbl/yr	Daily avg. shortage or need for Import in bbl/day
1999-00	75838	78192	-2354	-19740	-54
2000-01	98458	68479	29979	251396	689
2001-02	120454	40134	80320	673543	1845
2002-03	140251	40791	99460	834046	2285
2003-04	145588	43287	102301	857870	2350
2004-05	142450	39327	103123	864763	2369
2005-06	126315	20932	105383	883715	2421
2006-07	95376	13046	82330	690398	1892
2007-08	90021	13439	76582	642197	1759
2008-09	78256	-	78256	656235	1798
2009-10	85500	-	85500	716981	1964

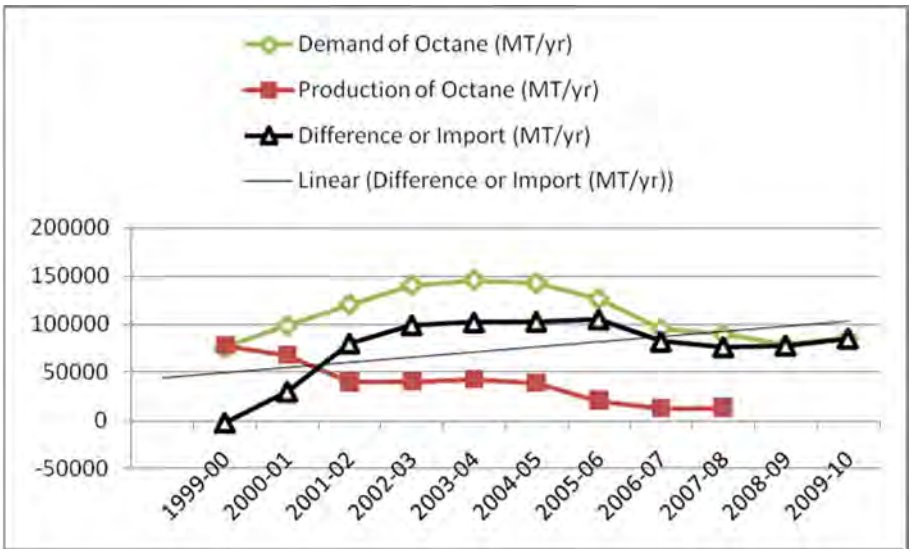

Fig.4.2: Annual Demand, Production and Shortage (or Import) of Octane (in MT/yr)

4.2.2 Octane Demand forecasting by Simple Moving Average Method

In the simple moving average method, the arithmetic average of past few periods are considered as the forecasted demand for the next period [29]. Here, we will use three years moving average for demand forecasting of Octane and Petrol.

Forecasted demand of Octane is determined in simple moving average method and is presented in Table-4.4. The difference between forecasted demand and corresponding actual demand is also shown in this table. Figure-4.3 gives the graphical presentation of forecasted and actual demand of corresponding periods.

Table-4.4: Simple moving Average Method, Demand Forecast of Octane in MT/yr

Financial Year	Demand of Octane (MT)	Forecasted Demand (3 Years Moving Average)	Difference = (Actual-Forecasted)	Difference in %
1999-00	75838			
2000-01	98458			
2001-02	120454	98250	22204	18.43
2002-03	140251	119721	20530	14.64
2003-04	145588	135431	10157	6.98
2004-05	142450	142763	-313	-0.22
2005-06	126315	138118	-11803	-9.34
2006-07	95376	121380	-26004	-27.27
2007-08	90021	103904	-13883	-15.42
2008-09	78256	87884	-9628	-12.30
2009-10	85500	84592	908	1.06
2010-11		81878		
2011-12		85500		

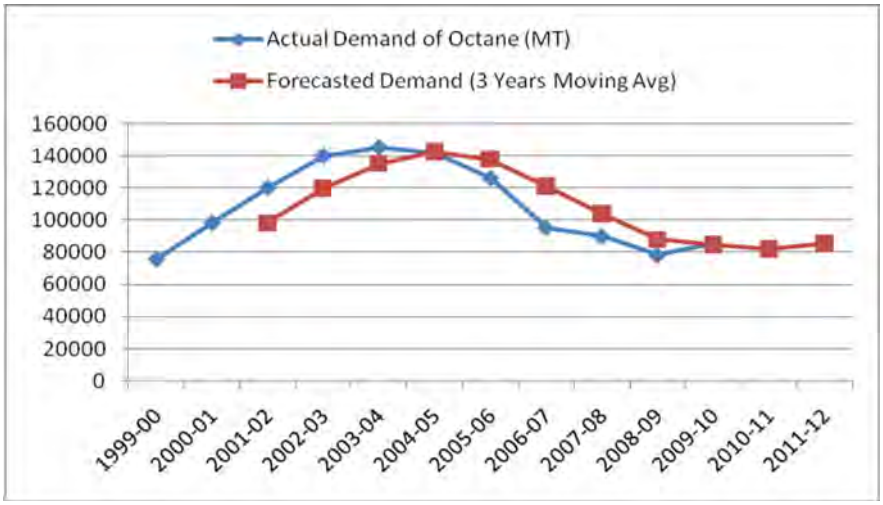

Fig.4.3: Actual and simple moving average forecasting of Octane demand (MT/yr)

4.2.3 Petrol (MS) Demand forecasting by Simple Moving Average Method

Forecasting of petrol demand is done by simple moving average method and presented in Table-4.5.

Table-4.5: Simple moving Average Method, Demand Forecast of Petrol (MS) in MT/yr

Financial Year	Actual Demand (MT/yr)	Forecasted Demand (3 Years Moving Avg.)	Difference = (Actual-Forecasted)	Difference in %
1999-00	194378			
2000-01	197046			
2001-02	187787	193070	-5283	-2.81
2002-03	164446	183093	-18647	-11.34
2003-04	151337	167857	-16520	-10.92
2004-05	143965	153249	-9284	-6.45
2005-06	153340	149547	3793	2.47
2006-07	129549	142285	-12736	-9.83
2007-08	124823	135904	-11081	-8.88
2008-09	115381	123251	-7870	-6.82
2009-10	127000	122401	4599	3.62
2010-11		121191		
2011-12		127000		

4.2.4 Demand forecasted by Bangladesh Petroleum Corporation (BPC)

BPC holds the sole responsibility to forecast demand, import of crude oil, production and import of finished petroleum fuels and marketing of those as per country's requirements. According to 'The Daily Kaler Kontho' page-6, dated 6/12/2010, BPC authority has published estimation on fuel oil requirement for the future 5years [5]. The estimated demand of MS (Petrol) and Octane in financial years (FY) 2007-08 to 2011-12 are presented in Table-4.6 and Fig.4.4.

Table-4.6: Demand of Petrol (MS) and Octane in FY 2007-08 to 11-12, estimated by BPC

Financial Year	Annual Demand of Octane (MT)	Forecasted Demand of Octane (MT)	Annual Demand of MS (MT)	Forecasted Demand of MS (MT)
2007-08	90021		124823	
2008-09	78256		115381	
2009-10	85500		127000	
2010-11		100000		140000
2011-12		110000		148000

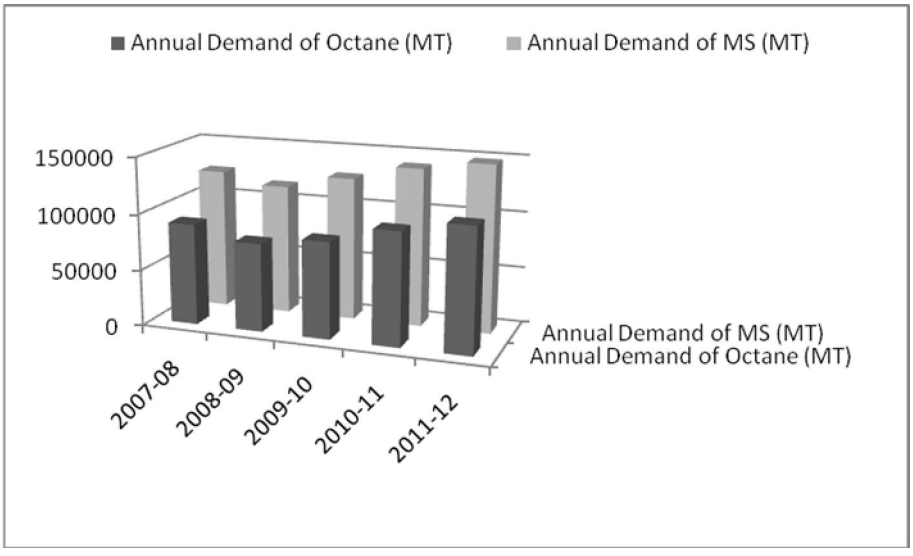

Fig.4.4: Annual demand of Petrol (MS) and Octane published by BPC on Dec, 2010

4.2.5 Comparison of the two Forecasted Annual Demand of Octane

Demand forecasting by simple moving average uses only 'historical data' and the forecasted demand has a lagging tendency to the actual demand trend. But Bangladesh Petroleum Corporation considers probable all factors affecting the demand, e.g.,

- Future growth of vehicles, the prime consumers of petroleum fuels in Bangladesh
- CNG network expansion in Bangladesh
- CNG pricing as an alternate to the Octane/Petrol or Diesel
- Effect of CNG rationing hours on the mentality of elite class
- Price of petroleum in the international and local market.
- Government's policy, regulations etc.

The summary of both demand forecast of Octane for the years 2010-11 and 2011-12 are presented in the following Table-4.7 and Fig.4.5.

Table-4.7: Comparison of annual Octane and MS demand forecasted in two methods

Financial Year	Simple Moving Avg. Forecasted Demand of Octane (MT/yr)	BPC Forecasted Demand of Octane (MT/yr)	Simple Moving Avg. Forecasted Demand of MS (MT/yr)	BPC Forecasted Demand of MS (MT/yr)
2010-11	81878	100000	121191	140000
2011-12	85500	110000	127000	148000

Here, it is clearly understood from the above table that, Demands of Octane and Petrol will be increased much more than the simple moving average forecast, as BPC

forecasting is sufficiently realistic, authentic and reliable. The forecasted data in the table is presented below in chart.

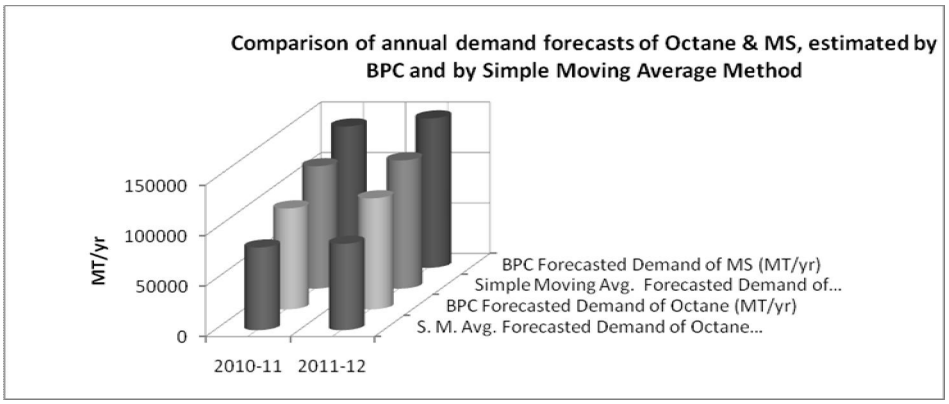

Fig.4.5: Comparison of annual demand forecasting methods (Simple Moving Average method and BPC method) for Octane and MS

4.2.6 Proposal on the basis of BPC estimation

According to BPC observation and estimation up to 2015, the demand of MS (Petrol) and Octane will be increased [5]. If it happens in such a way that, the demand of MS exceeds the internal total MS production capacity in Bangladesh, then the fractionated MS from the proposed plant will be marketed without converting it into Octane. This will save the additional cost for Octane booster and maximize profit.

4.2.7 Demand of Kerosene and Diesel

Every year Bangladesh needs to import a huge quantity of Diesel and Kerosene. Latest data available on BPC website is of year 2008-09. Imported quantity of Octane, Diesel and Kerosene was as the following Table-4.8.

Table-4.8: Import of Petroleum fuels in 2008-09 in (Metric Ton) [30]

YEAR	HOBC or Octane	SKO	HSD
2008-09	75000	152000	2010000

Source: www.bpc.gov.bd

The import data in the above table can be re-arranged after some calculations are presented in Table-4.9 and in Fig.4.6.

Table-4.9: Import quantities in bbl/yr and corresponding equivalent bbl/day for 2008-09

Import	HOBC or Octane	SKO or Kerosene	HSD or Diesel
Quantity in MT/yr	75000	152000	2010000
Quantity in bbl/yr	673854	1274633	16633565
Quantity in bbl/day	1846	3492	45571

Note: 159 Liter = 1bbl; Specific gravities of HOBC, SKO and HSD are 0.7, 0.75 and 0.76 respectively in the above table [19].

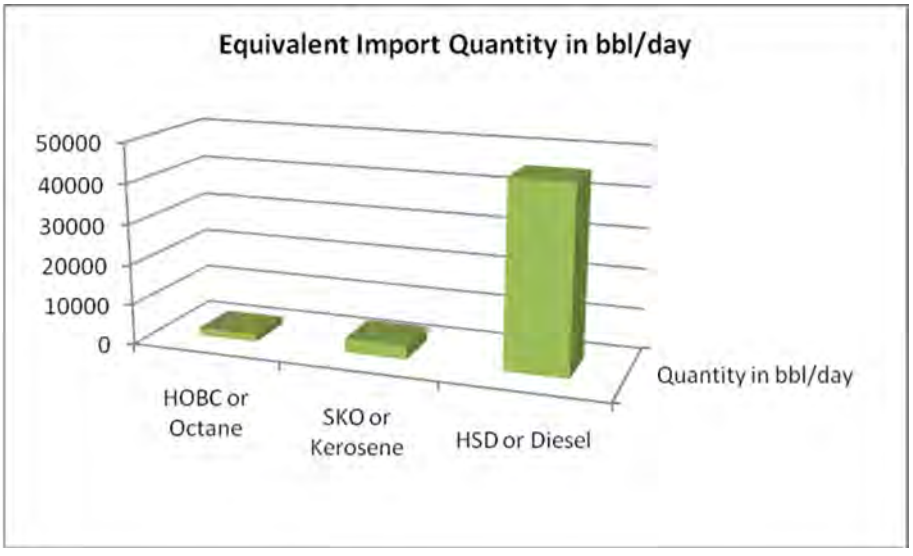

Fig.4.6: Import of Octane, Kerosene and Diesel in 2008-09, quantities equivalent to bbl/day

4.2.8 Observation and comment

From the above table and chart we can easily realize the deficit or need for import of petroleum fuels in Bangladesh. The daily average deficit of demand was 1846 bbl/day of Octane, 3492 bbl/day of Kerosene and 45571 bbl/day of Diesel in the year 2008-09 as presented in table-4.9. The demand is gradually increasing. So, here is sufficient room to produce these products. The Rashidpur Condensate Fractionation Plant (RCFP) is supposed to run at 3750 bbl/day condensate fractionation capacity from 2012. Around 1800 bbl/day of MS or Octane will be obtained from RCFP using Bibiyana condensate as feed. According to BPC forecast as mentioned above, the yearly total MS plus Octane demand in 2011-12 will be = (110000+148000) = 258000 MT/yr. Eastern Refinery Limited normally produces a total (MS plus Octane) quantity of less than 100000 MT/yr [Average annual MS production was ((59625+75714+66046+67046)÷4)= 67,108 MT/yr and Octane production was ((39327+20932+13046+13439)÷4)= 21,686 MT/yr] during 2004-05 to 2007-08. So, additional demand of 158000 MT/yr equivalents to 3850 bbl/day will be met up by other sources in the country or to be imported. RCFP will supply more 1800 bbl/day. The quantity other than RCFP is = 3850-1800 = 2050 bbl/day. In the year 2009-10 the daily average MS production of all Petrobangla fractionation plants except RCFP was $= \frac{(47958845-32331062)}{159 \times 365} = 270\ bbl/day$ [1]. So, the remaining =(2050-270)= 1780 bbl/day of MS or Octane demand will be met up by proposed Kailashtila Condensate Fractionation Plant and by Private enterprises. According to the NOCs and 'Guidelines for installation of condensate fractionation plants in Private sector' prepared by Petrobangla and EMRD representatives dated 25/8/2008 clause no.3: "Condensate produced from different gas fields inside the country will be supplied to the fractionation plants already

installed or to be installed in the govt. sector according to their demand. After fulfilling the demand of those plants, if there exists any surplus condensate, then that will be sold to the approved plant owner in the private sector through bidding" [25].

Chapter-5

Economical Feasibility

In this chapter capital investment requirement for plant installation, operation, product sales and all other costs will be estimated by proper following appropriate methodologies. Then expected outcomes will be determined to calculate profitability of the project. The financial and economic parameters will include Discounted Pay Back Period, Net Present Value, Benefit Cost Ratio, Internal Rate of Return etc. for various plant capacities.

Cost estimation and financial analyses done in this chapter by following the methodology described in 'Valle-Riestra, J. F.' [20], 'Peters, Timmerhaus' [21] and 'Sullivan' [31].

5.1 Calculation of Total Fixed Capital Investment

5.1.1 Materials, Engineering and Construction Cost

We can re-write the Power Law or Power Factor Equation as, $PC = C(Q/Q_0)^a$, where, PC is the Purchase Cost of the Proposed plant equipment,

C is the Purchase Cost of the Previous plant equipment,

Q is the Capacity of the Proposed plant

Q_0 is the Capacity of the Previous plant

According to 'Plant Design and Economics for Chemical Engineers' 4th Edition by Max S. Peters and Klaus D. Timmerhouse, Chapter-6: Cost Estimation, Method E: Power Factor Applied to Plant Capacity Ratio for Estimating Fixed Capital Investment. The value of power factor or exponent 'a' in the above mentioned equation has been found to average between 0.6 and 0.7 for many process facilities. Here, in this thesis, the relevant values* of Power Factor 'a' is taken inTable-5.1 and corresponding plant direct and indirect costs are determined in Table-5.2 to 5.4.

Table-5.1: Determination of 'Multiplying Factor' using assumed Power Factor 'a' value

Capacity of Previous Plant, Q_0 (bbl/day)	Capacity of Proposed new plant, Q (bbl/day)	Ratio (Q/Q_0)	For Plant direct Cost (Supply of Equipments, materials etc.)		For Plant Indirect Cost (Engineering Design)		For Plant Indirect Cost (Erection & Construction)	
			Power Factor 'a'	Multiplying Factor $(Q/Q_0)^a$	Power Factor 'a'	Multiplying Factor $(Q/Q_0)^a$	Power Factor 'a'	Multiplying Factor $(Q/Q_0)^a$
2500	750	0.3	0.65	0.45	0.30	0.70	0.50	0.55
2500	1250	0.5		0.64		0.81		0.70
2500	1500	0.6		0.72		0.86		0.78

*It is clear that, smaller value of 'a' gives the value of 'Multiplying Factor' nearer to 1

Table-5.2: Determination of 'Plant Direct Cost' i.e., cost of '**Supply of Equipment and Materials**' using 'Multiplying Factor': (cost in Lakh Taka)

Cost for the Previous Plant of Capacity Q_0=2500 bbl/day (In year 2006), C	Capacity of Proposed new plant, Q (bbl/day)	Multiplying Factor $(Q/Q_0)^a$ From Table-5.1	Plant direct Cost in 2006 $PC=C(Q/Q_0)^a$ Tk. In Lakh	Yearly Cost Escalation	Year 2006 to 2011 is=5yrs. So, Total Escalation is	Plant direct Cost in 2011 = Cost in 2006 + Escalation (Tk. In Lakh)
Tk. 3750.89 Lakh	750	0.45	1687.90	10%	50%	2531.85
	1250	0.64	2400.57			3600.85
	1500	0.72	2700.64			4050.96

Table-5.3: Determination of cost of '**Engineering Design**' i.e., 'For Plant Indirect Cost (**Engineering Design**)' using 'Multiplying Factor': (cost in Lakh Taka)

Cost for the Previous Plant of Capacity Q_0=2500 bbl/day (In year 2006), C	Capacity of Proposed new plant, Q (bbl/day)	Multiplying Factor $(Q/Q_0)^a$ From Table-5.1	Plant indirect Cost in 2006 $PC=C(Q/Q_0)^a$ Tk. In Lakh	Yearly Cost Escalation	Year 2006 to 2011 is=5yrs. So, Total Escalation is	Plant indirect Cost in 2011 = Cost in 2006 + Escalation (Tk. In Lakh)
Tk. 1196.72 Lakh	750	0.70	837.70	10%	50%	1256.55
	1250	0.81	969.34			1454.01
	1500	0.86	1029.18			1543.77

Table-5.4: Determination of cost of '**Erection and Construction**' i.e., 'For Plant Indirect Cost (**Erection and Construction**)' using 'Multiplying Factor': (cost in Lakh Taka)

Cost for the Previous Plant of Capacity Q_0=2500 bbl/day (In year 2006), C	Capacity of Proposed new plant, Q (bbl/day)	Multiplying Factor $(Q/Q_0)^a$ From Table-5.1	Plant indirect Cost in 2006 $PC=C(Q/Q_0)^a$ Tk. In Lakh	Yearly Cost Escalation	Year 2006 to 2011 is =5yrs. So, Total Escalation	Plant indirect Cost in 2011 = Cost in 2006 + Escalation (Tk. In Lakh)
Tk. 1617.70 Lakh	750	0.55	889.73	10%	50%	1334.60
	1250	0.70	1132.39			1698.58
	1500	0.78	1261.80			1892.71

5.1.2 Other Costs in Fixed Capital Investment

Despite Plant direct and indirect costs there are some other costs in Total Fixed Capital Investment. Those costs are for Land acquisition, land development, site preparation and miscellaneous construction works, project implementation office expenditure, Pre-shipment inspection cost, duties and taxes on imported machineries, contingency etc. Calculation of these cost items using Microsoft Excel spreadsheet are presented in the Annexure. Calculations are performed for plant capacities of 750 bbl/day, 1250 bbl/day and 1500 bbl/day are attached in Annexure-1, Annexure-2 and Annexure-3 respectively.

Here, estimated other costs for 1250 bbl/day capacity are shown in Table-5.5.

Table-5.5: Estimated costs other than plant direct and indirect cost (Taka in Lakh)

Sl.	Item	L.C.	F.C.	Total
I)	**Pre-construction Expenditure**			
	Land Acquisition 7.25 acres @100 Lakh taka/acre	725.00		725.00
	Land Development (filling & leveling) 48000 m3 @ Tk. 250.00/m3.	120.00		120.00
	Sub- Total of I	**845.00**		**845.00**
II)	**Construction Works** (all calculation based on PWD rate of 2008.)			
	Administrative Office Building 150m2 @ 16,660/- per m2	25.00		25.00
	Boundary wall 700 RM, @ Tk.10,000.00/RM	70.00		70.00
	Internal Road (RCC) 1000 m2, @ Tk.1200.00/m2	12.00		12.00
	Internal Drain 300 RM(600 mm depth, 300 mm width, @ Tk. 1668.00/RM	5.00		5.00
	Deep Tube-well & pump house	30.00		30.00
	Sub- Total of II	**142.00**		**142.00**
IV)	**Transport Vehicle**			
	Rental (@ Tk. 3000.00/day for 700 days) during project implementation	21.00		21.00
	Sub-Total- IV	**21.00**		**21.00**
V)	**Other Cost during Project Implementation**			
	Testing Fee (Laboratory Analysis)	4.00		4.00
	EMP Study	5.00		5.00
	Duties & Taxes (Cost has been estimated considering @ 3% for AIT)	105.44		105.44
	Bank Charges @ 1.25% on F.C. of EPC Contract	73.38		73.38
	Insurance @ 3% on imported materials	105.44		105.44
	Project office expenditure (Office furniture, 2 nos. A/C for site office, 1 Computer, 1 Laser Printer, 1 color printer with Scanner, 1 Photocopier, Tender notice publishing, fax/telephone/ courier/ postal bill, office stationeries and consumables, entertainment, transport maintenance, repair of office equipment & accessories, labor bill etc).	12.95		12.95
	Physical Contingency (2% of the total items)	44.43	117.40	161.84
	Price Contingency (2% of the total cost)	44.43	117.40	161.84
	Sub-Total- V	**395.07**	**234.81**	**629.88**

Cost of onsite training may be included in initial fixed capital investment cost. This cost may be considered as same although the plant capacities are smaller here.

So, cost of onsite training = cost (in 2006) for 2500bbl/day + cost escalation

= Tk. 4.37 Lakh + 10%*5 of (Tk.4.37 Lakh)

= Tk. 6.55 Lakh

Pre-shipment inspection cost (for 1250 bbl/day capacity plant)

= Cost of Supply of Equipment and Materials * 0.50%

= Tk. 3600.85 Lakh * 0.50%

= Tk. 17.57 Lakh

So, Total Fixed Capital Investment = Sum of (Sub-Totals I, II, IV, V) and (Materials, Engineering and Construction (EPC) cost) plus cost of onsite training plus PSI cost.

Here Total Fixed Capital Investment,

= (845.00 + 142.00 + 21.00 + 629.88) + (3600.85 + 1454.01 + 1698.58) + 6.55 + 17.57

= Tk. 8415.44 Lakh ◄

5.2 Calculation of Total Operating Capital Investment

5.2.1 Variable Operating costs calculations

Basis: Operating cost of Rashidpur condensate fractionation plant (RCFP) of present capacity 2500 bbl/day. The cost items are as follows:

- Salary & wages: As total paid for RCFP in FY: 2009-10
- Utility Gas consumption for heater and generator are taken on 9/3/2011, Plant ran on 102% capacity on that day.
- Heater gas consumption in 24hrs = 930 m^3
- Generator gas consumption in 24hrs = 661 m^3
- Gas cost for heater is in 'Industrial' rate at Tk. 5.86/m^3
- Gas cost for Generator is in 'Captive Power' rate at Tk. 4.18/ m^3
- Utility Water pumping electricity cost is covered by Generator operating cost.
- Maintenance and other miscellaneous costs are considered the yearly cost in 2009-10

Assumptions:

- For each cost item, a certain portion will be fixed and the rest portion will vary on plant capacity.
- For each cost item, it may be assumed that 30% of the cost will remain, if the plant operating capacity is minimum or zero.
- The rest 70% of each cost item will be the factor of plant capacity.
- In the Table-5.6 below, the cost calculation is presented for the Plant Capacities of 750bbl/day, 1250bbl/day and 1500bbl/day.

- Plant operating days = 330 days/year.
- Gas cost for Heater will not be considered, here the C_4 & lighter portion of feed will be used as Heater Fuel. Calculation results are shown below.

Table-5.6: Yearly Operating Expenses for variable Capacities: (cost in Lakh Taka)

Sl. No.	**Name of the Cost Item**	Cost for RCFP (2500 bbl/day)	Fixed part	Variable part of cost item for			Yearly Itemized total Operating cost		
			30%	750 bbld	1250 bbld	1500 bbld	750 bbld	1250 bbld	1500 bbld
1	Manpower Salary, wages and Allowances	180.00	54.00	37.80	63.00	75.60	91.80	117.00	129.60
2	Gas cost (consumption * Price rate) for heater	17.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Gas cost (consumption * Price rate) for Generator	9.12	2.74	1.91	3.19	3.83	4.65	5.93	6.56
4	Maintenance & all other miscellaneous expenses	99.56	29.87	20.91	34.85	41.82	50.78	**64.71**	71.68
5	Selling expenses (Product Carrying Charge)	364.71	109.41	76.59	127.65	153.18	186.00	237.06	262.59
	Yearly Total Operating Cost	**671.38**	**196.02**	137.21	228.69	274.42	333.23	**424.70**	470.44

5.2.2 Additional cost for water treatment

Deep tube well pumping cost is covered in electricity, manpower, maintenance & other miscellaneous expenses. In this project, additional cost for operation of a small scale (optional) water treatment plant is considered. Here, annual operating cost for water treatment is assumed as Tk. 1.80 Lakh. This cost is kept same for all three proposed capacities of condensate fractionation plants.

5.2.3 Other Costs

- **Depreciation:** According to 'Plant Design and Economics for Chemical Engineers'-4th Edition, by Max S. Peters and Klaus D. Timmerhaus, McGraw-Hill, Inc., Chapter-9, Table-2: Class life asset depreciation range, The depreciation life of assets used in petroleum refining is 19 years [21]. But in Bangladesh, the condensate of Jalalabad field is almost free from sulfur and plant depreciation life can be easily considered as 20 years. So, the annual depreciation rate is 5%.

In the abovementioned book, Chapter-9, Table-1: Estimated life of Equipment: Life of Buildings is 40-60 years [21]. For depreciation calculation, it is estimated as 33.33 years and annual depreciation rate is 3% in this project. The values are given in Table-5.7.

Table-5.7: Yearly Depreciation Cost for various plant capacities (Tk. In Lakh)

Sl.	Depreciable items	Investment cost for			Rate/ annum	Depreciation per year for		
		750 bbl/d	1250 bbl/day	1500 bbl/day		750 bbl	1250 bbl/day	1500 bbl/day
i)	Machinery and Equipment	5141.90	6777.56	7513.75	5%	257.09	338.88	375.69
ii)	Office buildings, store etc.	132.00	142.00	155.24	3%	3.96	4.26	4.66

Depreciation cost is not a practical expenditure and will not be considered as a cost in determination of Payback Period [21].

- **Allowance for Unforeseen:** For unforeseen cost in the future a yearly amount of Tk. 30.00 Lakh (local currency Tk. 20.00 Lakh and foreign currency of Tk. 10.00 Lakh) is kept for the fractionation plant of all capacities.

5.3 Cost of Raw Materials

The main raw materials are Condensate and Octane Booster. The cost will depend upon consumption which is directly proportional to plant operating capacity.

For the plant of 1250 bbl/day capacity,

Yearly cost for Condensate = ——— × ——— × ——— × ——— × ———

= Tk. 18751.05 Lakh/year ◄

By fractionating Jalalabad Condensate, yield of MS will be 70% of the volume of raw material. So, Yearly production of fractionated MS

= ——— × ——— × ——— × $\frac{\%}{\%}$ = 45,911,250 Liter MS/year

Octane Booster required to improve the RON of fractionated MS from 82 to 95 is 4.5% of the volume of fractionated MS. Cost of per Liter of Octane Booster is around Tk. 250.00

For the cost calculations, Octane Booster requirement will be considered as 5% by volume. So, the Cost of Octane Booster to convert the total of fractionated MS into Octane is = $\frac{45911250}{}$ × $\frac{5\%}{100\%}$ × $\frac{.250.00}{1}$ × $\frac{1}{100000}$

= Tk. 5738.91 Lakh/year ◄

Total Cost of raw material per year = Cost for Condensate + Cost of Octane Booster

= Tk. 18,751.05 Lakh + Tk. 5,738.91 Lakh

= Tk. 24, 489.96 Lakh ◄

5.4 Cost for VAT

VAT means the tax applicable for value addition. In the case of production of fuel oils from condensate, the VAT rate is 15% on the incremental value.To calculate the amount of incremental value (or value addition), we need to determine the annual output from the plant.

5.5 Calculation of annual output

The output or main three finished products from this plant are Octane, Kerosene and Diesel. Their quantities and corresponding revenue are presented in the following sub-sections.

5.5.1 Annual value of Octane

Quantity of produced Octane = quantity of fractionated MS + required Octane Booster

= 45,911,250 Liter MS/year + (5%*45,911,250) Liter/year

= 48,206,813 Liter/year

So, Annual value of Octane (without VAT) = ——————— × ———————

= Tk. 2810231590 /year

= Tk. 28102.32 Lakh/year ◄

5.5.2 Annual value of Kerosene

Quantity of produced Kerosene/year = 22% × Quantity of Condensate/year

=22%× ——— × ——— × ———

= 14,429,250 Liter/year

Now, Annual value of Kerosene = 14,429,250 Liter/year * Tk. 34.59652/Liter

= Tk. 499,201,836.2 /year

= Tk. 4992.02 Lakh/year

But, the Quality of our produced Kerosene is something inferior (i.e., lower smoke point).

So, the Price of our product Kerosene may be considered as Tk. 28.58937/Liter, i.e., same price as the raw material condensate (Price for Kerosene is Tk. 34.59652/Liter without VAT).

So, the annual value of Kerosene = 14,429,250 Liter/year * Tk. 28.58937/Liter

= Tk. 4125.23 Lakh/year ◄

5.5.3 Annual value of Diesel

Quantity of produced Diesel/year = 4% * Quantity of Condensate/year

$$= 4\% \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad}$$

= 2,623,500 Liter/year

In the similar way, the Price of Diesel may be considered as Tk. 28.58937/Liter, i.e., same price as the raw material condensate (Price for Diesel is Tk. 34.24957/Liter without VAT).

So, the annual value of Diesel = 2,623,500 Liter/year * Tk. 28.58937/Liter

= Tk. 750.04 Lakh/year ◄

Now, the total value of annual output before VAT is

= the total value of finished products before VAT

= value of Octane + value of Kerosene + value of Diesel

= Tk. (28102.32 + 4125.23 + 750.04) Lakh/year

= Tk. 32977.59 Lakh/year ◄

5.6 VAT Calculation for 1250bbl/day capacity plant using Jalalabad Condensate

Amount of VAT = 15%*(Summation of values of outputs – Summation of values of inputs) [Here, values will be obtained from sections 5.3 and 5.5].

So, the amount of VAT = 15% * (Tk. 32977.59 Lakh - Tk. 24489.96 Lakh)/year

= 15% * Tk. 8487.63 Lakh/year

= Tk. 1273.14 Lakh/year ◄

5.7 Income Calculation

INCOME = REVENUE – EXPENDITURE

Here, Yearly total REVENUE earnings are from sales of Octane, Kerosene and Diesel. It is calculated as Tk. 32977.59 Lakh/year in the section-5.5

Yearly total EXPENDITURE = Cost of raw materials + VAT + Total other operating expenses.

- Cost of raw materials = Tk. 24489.96 Lakh/year [as per section-5.3]
- VAT = Tk. 1273.14 Lakh/year [as per section-5.6]
- Total other operating expenses = Tk. 424.70 Lakh/year [as per Table-5.2.1]

So, yearly INCOME = Tk. [32977.59 – (24489.96 + 1273.14 + 424.70)] Lakh/yr

= Tk. 6789.78 Lakh/year ◄

5.8 Financial and Economic Evaluation of the Project

The methods/criteria more often used for evaluating a project are (1) Simple rate of return (SRR) (2) Payback Period (PBP) (3) Benefit Cost Ratio (BCR) (4) Net present Value (NVP) or Net Present Worth (NPW) and (5) Internal Rate of Return (IRR). The SRR and the PBP are the undiscounted measures while BCR, NPV and IRR are the discounted measures of project worth of Investment. Discussions and calculations on these methods are given below.

5.9 Calculation of Payback Period

5.9.1 Simple Payback Period

Payback Period or Payout Period is defined as the minimum length of time theoretically necessary to recover the original capital investment in the form of 'cash flow to the project' based on total income minus all costs except depreciation [21]. Generally, for this method, original capital investment means only the original, depreciable, fixed-capital investment, and interest effects are neglected.

Thus, $= \frac{\qquad\qquad\qquad\qquad}{\qquad\qquad}$

5.9.2 Discounted Payback Period

Here, Time value of money is considered. In this method, an appropriate interest rate is chosen representing the minimum acceptable rate of return (MARR). The annual cash flows to the project during the estimated life are discounted at the designated interest rate to permit computation of an average annual figure for profit plus depreciation which reflects the time value of money. The time to recover the fixed-capital investment plus compounded interest on the total capital investment during the estimated life by means of the average annual cash flow is the 'payout period including interest' or 'discounted payback period' [21], [30].

5.9.2.1 Calculation of Discounted Payback Period for 1250 bbl/day capacity plant

In the case of 1250 bbl/day capacity condensate fractionation plant project, annual cash flows are found as the following table-5.8 (Data are taken from the Table-5.7 and section-5.7).

Table-5.8: Annual cash flows for 1250 bbl/day capacity condensate fractionation pant

Years →	1	2	3	4	5	6	7	8	9
Yearly profit (Tk. in Lakh)				6789.78	6789.78	6789.78	6789.78	6789.78	6789.78
Total Yearly Depreciation				343.14	343.14	343.14	343.14	343.14	343.14
Yearly Cash inflow (Profit + Depreciation)	-914.24	-5686.71	-1814.50	7132.92	7132.92	7132.92	7132.92	7132.92	7132.92
Comment	Investment or Installation period			Period of Return on investment					

Here the cash flow diagram may be presented as Fig.5.1,

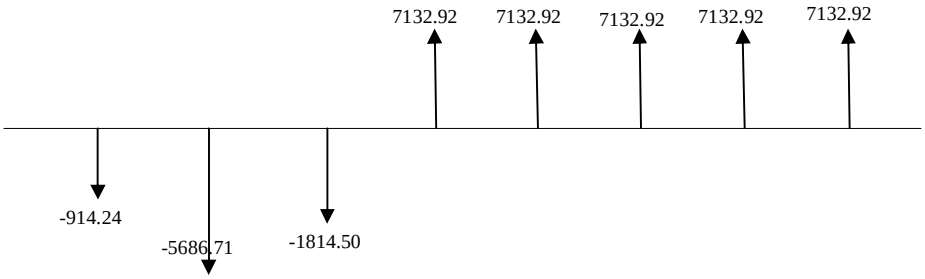

Fig-5.1: Cash flow diagram for 1250 bbl/day capacity CFP at KGF

According to Chapter-10 of Peters & Timmerhaus [21], for Payout Period calculation, zero time (end of zero years) will be the moment when Cash inflow or Return starts. In the table above, the starting of year-4 (or end of year-3) should be considered as zero time. The present value of the all capital investment should be calculated to that point of time at the specified discount rate.

Here, the Present worth of investment cost at the starting of return (at the end of year-3) will be,

PW= (-1814.50)*(1+15%)^0 + (-5686.71)*(1+15%)^1 + (-914.24)*(1+15%)^2

= -9563.30

Here, Discount rate (i.e., MARR) is 15%

So, the modified cash flow diagram for Payback period calculation will be as Fig.5.2 below. (Tk. in Lakh),

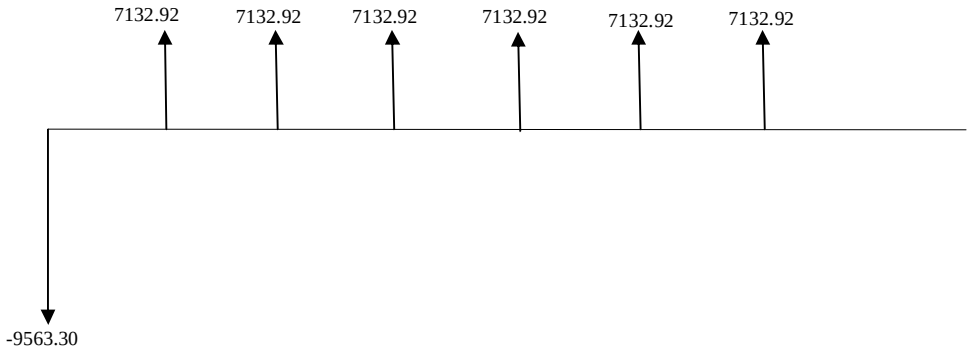

Fig-5.2: Modified Cash flow diagram for PBP calculation of 1250 bbl/day capacity

Now, the discounted payback period is calculated in the following Table-5.9.

Table-5.9: Calculation of the Payback Period for 1250 bbl/day capacity condensate fractionation plant at Kailashtila field.

End of year	Net cash flow (Tk. in Lakh)	Present Worth of cash flow (at i=15%/yr), PW	Cumulative PW at MARR=15%	Findings and comments
0	-9563.30	-9563.30	-9563.30	
1	7132.92	6202.54	-3360.76	
2	7132.92	5393.51	2032.75	Here, Cumulative Present Worth becomes '+ve' (positive) at the end of year-2. So, the Payback Period is less than 2years for this project.
3	7132.92	4690.01		
4	7132.92	4078.27		

It should be noted that, 'Payback Period' mainly indicates a project's *liquidity* rather than its profitability [30]. Historically, the payback period has been used as a measure of project's riskiness, since liquidity deals with how fast an investment can be recovered. A low-valued payback period is considered desirable.

As, the payback period for the 1250 bbl/day capacity project is estimated at less than 2 years, the project's liquidity is good and riskiness on return is low.

5.9.2.2 Discounted Payback Period for 1500 Bbl/Day Capacity Project

The discounted cash flow for 1500 bbl/day capacity is calculated for the same discount rate of 15%/yr and presented in Table-5.10. By following the same methodology of section-5.9.2.1, discounted payback period for 1500 bbl/day capacity condensate fractionation plant is determined in Table-5.10 and found as less than 2 years.

Table-5.10: Discounted Payback period Calculation for 1500 bbl/day

End of year	Net cash flow (Tk. in Lakh)	Present Worth of cash flow (at i=15%/yr), PW	Cumulative PW at MARR=15%	Findings and comments
0	-10586.14	-10586.14	-10586.14	
1	8567.29	7449.81	-3136.33	
2	8567.29	6478.10	3341.77	Here, Cumulative Present Worth becomes '+ve' (positive) at the end of year-2. So, the Payback Period is less than 2years for this project.
3	8567.29	5633.13		
4	8567.29	4898.37		

5.9.2.3 Discounted Payback Period for 750 Bbl/Day Capacity Project

The discounted cash flow for 750 bbl/day capacity is calculated for the same discount rate of 15%/yr and presented in Table-5.11. By following the same methodology of section-5.9.2.1, discounted payback period for 1500 bbl/day capacity condensate fractionation plant is determined in Table-5.11 and found as less than 3 years.

Table-5.11: Discounted Payback period Calculation for the plant capacity 750 bbl/day

End of year	Net cash flow (Tk. in Lakh)	Present Worth of cash flow (at i=15%/yr), PW	Cumulative PW at MARR=15%	Findings and comments
0	-7404.82	-7404.82	-7404.82	
1	4256.52	3701.32	-3703.50	
2	4256.52	3218.54	-484.96	Here, Cumulative Present Worth becomes '+ve' (positive) at the end of year-3. So, the Payback Period is less than 3years for this project.
3	4256.52	2798.73	2313.77	
4	4256.52	2433.68		

5.10 Net Present Value (NVP)

Net present value is computed by finding the difference between the present worth of benefit stream less the present worth of cost stream. Or it is simply the present worth of the cash flow stream since it is a discounted cash flow measure of project worth along with internal rate of return.

NPV = Present worth of Benefit Stream – Present Worth of Cost Stream.

Mathematically, it can be shown as,

$$= \sum \frac{\quad}{(\quad)} - \sum \frac{\quad}{(\quad)}$$

Or, NPV = Present worth of the cash flow stream.

Mathematically,

$$NPV = \sum_{t=1}^{t=n} \frac{B_n - C_n}{(1+i)^n}$$

Where,

B_n = Benefits in each year of the project.

C_n = Costs in each year of the project.

n = number of years in a project

i = interest (discount) rate

Bn – Cn = Cash flow in n_{th} year of the project

The project is profitable or feasible if the calculated NVP is positive when discounted at the opportunity cost of capital. Two types of NPV are calculated in the following section-5.13. Those are Financial Net Present Value, NPV(F) and Economic Net Present Value, NPV(E).

5.11 Benefit Cost Ratio (BCR)

It is the ratio of present worth of benefit stream to present worth of cost stream i.e.

$$= \frac{\sum_{=1}^{=}}{(1+)}$$

Mathematically it can be presented as, $= \frac{\sum_{=1}^{=}}{\sum_{=1}^{=}\frac{}{(1+)}}$

Where,

Bn = Benefit in each year

Cn = Cost in each year

n = number of year

i = interest (discount) rates.

The investment is said to be profitable when the BCR is one or greater than 1. This method is widely used in govt. sector economic analysis and not in private investment analysis.

5.13 Calculation of NPV and BCR

Net Present Value and Benefit Cost Ratio are calculated at a certain discount factor. It is generally defined as the Minimum Acceptable Rate of Return (MARR) or opportunity cost. In the govt. sector projects the usual value of MARR is 15% or 0.15 and it will be the discount factor here.

5.13.1 Calculation of NPV(F) and BCR(F) for 1250 bbl/day capacity plant

Table-5.12: Discounted Benefit and Cost Cal^{n} for 1250 bbl/day capacity plant (Tk. Lakh)

Sl. No.	Year	Investment Cost (PV)	Operating Cost (PV)	Total Cost (PV)	Benefit (PV)	Discount Factor **0.1500**	Discounted Total Cost	Discounted Total Benefit
0	1	914.24	0.00	914.24	0.00	1.000	914.24	0.000
1	2	5686.71	0.00	5686.71	0.00	0.870	4944.97	0.000
2	3	1814.50	0.00	1814.50	0.00	0.756	1372.02	0.000
3	4		29656.04	29656.04	37924.23	0.658	19499.33	24935.795
4	5		29656.04	29656.04	37924.23	0.572	16955.94	21683.300
5	6		29656.04	29656.04	37924.23	0.497	14744.29	18855.044
6	7		29656.04	29656.04	37924.23	0.432	12821.12	16395.690
7	8		29656.04	29656.04	37924.23	0.376	11148.80	14257.122
8	9		29646.04	29646.04	37924.23	0.327	9691.34	12397.497
9	10		29646.04	29646.04	37924.23	0.284	8427.25	10780.432
10	11		29646.04	29646.04	37924.23	0.247	7328.05	9374.289
11	12		29646.04	29646.04	37924.23	0.215	6372.22	8151.556
12	13		29646.04	29646.04	37924.23	0.187	5541.06	7088.309
13	14		24331.84	24331.84	35483.86	0.163	3954.60	5767.120
14	15		24331.84	24331.84	35483.86	0.141	3438.79	5014.887
15	16		24331.84	24331.84	35483.86	0.123	2990.25	4360.771
16	17		24331.84	24331.84	35483.86	0.107	2600.22	3791.975
17	18		24331.84	24331.84	35483.86	0.093	2261.06	3297.369
18	19		24331.84	24331.84	35483.86	0.081	1966.14	2867.278
19	20		24331.84	24331.84	35483.86	0.070	1709.68	2493.285
20	21		24331.84	24331.84	35483.86	0.061	1486.68	2168.074
21	22		24331.84	24331.84	35483.86	0.053	1292.77	1885.282
22	23		24331.84	24331.84	35483.86	0.046	1124.15	1639.375
						TOTAL :	142584.95	177204.45

From the above Table-5.12,

Discounted total Benefit is = Tk. 177204.45 Lakh

Discounted total Cost is = Tk. 142584.95 Lakh

So, Net Present Value = Tk. (177204.45 – 142584.95) Lakh = Tk. 34619.50 Lakh.

and it is the financial value. i.e., **NPV(F)** = **Tk. 34619.50 Lakh ◄**

Now, Benefit Cost Ratio is = (Tk. 177204.45 Lakh ÷ Tk. 142584.95 Lakh)

or, **BCR(F)** = **1.24 ◄**

5.14 Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is that discount rate which just makes the net present value (NVP) of the cash flow equal zero. It is considered to be the most useful measure of project worth and used by almost all the institutions including World Bank in economic and financial analysis of the project. It represents the average earning power of the money used in the project over the project life. It is also sometimes called yield of the investment.

Mathematically,

IRR is that discount rate ‘i’ such that

$$NPV = 0 = \sum_{t=1}^{t=n} \frac{B_n - C_n}{(1+i)^n}$$

Where,

Bn = Benefits in each year of the project.

Cn = Costs in each year of the project.

n = number of years in the project

i = interest (discount) rate.

A project is profitable or feasible for investment when the internal rate of return is higher than the opportunity cost of capital.

The computation of IRR for project involves a trial and error method. Here alternative discount rates are used to the cash flow streams of the project under consideration till the NPV of the project reaches zero. However, it is not always possible to get a discount rate which makes the NPV exactly equal to zero through this trial and error method. We may get discount rate, which makes the NPV nearer to zero i.e. either positive or negative. Under such situation, we use interpolation to estimate the true value. Interpolation is simply finding the intermediate value between too discount rates we have chosen.

5.14.1 Determination of IRR(F) for 1250 bbl/day capacity plant project

This calculation is done by trial and error method in the Excel spreadsheet for all 3 capacities of 750 bbl/day, 1250 bbl/day and 1500 bbl/day. Here the data table-5.13 presented with the final value of 'i' for which the NPV becomes zero (or nearly zero).

Table-5.13: IRR(F) for 1250 bbl/day capacity plant project

Sl. No.	Year	Investment Cost (PV)	Operating Cost (PV)	Total Cost (PV)	Benefit (PV)	Discount Factor **61.82%**	Discounted Total Cost	Discounted Total Benefit
0	1	914.24	0.00	914.24	0.00	1.000	914.24	0.00
1	2	5686.71	0.00	5686.71	0.00	0.618	3514.22	0.00
2	3	1814.50	0.00	1814.50	0.00	0.382	692.93	0.00
3	4		29656.04	29656.04	37924.23	0.236	6998.69	8949.94
4	5		29656.04	29656.04	37924.23	0.146	4324.98	5530.80
5	6		29656.04	29656.04	37924.23	0.090	2672.71	3417.87
6	7		29656.04	29656.04	37924.23	0.056	1651.66	2112.14
7	8		29656.04	29656.04	37924.23	0.034	1020.68	1305.24
8	9		29646.04	29646.04	37924.23	0.021	630.53	806.60
9	10		29646.04	29646.04	37924.23	0.013	389.65	498.46
10	11		29646.04	29646.04	37924.23	0.008	240.79	308.03
11	12		29646.04	29646.04	37924.23	0.005	148.80	190.35
12	13		29646.04	29646.04	37924.23	0.003	91.96	117.63
13	14		24331.84	24331.84	35483.86	0.002	46.64	68.02
14	15		24331.84	24331.84	35483.86	0.001	28.82	42.03
15	16		24331.84	24331.84	35483.86	0.001	17.81	25.97
16	17		24331.84	24331.84	35483.86	0.000	11.01	16.05
17	18		24331.84	24331.84	35483.86	0.000	6.80	9.92
18	19		24331.84	24331.84	35483.86	0.000	4.20	6.13
19	20		24331.84	24331.84	35483.86	0.000	2.60	3.79
20	21		24331.84	24331.84	35483.86	0.000	1.61	2.34
21	22		24331.84	24331.84	35483.86	0.000	0.99	1.45
22	23		24331.84	24331.84	35483.86	0.000	0.61	0.89
						TOTAL :	23412.94	23413.67

In the table above, we can see that for the discount rate of i=**61.82%**, the difference between discounted total benefit and total cost is = Tk. (23413.6-23412.94) Lakh = Tk. 0.73 Lakh (which is equal to 0.003% of the discounted total benefit) and can be considered as zero for IRR calculation. So, here, **IRR(F)**= **61.82%**

5.15 Cost Estimation and Economic Evaluation Summary

Beyond the PBP(F), NPV(F), BCR(F), IRR(F) etc., the calculations for Economic Net Present Value NPV(E), Economic Benefit Cost Ratio BCR(E) and Economic Internal Rate of Return IRR(E) are performed using the economic values of Costs and Benefits by multiplying those with corresponding SCF (Standard Conversion Factor prefixed by IMED under Planning Commission of Bangladesh. These parameters are evaluated for all 3 proposed plant capacities in the Microsoft Excel sheets and are attached in the Annexure. The results are presented in the following table-5.14

Table-5.14: Summary table of Cost Estimation and Economic and Financial Evaluation

Sl.	Name of the Financial or Economic Parameter	Value for			
		750 bbl/day (most likely)	750 bbl/day (Pessimistic)	1250 bbl/day	1500 bbl/day
1	Net Present value (*Financial*) @15% discount/yr (Taka in Lakh), NPV(F)	Tk. 17042.27 Lakh	Tk. 11727.31 Lakh	Tk. 34619.50 Lakh	Tk. 42360.69 Lakh
2	Net Present value (Economic) @15% discount/yr (Taka in Lakh), NPV(E)	Tk. 17417.80 Lakh	Tk. 12112.83 Lakh	Tk. 30456.04 Lakh	Tk. 37209.40 Lakh
3	Benefit Cost Ratio (*Financial*) @15% discount/yr, BCR(F)	1.19	1.16	1.24	1.25
4	Benefit Cost Ratio (Economic) @15% discount/yr, BCR(E)	1.24	1.20	1.25	1.25
5	Internal Rate of Return *(Financial)*, IRR(F)	50.35 %	43.83 %	61.82%	65.60%
6	Internal Rate of Return *(*Economic*)*, IRR(E)	52.71 %	45.97 %	64.25 %	68.20 %
7	Payback Period (Financial)	3 years	3 years	2 years	2 years
8	Total Fixed Capital Investment (Lakh Taka)	6497.99	7276.41	8415.44	9318.87

Chapter-6

SWOT Analysis

6.1 Definition of SWOT Analysis

SWOT Analysis is a strategic planning technique used to assess the internal and external environment in which a company operates and competes. Internal environmental factors are classified into Strengths and Weaknesses, while external environmental factors are classified into Opportunities and Threats [34].

Though the described analysis of the company and its environment we can see strong and weak points of the company as well as the opportunities and threats that are forcing it. Most managers know them on the basis of their experience and knowledge. But we emphasized that in today's complex environment a logical and methodological approach is necessary. We could even define the purpose of the analysis as finding out strengths, weaknesses, opportunities and threats. SWOT is an acronym for Strengths, Weaknesses, Opportunities, and Threats. The aim of the business and organization analysis is to find strengths and weaknesses of the company. The aim of environmental analysis and forecast is to find out opportunities and threats. We can combine both in SWOT.

The SWOT analysis is an extremely useful tool for understanding and decision-making for all sorts of situations in business and organizations. SWOT analysis provides

information that is helpful in matching the firm's resources and capabilities to the competitive environment in which it operates. As such, it is instrumental in strategy formulation and selection. Fig.6.1 shows how a SWOT analysis fits into an environmental scan [35].

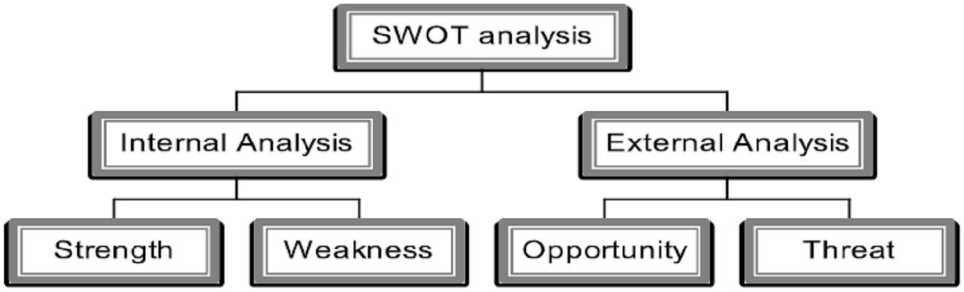

Fig.6.1: SWOT analysis frame work

Internal analysis examines the capabilities of the organization and its business. This can be done by determining and analyzing organization strengths and weaknesses. External analysis looks at the main points in the environmental analysis, and identifies those points that pose opportunities for the organization, and those that pose threats or obstacles to performance.

Strength and Weakness: A firm's strengths are its resources and capabilities that can be used as a basis for developing a competitive advantage. To know about the strength of a company, it is important to analyze about what the company does well and what makes the company stand out from competitors. What advantages does the company have over other competitors? The absence of certain strengths may be viewed as a weakness. To determine the weaknesses, we can list the areas that are a struggle for the company.

Opportunities and Threats: The external environmental analysis may reveal certain new opportunities for profit and growth. Therefore it is important to analyze the external environment and try to uncover areas where the strengths are not being fully utilized. Changes in the external environment may present threats to the company. Analysis of threats is important for understanding and estimation of damage that could happen due to the influence of external environment. To find out the threats to the company, analyzer should study the strength and weakness of competitors and their emerging business trends that may amplify the weaknesses. Apart from that any other external threats that may hinder in the success of the company should also be examined carefully.

6.2 SWOT matrix as the basis for performing strategies

SWOT Analysis is an effective way of identifying strengths and weaknesses, and of examining the opportunities and threats of an organization. It helps to focus activities into areas where the organization is strong and where the greatest opportunities lie and use for all sorts of decision-making process. **SWOT template enables proactive thinking, rather than relying on habitual or instinctive reactions.** It is important to clearly identify the subject of a SWOT analysis, because a SWOT analysis is a perspective of one thing, be it a company, a product, a proposition, and idea, a method, or option, etc. In general, SWOT analysis can be used to assess:

- A company (its position in the market, commercial viability, etc)
- A method of sales distribution
- A product or brand

- A business idea
- A strategic option, such as entering a new market or launching a new product
- An opportunity to make an acquisition
- A potential partnership
- Changing a supplier
- Outsourcing a service, activity or resource
- An investment opportunity and similar issues. It is the basis for preparing good decisions.

A firm should not necessarily pursue the more lucrative opportunities. Rather, it may have a better chance at developing a competitive advantage by identifying a fit between the firm's strengths and upcoming opportunities. In some cases, the firm can overcome a weakness in order to prepare it to pursue a compelling opportunity. To develop strategies that take into account the SWOT profile, a matrix of these factors can be constructed as shown in figure 6.2 below:

- S-O strategies pursue opportunities that are a good fit to the companies' strengths
- W-O strategies overcome weakness to pursue opportunities
- S-T strategies identify ways that the firm can use its strengths to reduce its vulnerability to external threats
- W-T strategies establish a defensive plan to prevent the firm's weaknesses from making it highly susceptible to external threats.

	Strengths	**Weaknesses**
Opportunities	S-O strategies	W-O strategies
Threats	S-T strategies	W-T strategies

Fig.6.2: SWOT / TOWS Matrix

6.3 Development of competitive advantage

Companies achieve competitive advantage through acts of innovation. They approach innovation in its broadest sense, including both new technologies and new ways of doing things (Higgins, Vincze, 1993, p.411). When a firm sustains proof it's that exceed the average for its industry, the firms is said to possess a competitive advantages over its rivals. Michael Porter identified two basic types of competitive advantage:

- Cost advantage
- Differentiation advantage

A competitive advantage exists when the firm is able to deliver the same benefits as competitors but at a lower cost (cost advantage), or deliver benefits that exceed those of competing products (differentiation advantage). Competitive advantage enables the firm to create superior value for its customers and superior profits for itself. The cost and differential advantages are known as positional advantages since they describe the firms positioning the industry as a leader in either cost or differentiation. A resource-based view emphasized that a firm utilizes its resources and capabilities to create a competitive advantage that ultimately results in superior value creation. The list below combines the resource-based and positioning views to illustrate the concept of competitive advantage:

Resources are the firm-specific assets useful for creating a cost or differentiation advantage. Capabilities refer to the firm's ability to utilize its resources effectively. **The firm's resources and capabilities together form its distinctive competences.** These competencies enable innovation, efficiency, quality and customer responsiveness, all of which can be leveraged to create a cost advantage or a differentiation advantage. The firm creates value by performing a series of activities, which is known as value chain. To achieve a competitive advantage, the firm must perform one or more value creating activities in a way that creates more overall value than do competitors. Superior value is created through lower costs or superior benefits to the consumer (differentiation).

- Distinctive
- Competencies
- Capabilities
- Cost Advantages or Differentiation Advantage
- Value Creation Resources

6.4 General questions for SWOT analysis

It is not only possible or necessary to make SWOT analysis in the way we described. SWOT matrix can be prepared directly on the basis of the knowledge and experience of managers. Though their discussion and / or questionnaires SWOT matrix can be prepared. Finding on SWOT analysis varies depending upon the purposes and the organization on which analysis is to be done. It is important to clearly mention the description of the subject for which SWOT analysis is to be carried out so that people contributing to the analysis, and those seeing the finished SWOT analysis, properly

understands the purpose of the SWOT assessment and implications. In the process of SWOT analysis, an analyzer generally tries to find the answers to the following questions as shown in matrix Table-6.1 below [36].

Table-6.1: General questions for SWOT analysis

STRENGTHS	**WEAKNESSES**
• Advantages of proposition? • Capabilities? • Competitive advantages? • USP's (unique selling points)? • Resources, Assets, People? • Experience, knowledge, data? • Financial reserves, likely returns? • Marketing - reach, distribution, awareness? • Innovative aspects? • Location and geographical? • Price, value, quality? • Accreditations, qualifications, certifications? • Processes, systems, IT, communications? • Cultural, attitudinal, behavioral? • Management cover, succession?	• Disadvantages of proposition? • Gaps in capabilities? • Lack of competitive strength? • Reputation, presence and reach? • Financials? • Own known vulnerabilities? • Timescales, deadlines and pressures? • Cash flow, start-up cash-drain? • Continuity, supply chain robustness? • Effects on core activities, distraction? • Reliability of data, plan predictability? • Morale, commitment, leadership? • Accreditations, etc? • Processes and systems, etc? • Management cover, succession?

Continuation of Table-6.1

OPPORTUNITIES	THREATS
• Market developments? • Competitors' vulnerabilities? • Industry or lifestyle trends? • Technology development and innovation? • Global influences? • New markets, vertical, horizontal? • Niche target markets? • Geographical, export, import? • New USP's? • Tactics - surprise, major contracts, etc? • Business and product development? • Information and research? • Partnerships, agencies, distribution? • Volumes, production, economies? • Seasonal, weather, fashion influences?	• Political effects? • Legislative effects? • Environmental effects? • IT developments? • Competitor intentions - various? • Market demand? • New technologies, services, ideas? • Vital contracts and partners? • Sustaining internal capabilities? • Obstacles faced? • Insurmountable weaknesses? • Loss of key staff? • Sustainable financial backing? • Economy - home, abroad? • Seasonality, weather effects?

Above questions are general in nature however some more points may have to be analyzed based on the nature of a business or organization [36].

6.5 SWOT analysis of KCFP

Kailashtila Condensate Fractionation Plant (KCFP) being associated with the condensate refining business, there are certain common factors that are influencing in the overall business performance to all the players. Condensate is non- renewable natural resources found in the earth crust on which all refineries are dependable. World oil, gas and condensate reserve is limited and it is predictable that with the present pace of consumption pattern it may last for about another 40/50 years. Although the price of condensate and crude oil is internationally standardized but due to its limited availability and having no other perfect alternative, price fluctuated frequently base on supply and

demand characteristics. Subsequently price of products also fluctuating based on supply and demand characteristics. The upstream industries i.e. the suppliers always enjoy advantage of market in terms of pricing and quality of condensate although SGFL or KCFP will get condensate at a different price prefixed by BERC or by the government. Refinery products are generally standardized and there is not much scope for product innovation and differentiation from the viewpoint of its quality and patterns. However, demand of petroleum products is all the time high, because of having no suitable alternative to customers till now. Petroleum refining business involves huge capital investment therefore any decision for investment cannot be taken in short term basis even though changing business environment is quite visible. In chapters 3 to 5, business and organization analysis of KCFP has been made in detail. Business analysis includes analysis of purchasing, production, and sales, financing and personnel. Analysis of purchasing include s the various practices adopted in RCFP and KCFP and advantages and disadvantages of existing practices. Analysis of production covers physical performance and yield pattern of RCFP during the year 2009 to 2011. The analysis covers various reasons for capacity under utilization, technological and bureaucratic bottleneck and effect of fuel and loss in the profitability of the condensate fractionation plant. Analysis of sales covers trends of products sales during 1999 to 2011 and its contribution in the profit and loss of the company in 2009-10. The analysis also includes demand and supply trend in Bangladesh. Financial analysis covers current, debt-equity and equity assets analysis for the years 2006 to 2010 to find out the liquidity, assets-liability and financial stability position of the company. Human resources analysis includes the analysis of personnel, their behavior, structure and relationship with the organization. Analysis of profitability of RCFP during 2009 to 2011 includes analysis of ROR and ROA

to find out the return of assets of the company. In the process analysis of net profit ratio and inventory turnover analysis is also made to find out the net earnings on net sales and operating efficiency of the company.

In the chapter, analysis of organization is made which includes analysis of organizational structure, culture and process. In the organizational structure corporate governance and formation of divisions and department and their functions are discussed. Under organizational culture, prevailing organizational cultural environment, their positive and negative impacts on organization are discussed. Under organizational process such as planning, organizing, leading and controlling of KCFP have been discussed. In this chapter, we are trying to analysis the external environment in connection with oil industries. Discussion on countrywide present oil industry scenario has been made. Under oil industries in Bangladesh, discussion has been made on refining capacity of the country, technology, supply-demand and export-import of crude oil and POL products. Considering all the above factors SWOT matrix of KCFP is prepared.

6.6 SWOT Matrix of KCFP

Strengths are the following:

- Experienced, well educated, well trained, meritorious above all skilled human resources working at Sylhet Gas Fields Limited, the implementing agency of KCFP. SGFL is the pioneer of condensate fractionation since 1960s.
- These personnel can easily be engaged to KCFP without any type difficulty as the proposed location is good, even best among the establishments of SGFL.

- Personnel working at SGFL (as well as at proposed KCFP) have excellent interpersonal, friendly relationship to help one another to perform a job.
- Personnel are dedicated having job satisfaction from financial point of view also. Their dedication and sincerity will be the most effective strength to KCFP.
- The accommodation facility for KCFP personnel is at the heart of Golapgonj pouroshova having easy access to good schools, markets, mosque, recreation and social institutes. All these things will keep the KCFP personnel mentally relaxed and efficient during their job.
- A large number of SGFL personnel are working and experienced with condensate fractionation activities at RCFP, KTL and Haripur. Even, more than 17 graduate and post-graduate engineers of different disciplines are working now at Rashidpur Condensate Fractionation Plant (RCFP).
- Good financial strength of SGFL to implement and operate the plant with own resources without any shortage of fund.
- Financial condition of SGFL is getting better day by day by the grace of almighty Allah and sincere labor of the people working here including its board of directors.
- Excellent plant location: Proximity to the condensate pipeline custody transfer meter (and scrapper unit) of Jalalabad field to receive raw materials easily.
- Condensate handling experience of Jalalabad field by SGFL personnel under premium contract.
- Uninterrupted Power Supply from KCFP's own captive power generator, neighboring PDB electric supply line and adjacent 2 MSTE plants' power supply in the case of emergency.

- Ability to access easily the road, rail, river and airport facility for transportation of equipments, products, raw materials and personnel.
- Own fire fighting truck, equipments and trained personnel to prevent and mitigate fire hazards.
- SGFL's own condensate reserve at KGF.
- Geographical location of the plant is favorable for transportation of raw materials and products, storm, temperature and other points of view.
- Recently a new Division headed by a General Manager (Liquid Petroleum and Marketing Division) is formed to operate and market mainly RCFP, KCFP etc products.

Weaknesses as a result of our analysis:

- Some employed people (though a few in number) are careless in their job
- Sometimes weakness in top management or board to pursue and approve company's interest from the government or corresponding authority.
- More expertise and tactfulness is expected in contract negotiation and contractor handling.
- Negative attitudes of some desk-in-charges or officers disturb the personnel mentality and reduce productivity by deteriorating job satisfaction. Company is paying much for its personnel, but those negative roles are worming its fruit.
- Lack of own products transportation pipelines.
- No self marketing ability.
- Personnel need to be more conscious in personnel protection and other safety issues.

- Method of standardization or system of bench marking of activities is not always based on time and manpower evaluation resulting un-uniform work distribution to individuals, which affects the work culture and also affecting overall company's performance
- No standardize tools applied for measuring performance of individuals System does not take care of reward and punishment
- A portion of middle management personals are not efficient with internet communication and IT.
- Existing online information system is incapable of timely communication of important business information to the management. Management has to depend on delayed information of furnished by divisional/ departmental heads leading to delay in decision-making process
- Employees' strength is higher compared to size of the company
- Annual performance appraisal system most often does not reflect actual performance of individuals.
- Sometimes, declining performance of marketing and refinery operations

Opportunities are the following:

- High potential for market growth in Bangladesh as well as in the world
- Scope to establish and improve condensate receiving facility very easily.
- Get easy access to police station, fire service and other related facilities from Golapgonj and Sylhet.
- Marketing tie-up for petroleum products with Bangladesh Petroleum Corporation and its marketing companies.

- Company is a subsidiary to Petrobangla, which is holding major market share in production and marketing of natural gas and minerals. Public image to the company is good.
- Easily can get the BERC license for production and storage of Petroleum products as, RCFP got.
- Company is one of the biggest public enterprises in the region.
- Cheap labor force available (casual labor).
- Attitude of government towards the company is favorable.
- Increase in demand for natural gas and petroleum fuels
- Rising oil and natural gas prices
- Increase in Petrol demand

Major threats are the following

- Petroleum oil marketing is dependable to BPC
- Competitors will be private firms whose owners are related with political leaders who can influence ministry and secretariat.
- Bureaucracy and corruption
- KCFP will be located in something earth-quake and flood-ridden area.
- On and off political disturbance in the region
- Threat from new entrants
- Stringent environmental regulation
- New technology adapted by the competitors
- Market driven pricing mechanism

SWOT analysis of KCFP reveals that the company has adequate infrastructure facilities for supply of condensate and dispatch of finish petroleum products by all available modes of transport (rail, road and pipeline). Even though the company does not have its own marketing network for selling or distribution of petroleum products but marketing tie-up with BPC, which is enjoying biggest market share in petroleum refining and marketing business in Bangladesh, is providing the company a great advantage. In fact KCFP being the subsidiary to SGFL, marketing tie-up is a good deal. The company ha s qualified long experienced skilled and rational work force. As a welfare measure of employees, the company provided well-developed township facilities with hospital and other recreational facilities like clubs, canteen, parks, playgrounds etc. The company' s medical policy for the employees and their family is attractive. All these facilities hold good for retaining experience work force of the company.

Condensate fractionation is a continuous process and any interruption in the operation causes serious loss to the company. Uninterrupted and stable supply of electricity is essential for continuous refinery operation. To avoid such situation, the KCFP will develop own captive power plant (CPP), which is adequate to cater the power and steam requirement for entire fractionation plant area. The company has reputations for its products' quality and environment friendly operation. Attitude of government as well as the public towards the company is good and enjoy the status of one of the biggest public enterprise in the region. However, the fractionation capacity of the KCFP is 1250 bbl/day only, which is 2.09 percent of total existing refining capacity of the country. The basic cause for capacity under- utilization was due to obstacle of sales. Further no significant growth/expansion in the business during last few years and resulting stagnation in

promotion and employees' personal development. Processing cost of the KCFP will be higher compared to new refineries with higher processing capacity and new technology. Even though infrastructure facilities for supply of raw material is available but the transportation cost of condensate is negligible due to its distance from the supply points. Transportation of others goods and supply of finished products also time to time interrupted due to negative policy of BPC and on and off political disturbance in the region. Geographical location of the industry is favorable for transportation of goods. Stringent environmental standards are another threat on which company may need to invested a huge sum of money in order to comply with the continual upgraded environmental standards.

Chapter-7

Conclusions & Recommendations

7.1 Conclusion & Recommendations

As the Government discourages condensate exporting, the produced condensate should be processed inside Bangladesh to produce usable petroleum products. One of the simplest processing is the fractionation in the conventional condensate fractionation plants. So, Additional fractionation plants of corresponding capacities should be installed depending upon the economics. If such types of plants are found financially viable, then the state owned enterprises should get the priority, depending upon their investment capability.

In this feasibility study, condensate fractionation plant location at Kailashtila-II is justified as excellent.

Products to be produced from this plant are Octane, Kerosene and Diesel. Substantial quantities of these products are being imported every year by the cost of huge amount of hard earned foreign currency. If the proposed plant is implemented, Bangladesh will be more self dependent in those fuels and can save valuable foreign currency.

Financial analysis shows that, the profitability increases as the plant capacity is increased as presented in table-5.15. The Financial Net Present Values for capacities 750 bbl/day, 1250 bbl/day and 1500 bbl/day are Tk. 17042.27 Lakh, Tk. 34619.50 Lakh and Tk. 42360.69 Lakh respectively (discounted@15% per year). The corresponding Financial Benefit Cost Ratio, BCR(F) are 1.19, 1.24 and 1.25 at the same discount rate. The Financial Internal Rates of Return, IRR(F) are 50.35 %, 61.82% and 65.60% respectively. The Discounted Financial Pay Back Periods are 3years, 2years and 2years respectively.

Economic Net Present Values, NPV(E) for 750 bbl/day, 1250 bbl/day and 1500 bbl/day capacity plants are Tk. 17417.80 Lakh, Tk. 30456.04 Lakh and Tk. 37209.40 Lakh respectively. Corresponding BCR(E) are 1.24, 1.25 and 1.25. And Corresponding IRR(E) are 52.71%, 64.25% and 68.20% respectively.

The values of Financial and Economic parameters determined in this project thesis shows that, for all 3 plant capacities NPV(F) and NPV(E) are highly '+ve', actually excellent. BCR(F) and BCR(E) for all of the capacities are greater than 1. IRR(F) and IRR(E) are also much higher than 15%. So, it is certain that, the fractionation plant project is economically and financially feasible for all the 3 capacities, e.g., 750 bbl/day, 1250 bbl/day and 1500 bbl/day.

In the above analysis, it is clear that, the profitability increases with the increase in plant capacity. But being more conservative on raw materials supply from Jalalabad field, it may be recommended to install a 1250 bbl/day capacity condensate fractionation plant now. And provision may be kept to increase plant capacity after year 2015 depending

upon increase in condensate production from this field on the basis of coming 3-D seismic survey results of this field.

Financial and human resource strength of SGFL to implement the proposed condensate fractionation plant project is self sufficient right now as discussed in this report.

So, it is strongly recommend installing a 1250 bbl/day capacity condensate fractionation plant at Kailashtila-II at earliest. SGFL board and concerned officers should be more sincere and tactical to overcome the obstacle imposed by selfish groups, corruption and Bureaucratic bottlenecking on the path of national benefits and progress.

In this project thesis, the octane value (RON) of the fractionated MS is improved by adding octane booster with it. Octane booster is a costly item, though the project will be profitable enough in spite of using it. Here, room for another feasibility study to improve the octane value by Catalytic Reforming or any other process to improve the RON (Research Octane Number) of the fractionated MS.

References

[1] Monthly MIS Report, Bangladesh Oil Gas and Mineral Corporation (Petrobangla), December 2010;

[2] Hall, JL & Charleston, W.; "Method of Treating Hydrocarbon Gases" – W. Va, assigner of one-half to Danciger Oil and Refineries, Inc. Fort worth, Tex, a corporation of Texas, Feb.8, 1944, pp. 1-4

[3] Brewster, OC.; "Separation of Hydrocarbons", Litchfield, Conn. Assignor to Refinery Engineers Inc. New York, N.Y., a corporation of Missouri, Nov.1, 1938, pp.1-6

[4] Bangladesh Petroleum Corporation-"Export of Natural Gas Condensate (NGC) during 2008-2010.

[5] The Daily Kaler Kontho, page-6, dated 6/12/2010

[6] Website of Bangladesh Petroleum Corporation: www.bpc.gov.bd

[7] SGFL Annual Report 2010

[8] 'Petroleum Exploration', published by Petrobangla 2008, p.45

[9] 'Bangladesh Petroleum Potential and Resource Assessment 2001', published by Hydrocarbon Unit, Ministry of Power, Energy and Mineral Resources, Bangladesh, p.88

[10] Daily Gas and Condensate Production and Distribution Report, Feb.7, 2010. Petrobangla website: www.prtobangla.org.bd

[11] Petrobangla Reference no. 41.11.04/419 dated Nov.28, 2004.

[12] Monthly Progress Report, MIS, SGFL, February 2011.

[13] Condensate Purchase and Sales Agreement of Jalalabad Gas Field, -2000

[14] "Towards Revamping power and Energy sector: A Road Map", June 2010, Ministry of Finance, Government of Bangladesh.

[15] Prices of Liquid Petroleum Products, Bangladesh gazette, EMRD, dated March 9, 2009.

[16] Year wise sale of gas in CNG sector, Petrobangla MIS, Dec 2010.

[17] Bangladesh Petroleum Corporation, Demand of Petroleum Products in Bangladesh 1999-2010

[18] Eastern Refinery Ltd., Test Report of Jalalabad Gas Condensate, dated 11-6-2005.

[19] BSTI: Specification of Petroleum Products, Bangladesh, 2003.

[20] Valle-Riestra, J. F. 'Project Evaluation in the Chemical Process Industries', McGraw-Hill, NY, 1983

[21] 'Plant Design and Economics for Chemical Engineers'-4th Edition, by Max S. Peters and Klaus D. Timmerhaus, McGraw-Hill, Inc.

[22] A text book on 'Design and Building of Process Plants'-some practical guidelines, by Dr. AKM.A. Quader, Professor of Chemical Engineering, BUET

[23] Development Project Proposal, SGFL, April 2010

[24] D. A. Begum, A. Rahman and K. Kirtania, 'Condensate Fractionation Column: Design variation study by simulation' Journal of Chemical Engineering, IEB; Vol. ChE. 25, No. 1, December 2010

[25] Kumar, S.; Contribution in Petroleum Geology and Engineering, vol.4: Gas Production Engineering.

[26] 'Terms and Conditions to issue NOC for Installation of Condensate Fractionation Plant in the Private Sector', Petrobangla, EMRD, Ministry of Power, Energy and Mineral Resources, dated 25-8-2008

[27] Condensate Analysis Report of Jalalabad, Moulvibazar and Bibiyana Gas Fields, Dec 2010.

[28] Chowdhury, P.K., 'Feasibility of a Second Oil Refinery in Bangladesh', M.Engg. project thesis, April 2010, PMRE Dept., BUET.

[29] Chase B. R. et al, 'Production and Operations Management, Manufacturing and Services', Tata McGraw-Hill, New Delhi, 1999

[30] The BPC website: www.bpc.gov.bd

[31] 'Engineering Economy', -11th Edition, by Willium G Sullivan et al.

[32] Energy and Mineral Resources Division, Decision no.5, Ref. no. EMRD/Dev-2/Gas-2/2008(part-2)-1262 dated 28-12-2-2010

[33] 'Feasibility Study', Drucker 1984; Hoagland and Williamson 2000; Thompson 2003c; Thompson 20010

[34] Sodhi M.S. & Tang C.S. 'The OR/MS Ecosystem: SWOT Operations Research' vol. 56, no. 2, March-April 2008

[35] http://www.quickmba.com/strategy/swot

[36] http://www.businessballs.com/swotanalysisfreetemplate.htm