VIABILITY OF CROSS COUNTRY PIPELINE WITH RESPECT TO COST AND THROUGHPUT

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DEHRADUN (UTTARAKHAND)

MAY 2010

VIABILITY OF CROSS COUNTRY PIPELINE WITH RESPECT TO COST AND THROUGHPUT

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree

of

Master of Technology

(Pipeline Engineering)

By

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May 2010

CERTIFICATE

This is to certify that the work contained in this thesis titled "VIABILITY OF CROSS COUNTRY PIPELINE WITH RESPECT TO COST AND THROUGHPUT" has been carried out by **NIMIT SONI** under my/our supervision and has not been submitted elsewhere for a degree.

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ACKNOWLEDGEMENT

I am happy to thank Dr.Sri Hari, the Dean of U.P.E.S. for giving me the opportunity to undergo this major project.

I would like to express my deep gratitude to Mr. Adarsh Kumar Arya – Assistant Professor (Pipeline Engineering) UPES Dehradun for his dedicated, valuable and constant guidance

I am also very grateful to all faculty member of UPES for providing me the guidelines and help to me during the project.

Lastly I would like to express my heartfelt thanks to all my friends and my family for giving me encouragement and unending support right from the initial stage of our project.

ABSTRACT

VIABILITY OF CROSS COUNTRY PIPELINE WITH RESPECT TO COST AND THROUGHPUT

Petroleum industry is dependent on transportation of oil and gas through pipelines. Through the pipelines crude, petroleum products and gas is transported. There are a number of advantages of transportation through pipelines. Pipelines are friendly to the environment, pipelines are very safe and reliable, transportation through pipelines is very economical and it is also less susceptible to thieving.

Success of any project is depends on the profit earn by the project. Same for the pipelines its success depends on benefits derived from it. The cost of transportation through pipelines is considered as the major factor for evaluating the benefits.

In this case study we are comparing the cost of transportation of Petronet CCK Pipeline with the other mode of transportation and by doing so we are evaluating the Viability of Petronet CCK Pipe line.

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1. INTRODUCTION:-

For the viability analysis we are doing a study on Petronet CCK limited Pipeline.

Petronet CCK LTD has laid a pipeline from BPCL's Cochin dispatch terminal (Irimpanam) to Karur via Irugur for transportation and downstream distribution of petroleum products. The throughput requirement considered for design of the pipeline system is 3.3 MMTPA in Phase-I and 4.0 MMTPA in Phase-II. The length of the pipeline from Cochin to Karur is 292.5 km. The pipeline is intended to transport Motor Spirit (MS), High Speed Diesel (HSD) and Superior Kerosene Oil (SKO). Existing storage tanks & new tanks at BPCL's existing terminal at Cochin (Irimpanam) will be used for this purpose.

At Irugur and Karur new terminal facilities are built by BPCL to meet this requirement. At Irugur heart cut of MS, SKO and HSD, was originally planned to be withdrawn and the balance product to be transported to Karur. The transported products are stored in storage tanks at Irugur and Karur terminals from where they are distributed to various locations by road.

The Petronet CCK Limited multi-product pipeline transports multi products from the Irumpanam Terminal of BPCL to the Marketing terminal at Karur through Irugur terminal at Coimbatore. The 292.5 km long pipeline starts from the storage tanks at BPCL Irumpanam. The intermediate station at Coimbatore is located 182.5 km from Cochin. The pipeline transports Motor Spirit (MS), High Speed Diesel (HSD) and Superior Kerosene Oil (SKO) from Cochin to Karur Receipt Terminal with an intermediate tap off point at Coimbatore.

2. LITERATURE REVIEW:-

The work that is being done is the viability analysis, for this purpose we are assessing the financial condition of the CCK pipeline. For this work the feasibility reports and financial and viability reports have been reviewed.

Financial analysis refers to an assessment of the viability, stability & profitability of a project. It seeks to ascertain whether the proposed project will be financially viable in the sense of being able to meet the burden of servicing debt and whether the project will satisfy the return expectations of those who provide the capital.

It also includes the Revenue analysis, which is estimation of the revenues which would be earned in the future. Revenue projections are formed on the basis of Output sales. It helps in finding out the profits/ losses in the future. Revenue analysis is all the more important in project finance because the debts have to be repaid through the revenues.generated by the project.

Once information about expected return and costs has been gathered, the next question arises: whether the project should be selected or not. There are many methods of evaluating the profitability of the project.

For evaluating the energy consumption the pressure /head losses has been considered , a lot of work have been done in this direction for accurately calculate the losses. We have considered the Colebrook formula.

And finally by the break even point analysis we will find the point where the viability exists for the pipelines.

3. BASICS OF PIPELINE SYSTEM:-

3.1 Basic Design :-

Length	292.5 kms (Cochin to Karur) Tap off point at Coimbatore
Flow rate	521/627 m^3/hr
Batch Sequence	SKO-MS- SKO-HSD - SKO - MS - SKO
Design Life	35 years
PL Grade & Wall thickness	18" API 5L X 65 – 6.4mm,7.9 mm, 9.5 mm and 12.7 mm 14" API 5L Grade B – 6.4 mm, 7.9 mm
Operating Pressure	83.5 kg/cm^2 (system inlet control valve setting Phase-I)
Operating Temp	Above ground- 15-45°C Subsoil- 20-25 °C
Design Pressure	18" – 99.5 kg/cm^2 (to Km. 43) 84.0 kg/cm^2 (from Km.43) 14" – 49.5 kg/cm^2
Design Temp	Above ground 65 °C Below ground 45 °C
Code	ANSI/ASME B31.4 and OISD standards
Throughput	3.3 MMTPA (Phase 1) 4.0 (Phase 2)

TABLE 3.1

3.2 FACILITIES:-

3.2.1 Pump station:-

3.2.1.1 Booster pumps:-

There are two booster pumps BP1 and BP2 (one operating & one standby) at Cochin. To start the booster pumps, booster pump unit start command is initiated.

After ensuring the required starting conditions, the selected booster pump unit starts and after a time delay the discharge valve of the selected unit is opened.

Once the booster pump is started, the booster pump unit control sends signal via station control for the readiness of the mainline pumps for start up.

3.2.1.2 Mainline Pumps:-

Three mainline pumps MP1, MP2 and MP3 (Two operating and one standby) are provided at Cochin. The pumps will be operating in series configuration. To start mainline pumps, the mainline pumps unit start command is initiated.

After meeting the required starting conditions the selected mainline pump unit starts and after a time delay the discharge valve of the selected unit is opened. Similarly, the second mainline pump unit is started.

3.2.1.3 Sump pumps:-

A sump tank has been provided at Cochin dispatch terminal for the collection of slop from various points such as header drains, scraper drain, line flushing, TSV relief, sample point etc. The collected slop is pumped back into the mainline along with HSD product during pumping operation.

3.2.1.4 Corrosion Inhibitor Pumps:-

Corrosion inhibitor is required to be dosed in the pipeline to reduce corrosion in the pipeline. For this purpose a corrosion inhibitor tank and two corrosion inhibitor dosing pumps (one operating + one standby) have been provided. The corrosion inhibitor is injected upstream of mainline pumps. The dosing capacity can be adjusted by stroke adjustment of pumps. A dosage of 3 ppm is advised.

3.2.1.5 Valve:-

The mainline valves (conforming to API STD 6D) are full bore, suitable for passage of all types of pipeline scraper and inspection tools and will provide an unobstructed profile for pigging operations. These valves are of double block and have bleed feature to facilitate complete flush, drain and venting of valve body and cavity. At major river crossings valves are provided at both upstream and downstream of the crossings. All these mainline valves installed at intermediate facilities/ sectionalising valve stations are butt-welded to the line pipe.

There are two types of SV stations along this pipeline. The first being a manually operated valve (HOV) with no other facilities or interfacing with the telemetry system. The second is a station where the valves have electrically driven actuators. These units have the capacity for remote or local actuation as well as manual. The unmanned valve stations have CO_2 fire protection system.

3.2.1.5.1 Flow Control Valve:-

Flow and pressure control valves used are globe valves and their actuators are the electro-hydraulic type. The pressure control valves at Cochin and Karur are 10" in size and have a rated Cv of 900. The flow control valve at Irugur is of size 6", with a rated Cv of 360. The control valves can be operated in both MANUAL and AUTO modes from the SCADA console

The valve is actuated in the field by a hydraulic double – acting cylinder, which is connected to the valve stem. The hydraulic power is supplied by an electric motor, which pumps the hydraulic oil from oil tank to an accumulator. Various flow and check valves are used to control the hydraulic flow and a 4/3 proportional solenoid valve performs the automatic operation of the actuator.

In case of any power failure or control signal failure, the valve maintains its position in the fail-safe mode of operation. The actuator system also monitors important parameters like low oil pressure & level, high oil temperature and gives a common alarm to the operator at the control room.

3.2.1.5.2 Safety valve:-

Pressure relief valve is used to keep the pressure in a pipe within a certain limit, so that the pipe and equipment connected to the pipe will not be damaged by unexpected high pressure generated in the pipeline, such as due to water hammer (pressure surges), or an accidental closure of a valve downstream while the pump is running.

The pressure relief valve, also called the safety relief valve, or simply the safety valve, is a small valve mounted on the wall of a pipeline.

3.2.1.6 Instrumentation:-

3.2.1.6.1 Density meter:-

The density skids have a vibrating tube as the transducer element. Depending on the density of the product, the resonant frequency of the tube changes and this change is converted to get the density.

The sensor also has an inbuilt temperature element (RTD) for accurate temperature measurement. These field inputs are connected to the density computer in the control room. This density computer gives out the line density and the corrected Density (API) for display by the PLC and SCADA.

3.2.1.6.2 Flow meter:

The meters are turbine flow meters of size 6". The meters have a linearity of 0.15% and a repeatability of 0 .02%, thus assuring high accuracy. The meters are rated for a flow range of 45 to 668 kl/hour. The meters have dual pulse pickups and the two outputs from each meter are connected to a Barton flow computer. The flow computer converts the flow meter signal in to the flow rate and flow total inputs to be displayed at the PLC / SCADA.

The flow meter has algorithms for pressure/temperature corrections and diagnostics conforming to API standards.

3.2.1.6.3 Pressure Instruments:-

Pressure transducers are perhaps the most common measurement on a pipeline. Pressures are used not only to monitor the current state of a pipeline, but also to control the action of devices such as pumps or compressors and control valves.

On gas pipelines, the SCADA software or other applications to calculate the line pack is important to the pipeline operator since it represents the amount of available inventory for meeting demands, which are greater than his supplies, frequently use pressures.

Liquid pipeline operators also depend heavily on pressure readings. SCADA applications will use the pressure measurements to calculate the head of the fluid. The operator will use these head measurements to make sure that the pipeline pressure is high enough so that the flow does not go slack, and low enough so that MAOP is not exceeded.

3.2.1.6.4 Temperature Instruments:-

Temperature sensors are normally placed at the same locations on a pipeline as the pressure measurements. The temperature of the fluid is important in determining the current line pack. In liquid systems transporting heavy crude oil, the temperature of the fluid must be closely controlled, since at lower temperature the fluid becomes very viscous and difficult to move.

3.2.1.7 Corrosion Protection System :-

Internal protection:

Corrosion inhibitor injection system at Cochin dispatch terminal and Irugur terminal.

External protection:

- 3 layer Polyethylene coating for pipeline portion
- Impressed current Cathodic protection

3.2.1.8 SCADA :-

The SCADA system aims at ensuring effective and reliable control; management and supervision of the pipeline from a centralized location using data provided from the terminals and SV stations.

Functional responsibilities are Data acquisition, Control, Alarm and event presentation, Real time and historical trending, Man Machine Interface (MMI), Report generation, Archiving, Communication handling and error recovery, Database configuration, System maintenance and security, Cathodic protection monitoring, Leak detection, Batch tracking, Any other feature that may be available.

The RTUs are installed at all the motor operated sectionalising valve stations and the terminals at Cochin, Karur and Irugur to transmit the process data to the SCADA servers.

The various inputs interfaced to the SCADA system from an SV station are the upstream, downstream pressures, product temperature, density, flowrate.

3.2.1.9 LDS :-

Locating and repairing leaks when they occur is a very important function of pipeline maintenance.

The Leak Detection System (LDS) generates alarms in case of a leak and also indicates its location. Very small leaks, which cannot be detected by the LDS, are normally reported by local public or else, reported by patrol parties.

Leak detection shall be done by volume/mass balance and also by simulated/transient model based techniques including static pressure testing facility (under shut down condition of pipeline section).

Necessary precautions are taken for inhibiting false alarms automatically due to start and stop of pumps, surge condition etc. of the pipeline. Due care was taken so that failure or change in calibration of any field instruments will not cause false alarms. Automatic tuning is an essential feature of software to adjust its calculations to account for the operating characteristics of the pipeline.

3.2.2_Sectionalizing valve stations:-

Sectionalizing valve stations are facilitated with the pressure and temperature instruments. The valves can be govern through pumping station by SCADA.

3.2.3 Receiving stations:-

Receiving stations are also facilitated with valves, metering unit, instruments, PCV's, TCV's, communication system, SCADA and tank farm.

3.3 Products to be Transported:-

The pipeline is intended to transport Motor Spirit (MS), High Speed Diesel (HSD) and Superior Kerosene Oil (SKO).

3.3.1 Properties of Product:-

Product	Specific gravity	CST Viscosity	Vapour pressure kg/cm^2 A@38 °C
MS	0.66-0.75	0.57 @ 20°C 0.50 @ 38 °C	0.7
SKO	0.75-0.80	1.53 @ 20 °C 1.18 @ 38 °C	Negligible
HSD	0.83-0.85	3.5 @ 40 °C	3.5 @ 40 °C

TABLE 3.2

3.4 OPERATING CONDITIONS:-

Flow Rate: 620 m^3/hr

BP Suction Pressure: 0.92 kg/cm^2

BP Discharge Pressure: 7 kg/cm^2

Density: 840.29 kg/m^3

MP Discharge Pressure: 87.3 kg/cm^2

FCV: 80% open

Pressure (Intermediate Station): 11.72

Pressure (Receiving End): 11.72 kg/cm^2

4 FINANCIAL ASSESSMENT:-

Cost of the pipeline project:-

- Capital cost
- Operating cost

4.1 Capital cost:-

4.1.1 Survey

This cost includes the survey of mainline route survey, sub-soil surveys & field engineering etc.

4.1.2 Land acquisition for ROW

Land required for station, mainline, T-point, terminal station and SV station is considered to be procured as the permanent land acquisition. Right-Of-Way (ROW) compensations have to be provided for the entire route. Crop compensation has also been considered for complete ROW of the pipeline.

4.1.3 Mainline pipes

The cost of pipes and coatings on pipes is also a major cost factor. Now a days Three Layer Poly- ethylene (3LPE) coating is more commonly used.

4.1.4 Mainline Materials:

The cost of materials such as casing pipe, coating materials, valves etc. is estimated on the basis of past experiences.

4.1.5 Mainline construction:

The cost incurred in mainline construction is also estimated on the basis of past experiences and the similar projects.

4.1.6 Pipeline Terminals

Major cost covered under this is instrumentation, valves cost and civil electrical and mechanical works and also the cost of erection.

4.1.7 CP system

This include the requirement for permanent and temporary cathodic protection system. The material required for the same and the installation cot. Generally estimated on the basis of previous projects.

4.1.8 Telecommunication

A proper telecommunication system is must for pipeline system. The cost incurred in this generally estimated on the basis of past experiences.

4.1.9 SCADA

The Supervisory Control and Data Acquisition System (SCADA) is provided for remote monitoring of the system.

4.1.10 Indirect Costs

Thes cost generally the cost which are not pre identified but these expense occurs due to some reason. The estimation of these cost is done on a lump sump basis. These costs involves te administration cost , security cost etc.

4.2 OPERATING COST:-

4.2.1 Power:

Power is required for the system and it is must at all stations. Requirement of power is planned to be drawn from state electricity board However, for continuous availability of power for controls and accessories the DG sets have to be considered.

4.2.2 Salaries and Wages:

The manpower is the very basic need of the pipeline system. Fitters ,LPMs and so many other grades of man power are required as the low grade and official grade man power is also required. The salaries of these has to be considered as accost factor.

4.2.3 Repair and Maintenance:

Repair and maintenance of the mainline has been considered @1% of the investment in the mainline. Similarly, repair and maintenance of the stations has been considered @2% of the investment on stations, telecommunications and telesupervisory system.

4.2.4 Water:

Water is required for fire fighting and it should be refilled and checked at a regular time interval.

4.2.5 Administration Expenses

This cost generally includes the management expenses, security and the other general expenses.

5 Revenue Analysis:-

5.1 Pay-Back Period Method:

It represents the period in which the total investment in permanent assets pays back itself. Under this method various investments are ranked according to the length of their pay-back period and the investment with a shortest pay back period is preferred. The pay-back period can be ascertained in the following manner:

$$\text{Payback period} = \frac{\text{Investment}}{\text{Cash Flows/year}}$$

5.2 ARR Method:

This is the average rate of return method it takes into account the earnings expected from the investment over the whole life of the project. According to this method the project with the highest rate of return is selected. The return on investment is calculated with the help of following formula.

$$ARR = \frac{\text{Average Annual Profits after depreciation \& Taxes}}{\text{Average Investment}} \times 100$$

Where, Average Investment = $\frac{\text{Original Investment + Salvage Value}}{2}$

5.3 NPV Methods:

It is the Net present value method and it is the modern method of evaluating investment proposals. This method takes into consideration the time value of money and attempts to calculate the return on investments by introducing the factor of time-element.

NPV= Present value of cash inflows – Present value of cash outflows.

5.4 IRR Method:

Internal rate of return is also known as discounted cash flow rate of return trial & error yield method. The following steps are needed to follow the internal rate of return method:

a) Determine the future net cash flows during the entire economic life of the project. The cash inflows are estimated for future profits before depreciation but after taxes.

b) Determine the rate of discount at which the value of cash inflows is equal to the present value of cash outflows. If annual cash flows are equal then it can be easily found out otherwise it has to be found out by hit and trial method.

c) Accept the proposal if the IRR is higher than or equal to the minimum required rate of return i.e. cost of capital or otherwise reject the proposal.

d) In case of alternative proposals select the proposal with highest IRR.

5.5 Profitability Index:

This method is also known as benefit cost ratio and is similar to NPV approach. It measures the Present Value of returns per rupee invested based on the following formula:

$$PI = \frac{\text{Present value of Cash Inflows}}{\text{Present value of cash Outflows}}$$

5.6 Based on NRF (Notional Railway Freight):

If the Crude/Product was not transported through pipeline, it should have been transported through roadways or railways. Revenue in this method is the amount saved by transporting the product/crude through pipeline, rather than transporting it through railways/roadways. Normally the revenue is considered to be 75 % of NRF.

6 COST COMPUTATION:-

(For 3.3 MMTPA)

6.1 Energy Cost :-

Energy plays a significant in Pipeline transportation of Petroleum products which includes Motors, CP systems & SCADA system.

Total Energy Consumption = Motors +CP system + SCADA

Energy cost = Energy Consumption Units * Unit rate

6.1.1 Motors:

Pump rating decides the motor rating which is given by the formula mentioned below

$$Energy = \frac{q \times h \times s \times g \times 8000}{1000 \times 3600 \times hp \times hm} \text{ kwh}$$

where,

q = flow rate in m^3/hr = 620 m^3/hr

h = liquid head in meter

s = Specific gravity of fluid (0.840)

g= gravitational constant (9.81 m/sec²)

h_p= pump efficiency (0.85)

h_m=motor efficiency(0.90)

Head requirement depends on delivery pressure , datum head, frictional loss in the pipeline.

Total head= head due to elevation + head due to friction loss + residual head

Pressure due to elevation: $(Z_2-Z_1)\, g\, \rho$

Where,

(Z_2-Z_1) = Elevation Difference

g = Gravitational constant

$= 9.8 \text{ m} / s^2$

Considering Density, $\rho = 840 \text{ kg/m}^3$

$(Z_2-Z_1) \, g \, \rho = (150 - 0) \, 9.81 * 840$

$= 1236060 \text{ N} / m^2$

Internal pressure due to friction ,$h_f = f \, l \, v^2 / 2D$ Nm / kg

Where,

f = Friction factor

L = Length of pipeline

V = Velocity of fluid = 1.1 m/s

Friction factor (f) is calculated by Colebrook formulae,

$1 / \sqrt{f} = 1.14 + 2 \log_{10} D / E - 2 \log_{10} [1 + 9.28 / (Re * E / D * f^{0.5})]$

E = Absolute roughness of pipe in m

D = Internal diameter in m

Re = Reynolds number

$Re = VD / \vartheta$

$= 1.1 * 0.457 / 2.2 * 10^{-6}$

$= 2.2 * 10^5$

The absolute roughness depends on the material, we will use carbon steel

$$E = 0.00015 \text{ m}$$

From the above formulae for D = 18 inch, the friction factor f = 0.017

$$h_f = 0.017 * 292.5 * 1000 * 1^2 / 2 * 0.457$$

$$= 5440 \text{ Nm / kg}$$

Pressure loss = 5440 * ρ

$$= 4569912 \text{ N / m}^2$$

The residual head is approx. 10 to 15 Kg / cm^2

$$= 1470 * 10^3 \text{ N / m}^2$$

Total head= head due to elevation + head due to friction loss + residual head

Total head=1236060 N / m^2 + 4569912 N / m^2 + 1470 * 10^3 N / m^2

Total head = 7276970 N / m^2

In terms of meter column of liquid (mcl) = (7276970 N / m^2)/(g * ρ)

$$= 883 \text{ mcl}$$

Energy consumption by motors:

$$Energy = \frac{q \times h \times s \times g \times 8000}{1000 \times 3600 \times hp \ \times hm} \text{ kwh}$$

=15600 KWH

6.1.2 CP Systems:

The energy required for cp for cp system is detailed below:

Current Requirement,

$I_t = S_a * I_d * S_m / 1000$

Where,

I_t = CP current requirement (mA)

S_a = Surface area of pipeline

I_d = CP protective current density (mA / m^2)

S_m = Safety margin (1.3)

From	To	Dia.(mm)	Length(m)	Surface Area(m^2)	Current Density	S_m	Current Required (Amp)
CHN	CBE	458	182500	262590	0.12 mA/m^2	1.3	40.96
CBE	KRR	356	110000	123025	0.12 mA/m^2	1.3	19.2

TABLE 6.1

Energy required:

$$Energy = \left(\pi \times (a_1 \times v_1 \times l_1 \times d_1 + a_2 \times v_2 \times l_2 \times d_2)\right) \times \frac{8000}{1000} \quad kwh$$

where,

d_1, d_2 = outer dia. of pipe in m

a_1, a_2 = current density in mA/m^2

v_1, v_2 = voltage requirements in volts

l_1, l_2 = distance in km

Voltage requirement is 25 volts

Energy required=6291+ 2949 kwh

=9240 kwh

6.1.3 SCADA Systems:

Components required for SCADA system energy consumption are Average current, Voltage, No of field devices per location and No of locations.

$$Energy = a \times v \times f \times n \times \frac{8000}{1000} \; kwh$$

where,

a= average current in amps (0.21amps)

v= voltage in volts (25volts)

f= No of field devices (5)

n = No of locations (3)

Energy required = 630 kwh

Energy required for different throughputs:-

Throughput (MMTPA)	Max Operating Pressure (mcl)	Energy (kwh)
1MMTPA	335mcl	1813kwh
2MMTPA	476mcl	5086kwh
3MMTPA	762mcl	12269kwh

TABLE 6.2

6.1.4 Electricity tariff rate:

The electricity tariff rate by the Kerala state electricity board is 4.5 rupees/unit for industries.

Total energy consumption for different throughputs:

Throughput (MMTPA)	Pumps (KWH)	CP (KWH)	SCADA (KWH)	Total Consumption (KWH)
1	1813	9240	630	11683
2	5086	9240	630	14956
3	12269	9240	630	22139
3.3	15600	9240	630	25470

TABLE 6.3

Cost of energy:-

Throughput (MMTPA)	Total Consumption (KWH)	Unit Rate (Rs/KWH)	Energy Cost (lacs)
1	11683	4.5	0.525
2	14956	4.5	0.673
3	22139	4.5	0.99
3.3	25470	4.5	1.15

TABLE 6.4

6.2 SALARIES:

The cost factor (ie) Salaries are also being considered as a subset of transportation cost in operating and maintaining a pipeline.

People involved in operating a pipeline like Vice president, HR, Managers, Officers and Technicians.

1 vice president	15lacs
1 HR	15lacs
3 Managers (3 x 10 lacs p.a)	30lacs
9 Officers (9 x 7 lacs p.a)	63lacs
15 Technicians (15 x 0.72 lacs p.a)	10.8lacs

TABLE 6.5

6.3 REPAIR & MAINTENANCE:

Repair and Maintenance are routine activities in Pipeline operation. Repair & Maintenance cost of Pipelines and its Stations are considered in terms of percentage of respective Capital Cost. (ie) 2% for station and 1% for pipelines.

Repair and maintenance cost is 18.3 crores

6.4 INSURANCE:

Insurance is a mandatory element in operating cost which is considered as 0.2% of capital costs of station and pipelines.

Insurance cost is 1.22 crores

6.5 DEPRECIATION:

Depreciation represents the recovery of investment in pipelines as opposed to profits from the investment.

Depreciation for 25 years is 12 crores.

6.6 ANNUALISED CAPITAL COST:

Present Value method is used for computing the annualized capital cost.

$$Cost = \frac{cc \times r}{\left\{100 \times \left(1 - \left(\frac{1}{(1+r)^n}\right)\right)\right\}}$$

where,

cc - Capital Cost in rupees (610 Crore)

r - Rate of Interest in % (8.5%)

n - Design Life in years (25 years)

Annualized capital cost = 52 crores

6.7 ADMINISTRATION EXPENSES:

These are general expenses that would be incurred in operating pipeline and stations like house keeping,canteen,vehicle hiring etc. These expenses are computed as a fixed amount annually for a pipeline with number of pumping stations.

Administration expenses = 1 crore (approx.)

6.8 PIPELINE CAPITAL COST:

Project cost at 2002 = 380 crores

Project cost at 2010 = 610 crores (at 7% inflation rate)

Pipeline capital cost break up:-

ROW	3%
Material	30%
Construction	40%
Stations	20%
Misc. and Contingency	7%

TABLE 6.6

ROW	18.3 crores
Material	183 crores
Construction	244 crores
Stations	122 crores
Misc. and Contingency	42.7 crores

TABLE 6.7

6.9 OPERATING COST:

Operating cost = Energy cost + Fixed operating cost

6.9.1Fixed Operating Cost:

Annualized Capital Cost	52 crores
Repair & Maintenance Cost	18.3 crores
Insurance	1.22 crores
Administrative	1 crores
Depreciation for 25 years	12 crores
Salaries	1.34 crores

TABLE 6.8

Throughput (MMTPA)	Energy Cost (in Crores)	Fixed Operating Cost (in Crores)	Operating Cost (Crores)
1	0.00525	85.86	85.865
2	0.00673	85.86	85.867
3	0.0099	85.86	85.87
3.3	0.015	85.86	85.875

TABLE 6.9

6.9.2 RAILWAY FREIGHT RATES:

FREIGHT RATES PER TONNE					
Distance			**Bitumen**	**Kerosene Oil and Liquefied Petroleum Gas (LPG)**	**Other petroleum products**
(Kilometers)			**(Rs.)**	**(Rs.)**	**(Rs.)**
1	-	100	141.8	150.1	175.1
101	-	105	146.5	155.2	181
106	-	110	151.1	160	186.7
111	-	115	155.9	165.1	192.6
116	-	120	160.5	169.9	198.2

121	-	125	165.2	175	204.1
126	-	130	169.8	179.8	209.8
131	-	135	174.6	184.9	215.7
136	-	140	179.2	189.7	221.3
141	-	145	183.9	194.8	227.2
146	-	150	188.5	199.6	232.9
151	-	155	193.3	204.7	238.8
156	-	160	197.9	209.5	244.4
161	-	165	202.6	214.6	250.3
166	-	170	207.2	219.4	256
171	-	175	212	224.5	261.9
176	-	180	216.6	229.3	267.5
181	-	185	221.3	234.4	273.4
186	-	190	225.9	239.2	279.1
191	-	195	230.7	244.3	285
196	-	200	235.3	249.1	290.6
201	-	205	240	254.2	296.5
206	-	210	244.6	259	302.2
211	-	215	249.4	264.1	308.1
216	-	220	254	268.9	313.7
221	-	225	258.7	274	319.6
226	-	230	263.3	278.8	325.3
231	-	235	268.1	283.9	331.2
236	-	240	272.7	288.7	336.8
241	-	245	277.4	293.8	342.7

246	-	250	282	298.6	348.4
251	-	260	291.4	308.5	359.9
261	-	270	300.7	318.4	371.5
271	-	280	310.1	328.3	383
281	-	290	319.4	338.2	394.6
291	-	300	328.8	348.1	406.1
301	-	310	338.1	358	417.7
311	-	320	347.5	367.9	429.2
321	-	330	356.8	377.8	440.8
331	-	340	366.2	387.7	452.3
341	-	350	375.5	397.6	463.9
351	-	360	384.9	407.5	475.4
361	-	370	394.2	417.4	487
371	-	380	403.6	427.3	498.5
381	-	390	412.9	437.2	510.1
391	-	400	422.3	447.1	521.6
401	-	410	431.6	457	533.2
411	-	420	441	466.9	544.7
421	-	430	450.3	476.8	556.3
431	-	440	459.7	486.7	567.8
441	-	450	469	496.6	579.4
451	-	460	478.4	506.5	590.9
461	-	470	487.7	516.4	602.5
471	-	480	497.1	526.3	614
481	-	490	506.4	536.2	625.6

491	-	500	515.8	546.1	637.1
501	-	510	525.1	556	648.7
511	-	520	534.5	565.9	660.2
521	-	530	543.8	575.8	671.8
531	-	540	553.2	585.7	683.3
541	-	550	562.5	595.6	694.9
551	-	560	571.9	605.5	706.4
561	-	570	581.2	615.4	718
571	-	580	590.6	625.3	729.5
581	-	590	599.9	635.2	741.1
591	-	600	609.3	645.1	752.6
601	-	610	618.6	655	764.2
611	-	620	628	664.9	775.7
621	-	630	637.3	674.8	787.3
631	-	640	646.7	684.7	798.8
641	-	650	656	694.6	810.4
651	-	660	665.4	704.5	821.9
661	-	670	674.7	714.4	833.5
671	-	680	684.1	724.3	845
681	-	690	693.4	734.2	856.6
691	-	700	702.8	744.1	868.1
701	-	710	712.1	754	879.7
711	-	720	721.5	763.9	891.2
721	-	730	730.8	773.8	902.8
731	-	740	740.2	783.7	914.3

741	-	750	749.5	793.6	925.9
751	-	760	758.9	803.5	937.4
761	-	770	768.2	813.4	949
771	-	780	777.6	823.3	960.5
781	-	790	786.9	833.2	972.1
791	-	800	796.3	843.1	983.6
801	-	825	819.7	868	1012.6
826	-	850	843	892.6	1041.4
851	-	875	866.5	917.5	1070.4
876	-	900	889.8	942.1	1099.1
901	-	925	913.2	967	1128.1
926	-	950	936.5	991.6	1156.9
951	-	975	960	1016.5	1185.9
976	-	1000	983.3	1041.1	1214.6
1001	-	1025	1006.7	1066	1243.6

Other Petroleum Products and Gases

Argon gas

Ammonia liquefied gas

Aviation Turbine Fuel (ATF)

Aviation spirit

Crude oil

Compressed gases

Diesel Oil

Furnace oil

High Speed Diesel (HSD)

Hexane

Low sulphur heavy stock Light Diesel Oil Methane gas and Naphtha

TABLE 6.10

Throughput (MMTPA)	Cost of transportation by rail for 292.5 km (in crores)
1	40.61
2	81.22
3	121.83
3.3	134

TABLE 6.11

6.9.3 TARIFF BY ROAD TRANSPORTATION:

Tanker capacity 15 kl

Tanker tariff: Rs 22 / km

$$No\ of\ Tankers\ Required\ (N_t) = \frac{Throughput}{Tanker\ Capacity \times Specific\ gravity}$$

$$Transportation\ Cost\ by\ Road = N_t \times Tanker\ Tarrif \times Distance$$

Throughput (MMTPA)	Cost of transportation by road for 292.5 km (in crores)
1	51
2	102
3	153
3.3	168

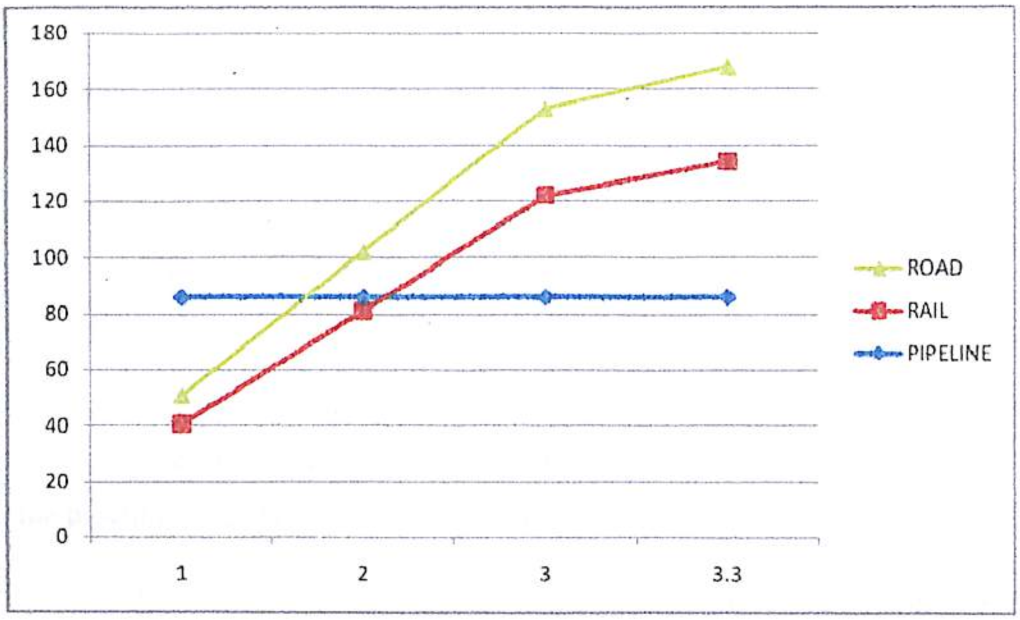
TABLE 6.12

7. COST COMPARISION:

The comparison of cost of transportation of petroleum products by all three modes of transportation is detailed below-

Throughput (MMTPA)	Transportation Cost in Crores		
	Pipelines	Rail	Road
1	85.865	40.61	51
2	85.867	81.22	102
3	85.87	121.83	153
3.3	85.875	134	168

TABLE 7.1



GARPH-7.1

(Throughput(MMTPA) at X Axis and Cost of Transportation (in crores) at Y Axis

By the above graph it is cleared that the **break even point** occurs at **2.1 MMTPA.**

8. <u>RESULTS</u>:-

1. Break even point occurs at 2.1 MMTPA.

2. So by the break even point it is cleared that the pipeline is viable over 2.1 MMTPA.

3. Over 2.2 MMTPA it is beneficial to operate the pipeline over rail and road mode.

4. The energy consumed in operating a pipeline plays less significant roll as compared to other expenses.

5. More a higher throughput it is very beneficial to transport by pipeline.

6. From the study the benefits of pipeline transportation realized.

7. From the study it is cleared that the Petronet CCK pipeline is generating a good amount of revenue.

8. The transportation cost by Rail and Road increases as the throughput increases.

9. CONCLUSION:-

Operating cost of the pipelines decreases as the throughput increases because the capital cost plays a more important role over other expenses and the capital cost is almost equal for a lower throughput and for a higher throughput. So it is always beneficial to operate the pipelines for higher throughput.

And for the specific case for the Petronet CCK pipeline the break even point occurs at 2.1 MMTPA, that means the line is viable for throughput over 2.1 MMTPA and the designed capacity of the pipeline is 3.3 MMTPA. So it is cleared that the line is viable.

And by the study it can be also concluded that once the pipeline have commissioned it should run for its designed throughput for generating the maximum revenue.

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