DESIGN & DEVELOPMENT OF CITY GAS DISTRIBUTION PlAN

A Project Report Submitted in Partial Fulfillment of the award for the Degree of

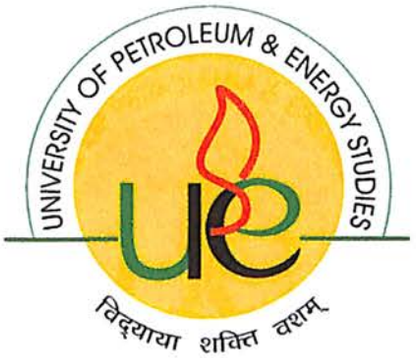
BACHELOR OF TECHNOLOGY

IN

APPLIED PETROLEUM ENGINEERING

Under the guidance of
Ms. Deepshikha
Associate Professor
COE,UPES

Submitted By:-
Himanshu Dhanik (R040207019)
Rohit Pandey (R040207047)
Vikram Kulora (R040207065)



College of Engineering
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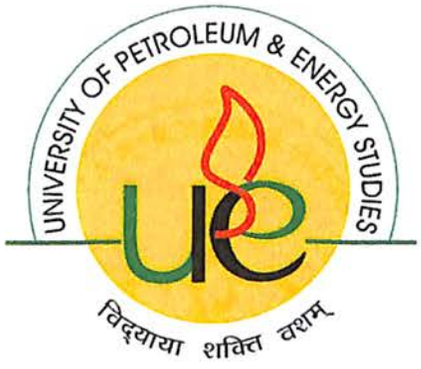

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Approved

Dr. Shrihari
Dean, College of Engineering
University of Petroleum & Energy Studies

College of Engineering
University of Petroleum & Energy Studies
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CERTIFICATE

This is to certify that the project report titled **"Design & Development of City Gas Distribution Plan"** is being submitted by using partial fulfillment of the requirements for the award of the degree of BACHELOR OF TECHNOLOGY (Applied Petroleum Engineering-Gas Specialization) of U.P.E.S. Dehradun.This is a bonafide record of the work carried out by them under our guidance and supervision. Further certified that this work has not been submitted for the award of any other degree or diploma.

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ACKNOWLEDGEMENT

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ABSTRACT

The work here relates to the development of pipeline network in a pre-defined geographical spread. Maintaining different levels of gas pressure to meet the demand of various segments of gas users -Domestic, Commercial, Industrial andAutomobiles.Designing high pressure and medium pressure network such that supply to any consumer is possible from either side.Design gas storage for maximum survival period.Consider safety at all stages.Balance growth of all consumer sectors, especially those cross subsidizing each other.This is the full City gas distribution (CGD) procedure right from exploration to processing to distribution.

I would be working on all the technical acpects in CGD within a state or city.

TABLE OF CONTENTS

INTRODUCTION

NATURAL GAS:-

Natural gas is a combustible mixture of hydrocarbon gases consisting primarily of methane but including significant quantities of ethane, butane, propane, carbon dioxide, nitrogen, helium and hydrogen sulfide.

BOILING POINT **-160^0C**

GROSS CALORIFIC VALUE **43000KJ/M3**

Flammable limit **4%-16%(volume% in air).**
Relative density **0.71**
Wobbe index **1328**

Typical Composition of Natural Gas:

Methane	CH_4	70-98%
Ethane	C_2H_6	
Propane	C_3H_8	0-20%
Butane	C_4H_{10}	
Carbon Dioxide	CO_2	0-8%
Oxygen	O_2	0-0.2%
Nitrogen	N_2	0-5%
Hydrogen Sulphide	H_2S	0-5%
Rare gases	A, He, Ne, Xe	trace

SOURCES OF NATURAL GAS:-

1.CONVENTIONAL RESERVES:-

ASSOCIATED NG – in contact, but not in solution with oil.

NON-ASSOCIATED NG – not existing with oil.

WET NG –Unprocessed or semi-processed NG from strata containing condensable (heavy) hydrocarbons.

DRY NG – Dehydrated. Also containing little or no recoverable liquid hydrocarbons. Almost pure Methane.

2. OTHER SOURCES OF GASEOUS FUELS:-

A.TIGHT SANDS:- Tight gas sands are defined as sandstone formations with less than 0.1 milli-darcy permeability. They are known to contain significant volumes of natural gas.

B.TIGHT SHALES:- Shale is a very fine-grained sedimentary rock, which is easily breakable into thin, parallel layers

C.GEOPRESSURIZED AQUIFERS:- Geopressurized zones are natural underground formations that are under unusually high pressure for their depth.

D.COAL BED METHANE:- Coal-bed methane, often referred to as 'CBM', is distinct from a typical sandstone or other conventional gas reservoir, as the methane is stored within the coal by a process called 'adsorption'.

E.METHANE HYDRATES:- Methane hydrates are the most recent form of unconventional natural gas to be discovered and researched. These interesting formations are made up of a

lattice of frozen water, which forms a sort of 'cage' around molecules of methane. These hydrates look like melting snow and were first discovered in permafrost regions of the Arctic.

COMPRESSED NATURAL GAS:-

Compressed Natural Gas (CNG) is a fossil fuel substitute for gasoline (petrol), diesel, or propane fuel. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels in the event of a spill (natural gas is lighter than air, and disperses quickly when released).

CNG is made by compressing natural gas (which is mainly composed of methane [CH4]), to less than 1% of its volume at standard atmospheric pressure. It is stored and distributed in hard containers, at a normal pressure of 200–220 bar (2900–3200 psi), usually in cylindrical or spherical shapes.

CNG is used in traditional gasoline internal combustion engine cars that have been converted into bi-fuel vehicles (gasoline/CNG). Natural gas vehicles are increasingly used in Europe and South America due to rising gasoline prices.

In response to high fuel prices and environmental concerns, CNG is starting to be used also in tuk-tuks and pickup trucks, transit and school buses, and trains.

CNG's volumetric energy density is estimated to be 42% of lNG's (because it is not liquefied), and 25% of diesel's.

Typical Composition of Natural Gas:

Methane	CH_4	70-98%
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Propane	C_3H_8	

Butane	C_4H_{10}	
Carbon Dioxide	CO_2	0-8%
Oxygen	O_2	0-0.2%
Nitrogen	N_2	0-5%
Hydrogen Sulphide	H_2S	0-5%
Rare gases	A, He, Ne, Xe	trace

TRANSPORTATION OF NATURAL GAS:-

The source of PNG supply in Delhi is the famous **HAZIRA-BIJAIPUR-JAGDISHPUR** (HBJ) pipeline of GAIl (India) limited.The major difficulty in the use of natural gas is transportation and storage because of its low density. **NATURAL GAS PIPELINES** are economical, but are impractical across oceans.

LNG carriers can be used to transport **LIQUEFIED NATURAL GAS (LNG)** across oceans, while tank trucks can carry liquefied or compressed natural gas (CNG) over shorter distances. They may transport natural gas directly to end-users, or to distribution points such as pipelines for further transport. These may have a higher cost, requiring additional facilities for liquefaction or compression at the production point, and then gasification or decompression at end-use facilities or into a pipeline.

USES OF NATURAL GAS AND H-CNG:-

POWER GENERATION:-

Natural gas is a major source of electricity generation through the use of gas turbines and steam turbines. Most grid peaking power plants and some off-grid engine-generators use natural gas. Particularly high efficiencies can be achieved through combining gas turbines with a steam turbine in combined cycle mode. Natural gas burns more cleanly than other fossil fuels, such as oil and coal, and produces less carbon dioxide per unit energy released. For an equivalent amount of heat, burning natural gas produces about 30% less carbon dioxide than burning petroleum and about 45% less than burning coal.

DOMESTIC USE:-

Natural gas is supplied to homes, where it is used for such purposes as cooking in natural gas-powered ranges and/or ovens, natural gas-heated clothes dryers, heating/cooling and central heating. Home or other building heating may include boilers, furnaces, and water heaters. CNG is used in rural homes without connections to piped-in public utility services, or with portable grills. However, due to CNG being more economical than lPG, lPG (Propane) is the dominant source of rural gas.

TRANSPORTATION:-

Compressed natural gas (methane) is a cleaner alternative to other automobile fuels such as gasoline (petrol) and diesel. As of 2005, the countries with the largest number of natural gas vehicles were delhi. The energy efficiency is generally equal to that of gasoline engines, but lower compared with modern diesel engines. Gasoline/petrol vehicles converted to run on natural gas suffer because of the low compression ratio of their engines, resulting in a cropping of delivered power while running on natural gas (10%-15%). CNG-specific engines, however, use a higher compression ratio due to this fuel's higher octane number of 120–130.

FERTILIZER:-

Natural gas is a major feedstock for the production of ammonia, via the Haber process, for use in fertilizer production.

AVIATION:-

Russian aircraft manufacturer Tupolev is currently running a development program to produce LNG- and hydrogen-powered aircraftThe program has been running since the mid-1970s.The advantages of liquid methane as a jet engine fuel are that it has more specific energy than the standard kerosene mixes and that its low temperature can help cool the air which the engine compresses for greater volumetric efficiency, in effect replacing an intercooler. Alternatively, it can be used to lower the temperature of the exhaust.

HYDROGEN:-

Natural gas can be used to produce hydrogen, with one common method being the hydrogen reformer. Hydrogen has various applications: it is a primary feedstock for the chemical industry, a hydrogenating agent, an important commodity for oil refineries, and a fuel source in hydrogen vehicles.

H-CNG:-

H-CNG is a mixer of hydrogen and compressed natural gas.In this mixture **20%H_2 AND 80% CNG**. H-CNG reduced the pollution but energy content is the same as of CNG.It is used in delhi to run the vehicle.

PIPED NATURAL GAS:-

PNG offers the convenience of ensuring continuous and adequate supply of PNG at all times, without any problems of storing gas in cylinders.PNG is used for domestic uses.

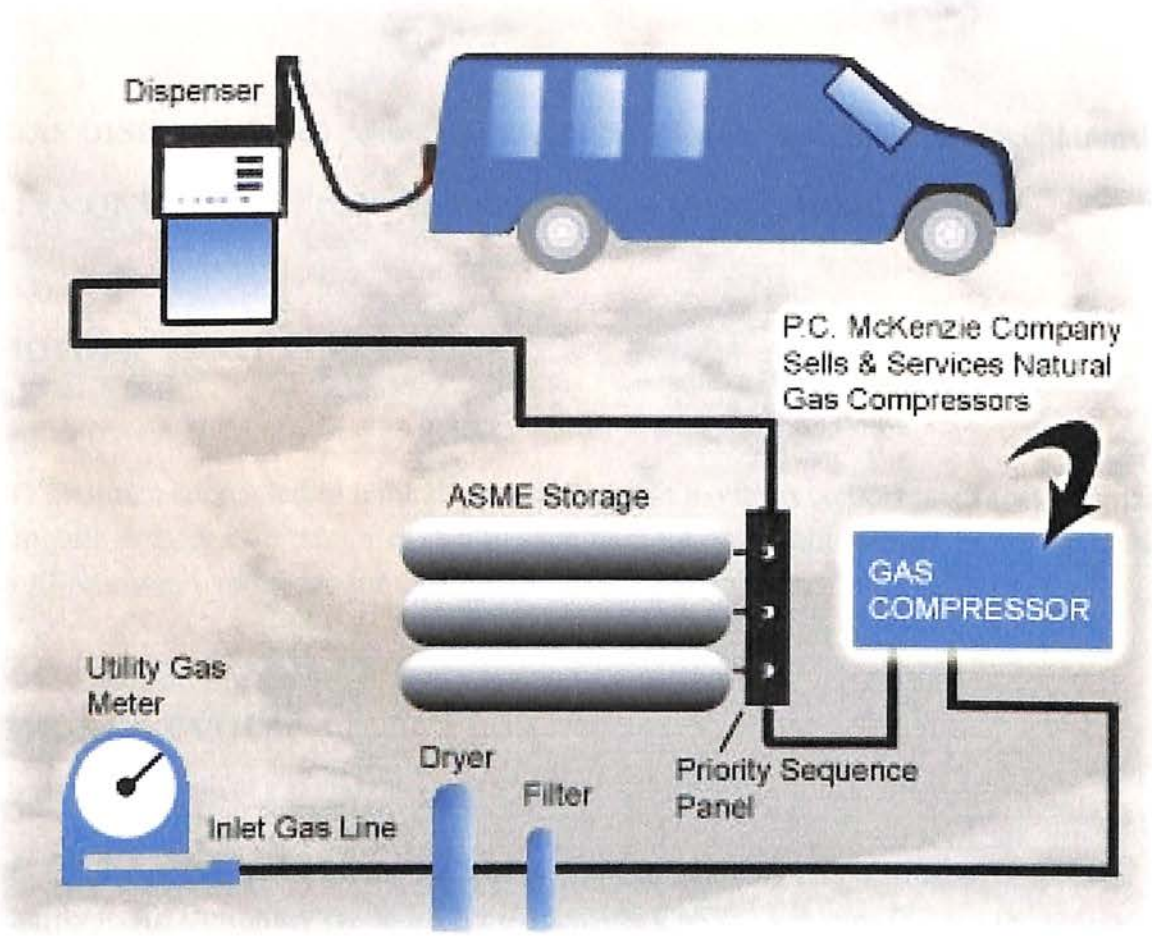
COMPARISON BETWEEN GASEOUS FUEL AND OTHER FUEL

Fuel Vs Emissions (gm/100 gm)

Fuel/ Emissions	CO_2	UHC	CO	NOx	SOx	PM
Petrol	22000	85	634	78	8.3	1.1
Diesel	21000	21	106	108	21	12.5
LPG	18200	18	168	37	0.38	0.29
CNG	16275	5.6	22.2	25.8	0.15	0.29

Source US Energy Department

CNG FILLING STATION:-



CNG FILLING COMPONENTS:-

L. INLET GAS LINE

2. INLET FILTRATION - filters gas before compression

3. GAS COMPRESSOR - elevates inlet gas pressure from the gas utility to3500psig.

4. PRIORITY/SEQUENCE PANEL - allows for temperature compensation of the gas as well as directs gas flow to storage or to vehicle.

5. ASME STORAGE - stores high pressure gas to be dispensed into vehicles.

6. GAS DISPENSER - dispenses gas into the vehicles and measures the amount transferred.

TYPES OF CNG STATION:- There are four type of CNG station.

1.MOTHER STATION:-

CNG facilities connected to natural gas pipeline and having a compressor meant primarily to fill mobile cascades for daughter station such facilities in addition to act as mother station can also fill stationary cascades for CNG dispensing into vehicles.

2.ONLINE STATION:-

CNG facility connected with natural gas pipeline and having and having a compressor primarily to fill stationary cascades for dispensing CNG to vehicles.In case the online station has enough space to accommodate mobile cascades filling it can be used to act as mother compressors stations.

3.DAUGHTER BOOSTER STATION:-

CNG facility not connected to natural gas pipeline and dispensing CNG to the vehicle through mobile cascades.

EQIPMENTS USED IN CNG STATION :-

1.COMPRESSORS

2. DISPENSER

3. MEETERING DEVICE

4.STORAGE

NATURAL GAS COMPRESSION:-

With the advent of Natural Gas and its use as a fuel the necessity arose of transporting NG.

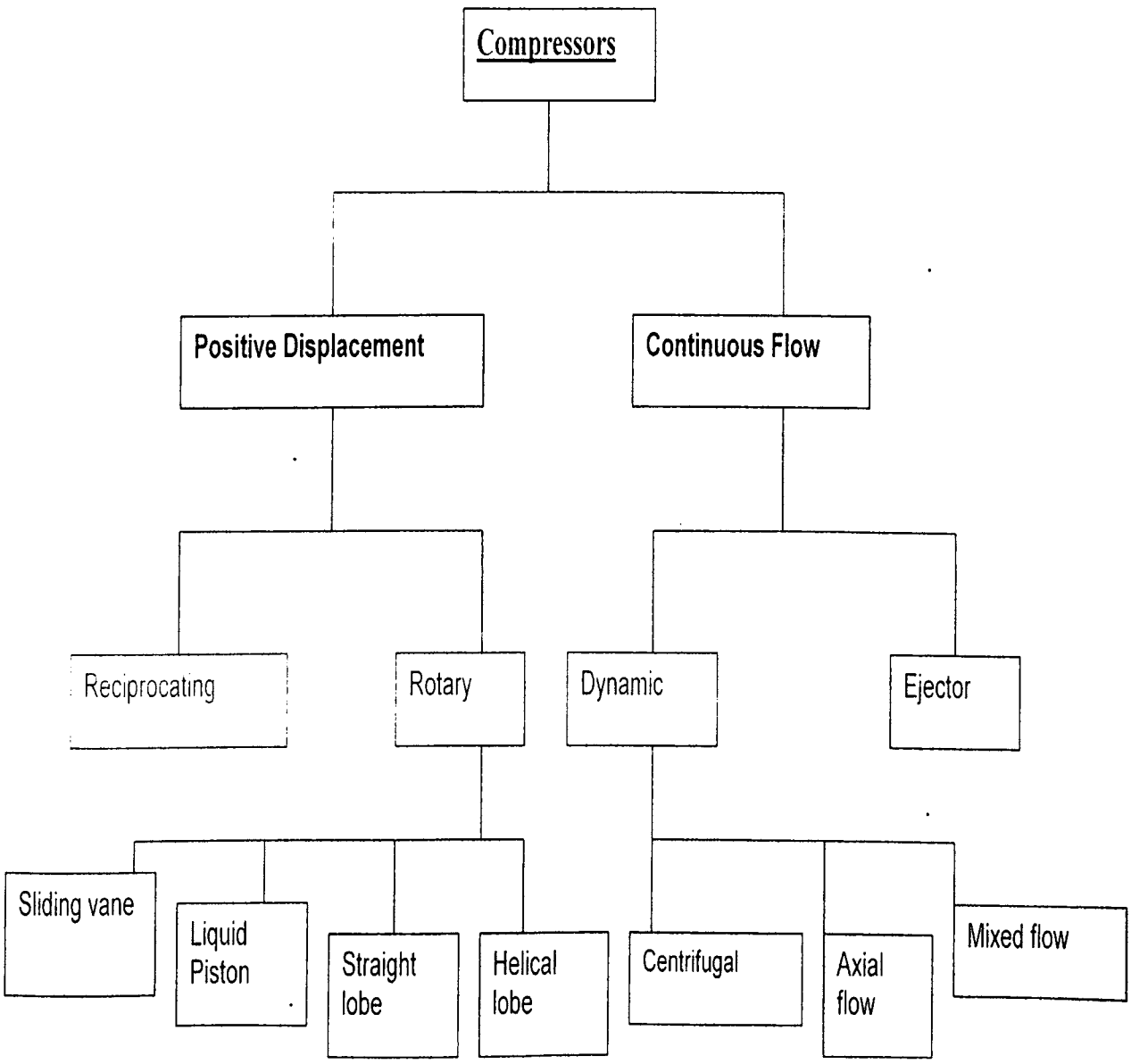
As long as pressure at the gas well could force the gas through the pipe line to the destination a compressor was unnecessary.

As soon as pressure dropped some out side means was needed to increase the pressure. So compressors were essential for gas transmission pipelines extended great distances from the gas field.

Another transport related application is for reducing the gas volume for shipment tankers or for storage.

TYPES OF COPRESSORS:-

- Types of Compressors



RECIPROCATING COMPRESSOR:-

Reciprocating compressors are most commonly used in the gas industry.

TYPES:

SINGLE ACTING : In which the piston compresses on only one side

DOUBLE ACTING : In which two single acting pistons operate in parallel inside one cylinder there by compressing on both sides.

Reciprocating compressors are typically used where high compression ratios (ratio of discharge to suction pressures) are required per stage without high flow rates.Besides the piston and cylinder a suction valve and discharge valve are provided.The suction valve opens when the pressure in the cylinder falls below the intake pressure .The discharge valve opens when the pressure in the cylinder equals or exceeds the discharge pressure.

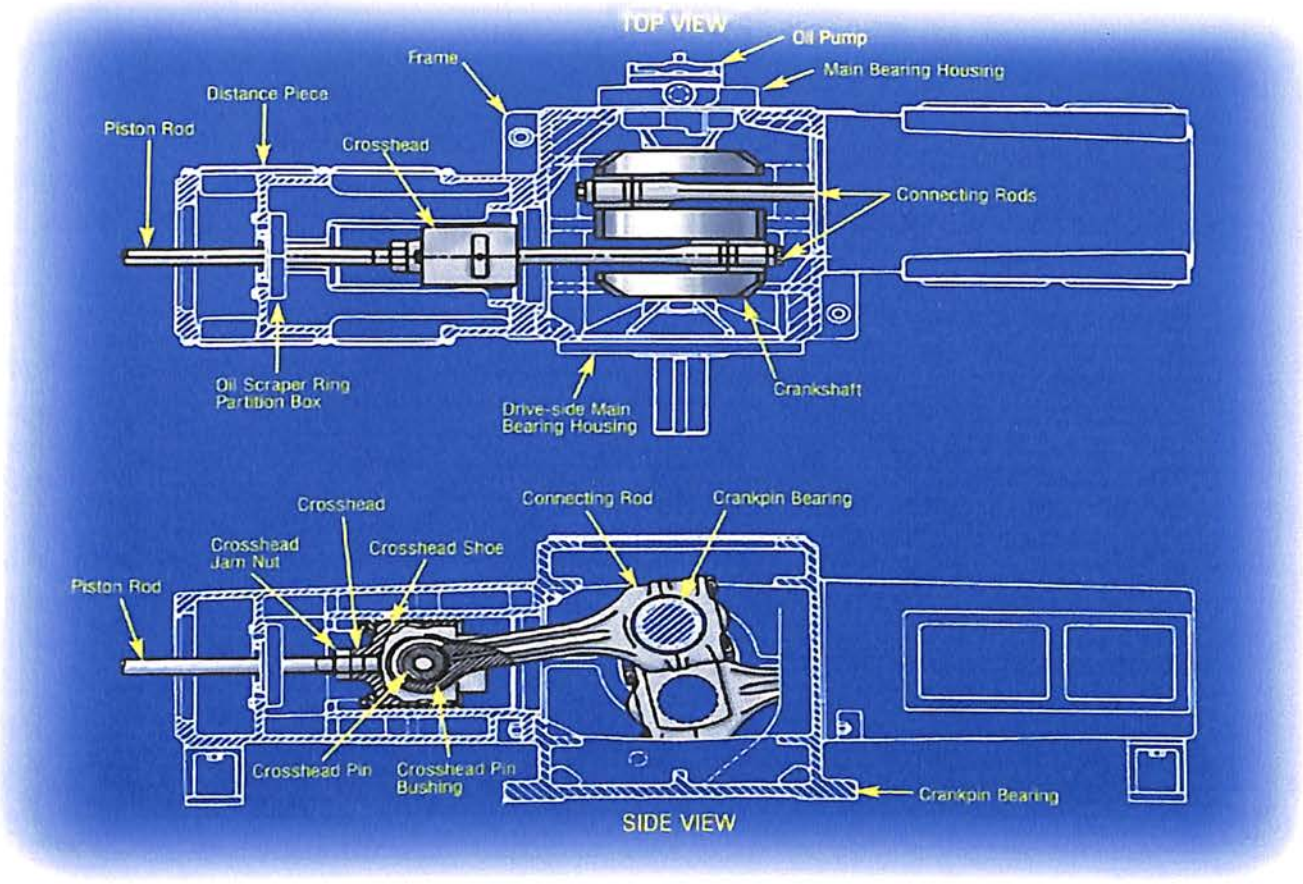
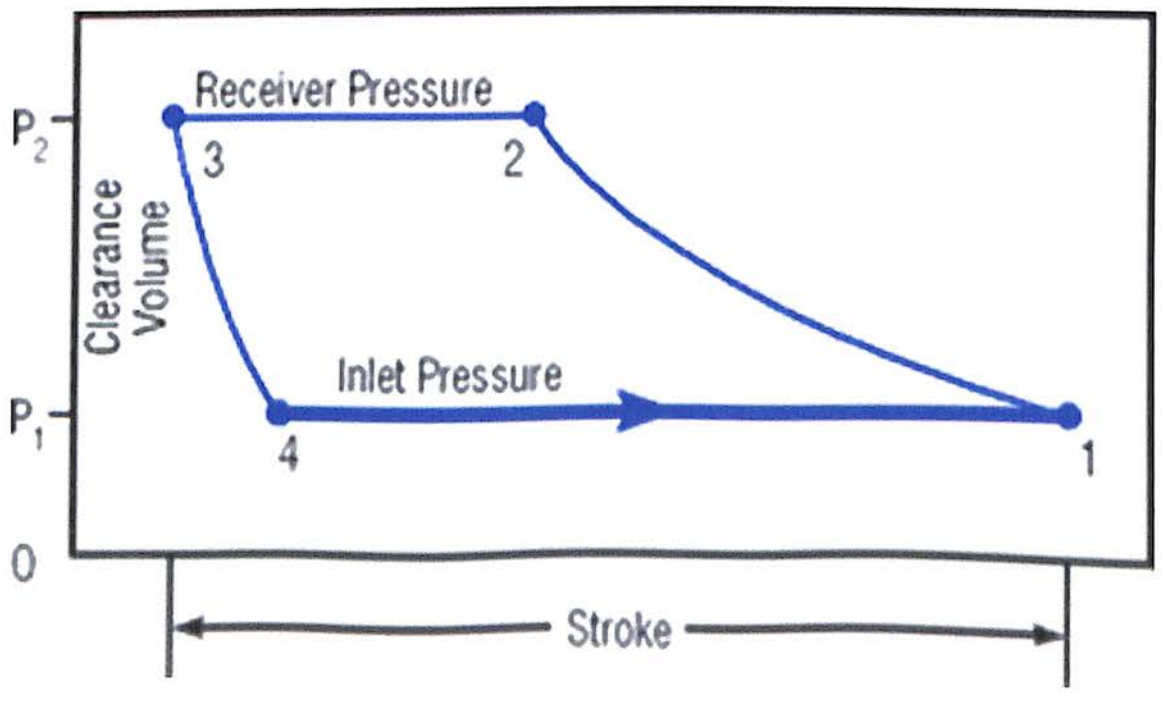


Figure 2 A. Two-throw HSE Frame and Running Gear

Thermodynamic Cycle



A few basic thermodynamic principles is necessary to understand the science of reciprocating compressors. Compression occurs within the cylinder as a four-part cycle that occurs with each advance and retreat of the piston (two strokes per cycle).

The four parts of the cycle are compression, discharge, expansion and intake. They are shown graphically with pressure vs. volume plotted in what is known as a P-V diagram

At the conclusion of a prior cycle, the piston is fully retreated within the cylinder at Vl, the volume of which is filled with process gas at suction conditions (pressure, Pl and temperature, Tl), and the suction and discharge valves are all closed.

This is represented by point l (zero) in the P-V diagram. As the piston advances, the volume within the cylinder is reduced. This causes the pressure and temperature of the gas to rise until the pressure within the cylinder reaches the pressure of the discharge header. At this time, the discharge valves begin to open, noted on the diagram by point 2.

With the discharge valves opening, pressure remains fixed at P2 for the remainder of the advancing stroke as volume continues to decrease for the discharge portion of the cycle.

The piston comes to a momentary stop at V2 before reversing direction. Note that some minimal volume remains, known as the clearance volume. It is the space remaining within the cylinder when the piston is at the most advanced position in its travel.

Some minimum clearance volume is necessary to prevent piston/head contact, and the manipulation of this volume is a major compressor performance parameter. The cycle is now at point 3.

Expansion occurs next as the small volume of gas in the clearance pocket is expanded to slightly below suction pressure, facilitated by the closing of the discharge valves and the retreat of the piston. This is point 4.

When P1 is reached, the intake valves open allowing fresh charge to enter the cylinder for the intake and last stage of the cycle. Once again, pressure is held constant as the volume is changed. This marks the return to point 1.

Comprehending this cycle is key to diagnosing compressor problems, and to understanding compressor efficiency, power requirements, valve operation, etc.

DISPENSER:-

CNG dispensers are the primary interface between a CNG station and the fueling customer. As such, considerations such as design, reliability, Performance and safety are vitally important to station owners.

CHAPTER 2

GAS DISTRIBUTION PLAN FOR KASHIPUR CITY

The objective of the proposed project to provide natural gas to domestic, commercial and industrial customers in the form of PNG and CNG through pipeline networking and compressors. The project aims is to cover the maximum potentially rich area of the city. The distribution network would include

- Tap off point (GAIL transmission pipeline)
- Sub transmission pipeline(Sub-transmission pipeline)
- City gate station
- Downstream pipeline network which include steel, MDPE and PE pipeline.
- District regulating station
- Industrial metering and regulating station(IMRS)

The natural gas would come to CGS through underground GAIL sub transmission pipeline at the pressure of 25 – 49 bar(g).

After entering city gate station, the pressure would be reduced to about 19 bar(g).

The odorants are added to the natural gas before distribution. The gas at 19 bar(g) would go to the primary steel pipeline from there according to the demand profile the gas would be send to the IPRS and DRS. location of DRS near the group of small industries helps in consolidating the smaller demand of individual units. After pressure reduction upto 4 bar(g), the gas would be fed into secondary pipeline system. In case of high demand of gas in industries IPRS would be installed with metering facility.

A detailed route survey was prepared by taking special consideration of sewage line,railwaylines, rivers, canals. Customer survey for different scope of distribution of natural gas was studied in the initial phase of the project.

2.1 CITY GATE STATION

After detailed survey the best place for CGS was selected near LH Sugar Factory. The CGS would get the gas from GAIL sub transmission pipeline with a pressure reduction system, a filtering unit, pigging and odorant injection facilities.

The specification of the filtering unit would be

- Removal of partial upto 3 micron size

- Have efficiency of 99.9%

The filtering unit would be incorporated with a borosilicate fiber glass cartridge and a manual drainage valve to remove the entrained particle.

2.2 PIPELINE NETWORK:

The pipeline network would be divided in two categories

- Primary network
- Secondary network

The primary steel pipeline network would connects CGS to various MRS and DRS with the operating pressure of 19 -4 bar(g). For supply of natural gas at this high pressure would be by MRS.

The secondary network operates at the pressure range of 4- 1 bar(g). It is of MDPE pipeline network designed to service the Gas to group of industries at low pressure.

By taking the future demand of gas, both the network is designed at 33% more than the estimated amount of gas.

2.3 METERING AND PRESSURE REGULATION STATION

The supply of gas at high pressure would be facilitates by MRS. The MRS would be installed neal the group of industry with auxilaaries like pressure reduction system, a filtering unit, a metering system, valves etc.

2.4 DISTRICT REGULATORY STATION

The supply of gas to group of industry would be done by DRS. DRS will serve the industrial area as well as various demand centre for domestic and commercial segment.

The main components of DRS are filtering unit, orifice metering system, drainage system, pressure reduction system. The filtering capacity would be same as MRS.

2.5 CIVIL

Civil structure are to be the constructed at CGS and CNG stations. This will provide shelter to man, machinery, various activities and processes. Control room, office, fire, protection, pump room, generator room, stores, roads etc are to be the constructed at CGS.

In CNG station various civil works include foundation for compressor, cascade, engine, shelter for dispenser, office building etc.

Fencing of CGS and CNG station will have boundary with fencing.

2.6 CATHODIC PROTECTION

For efficient and satisfactory functioning of the main grid line system, both from safety and economic point of view, the pipeline must be protected against corrosion.

External protection shall be provided for prevention of pipeline corrosion. This external protection shall be combination of corrosion coating and cathodic protection technique. Conventional coating of pipelines by 3-layer polyethylene/FBE coating shall be used as "passive" protection.

Complete corrosion protection can't be achieved practically by coating, as it is impossible to avoid fully minor defects such as pores or cracks in the coating. Welded pipelines are particularly subjected to corrosion at coating holidays because of their low longitudinal resistance, i.e. they practically don't resist the flow of current through the pipelines. At these holidays, dangerous pitting corrosion is initiated. Because of the high corrosion current density, this phenomenon often causes rapid corrosion failure.

Cathodic protection is a method for protecting the pipes reliably even at undetected coating holidays. The protective current supplies electron to the structure to be protected.

CHAPTER 3

DESIGN CONSIDERATION OF THE NETWORKING SYSTEM

3.1 DESIGN CONSIDERATION OF METER REGULATING STATION

All the Industrial and large commercial customers is connected either to the steel main grid line or to the nearby DRS through a Meter Regulating Stations (MRS) which shall be installed within the premises of Industrial / large commercials. The nos. and capacities of these MRS is selected based on the requirement of the industrial and large commercial consumers as per demand survey.

MRS comprises of

- Filtration
- pressure reducing, and
- metering with volume corrector

Filtration unit (with Cartridge Filter) is provided to filter the gas. Pressure Reducing Unit shall be provided to reduce the gas pressure to 2-3 kg/cm^2 (g). Slam Shut-off Valve and Pressure Safety Valves shall also be provided as per guidelines stipulated in OISD 220. Metering shall be in terms of volume as the billing to the consumers is on SCM basis. Thus the type of meters recommended for this purpose is either Turbine Meter (for large flow) or RPD Meter (for small flow).

3.2 DESIGN CONSIDERATION OF COMMERCIAL METER & REGULATOR ASSEMBIY.

The small & medium commercial consumers through MDPE pipes from a designated DRS. In the DRS the Gas outlet pressure shall be regulated to 3- 4 Kg/cm2(g) and then it will be supplied through MDPE pipes to the Meter / regulating assembly. In the Meter / regulating assembly the inlet pressure of the PNG shall be reduced to 300 mille-bars (0.3 bar).

The Meter / regulating assembly shall broadly comprise of:

- Pressure reduction
- Metering

Commercial Meters for these medium and small commercial consumers shall be of diaphragm type (designated as diaphragm meters).

Conventional metering type includes:

Type of customer	Metering system	Capacity
Domestic and Commercial	Diaphragm	0 – 23 SCMH/Customer
Medium to large Commercial	Rotary	0 – 750 SCMH/Customer
Very large industrial customers	Turbine	1100 – 2800 SCMH/Customer

The location selection of metering system will be finalize on the basis of;

- Ease of access for meter reading and maintenance
- Negligible hazardous position
- Clear of all type of crowd
- Aesthetics and noise
- Clear of down pipes for roof space and dripping water

MDPE PIPE FROM DRS UP TO THE CUSTOMER'S PREMISES

For domestic, commercial and small Industrial consumers it is recommended that low pressure [4 kg/cm2 (g)] underground MDPE network shall be provided for safety reasons, as it is safe for inhabited areas, easy to lay and economical. The MDPE pipes shall be tested as per procedure laid down in IS 14885. The pipeline shall have 180mm, 125mm, 63mm, 32mm and 20mm diameter pipes (as detailed in the table below) used to form the complete distribution reticulation system.

Material Grade	Normal Outside Diameter (mm)	SDR	Minimum Wall Thickness (mm)
PE-80	20	11.0	3.0
PE-80	32	11.0	3.0
PE-80	63	11.0	5.8
PE-80	125	11.0	11.4
PE-80	180	11.0	16.4

(SDR – quotient of the nominal outside diameter and the nominal wall thickness).

The system is divided in two broad categories, namely:

- MDPE Distribution Mains
- MDPE / GI Distribution Service

3.3 DESIGN CONSIDERATION FOR MDPE DISTRIBUTION MAINS.

The MDPE Distribution Mains is primarily responsible for carrying the gas to the customers' premises / colonies for further distribution by Distribution Services. Emphasis shall be placed on utilising modern construction techniques to install the distribution system. This includes, wherever possible, avoiding disruption/ damage to road and footpaths, by boring and drilling. large crossings, such as canals, major roads, etc., shall be carried out using Horizontal Directional Drilling (HDD). Valves have been envisaged on the distribution and transmission networks at strategic locations to ensure security of supply (two valves for every 2-km of distribution mains). Plastic protection strips (warning tapes) 300mm above the MDPE pipe are also considered to warn any agency from digging the area well ahead of reaching depth of MDPE pipe.

3.4 Design consideration for MDPE /GE Distribution services.

MDPE / GI / MS Distribution Service pipelines are laid underground to connect customers from the MDPE Distribution Mains up to the customer premises and then laid vertical to rise above the ground level just below the proposed regulator point. The few centimeters of the MDPE pipeline that rises above ground shall be protected by GI pipe sleeve. Since most services must cross roads/ footpaths to reach the customers, they are usually installed by boring to reduce restoration costs. Open excavation is required only at the connection to the main as well as at the service. Warning tapes shall be installed all along the route where open cut is used for pipe laying.

The MDPE pipes required to supply PNG to small industrials, commercials and domestic consumers.

CHAPTER 4

LAYOUT OF CONNECTIONS

4.1 INDUSTRIAL CONNECTIONS

Based on demand survey the industries along with the gas demand have been identified for providing PNG connections.

The gas supply to large number of small and medium size industrial consumers through steel feeder line tapped from the nearest steel grid line.

One feeder line may be dedicated to one or more than one industry depending on the geographical location and actual allocation. However, for the purpose of techno-economic analysis, following facilities have been assumed for one industry.

- Steel Feeder line
- Skid mounted Meter Regulating Station (MRS) consisting of
- Cartridge Filter
- Pressure Control Valve (PCV)
- Slam Shut Valve (SSV)
- Pressure Safety Valve (PSV)
- Flow Control Valve (FCV)
- Turbine Meter with Electronic Volume Corrector
- Valves. & Fittings

4.2 DOMESTIC CONNECTION:

In Domestic connections (which comprises the large / medium housing complex) the Gas inlet pressure is regulated from 3- 4 Kg/cm2(g) to 100 mille-bars (0.1 bar) through a service regulator at the entry point to the society / housing complex. It will be further supplied through MDPE and GI pipes to the Kitchen of individual flats with individual meter and regulator assembly. In the Meter / regulator assembly of the individual flats the inlet pressure of the PNG is reduced from 100 mille-bars (0.1 bar) to 21 mille-bars (0.021 bar). The Domestic Meters shall also be of diaphragm type (designated as diaphragm meters).

The components involved in the DRS / FRS is:

1. Filter

2. Slam shut l

3. Slam shut 2

4. Pressure Control Valve (PCV)

5. Pressure Shutdown Valve (PSV)

1. **Filter:**

Filter removes the dust particles from the gas which are of 5 to 15 μ in size.

2. **Slam shut 1:**

Slam shut 1 is used to shut the flow if the flow exceeds the designed value. This is active slam shut.

3. **Slam shut 2:**

Slam shut 2 is also used along with the slam shut 1 but this is used to monitor the active one. Even this serves the same purpose as the active one.

4. **Pressure Control Valve:**

Pressure control valve controls the pressure from 19 bar to 4 bar in two stages. The pressure reduction is DRS is done through PCV in two stages.

5. **Pressure Shutdown Valve:**

Pressure Shutdown Valve shutdowns the flow of gas if the pressure exceeds the desired pressure.

The downstream of the regulator contains the following components:

1. Isolation Valve

2. Pressure regulator (4 bar × 21m bar)

3. High / low pressure, slam shut cut off

4. Relief Valve

5. Bleed and

6. Appliance Valve

4.3 COMMERCIAl CONNECTION

It has already been proposed to connect the small & medium commercial consumers through MDPE pipes from a designated DRS (located at Bund Garden Road). In the DRS the Gas outlet pressure shall be regulated to 3- 4 Kg/cm2(g) and then it will be supplied through MDPE pipes to the Meter / regulating assembly. In the Meter / regulating assembly the inlet pressure of the PNG shall be reduced to 300 mille-bars (0.3 bar).

The Meter regulating assembly shall broadly comprise of:

- Pressure reduction
- Metering

Commercial Meters for these medium and small commercial consumers shall be of diaphragm type (designated as diaphragm meters).

CHAPTER 5

COMPRESSED NATURAL GAS

5.1 CNG - THE FUEL OF THE FUTURE

CNG has been widely used in vehicles since the 1930s, in countries that include Argentina, Russia and Italy. It is gaining increasing acceptance, particularly for city transport vehicles such as taxis, buses and delivery trucks due to its relative superiority over other conventional fuels.

5.2 WHAT IS CNG?

CNG is compressed natural gas. It mainly consists of methane (91.9%), with other constituents like ethane, propane and butane. It is an intrinsically pure fuel that emits negligible quantities of pollutants when burnt. Natural gas is compressed to a pressure of 200-250 kg/cm (to be stored in a cylinder) and hence the name Compressed Natural Gas. It is colorless, non-toxic, odourless, non-carcinogenic and lighter than air. CNG is not the same as lPG (liquefied Petroleum Gas) or lNG (liquefied Natural Gas). Compressed Natural Gas is a low smoke, low pollution, safe and cheaper (than petrol) fuel. It has been successfully and widely utilized by the transportation sector in developed countries

5.3 WHY NATURAL GAS IN VEHICLES?

- National Benefits of Natural Gas
- Balance of Trade
- Domestic gas cheaper than imported oil
- Imported gas cheaper than imported oil
- Reduced investment in processing plant
- Reduced supply dependency
- local Benefits of Natural Gas
- Reduced Pollution
- Health costs & loss of productivity
- Crop and building damage

5.4 CNG FUEI CHARACTERISTICS

- Mass of Air Flow required per k.cal of Fuel is practically same for most fuels as well as CNG
- NG provide more energy on mass basis but less on volumetric basis
- NG optimized Engine should be more efficient
- On equivalent Engine Efficiency & Volume of fuel CNG vehicle range will be less (based on volumetric energy)
- Acceleration and Max. Power depends upon fuel vapour density and heating value
- CNG, being lighter density fuel, displace air therefore less air per cycle
- Volume of fuel relative to volume of fuel/air mixture is 9.5 % for methane (CNG) which is high
- Vaporization of fuel increases air density due to cooling (CNG being gas vaporisation does not take place)
- CH_4 molecule oxidizes with no intermediate HC's results in efficient combustion with low emissions
- Principal pollutant from NG is unburned methane which is less reactive than heavier HCs
- NOx, CO & CO2 emissions are low as methane being low carbon fuel
- SO_2 & particulates emissions are low because of vary low sulfur in CNG

TYPICAI FUEI CHARACTERISTIC OF CNG WITH OTHER CONVENTIONAI FUEIS

Property	Gasoline	Diesel	CNG	IPG
Storage at STP	liquid	liquid	Gas	liquid at 8 bar
Specific Gravity	0.730	0.84	0.670	0.540
Heat Value (Net) Kcal/kg	10,400	10,200	10,400	10,970
Auto Ignition Temp. OC	390	280	640	520
AKI	88	45(CN)	120	104

Flammability limits (%v)	1.4-7.6	0.7-5.0	5.3-14	2.4-9.6
Flame Speed Stoic. A/F	39.6	39.6	33.5	33.5
Composition				
%wt. Carbon	85-88	84-87	75	82
%wt. Hydrogen	12-15	33-16	25	18

CNG as an automotive fuel

- CNG: 80-90 % Methane
- Excellent Knock Resistance
- Clean Burning
- Easy to meter
- low exhaust emissions
- low ozone forming potential
- low Cold-Start Emissions
- Zero Evaporative Emissions
- Reduced Catalyst damage
- Reduced CO_2 Emissions
- NG compressed to increase energy
- Density: 200 – 250 bar
- NGV: Potential

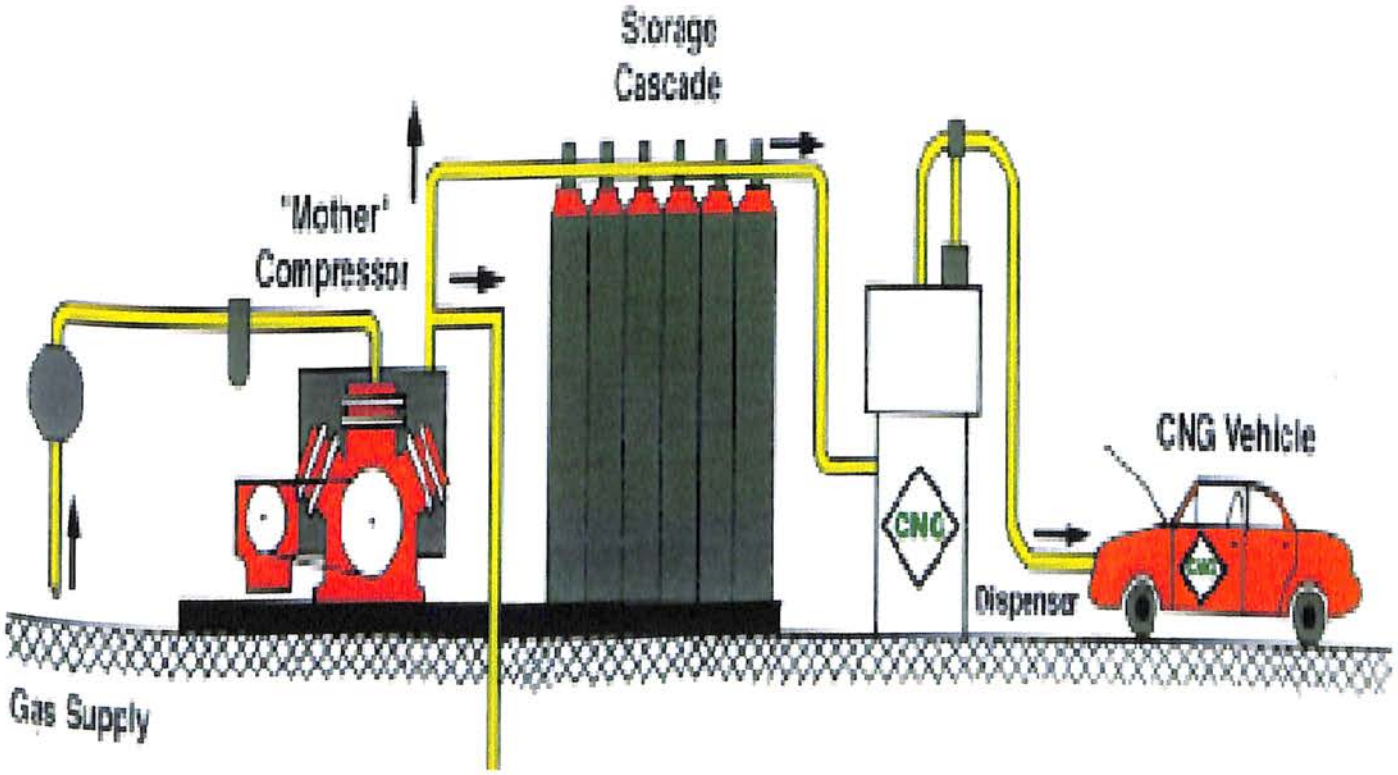
CHAPTER 6

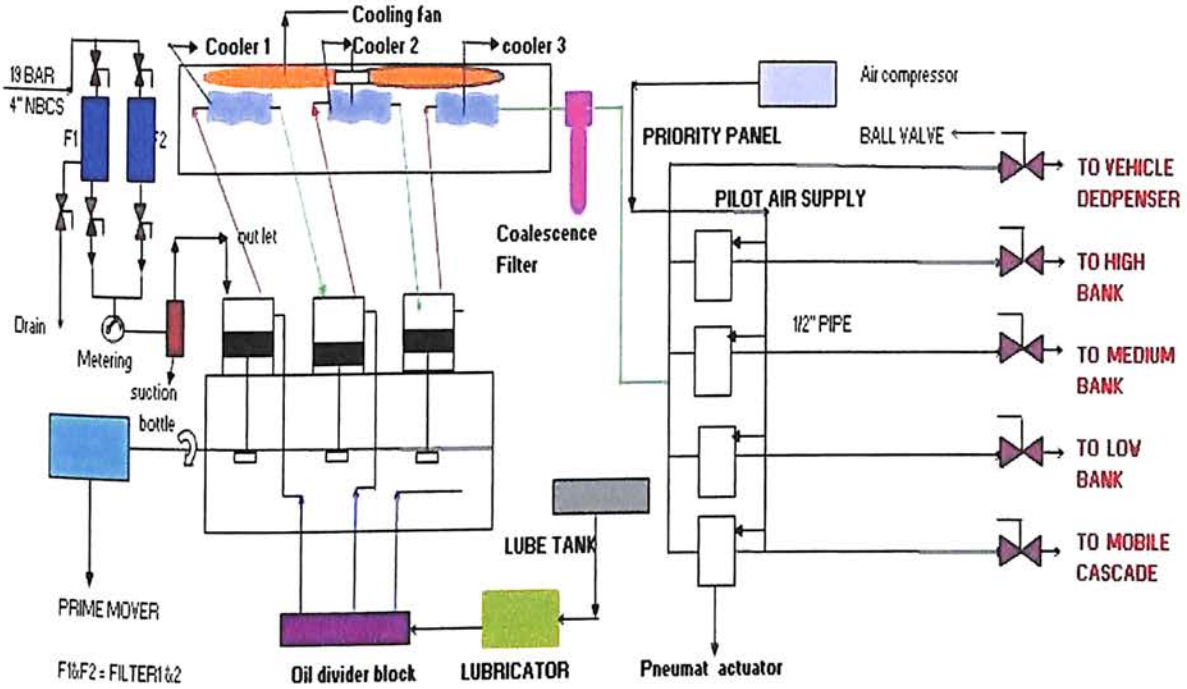
COMPRESSED NATURAl GAS (CNG) STATIONS

6.1 MOTHER STATION

The mother CNG station comprises of several units such as gas conditioning, gas compressor with the priority panel, storage cascade, dispenser and PlC controll station.The capacity of Mother stations is high. At the mother station, the no. of compressors is multiples. The no. would be decide according to the demand of the gas.

The following CNG stations are planned in Kashipur city for catering to the demand of automobile sector





P & I DIAGRAM FOR CNG STATION

A. Main Equipment

Mother Compressor alongwith auxiliaries

Dispensers for buses

Dispensers for cars and three-wheelers (autos)

loading facility for Mobile Cascades

Stationary Cascades

DG Set, UPS & Battery Bank, AVR, Electrical Control Panel

Instrument Air and Water Facilities

Metering skid

Fire Fighting equipment and safety sign

B) Other Facilities

Office cum Control Room

RCC forecourt, canopy over dispenser island and signages

Stainless steel tube connecting compressor, dispenser & cascades laid in U/G trenches

- U/G drainage and sewerage network
- Approach exit road, boundary wall etc.

Mother Compressor :

Reciprocating type compressors, each of capacity 1200 SM^3 /hr at suction pressure 19 Kg/cm^2 shall be installed at mother station. Approximate gas consumption of gas engine will be 55 SM^3 /hr. The compressor will start automatically in case cascade pressure falls less than 210 Kg/cm^2 and will unload at pressure 255 Kg/cm^2.

Main Specification/Features

- 3 stage reciprocating type compressor with console type air cooling and safety relief valve at each stage, after cooler at final discharge along with all services lines, tubing, valves, instrument and auxiliaries.
- Gas engine with air and coolant water based cooling system; gas flow meter with electronic volume corrector, totalizer and associated equipment.
- Control system will ensure unattended safe operation in automatic mode. The priority fill system will ensure maximum flow rate by filling of vehicle, storage cascade and mobile cascade in assigned order.
- Entire compressor equipment shall be mounted on one skid and packaged in an acoustically insulated housing.
- The engine and the compressor will be housed in the same package unit with a partition wall. The housing will provide a degree of protection equipment to IP 44 as per ASI939. The housing will be flame and fire proof and provided with forced ventilation, flame arrestor, infrared flame detection and alarm system, automatic shutoff, automatic CO2 flooding and other fire retardant features.
- The compressor will be provided with the required control system using PIC; air compressor for start up and pneumatic control; instrumentation and controls; emergency shutdown device and electric supply system.
- The entire compressor system shall be earthed.

Associated Piping

The high pressure pipelines have to be buried in culverts at a deep of at least 0.50 m the welded connections must be located in such a way that it is possible to perform periodic inspections.

Those pipelines that are connected to the dispensing unit must be anchored to the dispenser's base and must have a check valve (to prevent excess flow) near the anchorage point.

All the vent discharge lines must be realized in special pipeline and delivered in atmosphere in a safe area. The superior extremity of the manifold has to be located at a height not less than 2.50 m from the ground and protected through a flame arrestor device in stainless steel.

- From public gas pipeline to the compressor inlet:
- Type: carbon steel API 5lX A 105 – DN 80
- Pressure: maximum 20 bar
- location: buried in culverts at a deep of at least 0.50 m

- From the compressor outlet to the dispensers:
- Type: stainless steel ASTM A 269 TP 316 I – DN 25
- Pressure: maximum 250 bar
- location: buried in culverts at a deep of at least 0.50 m

Selection criteria of Mother Compressors

Selection criteria for mother station compressor

- uninterrupted power availability in a day.
- a comparative study of the gas engine driven vis-à-vis electric motor driven compressors
- price of electricity unit
- selling price of gas (per kg)

In case of selection of electric motor driven compressors, to cater for running of compressor during power cut a gas engine driven compressor of capacity 1200 SCMH shall be present at mother station.

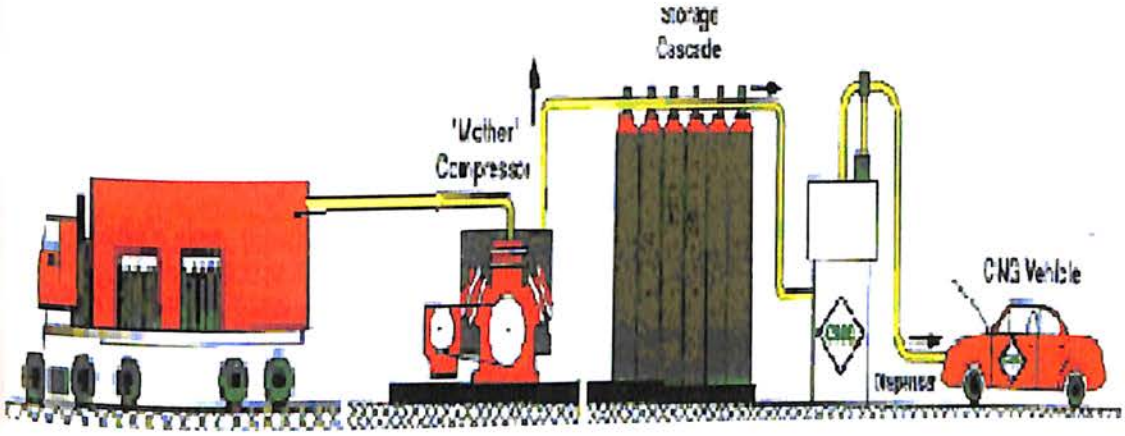
For online stations the DG set shall not be envisaged since these online stations will design for car and auto (3 wheeler) filling only and it will be possible to cater the load (dispensing) from the stationary cascade (of 4500 WI capacity) during the power cut.

6.2 DAUGHTER BOOSTER STATION:

The daughter booster stations are the subsidiary unit of mother station. The supply of natural gas to DBS is through the mother station by mobile cascade filled at the pressure of 200 Kg/Cm^2.

To increase the dispensing speed and reduce waiting time for filling at daughter station and better utilization of cascade capacity, one hydraulic/reciprocating type electric motor driven compressor of capacity 150 SM^3/hr at suction pressure of 30 Kg/cm^2 has been envisaged at daughter station. This booster compressor shall operate at mobile cascade pressure/suction pressure from 30 to 200 Kg/cm^2 with discharge pressure of about 250 Kg/cm^2.

The following units have been envisaged in each Daughter Booster Station:

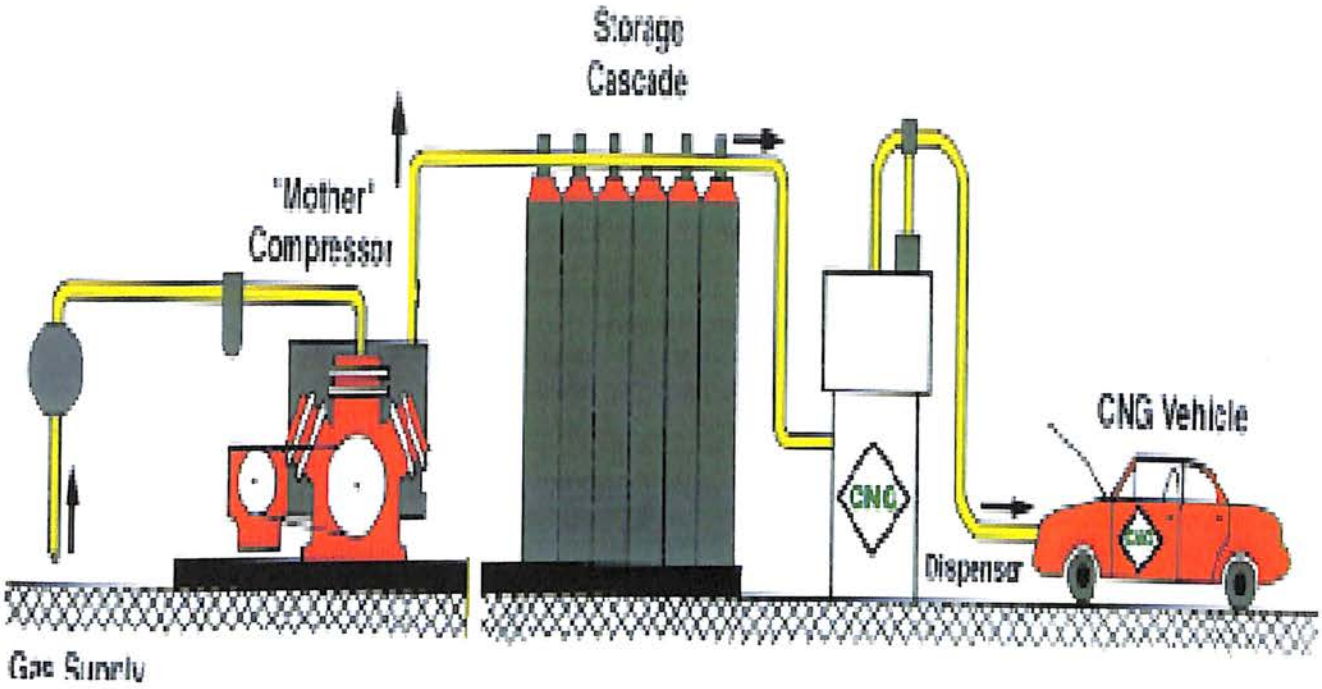


A. Main Equipment

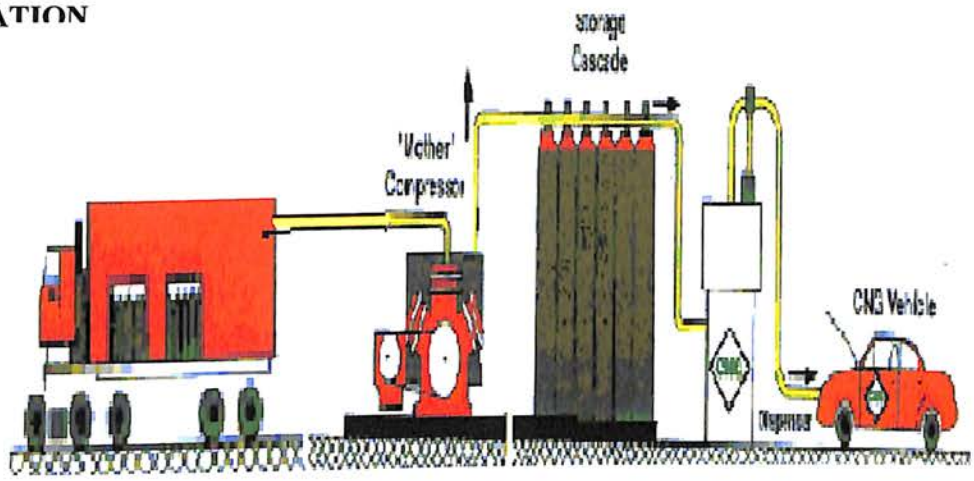
- Booster Compressor alongwith auxiliaries
- Dispensers for cars and three wheelers (autos)
- Stationary Cascades
- DG Set, UPS & Battery Bank, AVR, Electrical Control Panel
- Instrument Air and Water Facilities
- Fire Fighting equipment and safety sign
- Unloading facility from mobile cascades

B Other Facilities

- Office cum Control Room



6.3 ON LINE STATION



The following units have been envisaged in each On-line station:

A Main Equipment

- On line Compressor alongwith auxiliaries
- Dispensers for cars and three wheelers (autos)
- Stationary Cascades
- Instrument Air and Water Facilities
- Metering skid
- Fire Fighting equipment and safety sign

B Other Facilities

- Office –cum-Control Room
- RCC Forecourt, canopy over dispenser island and signages
- Stainless steel tube connecting compressor, dispenser & cascades laid in U/G. trenches
- U/G drainage and sewerage network
- Approach/exit road, boundary wall etc.

On-line Compressor

Reciprocating type compressors each of capacity 500 SM^3 /hr at suction pressure 19 Kg/cm^2 shall be installed at On-line station. Approximate gas consumption of gas engine will be 30 SM^3/hr. The compressor will start automatically in case cascade pressure falls less than 210 Kg/cm^2 and will unload at pressure 250 Kg/cm^2.

Air receiver and air compressor of suitable capacity shall be provided to meet the compressed air demand for gas engine starting and pneumatic control.

One priority fill system will be provided in the compressor to priorities the dispensing to car dispenser, stationary cascade (of capacity 3000 liters of water).

The packaging and safety features shall be in line with Mother Compressor.

6.4 EQUIPMENT DESCRIPTION

A) Dispensers

Compressed natural gas from compressor/cascade shall be dispensed to NGVs (natural gas vehicles) such as cars, three wheelers, buses, etc. through dispensers. Following two types of dispensers have been envisaged.

Bus Dispenser

To meet the requirement of bus filling at mother stations, single arm bus dispenser, each of capacity 80 Kg/min has been envisaged. The system shall be designed in such a way that when compressors are in operation, the bus dispenser will take about 65 Kg/min gas from the compressor.

Car Dispenser

To meet the requirement of car and three wheeler filling at mother; on-line and daughter stations, double arm type car/auto dispensers, each with a capacity of 15 Kg/Min have been envisaged. At the Daughter Booster Station, provision shall be kept to install one car dispenser in future.

B) Stationary Cascade

Cascades are used to store the CNG at high pressure, to absorb the surge of reciprocating compressor, frequent start and stop of compressor and to supply additional gas when dispensing rate is more than compressor capacity. Compressor will start if pressure in cascade falls below 210 Kg/cm^2 and stop at pressure 255 Kg/cm^2.For a pressure range of 220 Kg/cm^2 to 255 Kg/cm^2, in cascades of 3000 litre and 2200 litre capacity, about 90 kg and 65 kg respectively, of useful CNG can be stored. The maximum storage capacity of these cascades is approx. 600 kg. And 350 kg respectively. The cascade shall supply gas to bus as well as car/auto dispensers.

Main Specification/Features

- Cascade shall be made of group of cylinders fixed with structural steel frame having facility of lifting and placement.
- The cylinder and their neck threading shall be designed as per IS: 7285-1988 & IS: 3224-1979, respectively, and approved by Chief Controller of Explosives (CCOE), government of India.
- The cylinder shutoff valve shall be with fusible disc confirming to requirement of IS: 3224 or CCOE approved.

- All end connections for quick release couplings, PG, valves and fitting of cascade shall be within tamper proof enclosure. These shall be on one side of cascade for ease of operation.

C) Mobile cascade

This cascade of 2200 litre water capacity shall be fitted in, light commercial vehicle (ICV). Three nos. mobile cascades with ICV have been envisaged for each Daughter Booster Station. The mobile cascades will be fitted at Mother Station up to 255 Kg/cm^2 (g) pressure. Mobile cascade at this pressure will be sent to Daughter Booster Station for gas dispensing up to a pressure of 30 kg/cm^2(g). Empty mobile cascade at pressure lower than 30 Kg/cm^2 (g) shall return to Mother Station for refilling. Approximately 335 Kg of gas can be transported from this cascade. The entire assembly shall be CCOE approved.

Suitable loading facility at Mother Station and unloading facility at protection shed.

D) DG Set, UPS & Battery Back-up & AVR

DG Set - To meet the requirement of emergency of emergency power in case of grid power failure, one DG set of capacity 7.5 kW has been envisaged at each station. The DG set shall start automatically in case of grid power failure. Emergency loads shall be connected to DG set.

UPS & Battery Back-up – a one hour UPS and battery back-up system shall be provided at each station.

AVR - A suitable automatic voltage stabilizer based on local supply has been envisaged.

Electrical System - The electrical system shall comprise of conduit work including junction boxes, wiring for lighting and power; fittings and accessories, cables, mains and sub-mains; IT panel, main & sub-distribution panels, capacitor panels; cable trays, GI conduits; earthing system, area lighting, canopy lighting, signage lighting & control room illumination etc.

E) SS Tubing

SS Tubing shall run in underground concrete/masonry trenches for conveying compressed natural gas from compressor to priority panel to dispenser and priority panel to stationary cascade to dispenser. Generally these shall be ¼", ¾" or 1" size tubes of SS 316 grade

F) Water supply & Underground Services

To meet the water requirement at mother stations, water supply network consisting of bore well, vertical pumps, submersible pumps and interconnecting piping has been envisaged.

Two nos. underground RCC water tanks shall be constructed. These tanks shall receive water from municipality and bore well. Water from these tanks shall be pumped to overhead tanks placed at building roof. Two nos. vertical pumps of capacity 2000 to 2500 ltr/hr, head 19 to 26 M, 0.5 HP shall be installed in these RCC tanks.

One bore well of suitable depth and size will be constructed. One submersible pump of capacity 3,000 – 5,000 ltr/hr, head 50-60 meter, approx 2 H.P. shall be installed in the bore well.

Underground drainage, sewerage network comprising of drain pits, drainage pipe, septic tank and soak pit shall be installed apart from municipal connections.

G) Control Room-cum-Office & Other Facilities

This shall be an RCC framed structure of suitable size to house office, control room, electrical room, cash box and toilet. The front side shall have glazed partition for viewing dispensing operation. The floor will have ceramic tiled finish and synthetic emulsion paint on walls and ceiling has been considered.

- The station shall be enclosed with 2.1 m high boundary wall on three sides.
- The forecourt shall be made of high riding quality RCC pavement with wearing resistant surface.
- The SS tube trenches and drainage shall be covered with heavy duty precast SFRC covers of suitable design and manufacture.
- GI conduits shall be laid for cabling work.
- Properly designed dispenser island with safety guards shall be provided.

- Structural steel canopy shall be provided over the dispensing area for providing sum and rain protection. The canopy shall have provision of roof drainage, illumination and signage's.
- The station shall be provided with approach roads, entry and exit ways, parking bay, operation area fence, safety barbs, road signs, station drainage system etc.
- The station shall be provided with corporate traffic and safety signages using state of art techniques and landscaping.
- The station shall be provided with safety and firefighting equipment, earthling pits and safety instructions.

6.5 SELECTION CRITERIA OF CASCADES

All the stationary cascades in Mother stations shall be of 3000 WI capacity. All Mother stations, daughter booster station and On-line stations shall have as many nos. of stationary cascades as the nos. of compressors. However the stationary cascades in on-line stations shall be of 4500 WI capacity (for large buffer stock) to cater for dispensing during peak load. Further, the priority system in the stationary cascades have been designed and defined for car / auto and bus filling from cascades so as to match the priority system in the Mother / Online compressor.

The capacity of mobile cascade shall be depend on:

- load at daughter booster station and online station,
- No. of trips.
- Cost effectiveness
- Ease of transportation
- space constraints in the existing ROs proposed for DBS.

CHAPTER 7

ROUTE SELECTION & FACILITY LOCATIONS

7.1 ROUTE SELECTION

Safety: Pipe will be routed on the other side of road and away from the source of ignition and away from other underground services also.

Cost: Shortest route will be selected to minimize the cost.

Standards: OISD 141 standard, clause 13.11 Current Practice as mentioned above

Design Basis: All HP and MP mains are to be installed in the public road right of way except as may be required for specific safety or economic reasons.

Natural gas mains will be installed outside of the actual road 'structure wherever possible. This will minimize both the costs for restoration (i.e. pavement) and public inconvenience. Crossings and/or conflicts with the location of other utilities will be considered during final route selection.

Construction conditions in typical streets vary from paved wide roads to narrow side streets, depending on age of district.

Accuracy and reliability of foreign utility information (water, sewers, etc.) for older and newer areas of the city, is to be determined.

7.2 ROUTING

7.2.1 Selection of the route:

In consideration of the Environment requirements, construction methodology to be adopted, design and engineering factors, availability of the logistic support during construction, operation and maintenance of pipelines various feasible alternatives were identified based on the desktop study of the relevant topographic maps of the area.

After the desktop study of the route, reconnaissance study of the route was carried out for the collection of the various details of the route. After collection of the field data once again desktop analysis of data were carried out for arriving at the optimum route. For the final route selections following factors are considered:

- Maximum reach to potential demand centers with minimum length
- Use of existing defined pipeline corridors by respective authorities
- Minimum disturbance to Agricultural land
- Compliance with environmental regulations v Safety of people and property
- Shortest possible route
- Minimum number of Bends

- Favorable ground profile for construction
- Accessibility of the pipeline for the operation and maintenance
- location of pipeline facility and access thereto
- Avoidance mining area as far as possible
- Avoidance forest area as far as possible
- Minimum number of Road, Canal crossing
- Avoidance of rocky terrain
- Flexibility for future expansion
- Avoidance of the notified forest as well as thick plantation area
- Avoidance of the area reserved for the future development
- Avoidance of archeological and sensitive area
- Safe distance from the village

On completion of the above exercise final route is selected for the pipeline network.

7.3 THE PROPOSED ROUTE FOR KASHIPUR

The starting point of the route is the City Gate station. It is proposed to locate the City Gate Station at a location near IH sugar factory on Kashipur Rudrapur Road. GAIl (I) ltd will deliver gas at the city gate station.

The above optimum route is selected based on the following factors:

- Shortest length of the pipeline grid
- least topographical variations and minimum obstacles in the form of rail/ road/ river /canal crossings
- Minimum cost of the system layout
- Density of traffic flow
- Minimum number of turning points
- Availability of sufficient space on both sides of the road

7.4 APPROVAIS AND CIEARANCES

For the various major and minor crossings, permissions/clearances shall be obtained from the concerned authority. The broad lists of the approving authorities are as follows:

1. PWD CPWD
2. local Municipal Corporation 3RWA's
3. Ministry of Railways
4. Ministry of Environment & Forests
5. State Pollution Control Board (UPPCB)
6. Telephone Department
7. National Highway Authority of India
8. Jai Board / Water·board

9. Fire Department
10. Chief Controller of Explosives
11. Department of Forests / Horticulture

CHAPTER 8

METERING AND METER SETS

8.1 METERING

Metering not only provides a tool for allocation of volumes of gas to various customers. It also provides information required to prepare gas balances and track unaccounted for natural gas. If a natural gas distribution system is installed without metering, billing is done on an estimated allocation method. This approach does not directly encourage equitable energy usage, conservation, or environmental friendly practices. For this reasons for the feasibility study, all custody transfers of natural gas are to be metered.

For the natural gas system One meter per customer will be provided to each Industrial, domestic and commercial user. It is assumed natural gas customers will not be allowed to resell natural gas to others.

Internationally mass meters, sonic meters and compact conventional meters have been introduced. There has also been substantial progress made regarding remote and electronic meter reading. The creation of a new company and installation of an entire new natural gas system is an opportunity to adopt such promising technology. However, the selection of the most appropriate of these technologies for Kashipur would entail a substantial undertaking and may involve some risk for a small and new organization. It is further apparent that such move would be justified only if capital cost or operating saving could be achieved. Hence selecting conventional metering as the basis for the feasibility study allows the study to be completed independent of evaluating other technologies with the knowledge that cost savings may be available if new technology is adopted.

Conventional metering types include:

- Diaphragm - domestic and commercial: 0-23 SCMH/Customers.

- Rotary - medium to large commercial 0-750 SCMH/Customers

- Turbine - very large Industrial customers 1100-2800 SCMH.

Diaphragm meters will be used for residential and small commercial customers. Rotary meters will be used for large commercial customers with a peak hourly load in excess of 23 SCMH. Turbine / Orifice meters will be used for very large Commercial / Industrial customers where there is both a minimum flow rate, and also a high maximum flow rate.

Providing meter set locations and protection shall be the responsibility of the customer. Meter sets will normally be located at the property boundary line inside a meter box. However, even if the meter sets are adjacent to buildings they shall be outside buildings or in a separate room that is sealed against migration of gas. Meter rooms shall have explosion proof electrical fittings.

While locating the gas meter preference will be given to place the meter and its associated equipment in an external location for ease of access, safety, and economy wherever practicable. Access by Gas Company personnel at all times is a requirement. In selecting a mater set location following requirements will be considered:

- Clear access for meter reading and maintenance

- Clear of all hazards

- Clear of walkways, traffic and doorways

- Aesthetics and noise

- Clear of down pipes for eaves and dripping water

In locating the industrial meter sets the nature of customer's process, access restrictions and the maintenance frequency requirements will be considered in addition to the above requirements.

Meters set will be located well clear of any hazards that could cause damage. If there is no suitable location and the meter set is in a potentially hazardous area, the meter set will be protected.

An external meter box providing adequate protection against vandalism and accidental damage will be used whenever it is necessary.

Pressure Factor Measurement (PFM) - to reduce the capital and operating cost of equipment (i.e. electronic or mechanical pressure correctors), pressure factor measurement is to be used. Specifically, regulators that provide very consistent delivery pressures at variable inlet pressure will be installed on these meter sets. When the PFM meters are read for those customers that are provided with natural gas at delivery pressures exceeding 20mbar, the meter reading will be simply corrected for the delivery pressure.

8.2 METERING SYSTEMS

There are several methods, which could be used for metering including orifice plates, turbine meters and ultrasonic meters. Of these methods the orifice plate has been used for many years for fiscal metering of gas and subsequently there is sufficient corrective data available which allows the uncertainty of measurement to be reduced to very small values. For this reason many operating companies prefer them. Project shall also adopt orifice-metering concept. The turbine and ultrasonic meters are relative newcomers for the use in fiscal metering of gas with ultrasonic meter only adopted recently. Both of these meters are costlier and have added disadvantage of needing to be taken out of line for calibration.

The primary function of the metering system is to meter gas entering and exiting the operators' pipeline system for fiscal and operational purposes. The metering information is transferred to SCADA through local RTU and displayed bath locally and in the MCR.

The inlet metering and metering at the MRS feeding single consumer is for fiscal purpose and the overall uncertainty of the metered standard volume flow rate should not exceed +/- 1.0% over the full operating range. All fiscal metering shall have multiple meter runs with a spare to enable calibrations to be carried out. Each meter run has a dual chamber orifice fitting to allow routine orifice plate inspections.

It should be noted that flow rates may increase with time and that the metering facilities must be capable of meeting the ultimate design rate.

8.2.1 Check Metering

Metering at PRS feeding multiple consumers is for pipeline control and check purpose only and the overall uncertainty of the metered standard volume shouldn't exceed +/- 5% over the full operating range.

8.2.2 Fiscal Metering

The fiscal metering includes all systems for the following activities:

- Sales and allocation measurement gas
- Measurement of fuel and vented gas
- Sampling

- Gas Chromatograph

- The measurement system consists of the following main elements:

- Mechanical elements including flow meter

- Instrumentation

In Distribution of Natural Gas, the project will cover three sector

- Domestic
- Commercial
- Industrial

1. Domestic

Population of Kashipur city = 4.00000

Assume each family has four person (Average)

So. no. of family to whom PNG will be supply = 400000/4

= 100000 family

Assume each family consuming 14.2 Kg of LPG per month

So. LPG consumption = 14.2* 100000

= 1420000 Kg of LPG per month

Kg 1.28scm of NG)= 1817600 scm of Natural Gas per month

=1.817600 MMSCM/Month

= .075 MMSCMD

Economics Analysis of PNG

Assume one family consumes HPG cylinder per month = 310/month

Price of PNG = 17 scm

Consumption of HPG per month = 0.5 * 30

= 15 scm/month

So, rate of PNG/month = 15*17

= 255 Rs/month

Saving = 310 – 255

= 55 Rs.

% Save = 55/310

17.75% of saving per month

ii) Commercial calculation :-

No. of automobile (3 wheeler)

=800

No. of city bus + cars = 400

The average of 3-wheeler = 20 Km/litre

Distance cover in a day = 130 Km

So, fuel requirement per day

=130/20

= 6.5 litre

Total fuel requirement for 3-wheeler

= 6.5 * 800

= 5200 litre

Energy requirement per day by three wheeler

= 5200 * 8398

= 43.6696 * 10^6 kcal/day

Calculation for 4 wheeler

Assume average of 4 wheeler

= 7 Km/litre

Average distance covered

= 130 Km

So, fuel requirement

130/7

= 18.57 litre/vehicle

Total. fuel requirement for 4 wheeler

= 18.57*400*8398

= 62.3803*10^6 Kcal/day

So, Total energy requirement

= 43.6696*10^6 + 62.3803*10^6

106.0499*10^6 Kcal/day

The energy content of ING = 5031 Kcal/litre

Therefore, volume of natural gas required

= 106.0499*10^6*600/5031

= 12.6475*10^6

= 12647.57 scm

= .001264757 MMSCM

Combining the commercial and industrial sector requirement, the total natural gas requirement

= 0.023 + 0.012647

= 0.035647 MMSCM

Calculation for Compressors and Daughter Booster stations:-

Capacity of mother station compressor

= 1200 SCMH

Capacity of Daughter Booster Station Compressor

= 150 SCMH

SO, no. of mother station compressor

= 12647.57/1200

= 10.53

= 10 no. of MS compressor

In project, 3 no. of compressor will be installed at MS at three location

So, each Mother station will dispensed the CNG

= 9*1200 = 10800 SCMH

Amount of Gas dispensed by DBS

12647.57 - 10800

= 1847.8 SCMH

The no. of Daughter Booster Station required

= 1847.8/150

= 12.31

=12 no. of DBS

Network Analysis

Gas supply to domestic consumers of KATORATAl Colony, Kashipur.

Required quantity of gas:

According to the Municipality report of 2006 total population of the Municipal area of Katoratal colony is 100653. Now if we consider there are 4 member in a family, so on calculating equivalent domestic consumers that come 25200, and gas required for Katoratal colony domestic gas grid per day (cubic meter) is 50,400 cubic meter.

Here we have made up a network as per the water pipeline network of Katoratal colony and solve it for pressure at different nodes with the help of waymouth formula.

Gas consumed by one EDC per day (cubic meter)	**Total number of EDC**	**Total gas required for** Katoratal **colony (cubic feet per hour)**
2	**50,000**	**1,00,000**

Here we have reduced the network of water pipeline in Katoratal colony. On the basis of water pipeline network we can lay the gas pipelines. In this project we have reduced the network of water pipeline in the form of gas pipeline shows by **figure (A)**, which is made only for the main nodes of the pipeline network.

As water pipeline lay in region, same on that we made up the network of gas pipeline. And flow rate in each stream decided by the density of population in between different nodes, as per data given by water office in the form of **table (A)**.

I **100000cfh**

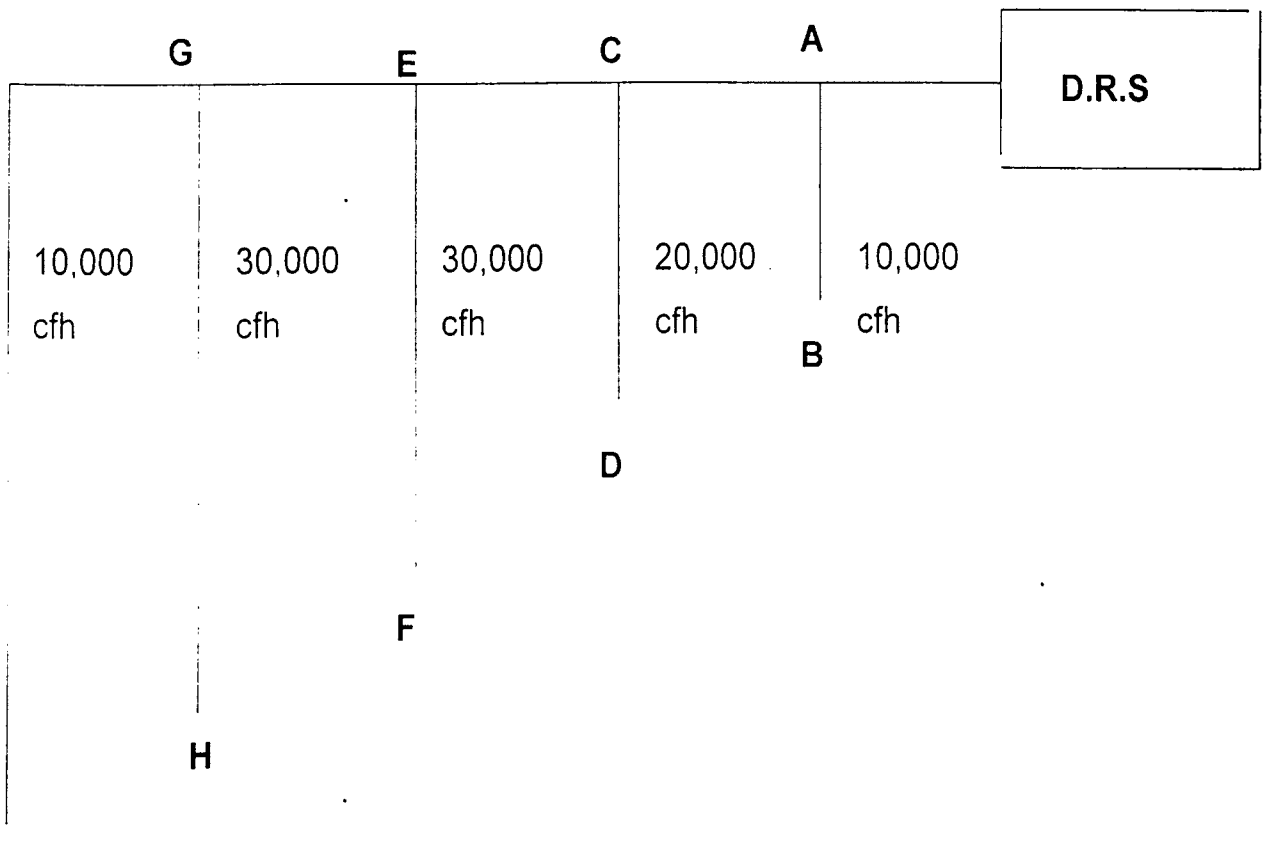


Figure A

Technical calculations:

Using waymouth equation

$$q_h = \frac{18.062\ T_b\ [(P_1^2 - P_2^2)D^{16/3}]^{1/2}}{P_b[\gamma_g T_l z]^{1/2}}$$

q_h = gas flow rate, cfh at P_b and T_b

T_b = base temperature, ^0R

P_b = base pressure, psia

P_1 = inlet pressure, psia

P_2 = outlet pressure, psia

D = inside diameter, inch

γ_g = gas specific gravity

T = average flowing temperature, ^0R

l = length of pipes, miles

Z = gas deviation factor at average flowing temperature and average pressure

Assume data

$T_b = 520^0R$

P_b = 14.73 psia

γ_g = 0.64

$T = 528^0R$

Z = 0.979

Pressure Calculation

Used formula

$$P_1^2 - P_2^2 = \frac{(q_h * Pb)^2 [\gamma_g Tlz]}{(18.062 * Tb)^2 D^{16/3}}$$

Pressure points

In between D.R.S. and point A

Initial pressure $P_1 = 4$ kg/cm^2 or 56.92 psia

$q_h = 1.00.000$ cfh

$l = 0.798$ miles

$P_1 = 56.92$ psia

$$P_2^2 = 56.92^2 - \frac{(100000*14.73)^2 [0.64*528*0.798*0.979]}{(18.062*520)^2 (8)^{16/3}}$$

P_2 = 56.04psia

At point C

$q_h = 90.000$ cfh

$l = 0.944$ miles

$P_2 = 56.04$ psia

$$P_3^2 = 56.04^2 - \frac{(90000*14.73)^2 [0.64*528*0.944*0.979]}{(18.062*520)^2 (8)^{16/3}}$$

P_3 = 55.18psia

At point E

q_h = 70,000 cfh

l = 1.485 miles

P_3 = 55.18 psia

$$P_4^2 = 55.18^2 - \frac{(70000*14.73)^2[0.64*528*1.485*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

P_4 = 54.35psia

At point G

q_h = 40,000 cfh

l = 1.562 miles

P_4 = 54.35 psia

$$P_5^2 = 54.35^2 - \frac{(40000*14.73)^2[0.64*528*1.562*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

P_5 = 54.06psia

At point I

q_h = 10,000 cfh

l = 1.60 miles

P_5 = 54.06 psia

$$P_6^2 = 54.06^2 - \frac{(10000*14.73)^2[0.64*528*1.60*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

P_6 = 54.04psia

At point J

$q_h = 10.000$ cfh

$l = 0.699$mile

$P_6 = 54.04$psia

$$P_7^2 = 54.04^2 - \frac{(10000*14.73)^2[0.64*528*0.699*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

$P_7 = 54.03$psia

At point H

$q_h = 30.000$ cfh

$l = 0.205$ miles

$P_5 = 54.06$ psia

$$P_8^2 = 54.06^2 - \frac{(30000*14.73)^2[0.64*528*0.205*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

$P_8 = 54.03$psia

At point F

$q_h = 30.000$ cfh

$l = 0.22$ miles

$P_4 = 54.35$ psia

$$P_9^2 = 54.35^2 - \frac{(30000*14.73)^2[0.64*528*0.22*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

$P_9 = 54.32$psia

At point D

$q_h = 20.000$ cfh

$l = 0.433$ miles

$P_3 = 55.18$ psia

$$P_{10}^2 = 55.18^2 - \frac{(20000*14.73)^2[0.64*528*0.433*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

P_{10} = 55.16psia

At point B

$q_h = 10.000$ cfh

$l = 0.1118$ miles

$P_2 = 56.04$ psia

$$P_{11}^2 = 56.04^2 - \frac{(10000*14.73)^2[0.64*528*0.1118*0.979]}{(18.062*520)^2\,(8)^{16/3}}$$

P_{11} = 56.03psia

CONCLUSION AND FINDINGS

The sample calculations for the network are conducted, selecting a small section within the network. The pipe diameters and gas quantity requirements according to Kashipurs population are also calculated.

ECONOMICS

The economic study is as follows:

Saving amount - Rs. 45

Percentage save = 15 %

(W.R.T. to IPG)

CNG PROJECT COST

The tables below show the cost requirements for construction of various CNG Stations. From these tables we can select the optimum type of CNG Station as per the gas demand.

Mother Station Cost

S.No.	Component	Cost (Rs.in Mn.)
1	Compressor	24.00
2	Cascade (2 Nos. 200 liter)	7.00
3	1 Dispenser	3.00
4	2 Power Dispenser	3.00
5	Civil & Other misc. works	7.50
6	Piping & Instrumentation	0.25
7	Fire detection	0.15
8	DG Set	1.00
9	Contingency	0.70
	Total	**46.60**

On-line Station Cost

S.No.	Component	Cost (Rs.in Mn.)
1	Compressor	7.50
2	1 Cascade	2.00
3	2 Cascade Dispenser	3.00
4	Civil & Other misc. works	7.50
5	Piping & Instrumentation	0.25
6	Fire detection	0.15
7	DG Set	1.00
8	Contingency	0.70
	Total	**22.10**

Daughter Station Cost

S.No.	Component	Cost (Rs.in Mn.)
1	1 Dispenser	1.50
2	2 Mobile Cascade	3.00
3	Civil & Other misc. works	7.50
4	Contingency	0.70
	Total	**12.70**

It is also seen that constructing a CNG Station on an existing petrol pump station is profitable and feasible as the cost of land etc. reduces and the various statutory requirements for such stations are lower.

References

Andrzej J. Osiadacz, "Simulation & Analysis of Gas Networks", Manchester April, 1986.

P.K Nag, "Heat Transfer" Tata McGraw-Hill, New Delhi, 2001.

C.P Arora, "Thermodynamics" Tata McGraw-Hill, New Delhi, 2001.

J.b.Maxwell, "Data Book on Hydrocarbons", Princeton, 1995.