UNIVERSITY OF PETROLEUM & ENERGY STUDIES

College of engineering
Dehradun

Major Project Report

PNG, CNG OPERATION AND DISTRIBUTION

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The University of Petroleum & Energy Studies must be credited for letting us do a project of our area of interest, keeping faith in us and letting it happen. Last and most assuredly not least, we are deeply indebted to many people who have helped us indirectly in this project

PNG, CNG Operations And Distribution

A thesis submitted in partial fulfillment of the requirements for the Degree of
Bachelors of Technology
(Applied Petroleum Engineering)

By
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Approved

Dr. Shrihari
Dean

15/5/10

College of Engineering
University of Petroleum & Energy Studies
Dehradun
May, 2010

CERTIFICATE

This is to certify that the work contained in this thesis titled "PNG, CNG Operations And Distribution" has been carried out by Deepak Kumar Sharma & Gaurav Anthwal under my/our supervision and has not been submitted elsewhere for a degree.

Rajeshwar Mahajan

Mr. Rajeshwar Mahajan

Contents

NATURAL GAS

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

Properties of Natural Gas

Boiling point	-161^0C
Gross calorific value	43110Kj/m3
Flammable limit	3%-15%(volume% in air).
Relative density	0.72
Wobbe index	1327

It is a preferred fuel because:

- In its pure form it is colourless, shapeless and odorless.
- It is low density & viscosity homogenous fluid.
- It gives off a great deal of energy when burned and is combustible.
- It emits lower levels of potentially harmful by products into the air.

Component	Typical Analysis (mole %)	Range (mole %)
Methane	95.1	87.0 - 96.0
Ethane	2.6	1.5 - 5.1
Propane	0.2	0.1 - 1.5
iso – Butane	0.03	0.01 - 0.3
normal – Butane	0.03	0.01 - 0.3
iso – Pentane	0.01	trace - 0.14
normal – Pentane	0.01	trace - 0.04
Hexanes plus	0.01	trace - 0.06
Nitrogen	1.2	0.7 - 5.6
Carbon Dioxide	0.8	0.1 - 1.0
Oxygen	0.02	0.01 - 0.1
Hydrogen	Trace	trace - 0.02

SOURCES OF NATURAL GAS:-

1. Conventional Reserves:-

Associated Reserves–They are in contact with oil, but not in solution.

Non Associated Reserves–They don't exist with oil

Wet NG Reserves–They are unprocessed or semi-processed NG from strata containing condensable (heavy) hydrocarbons

Dry NG Reserves– They are basically pure methane. It also contains little or no recoverable liquid hydrocarbons.

2. Other sources of Gaseous fuels:-

A. **Tight sands:**-These are less than 0.1 milli-darcy permeability tight gas sands. They contain significant volumes of natural gas.
B. **Tight shales:-** It is easily breakable into thin, parallel layers. It is very fine grained sedimentary rock.
C. **Geo pressurized aquifers:-** Geo pressurized zones are natural underground formations that are under unusually high pressure for their depth.
D. **Coal bed methane(CBM):-** It 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:-** The most recent form of unconventional natural gas to be discovered and researched are Methane hydrates These interesting formations are made up of a lattice of frozen water, which forms a sort of 'cage' around molecules of methane. These were first discovered in permafrost regions of the Arctic and look like melting snow.

PIPED NATURAL GAS (PNG)

It has application in the following areas of day to day life:

- Domestic
- Commercial
- Industrial

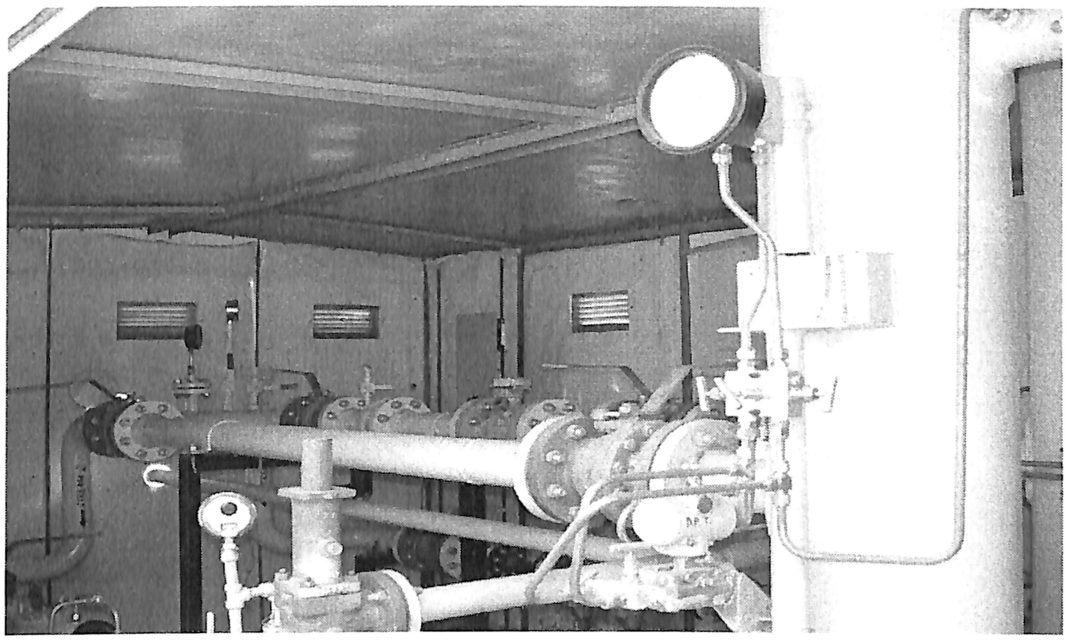
PNG benefits

- ✓ Uninterrupted supply which is hassle free.
- ✓ Safe.
- ✓ Low operating costs.
- ✓ Infrastructure development – one time cost.
- ✓ No spillage.
- ✓ Lower maintenance cost for appliances.

Major Equipment / Components Used For PNG Distribution

- ➢ Field regulating station
- ➢ Regulator
- ➢ Meters
- ➢ Meter regulating stations

FIELD REGULATING STATION



FEATURES

- ✓ Type- Twin Stream Active- Monitor Regulators With Slamshut Of Valves And Meter
- ✓ Inlet Pressure – 16 To 32 Bar
- ✓ Out Let Pressure – 4 Bar
- ✓ Design Pressure- 48 Bar
- ✓ Max. Flow- 5000 / 10000 Scmh
- ✓ Safety Features-

  Active- Monitor Regulation

  Over Pressure Shut- Off

  Under Pressure Shut-Off

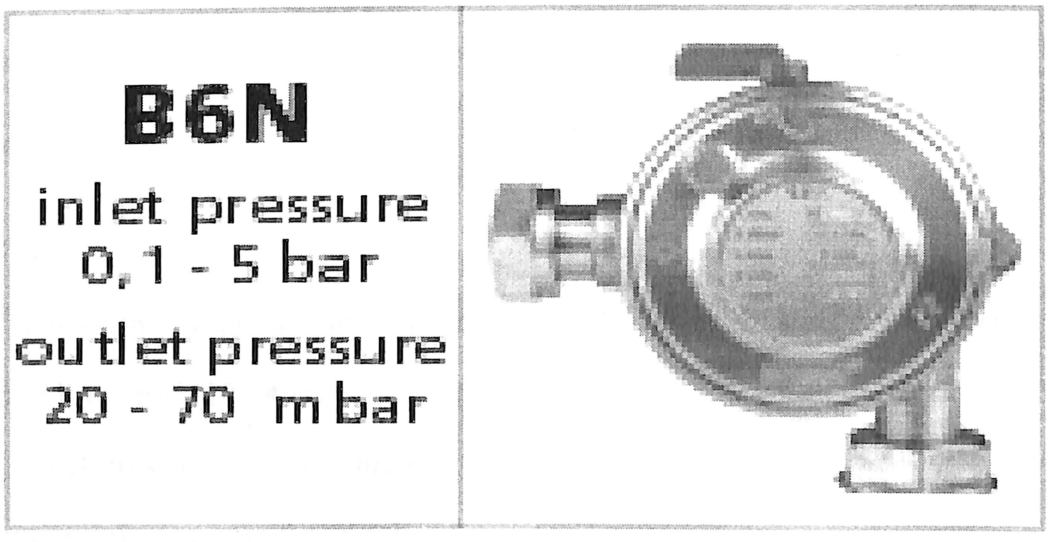
  Pressure Relief Valve

- ✓ Meter Type- Turbine / Rpd With Flow Computer

REGULATOR AND METER

Domestic Regulators

- ✓ Type- Direct Acting
- ✓ Inlet Pressure – 1.0 To 4 Bar
- ✓ Out Let Pressure – 22 Mbar
- ✓ Max. Flow- 6.6 Cu.M/Hr.
- ✓ Safety Features-
- ✓ Over Pressure Shut- Off
- ✓ Under Pressure Shut-Off
- ✓ Relief Valve



Domestic Meter

- Type – G-1.6
- Max. Flow - 2.5 Cu.M/Hr.
- Min. Flow – 0.016 Cu.M/Hr.
- Mop- 300 Mbar
- Accuracy – Q Max To 0.2 Q Max ± 2%

  0.2 Q Max To Q Min ± 3%

METERING REGULATING STATION INSTALLED AT COMMERCIAL

Features

- ✓ Customised
- ✓ Type- Twin / Single Stream Regulators With Slamshut Of Valves And Meter
- ✓ Inlet Pressure – 19 / 4 Bar
- ✓ Out Let Pressure – As Required
- ✓ Design Pressure - As Required
- ✓ Max. Flow - As Required
- ✓ Safety Features -
    - Over Pressure Shut- Off
    - Under Pressure Shut-Off
    - Pressure Relief Valve
    - Meter Type- Turbine / Rpd With Flow Computer
    - Pressure Gauges

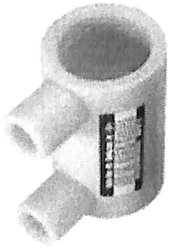
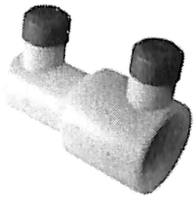
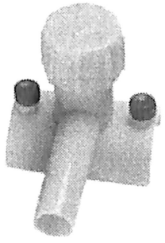
MDPE PIPES AND FITTINGS

- ✓ Standard Pipe Sizes Being Used Outside Dia In Mm- 180, 125, 90, 63, 32, 20
- ✓ Associated Fittings
  - ✓ Coupler
  - ✓ Elbow
  - ✓ Tee
  - ✓ Reducer

Categories Of Pe Fittings

- ✓ **Electro Fusion Fittings**

Injected moulded polyethylene accessories equipped with a heated element designed to transform electrical energy into heat to create self-welding

- ✓ **Spigot Fittings**

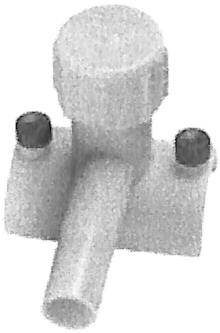
PE fittings having smooth ends which require electro fusion accessories to weld to other pipe / fittings

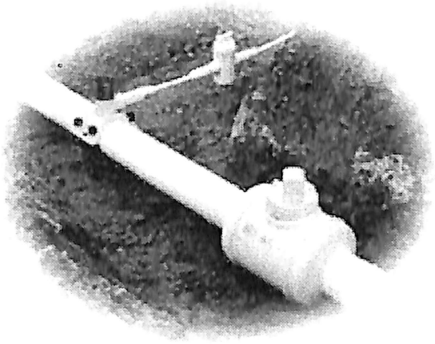

- ✓ **Pe Pipe Couplers**

For joining pipe to pipe and pipe to fitting


- ✓ **Tapping Saddle**

For Taking Tap-O ofs From Live Lines



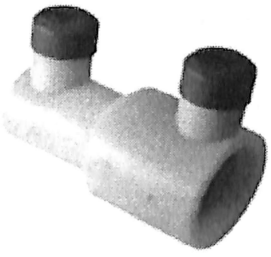


- ✓ **Pe Shut-Off Valves**

For isolating pe gas pipelines

- ✓ **Reducers**

For connecting pipes of different diameter



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. Cylindrical or spherical shapes hard containers are used to store ant distribute CNG, at a normal pressure of 200–220 bar (2900–3200 psi)

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.

Introduction to Indraprashta Gas Limited(IGL)

IGL is a joint venture company between GAIL (India) limited, Bharat Petroleum Corporation Limited (BPCL) one of the leading Oil Marketing Companies and Government of Delhi had a mammoth task of creating the CNG infrastructure in shortest possible time. IGL was Incorporated on 23rd December 1998 for supply of natural gas to domestic, commercial and Automobile sectors (CNG).

IGL's CNG Network in Delhi

IGL receives natural gas from GAIL's pipeline at various points. From these points, natural gas is transported to IGL's CNG station. At present, the company is using underground steel pipeline and of MDPE (Medium Density Polyethylene) pipeline, for CNG and PNG business respectively.

Steel Pipeline Network In NCT Of Delhi

12" Pipeline	: 55.40 KMS
8" Pipeline	: 38.40 KMS
6" Pipeline	: 24.04 KMS
4"/3" Pipeline	: 80.80 KMS
TOTAL	: 198.64 KMS

Steel Pipeline

MDPE PIPELINE : 240.00 KMS

TRANSPORTATION OF CNG

The source of CNG supply in Delhi is the famous Hazira-Bijapur-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.

Cng is transported by converting it temporarily to liquid form for ease of storage or transport. Liquefied natural gas takes up about 1/600th the volume of natural gas in the gaseous state. The liquefaction process involves removal of certain components, such as dust, acid gases, helium, water, and heavy hydrocarbons, which could cause difficulty downstream.

DESIGN OF A CNG STATION

There are some key pieces of information needed to properly size an NGV refueling station

1. **Type of vehicles to be refueled-** The type of vehicles you plan to fill will help us determine the best station design for your specific fleet. For example, if you have a school bus fleet you will probably refuel these in a different manner than say a taxi fleet based upon the vehicle operating times
2. **The amount of gasoline each vehicle requires-** We use a conversion factor of 125 scf per equivalent gallon of gasoline. So, if you have a pick-up truck that takes 10 gallons of gasoline every day we know that it will require 1,250 scf of natural gas every time it fills up. Try to get as accurate a number as you can since this will again determine station load

3. **Number of vehicles refueling at the site**

4. **Determine if the vehicles need to be fast filled or if they can be time filled**

5. **Will the station demand grow in the future and, if so, by how much?**

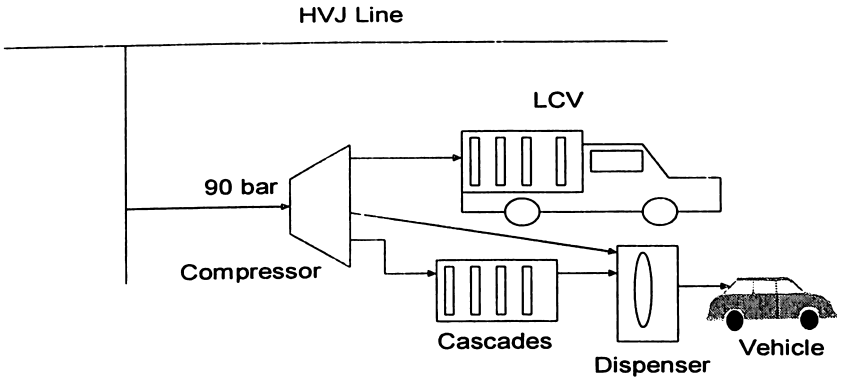
6. **Utilities available at the location where station is to be installed.**

7. **At what pressure will your vehicles operate?**

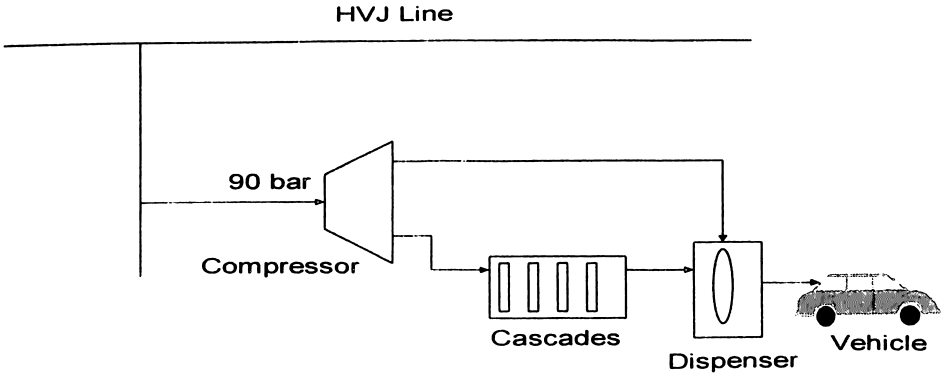
TYPES OF CNG STATIONS:-

There are four type of CNG stations.

1.Mother CNG 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.

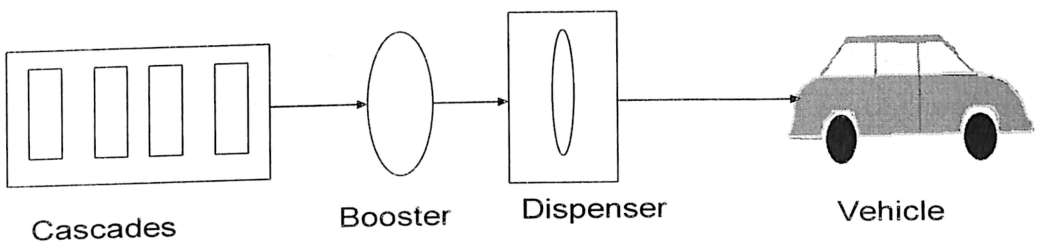


2. Online CNG Station:-CNG facility connected with natural gas pipeline and having and having a compressor to fill stationary cascades for dispensing CNG to vehicles. In case the online stationhas enough space to accommodate mobile cascades filling it can be used to act as mother compressor stations.



3. Daughter CNG Station:- CNG facility not connected to natural gas pipeline and dispensing CNG to the vehicle through mobile cascades.

4. Daughter Booster CNG Station:- CNG facility not connected to natural gas pipeline and dispensing. In this we use the boosters to compress the gas of mobile cascade to fill the CNG in the vechicle.



Note: Since we don't have an appropriate data. Therefore, to design a CNG Station & calculate its payback Period, most of the values has been assumed.

Payback Period for Daughter Booster Station(DBS)

Payback period is defined as that minimum time period in which we gets back our overall investment

Assumptions:

Sale through DBS: 4000 Kg/day

Net margin: Rs 4/Kg (w.r.t. Rs 24 RSP)

Investment in DBS

1. **Investment in DBS-** **RS.**

Plant & machinery	70lacs
+ Installation	8 lacs
+ Building + canopy+ driveway	
+ drainage+ transformer	50lacs
+ Security deposits/advances	3lacs
+ Miscellaneous approval	4lacs
Total	=Rs 135lacs

2. **Income / Expenses= Net Margin : Rs 4/kg**

Retail Selling Price of CNG – Rs 23/kg

Purchase price - Rs 7/kg

Transport, Marketing margins, Vat,other Taxes & Salary of the Staff Rs 12/kg

Total purchase price=7+12 =19

Net Margin =Retail SP –Total purchase price

= 23-19
= Rs 4.00/kg

3. **Savings:**

sale through DBS x (Margin in Rs/Kg)x30 days =4000kg/dayX4rs/dayX30days
=Rs 480000/- PM

Savings for a year: 480000 X 12= 57,60,000/-

Total Investment: 1,35,00,000.00

Total Savings in a year: 57,60,000.00

Pay Back Period: =Total investment/Total savings in a year

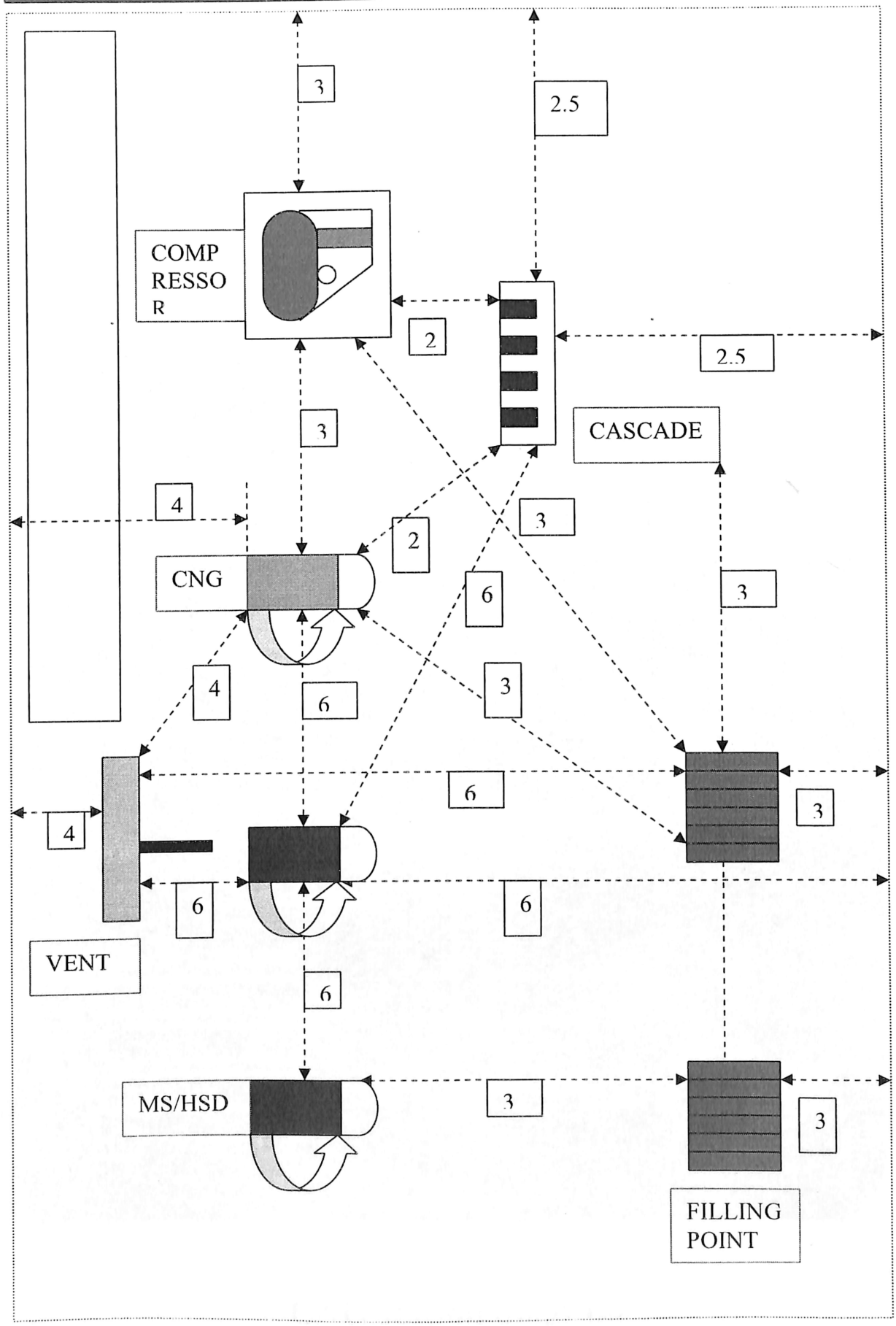
= 135 lacs / 57.60 Lacs

= 2.34 Years

Layout Of CNG Refuelling Station

INTER DISTANCES BETWEEN VARIOUS FACILITIES OF NATURAL GAS HANDLING AT INSTALLATION

Distance From (in meters)	1	2	3	4	5	6	7
1. CNG Compressor	-	3	2	3	6	6	T-1 (Min-3)
2. CNG Dispensing Unit	3	-	2	4	6	4	-Do-
3. Storage cascade	2	2	-	T-1 (2.5)	T-1 (Min-6)	T-1 (Min-4)	-Do-
4. Outer boundary wall/ CLF	3	4	T-1	-	6	4	-Do-
5 MS HSD dispenser	6	6	T-1 (Min-6)	6	-	6	-Do-
6. Vent of MS HSD u/g storage tanks	6	4	T-1 (Min-4)	4	6	-	6
7. Filling point of MS HSD	.....	.....	-T-1(Min-3).....	.....	.....	6	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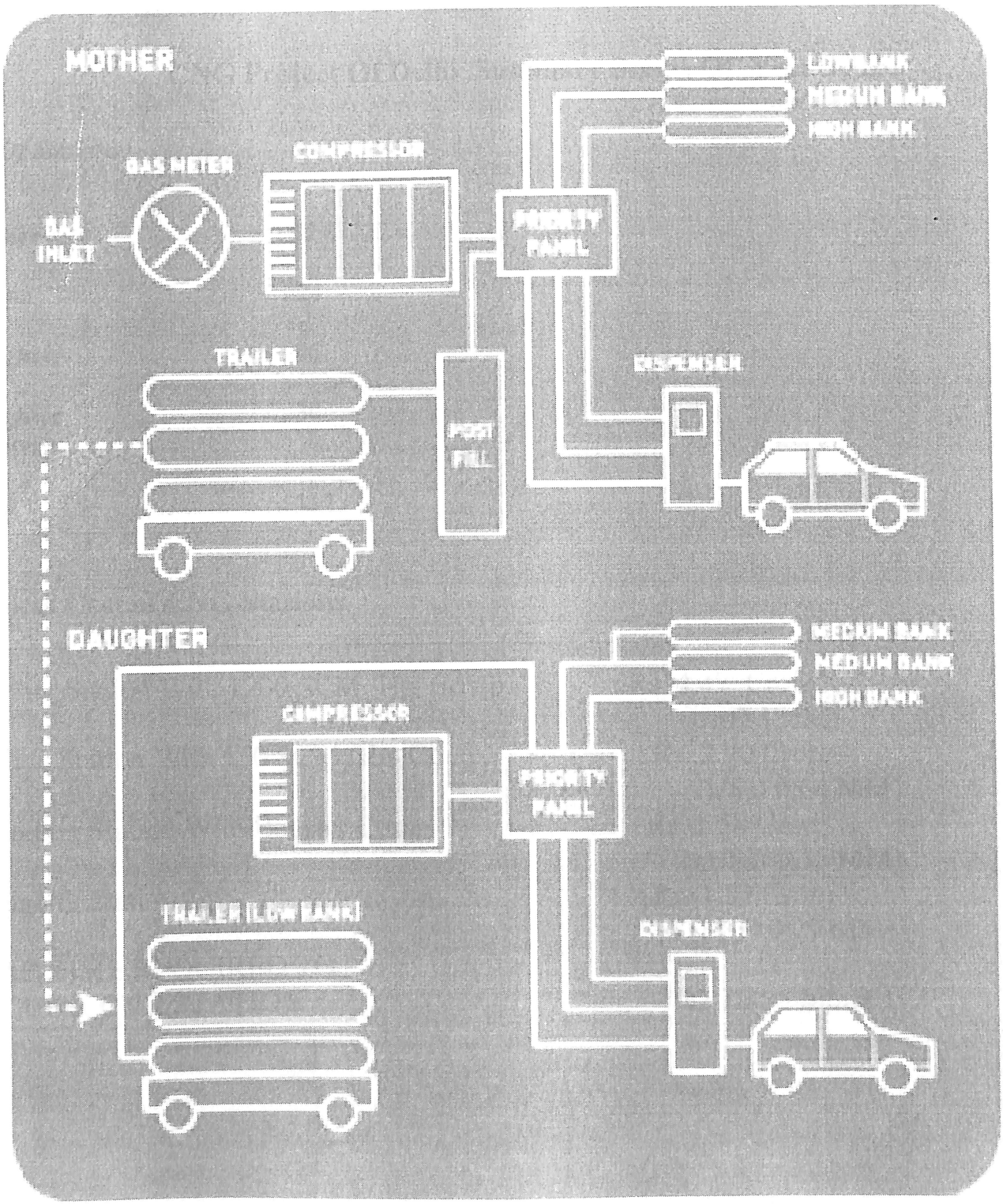
MS/HSD
3
3
FILLING
POINT



CNG station diagram

CNG Project Of Delhi Summary Status Of Year 2003

'o. Of Stations

lother	**: 57**
)nline	**: 24**
)aughter	**: 06**
)aughter booster	**: 30**
'otal	**: 117**

Typical Cost of CNG Stations

Mother Station With 1200 SCM /Hrs Comp.	: Rs. 4.47 Crore (USD 1MM)
Online Station With 550 SCM /Hrs Comp.	: Rs. 2.90 Crore (USD 0.64 MM)
Daughter Station With Booster Comp.	: Rs. 1.58 Crore (USD 0.35 MM)
Daughter Station	: Rs. 1.32 Crore (USD 0.29 MM)
LEAD TIME REQUIRED TO SET UP A CNG STATION	: 12 To 15 Months

Constraints IN GAS DITRIBUTION

- Public Expectations
- Availability of land
- Availability of Gas
- Clearances from state government
- Approvals
- Controlled Expansion
- Fierce Competition from rivals.
- Layout and Demographics
- Limited natural gas availability
- Uncertainty about conversion of vehicles
- Lack of indigenous technology
- Capital intensive project

Equipments used at CNG stations-

1. Compressors
2. Dispenser
3. Metering device
4. Cascades for storage of natural gas

COMPRESSORS

A gas compressor is a mechanical device that increases the pressure of a gas by reducing its volume. Compression of a gas naturally increases its temperature.

APPLICATIONS

Gas compressors are used in various applications where either higher pressures or lower volumes of gas are needed.

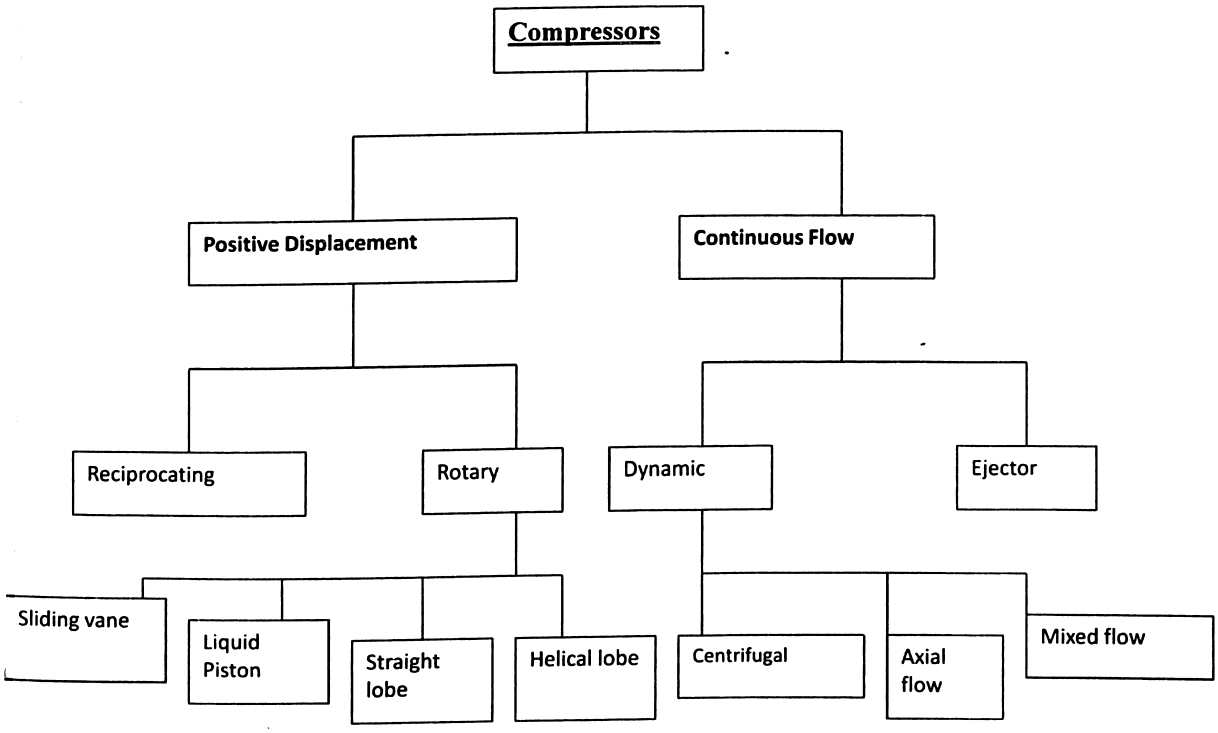
1.In pipe line transport of purified natural gas to move the gas from the production site to the consumer

2.In petroleum refineries, natural gas processing plants, petrochemical and chemical plants, and similar large industrial plants for compressing intermediate and end product gases.

3.In refrigeration and air conditioner equipment to move heat from one place to another in refrigerant cycles.

4. In gas turbine systems to compress the intake combustion air

Types of Compressors



RECIPROCATING COMPRESSOR:-

Reciprocating compressors are most commonly used in the gas industry.

Types:

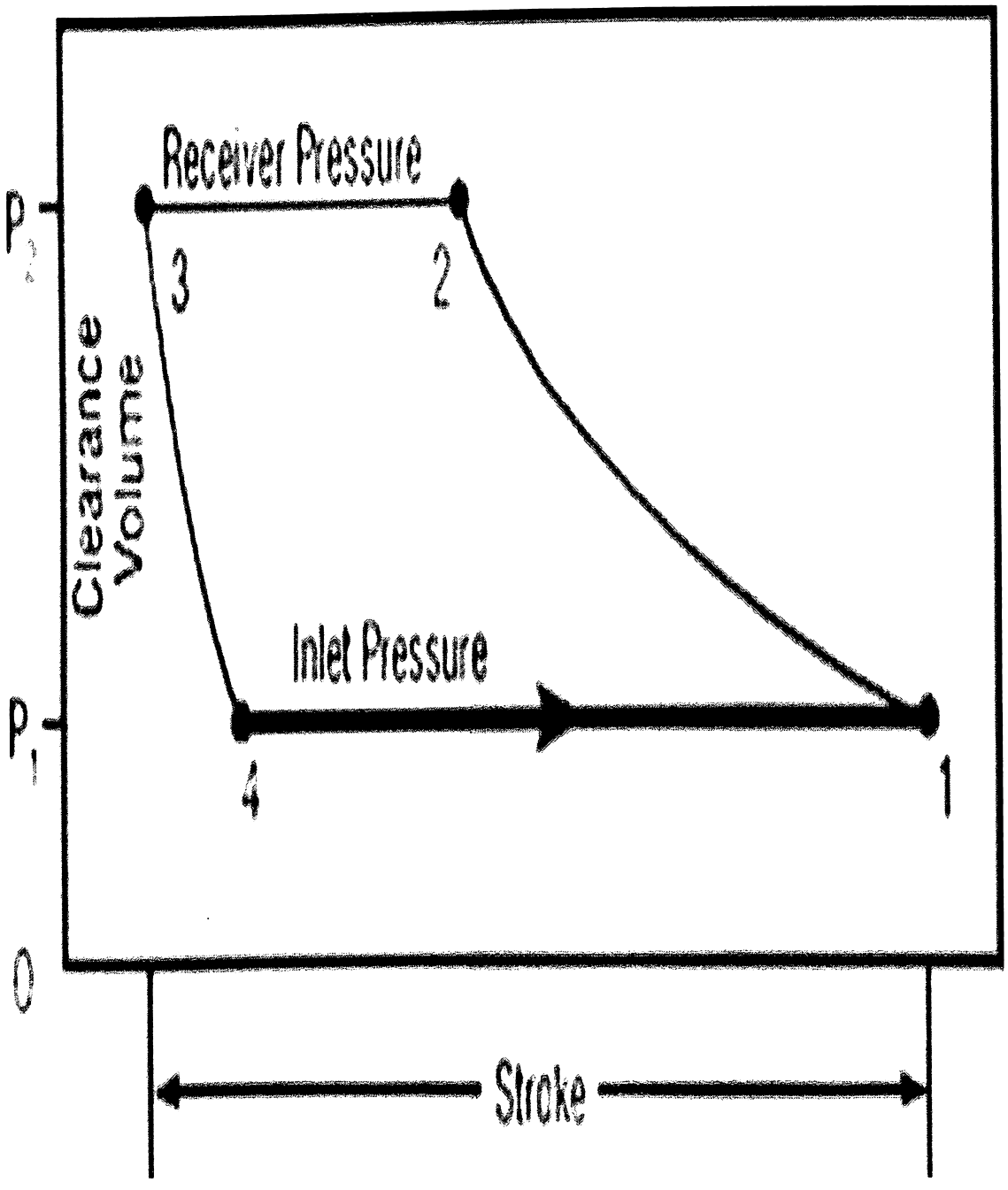
Single acting : In this type the piston compresses on only one side

Double acting : In this 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

ntake pressure . When the pressure in the cylinder equals or exceeds the discharge pressure the discharge valve opens.

Thermodynamic Cycle



The four parts of the cycle are – 1. Compression

2. Discharge

3. Expansion

4. Intake

At the conclusion of a prior cycle, the piston is fully retreated within the cylinder at V1, the volume of which is filled with process gas at suction conditions (pressure, P1 and temperature, T1), and the suction and discharge valves are all closed.

This is represented by point 1 (zero) in the P-V diagram. The volume within the cylinder is reduced as the piston advances. Until the pressure within the cylinder reaches the pressure of the discharge header it causes the pressure and temperature of the gas to rise. At this time, the discharge valves begin to open, noted on the diagram by point 2.

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

The piston comes to a momentary stop at V2 before reversing direction. Note that some minimal volume remains, known as the clearance volume. Clearance volume is defined as 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.

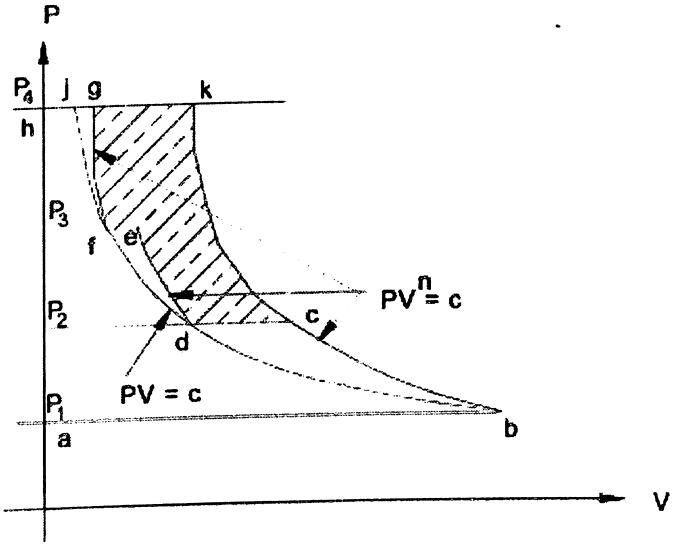
The clearance pocket is expanded to slightly below suction pressure, facilitated by the closing of the discharge valves and the retreat of the piston as the small volume of gas et expanded. This is point 4.

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

Multi stage compression

When air at high pressure is required, multi-staged compression is more efficient than using a single stage compressor . The change in lubrication and increase in risk of burning results as single stage compressors delivers high pressures which results in high gas temperature.

t is required to compress air from P_1 to P_4. The diagram below shows the curve for single stage compression .a-b-c-k-h. The curve for ideal isothermal compression is also shown a-b-j-h. The area enclosed by the curves indicates the work done per cycle and it is clear that the work done in the ideal isothermal process is far less than that done in the single stage compression.



Assume a three stage compressor process is used.
The air is compressed from P_1 to P_2 (a -> c) and the air is transferred into a receiver and cooled to its original temperature (c -> d) and the air is then transferred from the receiver to a second cylinder and compressed to P_3 (d -> e).
The air is then transferred to a second receiver and cooled back to its original temperature (e -> f) and transferred again to a third cylinder and compressed to P_4(f -> g)

The overall process is represented by curve a-b-c-d-e-f-g-h. The cooling brings the process closer toward the ideal isothermal (constant temperature) curve. The saving in work done per cycle is identified by the shaded area.

Why Multi Staging Is Required?

Multi stage compression is used instead of single stage compression. Limitations of stage compressors are:-

1. Outlet temperature

2.Compression efficiency

3.Mechanical stress

4.Compression ratio

5. Effect of Clearance

Rotary Screw Compressors

Rotary air compressors are based on the principle of positive displacement compressors. The single stage helical or spiral lobe oil flooded screw air compressor are the most common type of rotary air compressor .These compressors consist of two rotors within a casing where the rotors compress the air internally. There are no valves . The oil seals the internal clearances. These units are basically oil cooled

The working parts never experience extreme operating temperatures Since the cooling takes place right inside the compressor .The rotary compressor, therefore, is a continuous duty, air cooled or water cooled compressor package

Rotary screw air compressors are easy to maintain, operate and provide great installation flexibility because of the simple design and few wearing parts. Rotary air compressors can be installed on any surface that will support the static weight.

The two stage oil flooded rotary screw air compressor uses pairs of rotors in a combined air end assembly. Compression is shared between the first and second stages flowing in series. This increases the overall compression efficiency up to fifteen percent of the total full load kilowatt consumption.

Rotary screw air compressors are available air cooled and water cooled, oil flooded and oil free, single stage and two stage.

Rotary Compressors

The positive action of rotating elements is used for compression and displacement.

Advantages:

1) At comparatively low horse power large quantities of low-pressure gas can be handled

2), it is simple to install and easy to operate and attend and has small initial cost and low maintenance cost

3) Minimum floor space is required for the quantity of gas removed

Disadvantages:

1) It can't withstand high pressures

2) Due to gear noise and clattering impellers it has noisy operation

Sliding Vane Compressors

In a cylindrical chamber the rotary slide vane-type axial vanes, sliding radially in a slotted rotor mounted.The sliding vane compressor features a one piece rotor eccentrically mounted inside a water jacketed cylinder

Centrifugal Compressors

Gas flow is radial and the energy transfer is effected by changing the centrifugal forces acting on the gas in centrifugal compressor,

The impeller force the gas during the mechanical action of the rapidly rotating impeller vanes

The velocity thus generated is converted into pressure partly in the impeller itself and partly in stationary diffusers following the impeller

Axial Flow Compressors

In Axial compressors the fluid flows mainly parallel to the rotation axis.
By means of a number of stages of blades energy is transferred
Axial compressors are widely used in gas turbines, notably jet engines. Engines using an axial compressor are known as axial-flow.

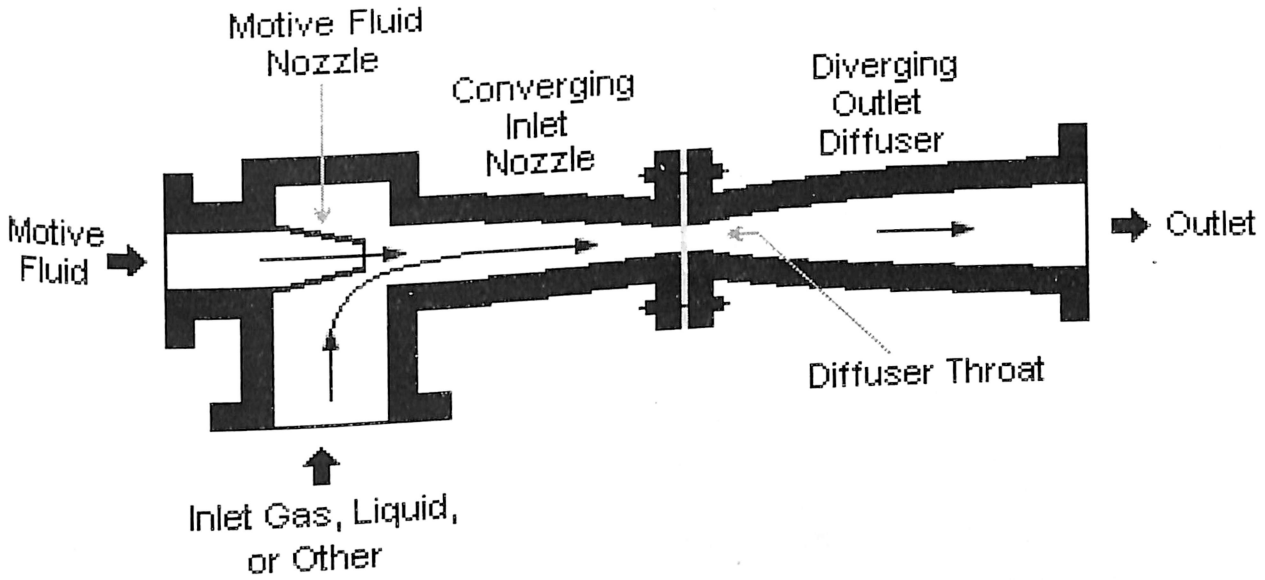
EJECTORS

It consists of a motive fluid inlet nozzle and a converging- diverging outlet nozzle. . The motive fluid is high pressure stream in steam ejector

At the throat of the convergent-divergent the high-pressure steam is converted into a high-velocity jet nozzle which creates a low pressure at that point.

As a results of low pressure the suction fluid (a vapor or gas in this case) is drawn into the convergent-divergent nozzle where it mixes with the high-pressure steam.
The pressure energy of the inlet steam is converted to kinetic energy in the form of velocity head at the throat of the convergent-divergent nozzle.

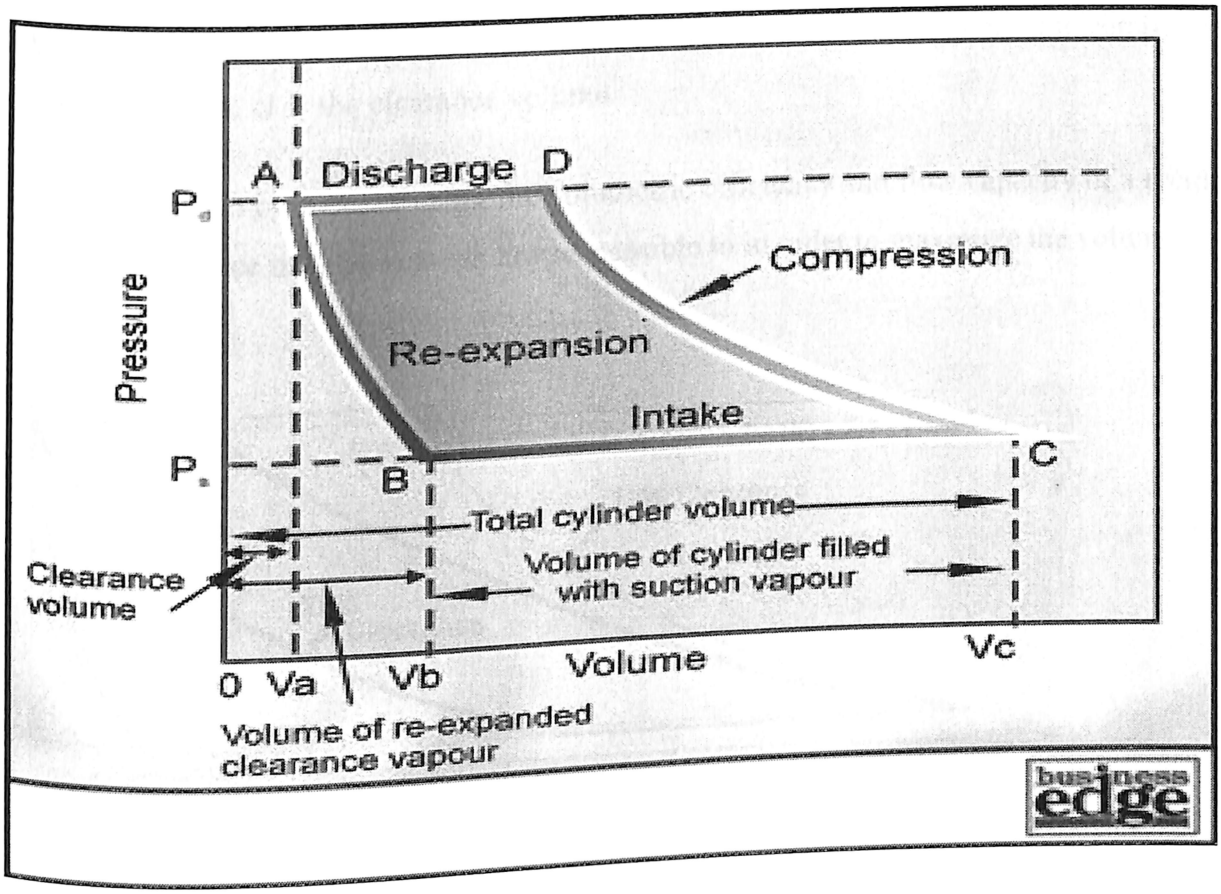
The kinetic energy is converted back to pressure energy at the diffuser outlet in accordance with Bernoulli's principle as the mixed fluid then expands in the divergent diffuser



AN EJECTOR

Clearance volume

The volume remaining in the cylinder when the piston is at TDC is *clearance volume* . The clearance volume is calculated empirically by filling the chamber with a measured amount of fluid while the piston is at TDC, because of the irregular shape of combustion chamber.. This volume is then added to the displacement volume in the cylinder to obtain the cylinders total volume



CLEARANCE –The ratio of clearance volume to the piston displacement is known as clearance

$$CL= V_{A/}V_c\text{-}V_A$$

Effect of clearance on work done

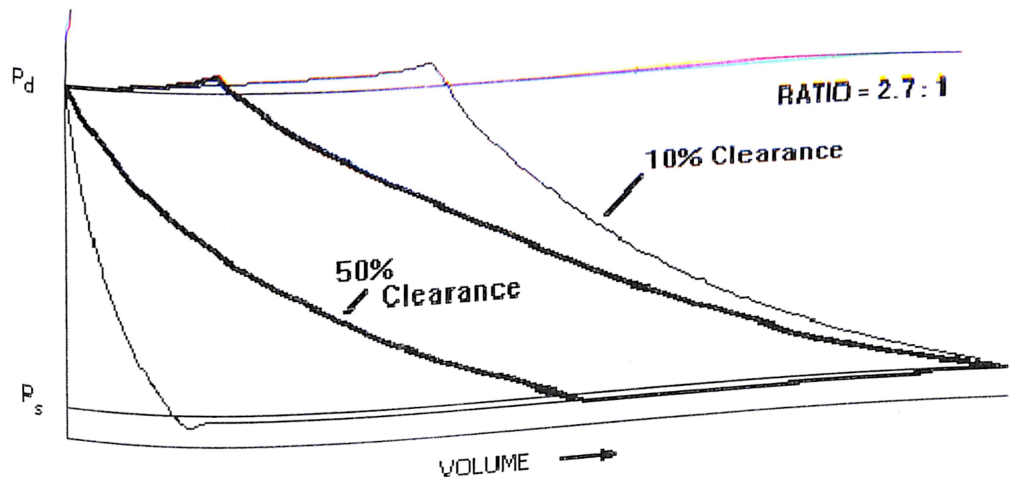
The horsepower being wasted in simply compressing and re expanding the trapped gas as Clearance usually varying from 0.04 to 0.16 limits compressor throughput.

Ratio of volume of gas actually delivered to piston displacement is known as volumetric efficiency of reciprocating compressors. It represents the efficiency of compressor cylinder in compressing the gas and accounts for gas leakage, heating of gas, re expansion of gas etc.

$$\square_v= 1\text{-}(r^{1/k}\text{-}1)cl$$

Where η_v is the volumetric efficiency, r is the compression ratio,k is the isentropic componenet for compression process, cl is the clearance volume.

These parameters can be varied to alter the volumetric efficiency and flow capacity of a reciprocating compressor. Clearance may be kept as low as possible to in order to maximize the volumetric efficiency.



Metering done at CNG station

At the CNG station it is important to determine the hourly and daily consumption by measuring the gas entering into the plant. By sub-metering, at every point we can get the mass flow rate , temperature and pressure of the gas with the help of pressure gauges, temperature sensors and pressure regulators etc. The whole process of metering takes place in the following manner:-

First the gas coming to the station enters the **Suction** where the pressure and flow of the gas is regulated with the help of pressure and flow regulators and the whole data is collected. A **Slam shut down** valve is provided before the gas enters the low pressure filter. Slam shut down valve is capable of operating both at high and low pressure .Its main advantage is that it shuts down if the pressure rises up or falls down than actually needed pressure without gas being discharged to the atmosphere.

Flow of pressure in the pipeline is generally 19-22 kg/cm^2. The gas after passing through shut down valve enters the filter.

Contaminants can enter into the gas at any stage of this processing. Filters are critical at each stage to ensure clean gas as a final product. Contamination that collects during handling, water that condenses in tanks and compressors that leak oil into the fuel stream are all problems that could shorten the life of expensive equipment, create unnecessary downtime and increase maintenance costs. From pipeline to engine, filters provide the critical filtration required for most alternative fuel systems.

Installing a lower pressure particulate filter before the compressor station will remove pipe scale to prevent compressor damage. Before the gas is transported from storage to the dispenser, pre filtration of the gas with two-stage coalescing will eliminate solids, oil and water generated during underground transit. For extra protection, a high efficiency coalescer should be placed at the gas dispenser to protect sensitive dispenser metering equipment and prevent oil from making its way into the vehicle.

Filters are rated according to liquid particle retention size (micron) and efficiency, such as 0.50 micron and 99.99% .O.P. efficient, or 0.01 micron and 99.9999% D.O.P efficient.

Pipelines include a great number of valves along their entire length. These valves work like gateways; they are usually open and allow natural gas to flow freely, or they can be used to stop gas flow along a certain section of pipe. For proper flow of gas through metering skid two lines are provided . In case if emergency occurs in one of the lines then vales of this lines will get closed allowing the flow through other line.

USE OF ETHYL MERCAPTAN IN CNG GAS

Since CNG is a colourless and odourless gas so a compound known as ethyl mecaptan or ethan thiol is added to it to detect its leakage through pipelines. Ethanethiol is the organic compound with the formula CH_3CH_2SH. Ethanethiol has a strongly disagreeable odour that humans can detect in minute concentrations. The threshold for human detection is as low as one part in 2.8 billion parts of air. Ethyl mercaptan is added in very small amount in natural gas. Its odour resembles that of leeks or onions.

PHYSICAL AND CHEMICAL PROPERTIES

Appearance/Odour -water white liquid gassy or mercaptan order Ph

Specific Gravity 0.839 @ 20 C

Vapour Pressure	535 hPa @ 20 C Calculated
Vapour Density	2.1
Melting Point	-148 C
Freezing Point	-148 C
Boiling Point	35 C
Solubility In Water	6.8 g/l @ 20 C
Solubility in Other Materials	Alcohols, hydrocarbons
Evaporation Rate	NE
Percent Volatile	100
Viscosity	0.29 cP @ 20 C
Molecular Weight	62.13
n-Octanol/Water Partition Coefficient	1.26 @ C Calculated

OTHER PHYSICAL DATA ARE-

Odour threshold: 0.4 ppb (approximately)

Henry's constant: 455.8 Pa m3/mole

Refractive index: 1.431 @ 20 C

Critical pressure: Pc = 54.2 bar

PRECAUTIONS TO BE TAKEN WHILE HANDLING ETHYL MERCAPTAN-

Ethyl Mercaptan should be stored in cool, dry, well-ventilated areas which are away from heat, flame or oxidizers.

Keep Ethyl Mercaptan container tightly closed & provide it with safety relief valve to release the pressure in case if it exceeds the safety pressure inside the container.

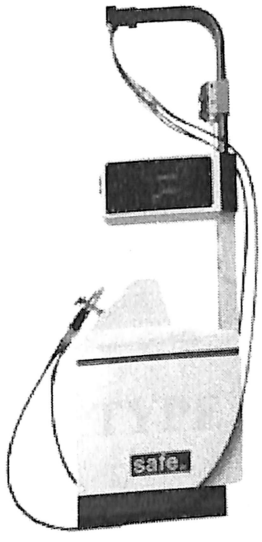
While handling Ethyl Mercaptan, try to avoid contact with liquids or vapour. Therefore, use rubber gloves, protective over clothing and covered safety goggles/face shield.

Recommendation from safety point of view in the plant if fire occurs in handling & storing areas of Ethyl Mercaptan leading to release of toxic or flammable vapors: Keep the container cool by spraying water.

DISPENSERS USED AT CNG STATIONS

QUICK FILL: DIGITAL MASS FLOW METER DISPENSER

"ESP"

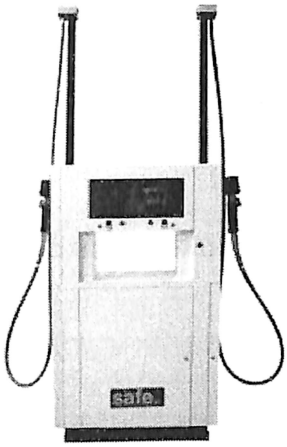


The QUICK FILL DISPENSER meters and dispenses gas into the vehicle. A wide variety of dispensers are available, ranging from a simple cabinet with a digital display to a sophisticated microprocessor controlled dispensing system.

It is typically used when the vehicle must be refuelled in a time period and manner similar to that of liquid fuels. The compressor fills the cascade; from where gas is transferred to the vehicle via the dispenser.

The calculation of gas in the dispenser type ESP is done in Kilograms through a high precision mass meter (+/- 0.5%). This dispenser is mainly used in public stations with possibility to install computerized payment systems, called Easy Host and Easy Card Systems. The maximum flow rate of this dispenser is 80 kg per minute.

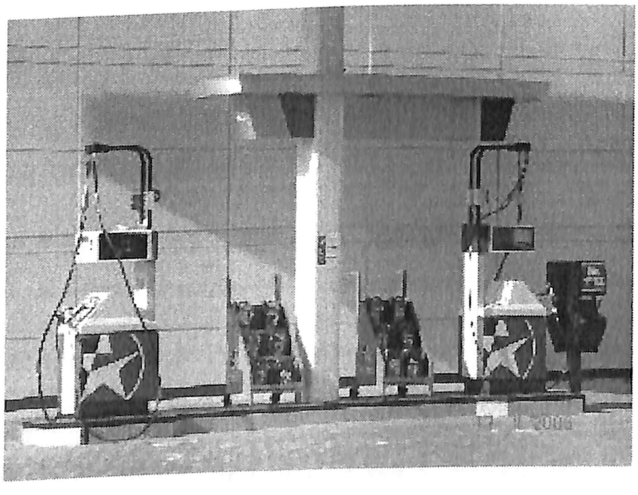
The precise engineering and manufacturing of the dispenser allows for a simple and easy programming as well as minimum maintenance once installed in the station.



TIME FILL: FILLING POINT TYPE "ESV"

For bus terminals and private stations with various capacity compressors. ESV dispenser is designed It is generally used when all the vehicles return to a central location, during which time they can be refueled.. All the vehicles are filled simultaneously via the hose poles.

It is used together with a mass meter controlled from PLC and is able to attain sequential refuelling of the light and heavy vehicles. Due to its compact size it allows for a large number of refuelling points to be installed in a smaller place and to reduce the distribution cost.



View Of Properties of Time Fill and Fast Fill Dispensers

TIME FILL DISPENSER-

- It Includes connector assembly fuelling valve, pressure gauge and hose .

- High reliability and Cost effective
- Unmanned operation once connected
- Can lower energy costs through use of cheaper off peak energy rates
- No need for storage systems
- Ideal for depot based overnight refuelling with modest daily mileage.

FAST FILL DISPENSOR-

It has "Breakaway" safety connections with single or dual hose designs

- Two types of nozzles are available NGV1 or NGV2
- Bank sequencing options are available in the range of 1-3..
- It is ideally suited for single car dispensing or as a backup dispenser at a refuelling depot.

SPECIFICATION OF DISPENSOR-

Configuration:	High profile cabinet with single delivery hose, side/lane mounted nozzle
Filling Pressure:	200bar
Maximum Working Pressure:	350bar
Maximum Flow Rate:	Up to 70 kg/minute
Operating Temperature Ranges:	-40° F to +160° F (-40° C to +60° C)
Design Codes and Standards:	NEC for Class 1, Division 1, Group D Hazardous Location ASME B31.3
Electrical Requirements:	120 VAC, 60 Hz, 3A/ or 220 volts, 50 Hz, 3A
Sequencing:	3 bank sequencing
Dimensions (W*D*H):	33" W x 22" D x 92" H
Approximate Weight:	650 lbs
Approval:	ATEX Approved

PRIORITY PANELS

Priority panel is a pressure depend valve operation panel that directs the gas flow to either high pressure storage or directly to the dispenser (or) vehicle.

To control the flow of discharge gas from the compressors to a series of storage pressure vessels the 3 bank priority panel uses a single multi port valve or multiple valves. The pressure vessels are divided in to 3 banks with each bank having one or more pressure vessels joined by a manifold. The 3 storage banks are designated as the high, medium and low banks, with the high and low banks having the highest and lowest filling priority respectively. Through the priority panel by filling the high bank , medium bank , low bank in turn the compressors operates to maintain maximum pressure in the storage banks If all storage vessel banks are depleted in pressure most priority panels shift all compressors discharge flow to feed the refuelling vehicles directly.

CNG STORAGE

One of the key components in a fast-fill NGV Refueling Station is the CNG Storage. How much storage is needed depends on the amount of vehicles, the amount of gas each vehicle requires, and the time frame in which the vehicles need to be filled.

Vessels are approximately 23 foot long. are 20" in diameter Each vessel will hold 10,000 cubic feet at 5,000 psi. They are arranged in a three bank cascade- 1. low bank vessel

2. medium bank vessel

3. high bank vessel.

A priority sequential panel is used to direct compressor discharge to the high, then medium, then low bank. When filling, a vehicle will draw first from the low bank, then the medium bank and top off from the high bank. The Compressor will replenish the cascade by filling the high bank first, then the medium bank and finally the low bank.

The storage systems used for compressed natural gas are infinitely stronger that the gasoline tanks found on cars and trucks today.

All CNG cylinders are constructed to with hold up to 1.25 times their operating design pressure and include valves and other safety devices to prevent leakage.

STORAGE SPECIFICATIONS

- 80 litres water capacity per cylinder
- Compressor feed lines – 12mm OD 316 stainless steel tubing & fittings
- Dispenser bypass line – 16mm OD 316 stainless steel tubing & fittings
- Mechanical valves set storage bank filling priority
- Maximum working pressure 350 bar g
- Gauges fitted to compressor feed line and all storage bank lines
- Lightweight panel with flexible mounting options

As a general rule of thumb, only 40% of the stored gas in a three bank cascade arrangement is available for refueling. This means that a 30,000 cubic foot storage cascade will deliver about 12,000 cubic feet of natural gas quickly. This equates to about 96 equivalent gallons of gasoline.

Storage Spheres are an alternative to the long tubes shown previously. Another form of storage that has lost popularity is DOT bottles. They resemble welding bottles and have burst disks instead of ASME relief valve. We do not like these for a number of reasons. First they need to be re-certified every five years, and second they do not have any drain valves

CONCLUSION

CNG at the present day can be seen as the future perspective. Today, the entire public transport system in Delhi NCT is running on single fuel mode of CNG. The public transport system includes around 10,500 buses, 65,000 autos and 20,000 other vehicles. Since it is a green fuel and economically has lower cost as compared to diesel, LPG or petrol. Use of CNG has made a pollution free environment possible in Delhi up to great limit As per a study conducted by the Central Pollution Board in 1998, Delhi was the most polluted metropolitan city in the country where about 65 per cent air was pollution caused by vehicles, But with the use of cng Delhi won the "Clean Cities International Award" from the US Department of Energy in 2003. Since other states of country are showing their keen interest in setting up CNG stations, so it can be easily said there is a bright future with this green gas.

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