

Assessment of Saving in Energy by Replacing Three Stage Compressor With Two Stage Compressor with Higher Suction Pressure for Natural Gas Compression at City Gate Station

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ABSTRACT

Human beings are using energy from the time of known history. Initially, mankind started using energy by firing wood. With the evolution and development of technology, world moved towards the usage of less carbon dense fuels (Wood → Coal → Liquid Petroleum products like Petrol & Diesel etc → Gases like LPG, Natural Gas etc → Renewable Energy) [1]. As Natural resources are moving towards depletion, world is looking for its alternate in development through renewable energy. With the discovery of Shale Gas (a form of Natural Gas), it can be expected that Natural Gas will act as long-term bridge from petroleum products towards renewable energy. Being eco-friendly through less carbon emission as compared to Petrol, Diesel & LPG, it is positively promoted worldwide to reduce carbon footprint. Natural gas distribution business is expanding at very faster rate in India. Thus, energy saving in this sector will further make it attractive to investor as well to customer through cost reduction.

Keywords: City Gate Station, Natural Gas compression, Compressor, Energy saving, Compressed Natural Gas, Two stage compression, Three stage compression.

I. INTRODUCTION

City Gas Distribution (CGD) is the process of distributing Natural Gas (NG) through an interconnected grid of pipelines and the allied equipment's used to transfer gas from a bulk supply high pressure transmission main trunk pipeline to the medium pressure distribution network. Natural gas is further supplied to domestic, industrial or commercial consumers and CNG filling stations at requisite pressure in a strategically located geographical area, with the help of the service pipelines.

As per an article in The New Indian express, NDA government had declared city gas distribution (CGD) networks as the status of public utility. This status makes it comparatively easier to secure government licences and clearances, and brings CGD networks under the ambit of Essential Commodities Act, which will further help increase the reach of networks such as domestic piped natural gas (PNG), industrial PNG, commercial PNG and compressed natural gas (CNG) in cities.

City Gas Distributors mainly purchases gas from mid-stream companies at specified terminals within or nearby their authorized city area by Petroleum and Natural Gas Regularity Board (PNGRB) called City Gate Station (CGS). CGS is custody transfer point, wherein mid-stream companies (like GAIL, Reliance etc) sells or transfers gas to downstream City Gas Distributors (like MGL, IGL, GGL etc), from which gas is supplied throughout the city with its distribution networks of pipeline. The pressure in distribution pipeline networks keeps on decreasing from city gate stations till consumer premises with the help of various equipment's like District Regulating Station (DRS), Meter Regulating Station (MRS), Service Regulators (SR) etc.

By promoting CGD networks, the government expects to reduce emissions which will be in line with India's commitment towards reducing its carbon footprint. This comes in the backdrop of India setting a target of natural gas contributing 15% to India's energy mix from the current level of 6.5% [2]. Proved Natural gas reserve by the end of 2015 was 1.5 trillion cubic metres in India,

which 0.8 % of world share with R/P¹ ratio of India as 50.9 [3].

II. AN OVERVIEW OF CITY GAS DISTRIBUTION

The City Gas Distribution companies purchases gas at city gate stations and supplies it to most of the city parts through gas pipelines. However, it is not always possible in certain cases to supply gas through the pipeline for certain period due to technical difficulties like major water body en-route, very long distance of stations from city gate stations, technical difficulty in building pipeline infrastructure etc. In such scenario, the natural gas supply within cities are made through cascade cylinders mounted on Light Commercial Vehicle or LCV. These LCV carries cascade cylinders through road to the Daughter Booster CNG Stations from the point of cascade filling i.e. CNG Mother Stations.

City Gate Stations are strategically located since it need to supply PNG (Piped Natural Gas) and CNG (Compressed Natural Gas) throughout the city. City Gate Stations receives gas from midstream gas suppliers in pressure range of 40 - 60 bar (g) range, which is reduced to 16-19 bar(g) by throttling process to supply through in city area. This pressure is maintained considering safety aspects of population & regulatory requirement in mind.

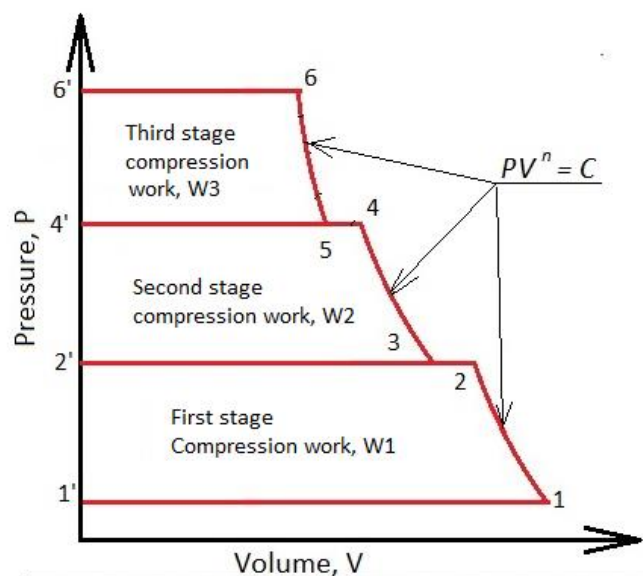
CNG Mother Stations receives gas at 16-19 bar(g), which is further compressed up to 220-230 bar(g) pressure for cascade cylinder filling. This compression is done by using 3 stage compressors from initial pressure of 16-19 bar(g) to 220-230 bar(g) & supply to city through cascade cylinder. This very high-pressure gas in cascade cylinders are supplied to Daughter Booster CNG Station to fill into CNG vehicles.



Figure1. Cascade cylinder for storage and transportation of Natural Gas.

III. THEORY

Compressors are basically intended to increase the pressure of gases. But during the compression process, temperature of gases also increases. This increased temperature is due to its release of its own internal energy. Since the process does not have any external heat addition, it may be termed as adiabatic compression process. Heat produced is dissipated through air intercooler [4].



P-V diagram for three stage compression by polytropic process

Figure 2. P-V diagram for three stage compression in poly-tropic process

Above graph represents the P-V diagram for three stage compression by poly-tropic process. Let W1, W2 & W3 are the work required in first stage, second stage and third stage of the compression respectively.

For $W1 > 0$ i. e. for positive work required for first stage of compression;

$$W1 + W2 + W3 > W2 + W3$$

i.e. work required for compression by three stage compression is more than work required for two stage compression.

This above-mentioned principal will be used to for the current project work. The overall power requirement for gas compression could be reduced by elimination of first stage compression. The elimination could be done by the use of 2 stage compressor with higher suction pressure as compared to three stage compressor.

Since the gas is supplied by midstream companies at City Gate Stations at 40-60 bar(g). By supplying this high-pressure gas directly to 2 stage compressors inlet at City Gate Stations, one complete stage of compression can be eliminated. This reduction in number of stage in compressor will help to save significant amount of energy during filling of cascade cylinders mounted on LCVs.

IV. SIGNIFICANCE & CONCLUSION

The government's gas utilization policy has put CGD on priority after fertilizer, petroleum and power projects. In future, the domestic gas production as well as imported gas are expected to grow. The future projections for availability of Natural Gas is shown in figure 3.

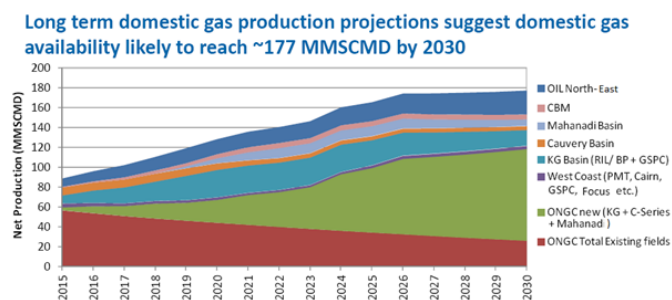


Figure 3. Long term domestic gas production projections [5]

The growth of Natural gas production will also help India to move towards gas driven economy. The government will be able to decrease the subsidies on LPG, Kerosene, Petrol, Diesel etc. Simultaneously huge import bill of these petroleum products will be reduced. These funds could be used in another area for the development. By achieving the energy savings, energy

bill could be reduced by significant amount. All energy savings made are added directly to the profitability of the company. Also, the use of Natural Gas is expected to contribute in government target to reduce carbon footprints.

V. REFERENCES

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