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Compressed Natural Gas – Turning Discrete into Useful

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Abstract

Most developing cities in China face a gas shortage problem. Expensive gas supplements are used to maintain grid gas pressure. China is rich in natural gas reserves. However, these tend to be located discretely in small-scale gas fields that cannot be utilised effectively. By converting these reserves into compressed natural gas (CNG), it is possible to turn the gas into a useful energy resource. CNG is a more convenient energy source and much cheaper than synthetic natural gas and is beginning to set a new trend for gas supplement in China, especially in small cities. The author of this paper is in charge of a CNG development project in Jilin City, in north-east China, and shares his views and thoughts regarding related engineering techniques, process flow in the gas network, safety, benefits and limitations. Future CNG business prospects are also discussed.

Background

Mushrooming development in China in the last decade has seen traditional utilities unable to meet current growth in energy demands, and temporary supply shortages are common. Gas supply is no exception. Therefore the government is putting great effort on transporting gas from gas-rich provinces to fast developing cities, such as Beijing and Shanghai. However, for those cities not so favoured, the local gas service providers have to find a means to supplement their stocks by, for example, uploading synthetic natural gas (SNG) to their grids. However the cost of supplementary gas is always higher than the selling price, (due to government price restrictions) so this obviously involves a loss for every cubic meter of gas sold.

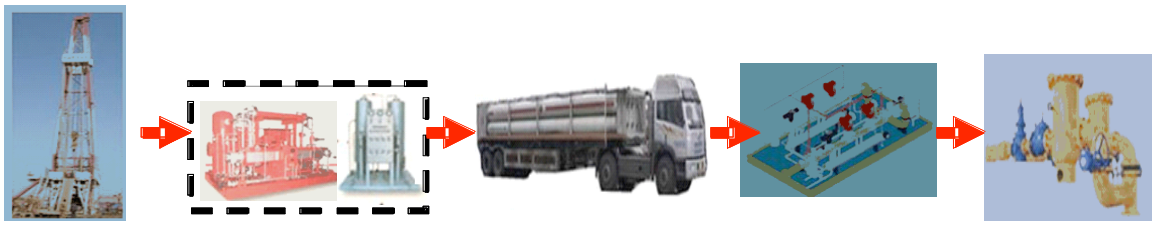
China is relatively rich in natural gas (NG) reserves, especially in the northeast. However, distribution is discrete, being spread out, and originates mostly far away from the gas main trunk, which is a high pressure pipe connects the large gas field to the major consumption cities. In order to make use of these discrete gas sources, compressed natural gas (CNG) transportation is now increasingly used as a means to facilitate uploading to the grid.

Turning Discrete into Useful

Constructing a gas pipe to connect the grid to sources in small gas fields is not cost-effective. The really only effective means is to convert NG upstream into CNG and then sell to downstream companies.

Since CNG is highly pressurised, downstream companies must have depressurising equipment before converting back into a usable form. CNG is transported by special trucks, each carrying 4,000-4,500m^3 of NG. Depending on scale and development of a city, downstream companies can determine the quantity of trucks by calculating expected consumption.

Equipment and Work Flow



The upstream CNG station is called the “mother station” where NG is pre-treated after being collected from nearby gas fields via small pipes, usually 50mm-100mm in diameter. As raw gas carries moisture from underground water, it is firstly “dried out” at the mother station before undergoing filtration to remove dirt and high-carbon substances. If the gas is high in CO_2 and/or contains H_2S, an extra process is added to eliminate these gases before the processed gas passes into a buffer tank. The gas is then compressed up to 25MPa before being finally injected into special trucks for transportation.

The mother station should have enough parking places for the required number of trucks to queue up for loading, partly to make the whole process cost-effective and partly because CNG loading time is totally dependent on performance of the compressor although it can be as quick as 1.5 hours.

Downstream, trucks unload CNG to the grid at a “daughter station”. This station consists of a governor and a preheating system which compensates for the heat loss from the Joule-Thompson effect during depressurisation. The governor is a three-stage regulating system, firstly reducing pressure from 20MPa to 8MPa, then to 1.6MPa and finally to 0.2MPa (or any other pressure as required). The gas can then be directly uploaded to the grid.

CNG uploading time is dependent on actual need with a maximum flow as high as 1,800m^3/hour. Flow is controlled simply by opening/closing the outlet valve.

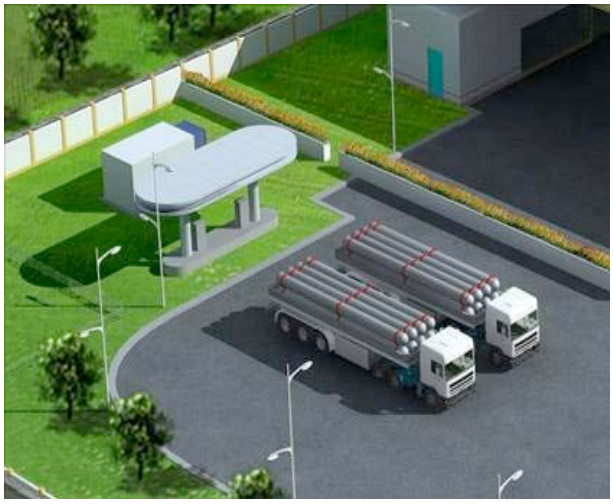
Logistics

CNG projects are heavily reliant on getting the logistics right. Time management is crucial in relation to CNG uploading and loading; dangerous goods handling has to be considered; speed control of trucks, route design,

labour arrangements and emergency handling all have to be taken into account.

If we take the case of the Jilin City as a reference, the following logistical arrangements easily bridge a 45,000m^3 gas shortfall per day.

- 600km traveling distance (round trip)
- 10 competent drivers (2 persons for round-trip transportation)
- 5 truck engines and 10 tankers
- 2 hours for loading and unloading respectively
- global positioning system (GPS) on truck (engine).



In Jilin, the most economical CNG projects are restricted to areas within an effective distance of less than 800 km (round trip). Longer transportation distances would be unjustified in view of operational costs including transportation, consumables, labour requirements, time and depreciation.

Advantages of CNG

There are many advantages in using CNG. Firstly, CNG trucks can act as gas holders for peak shaving. Although holding capacity is lower than traditional water- (or oil-) sealed gas holders, operating costs are much lower and operators can “reserve” required trucks for entire peak shaving periods. CNG also satisfy pressure and flow requirements simultaneously, whereas traditional gas holders do not.

Secondly, downstream operators can have business contracts with multiple upstream mother stations so as to ensure a stable gas supply, and trucks can be sent to different mother stations to avoid idling time of queuing at a

particular station. Use of multiple suppliers is also good for price bargaining as it lessens control by third parties.

Thirdly, the investment assets, both upstream and downstream, become mobile as opposed to a traditional fixed underground piped gas network, and operators can be more agile regarding their future business strategies. Upstream, if the gas field dries up, the equipment in the mother station can be reused for supply from another gas field. Similarly, the equipment at the daughter station can be recycled if the downstream operation is relocated to take advantage of dynamic market conditions.

Finally, if the mother station is owned by the downstream gas provider, the quality, quantity and price control of CNG can be further improved. In addition, the CNG provider can offer any surplus for sale to other mid-stream companies and potentially develop a CNG vehicle business if current petrol-fueled vehicles are converted to CNG.

Safety

CNG loading to the truck should be less than 220MPa in winter and not more than 200MPa in summer so as to ensure the safety of the cylinders where pressure may rise due to heat gain during transportation.

However, as a precaution, all CNG cylinders should be fitted with a pressure relief valve to vent off the gas if the pressure reaches 250MPa.

Fire equipment, such as extinguishers and protective clothing, should be automatically part of a truck's accessories. Drivers should also be trained to use all safety devices and competent to safely deal with the potential emergency.

Extended Applications

Industrial users located in rural areas beyond reach of city grids either have to bear the heavy construction cost of pipe laying so they can access grid gas supply, or forsake piped gas for other more easily accessible sources of fuel. But with CNG, all they need do is set up their own daughter station and buy directly from upstream (with guidance and help from downstream companies).

The benefits of using/switching to CNG are not limited to reliability of supply or

reduced fuel costs but also extend to environmental advantages. The greater the utilisation of CNG, the lower the pollutant emissions will be, owing to reduced use of coal.

Limitations

There are two main limitations to CNG development:

1. Several discrete NG resources must be available in provinces or cities to be cost-effective and more than one mother station is recommended.
2. Transportation distances should ideally be shorter than 400km one way from mother to daughter station so as to keep operating costs as low as possible and the selling price in an acceptable range.

Conclusion

CNG is an ideal solution for solving the problem of energy shortages in developing cities in China, especially for supplementing the existing network. The investment is reasonable and CNG trucks can be used as mobile gas holders for peak shaving. Technically, CNG can satisfy the pressure and flow requirements during unloading so as to ensure an uninterrupted supply of gas. Although CNG projects have to be limited to resources within reasonable transportation distance, CNG is relatively simple to utilise with room for future business expansion.

The author believes that CNG will be an important trend in gas engineering development in coming decades, not only for China, but other countries where energy shortages are prevalent and discrete NG resources are available within reasonable transportation distances of gas consumption areas. The successful case of turning discrete into useful in Jilin City has proven its value and could be a model for other cities experiencing similar conditions.