

Compressed natural gas: A problem or a solution?

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Productivity of the citizens depends on their health. In a polluted environment, health will be the first casualty. The Supreme Court passed an order for converting all public transport vehicles, which were considered to be highly polluting, to compressed natural gas (CNG) mode in an effort to clean the environment of Delhi. This article endeavours to address the issues on clean fuel, specifically focusing on CNG.

CONFUSION and chaos prevailed in Delhi during the first week of April last year. People were stranded all around trying to reach their destinations. With a handful of 'packed' buses, the impending journey gave them nightmares. 1 April 2001 marked the deadline for converting all public transport vehicles to compressed natural gas (CNG) mode, without which they could not ply on Delhi roads. The Supreme Court (SC) had passed this order in July 1998 and had given enough time for the switch-over. However, the various governmental bodies, including the Delhi government failed to ensure implementation of the SC's orders.

The air in Delhi in the past decade had become one of the most polluted in the entire world, over 60% of this pollution being vehicular. Separate studies done by various agencies prove that this leads to a terrible burden on the health and efficiency of the citizens. Intervening in the matter, the SC wanted the then government to take steps to curb the pollution. The Delhi government in 1996 filed an affidavit stating that CNG had the best potential for controlling pollution in the city and asked for two years time to convert all city buses to the new CNG mode. On 28 July 1998 the SC set 31 March 2001 as the deadline for converting the entire fleet with single-mode CNG kits, to cut air pollution. The SC gave directives that more than 2000 pre-1990 modules of taxis and auto-rickshaws had to be phased out by 31 March 2000 and an equal number of post-1991 models had to be phased out by 31 March 2001. In March 1999 (8 months after the SC's order), the Delhi government announced the first tender for conversion of its fleet of buses. CNG emission norms came in February 2000 (more than one and half years after the order) and the Ministry of Surface Transport approved the CNG conversion kit design in January 2001. The entire process was at such a slow pace that at

the end of the deadline, the government tried to use chaos in public transport as a weapon to pressurize the court.

Delhi's transport system

The number of motor vehicles in Delhi is more than those in Chennai, Mumbai and Kolkata combined (Table 1). Over 37% of the present estimate of 35 lakh plus vehicles in the city is in the category of personalized transport. Two wheelers, mostly with two-stroke engines account for the largest share of total number of registered vehicles in Delhi. Public transport vehicles are less than 1.5 lakh in number, of which buses are about 10,000, taxis 15,000 and auto-rickshaws about 45,000 in number. Buses in Delhi constitute less than 1% of its total transport fleet, but meet 50% of travel demand and cause over 25% of accidents in the capital.

Ring rail in Delhi is utilized only up to 30% of its capacity. Trucks are the single largest polluters of the city's environment. About 50,000 trucks running on diesel pass through or ply in the capital every day. They cannot be converted to CNG mode as they frequent other cities as well.

Natural gas – Some basic facts

The concept of natural gas (NG) as an automotive fuel dates back to the 1930s. In Australia it was considered as an automotive fuel in 1937 and France used it during the World War 1. Canada and New Zealand started their conversion programme in the early 1970s and some Asian and South American countries in the 1980s. Besides using NG to power vehicles, it has been tried out for electricity and for heating homes and commercial buildings.

NG in India is being consumed mainly by the fertilizer and power industry since 1984. In 1992, the Gas Authority of India Limited introduced a CNG network in India, but it failed to take-off due to limited number of private

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vehicles switching over. CNG has been an option as an automotive fuel since 1994 under the Central Motor Vehicle Act. Major bulk of vehicles running on CNG is found in Mumbai and Delhi, as well as a few cities in Gujarat like Vadodara, Surat and Ankleshwar.

NG is a fossil fuel more evenly distributed worldwide than crude oil. It is found in reservoirs 3000 to 15,000 feet below the surface of the earth, with reserves in about 90 countries around the world. World-proved reserves of NG at the end of 1999 were about 5172 trillion cubic feet (TCuF)¹. While two-thirds of crude oil reserves are concentrated in the Middle East, only one third of NG reserves is found there (Table 2). India has more gas reserves than oil reserves. According to the Ministry of Petroleum and Natural Gas, in 1999 India had 660.32 million tonnes (MT, 1 t = 1000 kg) of crude oil reserves, while NG reserves were 647.96 billion cubic metres (BCuM, 1 cubic m = 1000 l)². NG can thus reduce the dependence on oil, stretching its availability and thereby cutting the import bills. In India, it is obtained from Bombay High and is also available in other areas like Krishna–Godavari basin, Assam and Tripura in the north-east, the Cauvery basin, etc. Unlike oil, natural gas is not required to be imported by India. The gross production was 28,446 million cubic metres (mcm) in 1999–2000, while utilization was 26,885 mcm (ref. 3).

CNG – An alternative

CNG is a safe fuel. Being lighter than air, it disperses easily into the atmosphere and does not form a sufficiently

rich mixture for combustion to take place. CNG is 130 octane, which is considerably higher than 93 octane for petrol; consequently, CNG vehicle is more energy-efficient. Higher octane rating allows higher compression ratios and improved thermal efficiency⁴, reducing carbon dioxide emissions. CNG allows the use of catalytic converter more efficiently than diesel. Compared to petrol or diesel, CNG vehicles emit 40% less of nitrous oxide (a toxic gas that creates smog), 90% less of hydrocarbons (which carry carcinogens), 80% less of carbon monoxide (a poisonous pollutant), and 25% less of carbon dioxide (a major greenhouse gas). Further, noise level of CNG engine is much lower than that of diesel⁵.

According to the World Health Organization, diesel exhaust is 'probably carcinogenic', while the United States Environmental Protection Agency declared it 'likely to be carcinogenic'. Diesel exhaust has a high fraction of polycyclic aromatic hydrocarbons (PAHs) and suspended particulate matter (SPM) that cause cell mutations which may ultimately lead to cancer. High-quality diesel with low sulphur (or ultra-low sulphur diesel, ULSD) emits very minute particles, which can even penetrate deep into the lungs. According to German Federal Environmental Agency's estimate a conventional diesel bus is roughly 100 times more harmful than a CNG bus, while diesel engines with particulate filters (Euro IV) still being more harmful than CNG engine by a factor of four⁶. However, a thorough comparative study, with pros and cons of ULSD is not yet available. Various experiments are being conducted around the world and as of now, CNG seems to have passed the test of a better fuel than diesel.

Table 1. Registered motor vehicles in metropolitan cities of India (in thousands)

Year*	Kolkata (K)	Chennai (C)	Mumbai (M)	Total (K + C + M)	Delhi
1986	339	228	480	1047	961
1991	475	544	629	1648	1813
1994	545	689	608	1842	2239
1998	664	975	860	2499	3033

*As on 31 March 2001

Source: Handbook on Transport Statistics in India 1999 and Motor Transport Statistics of India, 1997–98.

Table 2. Distribution of world natural gas reserves and oil reserves, 1999

Region	Natural gas reserve		Oil reserve	
	Trillion cubic feet	Percentage of total	Thousand MT	Percentage of total
North America	258.0	5.0	8.4	6.2
Central and South America	222.6	4.3	12.9	8.7
Europe	181.7	3.5	2.7	2.0
Former USSR	2002.6	38.7	9.1	6.3
Middle East	1749.3	33.8	91.5	65.4
Africa	394.2	7.6	10.1	7.2
Asia Pacific	363.4	7.0	5.9	4.3

Source: Ref. 1.

Risks involved: The darker side

CNG technology is in a state of evolution and therefore changing all commercial vehicles to single-fuel CNG might not be feasible. The entire investment in changing the vehicles to CNG mode and acquiring new vehicles within a short span will lead to ageing of all the vehicles at approximately the same time. A huge cost required to set-up the infrastructure for CNG in a very short span is bound to reflect in budgetary deficit. Further, any mishap or disruption in a 1200 km pipeline supplying CNG can bring the entire public transport in Delhi to a standstill.

A dedicated CNG vehicle can be stranded on the way for want of gas due to limited number of CNG filling stations. Therefore, a dedicated CNG vehicle has to be close to a refuelling facility, limiting its driving range. According to the SC order the entire public transport is to be converted to only single-mode CNG and hence dual-fuel technology cannot be operated in Delhi for public transport. (However later the SC has clarified that taxis and auto-rickshaws with 4-stroke engines could run on low benzene petrol, but buses could only ply with CNG in Delhi.) As, at present, CNG facilities are not available outside Delhi, tourist and transit buses that ply outside Delhi do not have access to CNG outside the city. Currently there are other problems: (a) it takes hours for refuelling of CNG vehicles because of long queues due to inadequate number of filling stations. (b) Most of the filling stations in Delhi are located in the southern half of the ring road because of which the vehicles have to travel a long way for filling gas and (c) Paucity of trained mechanics for CNG kits have made repairs expensive. Commitment is required on the part of the government, to improve the infrastructure quickly to eliminate the long queues.

Other options

Various efforts are on to find alternative fuels viable for Delhi. Battery-operated vehicles are the cleanest 'zero

emission' vehicles and are plying on selected routes in Delhi, but have a limited range and carrying capacity. Further, the frequent load-shedding prevalent, especially in Delhi, is likely to affect timely recharging. Liquefied petroleum gas (LPG) has been recently given the green signal for use as automotive fuel. The safety considerations are vital and need to be addressed on priority basis. Setting up an LPG pump is expensive. The conversion costs of vehicles to LPG may be lower compared to CNG, but the running cost is much higher. About 15–20% substitution of diesel with alcohol has been in use in the West, but the vehicle requires retrofitted fumigation system. The Petroleum Ministry in India had favoured methyl tertiary butyl ether (MTBE), a carcinogen, as a blending stock resisting the use of ethanol. But now reports of ethanol being used to blend gasoline are under trial in some cities in Maharashtra and Uttar Pradesh and performance in respect of vehicle functioning and air pollution is being studied. Propane is a clean fuel, but very expensive. In the US, although LPG dominates the alternative fuel vehicles (AFV), CNG has lately shown the highest growth rate among all AFV types (Figure 1), due mostly to the low cost of NG and extremely low emissions from CNG vehicles, which make them attractive to fleet operators in urban areas⁷.

Examples from other countries

Argentina is the only country in the world to have converted over 6 lakh vehicles to CNG and is presently converting 3000 vehicles every year to CNG. Many countries like USA, Canada, UK, Italy, Thailand, Iran, Australia and New Zealand use CNG as an automotive fuel. Australia and America use it in fleets and other countries prefer it in private vehicles. The US has 87,500 vehicles running on NG with 40% of the total number of CNG refuelling stations in the world, according to the latest data from International Association for natural gas vehicles. The US now plans to power one out of every five new buses with alternative fuels, mostly NG. Accord-

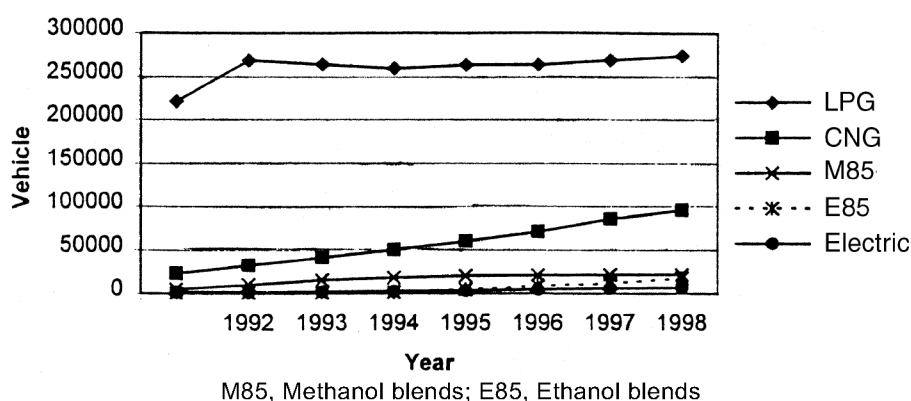


Figure 1. AFV populations by fuel type (Source: Ref. 7).

ing to China's Energy Policy of 1977, gasoline and diesel were to be substituted with NG for motor vehicles, which is now a mature technology. Most of the vehicles in Japan run on LPG, but are now opting for CNG. Bangladesh too plans to convert its fleet to CNG mode. Italy has about 3,00,000 vehicles running on CNG, with a network of 280 filling stations. Pakistan has declared CNG as 'the fuel of the future'. The conversion process has been going on for the past five–six years and Pakistan is now successfully running about 1,60,000 vehicles on CNG. By converting 1,00,000 cars to CNG, Pakistan plans to save about US \$ 30 million per year. In UK, the market for CNG vehicles has expanded rapidly over the past five years. Korea too proposes 20,000 diesel-powered buses to be replaced by those running on CNG.

The CNG debate

A few experts believe that it is not desirable to have the entire public transport system based on one clean fuel. Consequently the SC, in September this year, clarified that taxis and four-stroke auto-rickshaws could run on low benzene petrol. A few other experts believe that buses plying on the CNG mode might be eco-friendly, but not people-friendly. A campaign, that CNG might cause severe problems by emitting ultra-fine particles that may lodge in the lungs adversely affecting the health of the people, was launched in Delhi. Although CNG engines emit ultra-fine particles, they are less in quantity than those of diesel engines, and particles from diesel engines are more toxic than particles from CNG engines. Others opine that it would be desirable to lay down permissible limits to pollution and specify the degree of environmental quality that should be achieved and maintained than to prescribe specific technologies and regimented solutions. However, according to the standards laid down by the Bureau of Indian Standards (BIS), Delhi is not just polluted, but 'highly polluted'. And various studies show that more than 50% of this air pollution is due to vehicles, diesel vehicles being the worst contributors. An unpublished study by Centre for Science and Environment, Delhi on 'Emission Load Estimation' predicts that more than 50,000 additional deaths will occur over the next ten years (2001–2010) due to toxic particles in Delhi, if the SC's orders, on moving the entire public transport to CNG are not implemented as scheduled. The Tata Energy Research Institute argues that nowhere in the world has any agency, responsible for meeting travel needs on a large scale, opted to convert its entire fleet to run on CNG⁸. Nevertheless there are examples coming from other countries like Pakistan, who have changed over some private vehicles and the entire fleet of buses (aggregating to over one and a half lakhs) to CNG mode and consider it a success in cutting import bills.

A study commissioned by the Indian Oil Corporation (IOCL) and conducted by Indian Institute of Technology,

Delhi⁹ on air quality impact assessment by changeover to CNG buses in Delhi states that CNG is no better than ULSD as an automotive fuel. It states that conversion to CNG reduces nitrogen oxide and particulate matter, but increases carbon monoxide and hydrocarbons. However the study has been done over a short period of time, at busy traffic locations. A few experts believe that the study should have been based on emission measurements rather than on a model using traffic flow measurements at busy traffic locations which is a wrong method of assessing pollution levels. Also it is based on assumptions that if the bus fares go up there would be a shift of passengers to 2-wheelers and 4-wheelers which would increase the pollution.

The Bhure Lal Committee had termed CNG as well as ULSD as only 'environmentally acceptable' fuels and not clean fuels. This report¹⁰ was submitted to the SC in reply to the court's demand for finding out a clean fuel. In fact, ULSD is termed acceptable only if the vehicle has exhaust fitments like catalytic regeneration trap (a gadget similar to a catalytic converter, but costs much more). Yet it does not mean that ULSD is a better fuel compared to CNG.

Safety aspects

Safety of CNG vehicles is a very important aspect. Authentic cylinders are priced between Rs 10,000 and 15,000 depending on the capacity, while spurious versions are reportedly available for Rs 5000 in Delhi and between Rs 1000 and 3000 in Mumbai. The spurious cylinders are the main cause of explosion and accidents in CNG vehicles. The BIS is preparing a status report on safety norms for CNG-run vehicles. The draft document of CNG safety has design requirements for the components of CNG-run system. Norms evolved for CNG vehicles by the International Organization of Standards (ISO) – the apex body under the United Nations umbrella – are in the 'final-draft' stage. The BIS normally waits for international guidelines before coming out with its own ones. While ISO guidelines would be used as broad guidelines, the national standards would be more specific.

Conclusion

A comprehensive public transport policy coupled with good infrastructure is needed in Delhi to meet the needs of its ever-increasing population. CNG technology is in the state of evolution. Introducing a new technology takes time to mature. It was the government which had suggested that CNG is a better option for solving Delhi's air problem. Accepting the judgement of the Honourable Supreme Court, Delhi has to changeover with some hardships to its commuters. Once the whole infrastructure starts running smoothly, Delhi will definitely experience the pleasure of breathing cleaner air. Although no sys-

tematic study on trials, infra-structural requirements and safety aspects were done for Delhi roads, CNG vehicles are plying with public experiencing the strengths and weaknesses of the system in real time and specifically the aspects mentioned above. The government has to gear up with its process of making the infrastructure available anticipating the growing demand in future. In fact, a systematic study of demand–supply and various components would be worthwhile. Further, the safety norms need to be highlighted immediately as well as making the users aware of the precautions for handling the vehicle. If proper training is imparted to the users, CNG can become a cost-effective, efficient, easy to maintain and user-friendly solution to overcome environmental problems. If the choice lies between living in a cancerous environment and a cleaner environment with hardship for sometime, people are sensible enough to make their decision and would surely honour the SC's decision.

Various steps need to be followed strictly to improve the quality of air. Pollution Under Control (PUC) certificates are no longer effective and need to be replaced by random surprise emission checks. This rule needs to be followed strictly not only in Delhi, but also throughout India. A national agenda is required rather than concentrating on National Capital Region. There is an urgency in defining the national emission norms. Thereafter manufacturers could take full responsibility for the emission of vehicles on the road. 22 September 2000 was observed as a car-free day in over 800 cities in Europe to emphasize the importance of improving air quality. India could also

take up similar initiatives in its awareness programme and make people aware of the difference in breathing polluted and pollution-free air.

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