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Reduction in Vehicular Pollution and Cost of Fuel in Gulbarga City –A Case Study

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Abstract : *This paper deals with the pollution emitted by the Diesel fueled vehicles of Gulbarga city and suggestions to reduce the emission levels by the use of an alternative clean fuel CNG. The pollution loads have been calculated and compared by considering usage of the Compressed Natural Gas (CNG) in place of conventional diesel fuel in various categories of vehicle running in Gulbarga City.*

To carry out this study, the Gulbarga city was considered and collected the required information such as the total number of diesel fueled vehicles and daily kilometres operated by the various vehicles. Total diesel consumption every day was also collected. These vehicles run on diesel fuel and are responsible for largest amount of lead emissions and various other pollutants. The pollution loads calculated on the basis of information collected from the Automobile Research Association of India (ARAI), Central Pollution Control Board (CPCB), Environment Protection Agency and previous studies carried out in this regard by various important agencies. The use of CNG shows tremendous reduction in various pollutants in gm/km. By the use of CNG we can find 84% reduction in CO, 58% reduction in NOx and 97% reduction in PM.

Keywords: *Vehicular Pollution, Cost of Fuel, Gulbarga city, Compressed Natural Gas (CNG)*

INTRODUCTION

At present, 'Gulbarga' is officially called as 'Kalaburagi' which means stony land in Kannada. Kalaburagi district is situated in the northern part of Karnataka State. In the earlier days, Kalaburagi was a district of Hyderabad Karnataka area and became a part of Karnataka State after re-organization of states. Kalaburagi is 613 km north of Bengaluru, the capital city of Karnataka and well connected by road to Bijapur, Hyderabad and Bidar.

Bengaluru is one of the most polluted cities and Kalaburagi city is the next polluted city in Karnataka (Kozhisseri, 2008). The high level of air pollution is because of vehicles and construction activity according to the Chairperson of the Karnataka State Pollution Control Board (2010). The study was conducted across 14 monitoring locations under the National Ambient Air Quality Monitoring Program. The recent study reveals that the ambient air concentration of Kalaburagi air pollutants is above acceptable levels.

The reason behind Kalaburagi's increased air pollution is mainly because of cement industries existing around the Kalaburagi city and enormous increase in the vehicles of all the classes in and around the city.

Diesel related pollutants are either already very high or rapidly increasing in all Indian cities. Both particulates and nitrogen dioxides have emerged as pollutants of concern in Indian cities. The contribution of diesel emissions to fine particulate matter, oxides of nitrogen and other carcinogens like polycyclic hydrocarbons cannot be underestimated. The sulphur dioxide (SO2) and nitrogen oxides from diesel vehicles also contribute significantly towards the build-up of secondary particulates and ozone. The particulate emissions from uncontrolled diesel engines are 6-10 times greater than those from petrol engines. Extremely tiny diesel particles go deep into the lungs and are also very toxic. Diesel vehicles, however, emit lower carbon monoxide (CO) and hydrocarbons (HCs) compared to petrol vehicles.

Controlling urban air pollution is turning out to be an enormous challenge not only because of the rising number of total vehicles but also due to the increased toxic risk from the growing number of diesel vehicles. In 1999, Centre for Science and Environment (CSE) had advocated the ban on diesel vehicles. Accordingly, Govt. of Delhi implemented and started using CNG in place of conventional diesel fuel and it is found that enormous reduction in air pollution was reported.

We need cleaner alternative fuels to Kalaburagi city's vehicles. Serious efforts are needed to create awareness among the consumers to make their vehicles eco–friendly to reduce emissions. In this study, we are proposing alternative fuel – CNG for the vehicles of Kalaburagi city because of its many benefits.

There is also a need to exploit propane and other cleaner fuels like bio-diesel etc. CNG is considered as alternative fuel because of its many benefits stated below:

1.2 Benefits of CNG

1. Low NOX emission due to lower combustion temperature.
2. High possible power output: A suitably designed natural gas engine may have a higher output compared with a petrol engine.
3. High octane number than gasoline.
4. Higher compression ratio: the octane number of natural gas is higher than that of petrol as this would allow for an engine design with a higher compression ratio.
5. No possibility of fouling of spark plug: Due to the absence of any lead or benzene content in CNG, the lead fouling of spark plugs is eliminated.
6. Lower maintenance costs: when compared with other fuel-powered vehicles.
7. No spill and evaporation losses.
8. Increased life of lubricating oils: CNG does not contaminate and dilute the crankcase oil.
9. No visible tail pipe emissions.
10. Eliminates Sulphur and lead from the exhaust emissions.
11. Reduction in CO, NOx and PM emissions.
12. Significant reduction in benzene and other toxic emissions.
13. Higher octane value of CNG reduces knocking problems of a vehicle.
14. Reduces noise from running vehicles.
15. CNG cannot be adulterated.
16. Reduce noise in operation.
17. Easy mixing with air for combustion: CNG mixes easily and evenly in air being a gaseous fuel.
18. High auto ignition temperature: since it has a high auto-ignition temperature (540°C) and a narrow range (5%-15%) of in flammability.
19. Because of all these the CNG is used as future alternative fuel for Transport Sector in India for another 30 years, because it is estimated that overall local reserves of Natural Gas in India amounts to 27 years of supply with the current demand (As per Indian Petroleum and Natural Gas Statistics 2010-11) and easily available technology.

1.3: Scope and objectives of the present study

Kalaburagi is the Regional headquarter and is very much plagued today by environmental degradation. Particularly air pollution is alarming because of the high growth in vehicle population. Kalaburagi is second highly polluted city in Karnataka. The pollution is mainly due to emissions from increasing population of vehicles of all categories, in addition to emissions from cement industries around the city. The main scope and objective of the present study is to minimize the present vehicular pollution by using an alternative fuel, mainly CNG as this is better alternative fuel in terms of reduction of emission towards saving the environment.

Euro III diesel cars emit 7.5 times more toxic particulate matter (PM) than comparable petrol cars. This means, one diesel car is equivalent to adding 7.5 petrol cars to the car fleet in terms of PM. Diesel Vehicles are legally allowed to emit nearly three times more NOx as per the Bharat Stage III (Euro III equivalent) norms. Investigations carried out by CSE, based on actual emissions data available from the Pune-based Automotive Research Association of India; expose enormous differences in the actual emission levels of Euro III (Bharat Stage III) diesel and petrol cars that are currently sold in Delhi and other major Indian cities. Euro III diesel cars emit 7.5 times more toxic particulate matter (PM) when compared to petrol cars. This means, one diesel car is equal to adding 7.5 petrol cars to the car fleet in terms of PM emissions and 3 petrol cars in terms of NOx emissions. This clearly reflects the flawed emission standards that allow diesel cars to emit more NOx and PM when compared to petrol cars. Therefore, to avoid the diesel pollutants, the study gives awareness to the Kalaburagi people to switch over to the clean and green alternative fuel, CNG to minimize the pollution level in the city and to save the environment.

When compared to several other cities in India in particular, and several other cities around the world, Kalaburagi city is considered in this study as a case in point, for detailed study to minimize the vehicular pollution by using alternative fuel CNG by collecting data for a period from 2010 to 2014.

1.4: Scenario of CNG Availability at Kalaburagi

City Gas Distributors (CGD) Bidding Rounds for grant of authorization to develop CGD networks has been notified the Public Notice by Petroleum and Natural Gas Regulatory Board 1st Floor, World Trade Centre, Babar Road, New Delhi -110001 on 8th September, 2014 for the Kalaburagi District of Karnataka by its Annex-II. (Public Notice by Petroleum and Natural Gas Regulatory Board 1st Floor, World Trade Centre, Babar Road, New Delhi -110001 on 8th September, 2014).

KSIIDC's Chairman and Managing Director, V.P. Baligar told The Hindu (The Hindu, 2014) that without waiting for the new company to be formed, the State body would pitch for the project jointly with its Union government partner.

Within Bangalore, he said setting up the gas pipeline network would take 18 months and could have been done speedily if the project was assigned directly. While home supply is one plan, the other is to bring clean compressed natural gas to city transport systems, he said. GAIL and KSIIDC have for some time planned to form the joint distribution company, tentatively named Karnataka Natural Gas Ltd. Mr. Baligar said the State was keen on taking the project to Mangalore, Mysore, Hubli-Dharwad, Kalaburagi and places that fall near the 1,000-km Dabhol-Bangalore gas pipeline. Accordingly Kalaburagi city and various other cities in Karnataka also get CGD and hence, we will be getting CNG pipe line connection for Domestic as well as Transportation Purpose (The Hindu, 2014).

2. METHODOLOGY

The following methodology has been adopted during present study: Relevant literature has been reviewed from various journals, conference proceedings, unpublished reports of Government and Non-Government Organizations, and other published literature.

1. Data related to types and number of vehicles were collected from the RTO, Kalaburagi.
2. Information regarding the total number of buses entering the Kalaburagi Bus Stand every day from NEKRTC, Kalaburagi Central Bus Stand was collected.
3. Information about the number of Omni buses in Kalaburagi city was collected from RTO, Kalaburagi and their average operated kilometer per day, was collected from various school bus drivers.
4. The emission factors of various class vehicles were collected from Automotive Research Association of India, Pune, Central Pollution Control Board, New Delhi and from other important agencies and reliable sources.
5. The available data was be processed and analyzed with data collected from Kalaburagi city the for the purpose of study.
6. Pollution loads were calculated by using emission factors and vehicle travel kilometer for various categories of vehicles.
7. Predictive mathematical calculations were made for the future predictions of pollution loads in Kalaburagi city up to the year 2020.
8. To estimate, the impact of the conversion of vehicles to CNG under this approach, first estimated the emissions load of CNG vehicles, which, in turn, is given by the emissions factor for CNG

3. COLLECTION OF DATA

For the purpose of the study, the data of various vehicles registered in Kalaburagi for the financial year 2010-11 and 2011-12 was collected from RTO Kalaburagi, and using this data the increase in number of vehicles of Kalaburagi projected up to the year 2020 and is as given below in table 3.1.

The buses visiting Kalaburagi Central Bus Stand was collected for the study purpose by visiting and enquiring the number buses entering the city from various places and the same is tabulated in the following Table No. 3.2

The traffic survey was conducted at various points (places) of Gulbarga city to count the vehicles on road side and their travel kilometer in Gulbarga city.

The questionnaire was prepared as given below.

1. Registration Number
2. Name of the jeep owner
3. Daily average kilometer travel
4. Daily average fuel consumption
5. Monthly average kilometer travel

By using this data Projected km travel/day of all vehicles in Kalaburagi City as on 31/03/2020 were calculated and shown in following table.

Table 3.1: The increase in number of vehicles of Kalaburagi projected up to the year 2020

Kalaburagi	Jeeps	Rental Cars/ Cabs	Omni Buses	Goods-Vehicles
Percentage	19%	64%	7%	50%
2013	1388	1250	2424	10842
2014	1651	2000	2594	18070
2015	1964	3200	2775	27105
2016	2337	5120	2970	40658
2017	2781	8192	3178	20328
2018	3309	13108	3400	30492
2019	3937	20972	3638	45739
2020	4685	33555	3893	22870

Data Collection of Emission Factors for Vehicles from ARAI

As per the objectives of research the Summary of Finalized Emission factors for Indian Vehicles have been collected from the Automotive Research Association of India (ARAI), Pane for the purpose of calculation of pollution loads of the Kalaburagi city. The data is given below in Table 4-19 and 4-20

This particular study draft report on "Emission Factor development for Indian vehicles", as a part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies, Pune, is done by the Automotive Research Association of India (ARAI), 2007. This is very essential to our research work, it consists all aspects of our study. The data of emission factors are taken from this study and analyzed with our study. This has shown the reduction in emissions of Kalaburagi City by replacing conventional fossil fueled vehicles into CNG.

Table: 3.2: Buses coming to Central Bus Stand, Kalaburagi every day from various places

Sl. No	Plat Form Numbers	Towards Destination	Number of Buses coming to GBS/Day	Kilometer Travelled in City from Kalaburagi Bus Stand	Total KM travelled
1	1 and 2	Jevargi	124	6+6=12 *124	1488
2	3	Hyderabad	57	5.9+5.9=11.8*57	672.6
3	3A	Bidar	113	5.9+5.9=11.8*113	1333.4
4	4	Bijapur	100	6+6=12*100	1200
5	5	Chincholi	54	9+9=18*54	972
6	6	BasavKalyan	43	5.9+5.9=11.8*43	507.4
7	7 and 8	Aland	106	4.8+4.8=9.6*106	1017.6
8	9 and 10	Afjalpur	119	5+5=10*119	1190
9	11	Shahabad	27	6+6=12*27	324
10	11A	Chittapur	37	9+9=18*37	666
11	12	Seram	83	9+9=18*83	1494
13	13	Shapur, Surpur	104	6+6=12*104	1248
	Total Travel km of 967 buses per day in Kalaburagi city is equal to 12113km				

Table 3.3: Projected km travel/day of all vehicles in Kalaburagi City as on 31/03/2020

Sl. No.	Type of Vehicle	Number of Vehicles as on 31/03/2020 as per Table 5.4	Daily avg. travel km of vehicles	Total Km travelled in Kalaburagi City
1	Buses	4248	24	1019712
2	Trucks/Lorries	17327	15	259905
3	Dumpers	8901	12	106812
4	Cement Trucks	4508	12	54096
8	Jeeps	4685	75	351375
9	Rental Cars	33555	91	3053505
10	Omni Buses	3893	50	194650

Table 3.4: Summary of finalized Emission Factors for Cars & HCVs from ARAI

Sl.No	Type of Vehicle	Sub Category	Vintage	Fuel used	Emission Factors in gm/km				
					CO	HC	NOx	CO_2	PM
1	Passenger Cars/Jeeps (Diesel) BS-I	<1600cc	Post 2000 MIDC	BS-II	0.72	0.14	0.84	156.76	0.19
2	Passenger Cars (CNG) BS-I	1000-1400cc	Post 2000 (MIDC)	BS-II	0.6	0.36	0.01	131.19	0.002
3	HCV Diesel Bus	>6000cc	Post 2000	BS-II	3.97	0.26	6.77	735.51	1.075
4	HCV Diesel Truck	>6000cc	Post 2000	BS-II	6	0.37	9.3	762.39	1.24
5	HCV CNG Bus	>6000cc	Post 2000	BS-II	3.72	3.75	6.21	806.5	0.044

(Source: ARAI, Draft Report-2008)

4. CALCULATION OF POLLUTION LOADS

The pollution loads have to be calculated in gm/km, kg/day, ton/day or ton/year. To calculate pollution loads we require Emission factors of various vehicles and vehicle travel kilometer. "Emission Factors", by definition, represent the release of a pollutant due to combustion of fuel, with common units of gm/veh-km, under a variety of conditions, e.g., loaded and unloaded; idling; cold starts; and cruising. An emission factor is typically established based on testing a number of vehicles (with varying age and mix) to arrive at an average number.

Therefore, For the purpose of the present study the data of emission factors of various vehicles were collected from Automotive Research Association of India, Pune, as it has conducted the test of similar vehicles as shown in Table .3.3 and 3.4 and vehicle travel kilometers were collected by conducting various surveys in Kalaburagi city. The buses visiting Kalaburagi Central Bus Stand were collected for the

study purpose by visiting the and enquiring the number buses entering the city from various places and the kilometer travelled in Kalaburagi city were taken from the Table 4-16 and Emission factors were taken from 3.3 and 3.4. The Pollution loads are calculated and shown in the following Table 4-1

Table 4.1 The Comparative emission factors in gm/km of Kalaburagi city's buses travelling total of 27312 km/day as on 31/03/2015

Type of Vehicle	Emission Factors in gm/12113km/day				
	CO	HC	NOx	CO_2	PM
HCV Diesel Bus >6000cc Post 2000, BS-II	3.97*27312 = 108428.64	0.26*27312 = 7101.12	184902.24	735.51*27312 = 20088249.12	1.075*27312 = 29360.4
HCV CNG Bus>6000cc Post 2000, BS-II	3.72*27312 = 101600.64	3.75*27312 = 102420	6.21*27312 = 169607.52	806.5*27312 = 22027128	0.044*27312 = 1201.72

In this way the calculations were calculated and given in the following table:

Table 4.2 Gross reduction various emission factors in Ton/Year by the use of CNG in Kalaburagi city as on31/03/2020:

Type of Vehicle/Pollutants	CO (Ton/Year)	HC (Ton/Year)	NO_X (Ton/Year)	PM (Ton/Year)	CO_2 (Ton/Year)
Jeeps	149.13	-----	1029.3	233.64	31776.9
Omni Buses	17.76	-----	39.78	73.24	4899.41
Buses	93.04	------	208.42	383.73	25666.55
Trucks/Lorries/Dumpers	350.19	------	474.5	183.70	10592.03
Total Reduction	14300.12	2178.21	1798.72	1412.216	97335.14

Table: 4.3: The Total fuel i.e., Diesel, Petrol and LPG required in Indian Rupees

Sl. No.	Type of Vehicle	Number of Vehicles as on 31/03/2020 as per Table 5.4	Total Km travelled in Kalaburagi City	Avg. Consumption of Fuel /Liter	Fuel Required in Liters	Cost of Diesel/ Petrol /LPG/ Liter in Rs.	Total cost in Rs.
1	Buses	4248	1019712	4.5 km/liter	226602.66	55.83	1265144.64
2	Trucks/Lorries	17327	259905	4.4	59069.31	55.83	3297839.57
3	Dumpers	8901	106812	4.2	25431.42	55.83	1419836.17
4	Cement Trucks	4508	54096	4.2	12880	55.83	719090.4
5	Jeeps	4685	351375	12.25	28683.67	55.83	1601409.29
6	Rental Cars	33555	3053505	10	305350.5	55.83	17047718.41

Table: 4.4: The total fuel i.e., CNG required in Indian Rupees

Sl. No.	Type of Vehicle	Number of Vehicles as on 31/03/2020 as per Table 5.4	Total Km travelled in Kalaburagi City	Avg. Consumption of Fuel /Liter	Fuel Required in Liters	Cost of CNG/kg Rs.	Total cost in Rs.
1	Buses	4248	1019712	4.5 km/liter	226602.66	38	8610901.08
2	Trucks/Lorries	17327	259905	4.4	59069.31	38	2244633.78
3	Dumpers	8901	106812	4.2	25431.42	38	966393.96
4	Cement Trucks	4508	54096	4.2	12880	38	489440
5	Jeeps	4685	351375	12.25	28683.67	38	1089979.46
6	Rental Cars	33555	3053505	10	305350.5	38	11603319
7	Omni Buses	3893	194650	5	38930	38	1479340

CONCLUSIONS

1. By the use of alternative fuel CNG in Kalaburagi City, in place of Diesel, Petrol and LPG in various categories of vehicles, it is estimated that, we can reduce various pollution loads in the Environment of the Kalaburagi city in Ton/Year, as on by 31/03/2020 with an increase of total vehicle travel kilometer of 60605327 km/day by 2020 are as follows:

(i) CO can be reduced by 14,300.12 Ton/Year,
(ii) HC can be reduced by 21,78.21 Ton/Year,
(iii) NO_X can be reduced by 1,798.72 Ton/Year,
(iv) PM can be reduced by 1,412.216 Ton/Year, and
(v) CO_2 can be reduced by 97,335.1 Ton/Year.

2. By using CNG in place of Conventional Diesel fuel we can minimize the cost of fuel in Gulbarga city
   (i) Per day in Rs. 1040493.38
   (ii) Per Month in Rs. 31214801.4
   (iii) Per Year in Rs. 379780083.7

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