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EMISSION CHARACTERISTICS OF IN-USE CNG VEHICLES IN DHAKA CITY

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ABSTRACT

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Keywords: Template, Typing Instruction, Double column.

1. INTRODUCTION

In Bangladesh, the number of motor vehicles has grown from 0.1 million in 1951 to approximately 20 million in 2001 of which two wheelers account for more than 40 percent of the total vehicular population. Moreover nearly 25% of the total energy in the country is consumed by the road transport sector of which 98% comes from oil. The higher consumption of fuel has lead to increase in vehicular pollution loads and deterioration in air quality especially in metropolitan cities. Air pollution levels in these large urban centers invariably exceed the NAAQS (National Ambient Air Quality Standards). Vehicular emissions have been identified as one of the major contributors in deteriorating air quality [3,4]. The problem has further been compounded by the concentration of large number of vehicles and comparatively high motor vehicle/ population ratios resulting in higher pollution levels in these cities [4-8].

Road transportation has most adversely affected the air quality in Dhaka City. The existing fleet of 1 million motor vehicles in Dhaka contributes nearly 70% of the total air pollution load. To improve the air quality status in Dhaka various measures viz. improvement in fuel quality and engine technology, use of exhaust treatment devices, use of cleaner alternative fuels (CNG) etc. have been adopted in the recent past.

The Government of Bangladesh is trying to establish regulations to use CNG as automotive fuel in Dhaka for public transport vehicles, which include diesel-driven buses, taxis (petrol) and petrol-driven three wheelers (auto rickshaw: intermediate public transport). These vehicles present a combination of new, converted and retrofitted vehicles operating on CNG. In addition, a large number of private vehicles also operate on CNG (duel-fuel: petrol and CNG).

In Dhaka, more than 20-year old buses and pre-2001 petrol driven three wheeler auto rickshaws have already been scrapped since March 2002. Hence, nearly 6,000 buses and 7000 taxis are required to run on CNG. The existing dispensing stations are unable to meet the demand due to various factors. This has resulted in long queues (at dispensing stations) along the roads, thus seriously hampering the flow of traffic and has induced congestion and unwarranted pollution loading along the corridors.

Motor vehicles have been closely identified with increasing air pollution levels in urban centers of the world. Substantial CO_2 emission besides, significant quantities of CO, HC, NOx, SPM and air toxins are emitted, causing serious environmental and health impacts. Like many other parts of the world, air pollution from motor vehicles is one of the most serious and rapidly growing problems in urban centers of Bangladesh.

Dhaka has the dubious distinction of one of the most polluted cities of the world. The city is facing serious environmental problems due to increasing vehicular emissions and high concentrations of pollutants in its urban atmosphere. It can further be substantiated by the fact that approximately 8% of the total vehicles in Bangladesh are registered in Dhaka alone. The air pollution levels generally exceed the NAAQS and the WHO guidelines. It has been reported that contribution of motor vehicle emissions to total air pollution has increased from 42% in 1981 to 64% in 1991 and

projected to increase to 72% in 2001. It has also been estimated that motor vehicles account for approximately 97% of total HC, 48% of NOx, 76% of CO, 10% of SPM and 6% of SO_2 emissions in Dhaka. At present there are more than 3.5 million motor vehicles are registered in Dhaka. It is noteworthy that despite the phenomenal growth of vehicles in Dhaka (over the years), the proportion of different categories of vehicles has remained more or less unchanged.

Private vehicles (three wheelers and cars) constitute about 90% of the total vehicles. Hence, for any air pollution control strategy to be effective in Dhaka, efforts should be directed towards controlling emissions from these vehicles.

2. EXPERIMENTAL INVESTIGATIONS

In-use CNG vehicles (factory fitted/retrofitted/ converted) consisting of three wheelers and cars were tested for their exhaust emission characteristics between June 2003 to August 2003, using Smart 2000ec Automatic Emission Gas Analyzer. The tailpipe emissions of CO, HC (n-hexane equivalent), CO_2, O_2 and lambda (λ, air fuel ratio) were measured under idle conditions. The instrument was calibrated as per the operating manual of the instrument. Precaution was taken to replace the filter at regular intervals. The other information such as category of vehicles, registration number, year of registration etc. was also recorded. The emission data so collected were analyzed and compared with other in-use petrol driven vehicles as shown in Fig.1 to Fig.8.

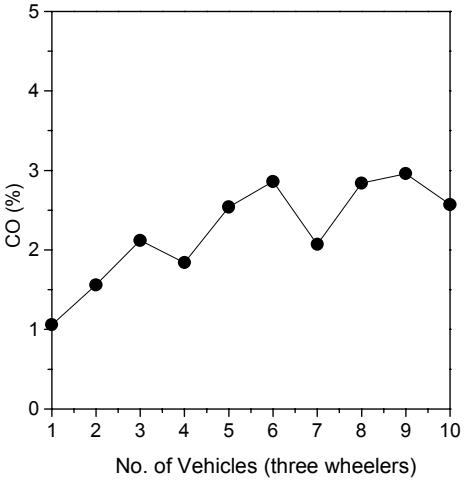

Fig.1 Frequency distribution of CO for three wheelers

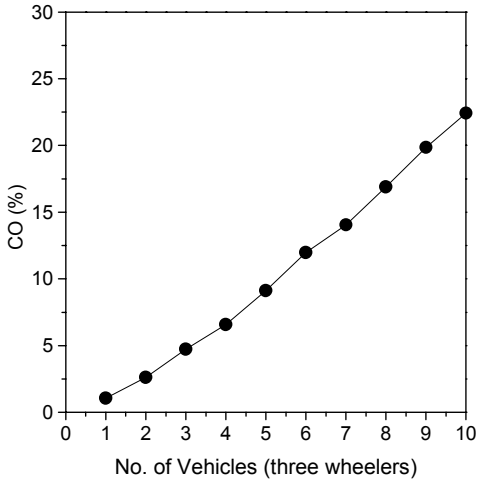

Fig.2 Cumulative distribution of CO for three wheelers

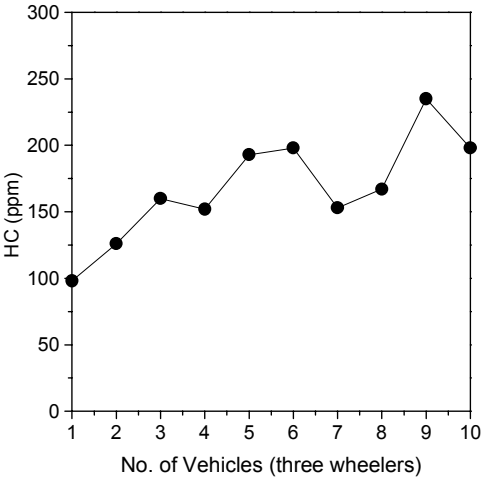

Fig.3 Frequency distribution of HC for three wheelers

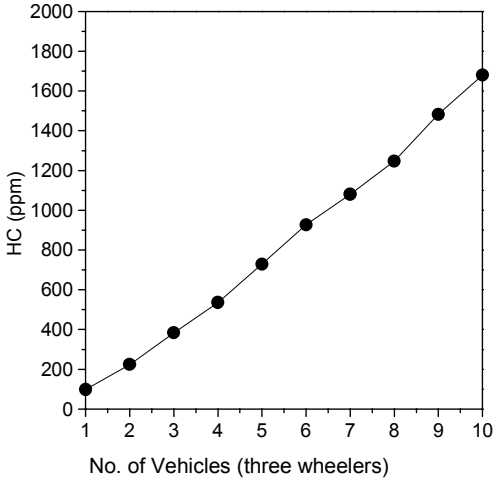

Fig.4 Cumulative distribution of HC for three wheelers

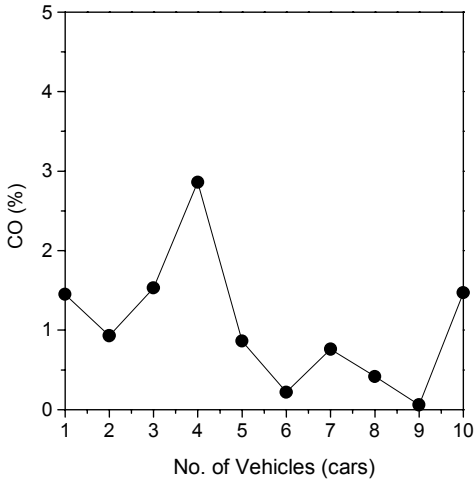

Fig.5 Frequency distribution of CO for cars

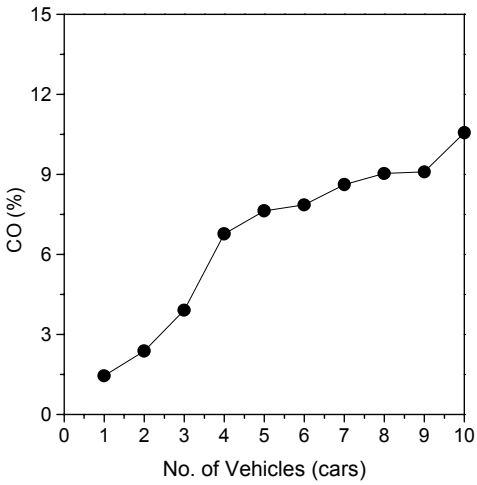

Fig.6 Cumulative distribution of CO for cars

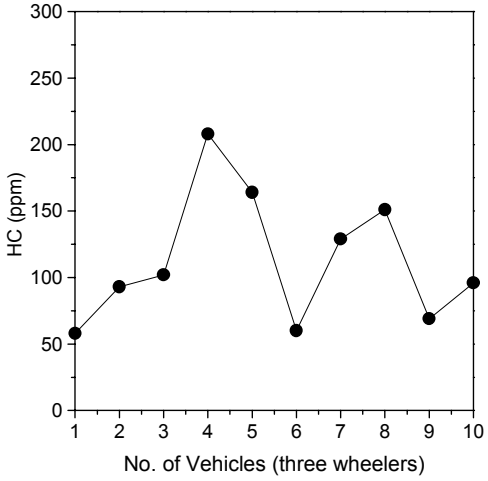

Fig.7 Frequency distribution of HC for cars

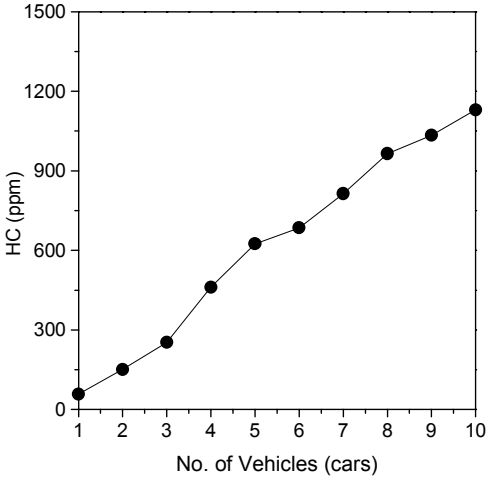

Fig.8 Cumulative distribution of HC for cars

3. RESULT AND DISCUSSION

A total of 20 CNG vehicles (converted/ retrofitted), consisting of three wheelers and cars were checked for evaluation of their emission characteristics. The compliance levels of these CNG vehicles were evaluated and have been shown in Table-1. Emission benefits from replacing petrol three wheelers and cars with CNG three wheelers and cars are shown in Table-2 and Table-3 respectively. Three wheelers (auto) and cars have constituted approximately 43% and 47% respectively. Almost, all the three wheelers (four-stroke) checked were OE vehicles, whereas the cars were duel fuel CNG vehicles (retrofitted / converted). Table-4 presents the proposed in-service petrol and CNG engine vehicle emission standards for Dhaka.

Table-1 Summary of the exhaust emission analysis of in-use CNG vehicles.

Types of vehicle	No. of vehicles	Prescribed limit of CO (%)	No. of vehicles within limits	% compliance
Cars	10	3.0	8	80
Three wheelers	10	4.5	10	100

Table-2 Emission benefits from replacing petrol three wheelers with CNG three wheelers

Fuel	CO (%)	HC (PPM)
Petrol	6.92	3170
CNG	2.24	168
% reduction	68%	95%

Table-3 Emission benefits from replacing petrol cars with CNG cars

Fuel	CO (%)	HC (PPM)
Petrol	5.02	590
CNG	1.06	113
% reduction	79%	81%

Table-4 Proposed in-service petrol and CNG engine vehicle emission standards for Dhaka

Fuel	CO (%)	HC (PPM)
All 4-wheeled petrol vehicles	4.5	1200
All 4-wheeleed CNG vehicles	3.0	-
All 4-stroke engine petrol 3-wheelers	7.0	3000
All CNG 3-wheelers	3.0	-

Because of the limited data and in absence of other pertinent information regarding performance of CNG engines, it was not possible to evaluate in detail the relative emission characteristics of in-use CNG vehicles.

Amongst the three-wheeler category the percentage compliance was observed to be 100% whereas, the percentage compliance for cars was found to be approximately 80%. The overall compliance level for in-use CNG vehicles was found to be approximately 91%. An effort has also been made to compare the emission characteristics of in-use CNG vehicles with in-use petrol driven counterparts. The vehicle emission analysis data for petrol driven vehicles were taken from earlier study for comparison purposes.

4. EMISSION DISTRIBUTION ANALYSIS OF IN-USE CNG VEHICLES

Fig.1 to Fig.4 detail the observed frequency distribution and cumulative frequency pattern of CO and HC for three wheelers. It is evident from the figures that for most of the three wheelers (~ 70%) CO levels were lower than 0.1% (by volume). None of the three wheelers was found to emit CO more than 3% (compliance limit value of 4.5% of CO by volume) hence have shown a compliance level of 100%. With regard to HC emissions, approximately 75% of the vehicles had HC emission values lower than 200 ppm (by volume); approximately 90% vehicles had HC emission values lower than 400 ppm.

Fig.5 to Fig.8 show the frequency and cumulative frequency distribution of CO and HC for cars. Most of the cars (~ 60%) were observed to have CO emission levels of less than 0.5% (by volume) in the exhaust. Approximately, 80% of cars had CO levels less than 2% (compliance limit value of 3% of CO by volume). However, emission values of as high as 8% of CO were also recorded. As regards to HC emission distribution analysis, most of the cars (85%) were found to be in the range of 0 to 200 ppm range. Approximately 10% of the vehicles had HC emission values between 200 to 400 ppm ranges. However, HC levels as high as 2400 ppm was found for a few of the cars also.

5. CONCLUSION

The analysis of exhaust emission characteristics of in-use CNG vehicles has revealed a high percentage of compliance to the existing norms of exhaust emissions for motor vehicles. The present study stresses the need for notification of separate and more stringent norms for pollution under control certification for different category of CNG vehicles.

At present, only a small fraction of the total vehicles are operating on CNG. There is no doubt that CNG is a cleaner and comparatively environment friendly fuels as far as CO, HC and CO_2 emissions are concerned. But with the present number of CNG vehicles significant improvement in air quality is not envisaged unless suitable measures are taken to target the private vehicles in Dhaka. Also at this juncture it is not clear what strategy will be best suited in addressing the core issue of vehicular pollution and what price would be paid for reducing the vehicular air pollution load in Dhaka? However there appears to be no clear road to attain air quality improvement under present circumstances.

6. REFERENCES

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