Volume : 3 | Issue : 2 | February 2014 • ISSN No 2277 - 8179

Research Paper

A Comparative Study on The Exhaust Emissions From the Gasoline Powered Vehicles Used in a Sub-Urban Indian Town

Engineering

KEYWORDS : gasoline powered vehicles, Exhaust emissions, Petrol engines, diesel engines, CO Emissions

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ABSTRACT

The automobiles play an important role in the transport system. With an increase in population and living standard, the transport vehicles as well as car population is increasing day by day. In addition to this there is a steep increase in the number of two wheelers during the last two decades. Vehicular Exhaust emissions of some popular automobile models will be assayed for regulated parameters of carbon monoxide (CO) and hydrocarbons (HC) Carbon di-oxide (CO_2) and Nitrogen oxide (NO) for gasoline powered vehicles. Production of 2-wheelers and 3-wheelers vehicle has been expanding rapidly over the past several years, especially in the urbanized areas of Asia. These vehicles emit substantial quantities of pollutants such as hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx) and particulate matter (PM). These pollutants have significant adverse health effects and deteriorate environmental quality. Presented in this project are the results of experimental studies carried out to investigate the 2-wheeler emissions (CO_2, CO, NOx, and HC) by an on-board measurement method in a sub-urban area- Chidambaram. Total number of fourty 2-wheelers vehicles randomly selected relatively between the 1990-2012 model years at various places. Vehicles of various makes and models are in use in Chidambaram. The most common among the two wheel gasoline vehicles are Hero Honda motor bike (4 stroke, 100cc), Yamaha motorbike (2stroke 100cc) Tvs jive motorbike, Tvs flame motorbike 125cc, Bajai platinum motorbike, Tvs XL motorbike, Apache motorbike, Bajai Discover 135cc motorbike, Bajaj Pulsar 150cc DTS-I motorbike and Honda Unicorn motor bike etc. The real time values were compared with standard ones, and the level qualified. Emissions from motor vehicles have substantially changed over the last decade because of new fuels, changed engine designs, and improved emission-control technology.

INTRODUCTION

Although vehicle exhaust emissions of air pollutants are generally decreasing, it has not been possible to reduce air quality problems in cities in the past 10 years. In particular, the concentrations of particulates and ozone are too high, causing severe health effects. Besides improving the local air pollution situation, the reduction in global warming due to greenhouse gas emissions is of great importance for the mobility sector, in view of increasing worldwide mobility and demand for transportation. Finally, numerous established researchers are predicting bottlenecks in energy supply for the next few decades, pointing to the importance of clean biofuels. The requirement for future motor vehicles is therefore very clear: emissions of toxic pollutants such as particulates and ozone precursors have to decrease to near zero, greenhouse gas emissions have to be reduced far more than in recent years and the introduction of biofuels has to be enabled on a large scale.

Exhaust emission Measurements on motor vehicles are often performed using the official European driving cycle. This is a practical test cycle for type approval purposes, but allows limited comparability with real-world driving. Few exhaust gas and particulate emission data are available for modern motor vehicles representing a real-world driving patterns. The major air pollutants include gases like carbon monoxide, sulphur dioxide, oxides of nitrogen and particulates like respirable suspended particulate matter and suspended particulate matter. These air pollutants in the atmosphere have an adverse effect on human life and are contributed from various sources. In order to protect human health, property, and the environment from the adverse effects of air pollution, the National Ambient Air Quality Standards have been set by the Central Pollution Control Board. The air quality standards have been developed primarily on the dose effect/dose response relationships. The standards set are an integral part of air quality management which is required to set long term as well as short-term goals for air quality improvement and formulation of strategies and implementation of various programs.

The National Air Quality Monitoring Programme was initiated by the Central Pollution Control Board in 1984-85 to identify those areas in need of restoration of air quality. In Karnataka the monitoring of air quality under the National Air Quality Monitoring Programme is undertaken by Karnataka State Pollution Control Board in the cities of Bangalore (Anand Rao Circle, AMCO Batteries, and Graphite India) and Mysore (KSRTC building). Particulate matter, chemicals like hydrocarbons, Ozone, SOx and emissions from leaf burning cause respiratory health problems like asthma, susceptible to coughs, colds, pneumonia, tuberculosis, skin allergies and eye irritation. (10 % increase in diseases). Monsoons and winters accentuate these problems by creating smog. Air pollution also affects the heart, depletes physical strength, and promotes cancer and skin diseases. To escape the congestion, many Puneites flocks to nearby hills and open spaces, such as the fetal hill, Parvati-Panchgaon, Simhagad for a breath of fresh air in reducing air and noise pollution, even today. Their rapid disappearance is aggravating the problem. A better option would be to wipe out the root cause. Hence, the RTO at Pune is thinking of reducing the registration of new two wheelers. Six-seaters have also been banned from the city limits. In addition, Hindustan Petroleum has introduced LPG for vehicles, after the RTO has permitted the use of LPG in two and four wheelers! Now the situation is expected to improve substantially.

PREVIOUS WORK

Kleeman et al. (2000) has shown that gasoline and diesel fueled vehicles produce particles that are mostly less than 2.0 µm in diameter. Cadle et al. (1999) found that 91% of PM emitted by in-use gasoline vehicles in the Denver area was in the PM25 size range, which increased to 97% for “smokers” (i.e., Light-duty vehicles with visible smoke emitted from their tailpipes).

Durbin et al. (1999) found that 92% of the PM were smaller than 2.5 µm for smokers. The mass median diameter of the PM emitted by the gasoline vehicles sampled by Cadle et al. (1999) was about 0.12 µm, which increased to 0.18 µm for smokers. Corresponding average emissions rates of PM25 were 38 mg/mi for normal emitting gasoline vehicles and 222 mg/mi for gasoline smokers. Durbin et al. (1999) point out that although smokers constitute only 1.1 to 1.7% of the light-duty fleet in the South Coast Air Quality Management District in California, they contribute roughly 20% of the total PM emissions from the light-duty fleet. Motor vehicles that are high emitters of hydrocarbons and carbon monoxide can be high emitters of PM (Sagebiel et al., 1997; Cadle et al., 1997). National distributions of smokers and high emitting vehicles for PM have not been evaluated.

Volume : 3 | Issue : 2 | February 2014 • ISSN No 2277 - 8179

EMISSION MEASUREMENT SYSTEMS

For more than 55 years, the name HORIBA has been synonymous with high quality analyzers and systems. Exceptional results in the automotive engine emissions Measurement and environmental monitoring are internationally recognized, as well as the excellent performance of our instruments. Making the right solutions for the industry has enabled HORIBA to grow into its leading role. HORIBA's drive for innovation and performance is underlined by the fact that 800 engineers are employed in the R&D departments around the world. HORIBA develops and manufactures products and systems for testing of all types of engines: heavy-duty to small utility, on road systems to non-road, marine to the locomotive, automotive to aeronautic. Our extensive product line includes analyzers, analytical systems, dilution/ sampling systems, Dynamometers and automation systems to assist engineers to evaluate and advance exhaust gas and particulate emissions, engine performance, fuel economy, fuel cell reformer efficiency, other parameters of engine and vehicle. Figure 1 shows the Front view of Automotive, Emission Analyzer. HORIBA offer products covering the following ranges of Emissions Measurement Systems:

- Analytical Systems
- On-board Systems (PEMS)
- Portable Emissions Analyzers
- Dilution / Sampling Systems
- Other Systems

The MEXA-584L simultaneously measures CO, HC, $C0_2$ (non-dispersive infrared: NDIR) and air-to-fuel ratio (AFR) or excess air ratio (A) in idle state. Lt optionally measures O_2, NO, engine speed (RPM) and oil temperature (TEMP). Lightweight and compact with a clear LCD and effortless operation, it can be used as a simple Measurement instrument in any work situation. Figure 2 shows the Automotive, Emission measurement of Automotive Emission Analyzer.

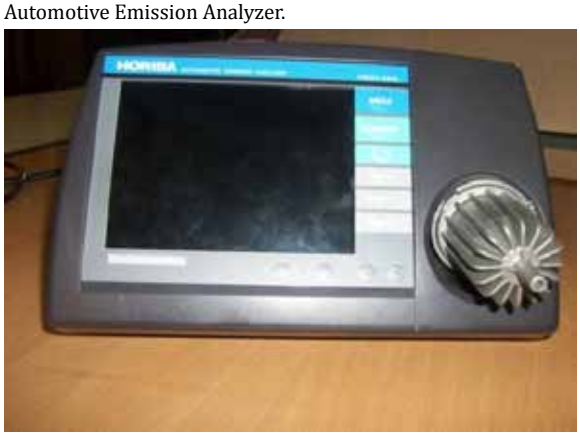

Figure 1: Front view of Automotive Emission Analyzer

Figure 2: Emission Measurement of Automotive Emission Analyzer

Vehicles of various makes and models are in use in Chidambaram. The most common among the two wheel gasoline vehicles are Hero Honda motor bike (4 stroke, 100cc), Yamaha motorbike (2stroke 100cc) TVs jive motorbike**, TVs** flamemotorbike-125cc, Bajai platinum motorbike, TVs-XL motorbike, Apache motorbike, Bajai Discover 135cc motorbike, Bajaj Pulsar150cc DTS-I motorbike, active etc. Almost none of the vehicles were having catalytic converters at the time of study. The real time values were compared with standard ones, and the level qualified.

Estimation of CO, Hydrocarbon CO_2 and NO

The exhaust emissions of gasoline-powered vehicles for CO and Hydrocarbon were monitored using an Automotive Emission Analyzer MEXA-584L idling conditions, 1/4 throttling, 1/2 throttling, 3/4 throttling and full throttle conditions. The MEXA-584L simultaneously measures CO, HC, $C0_2$ (non-dispersive infrared: NDIR) and air-to-fuel ratio (AFR) or excess air ratio (A) in idle state. lt optionally measures O_2, NO, engine speed (RPM) and oil temperature (TEMP). Lightweight and compact with a clear LCD and effortless operation, it can be used as a simple Measurement instrument in any work situation.CO, HC, and CO_2: Non-dispersive infrared (NDIR) Air-to-fuel ratio (AFR), Excess air ration (lambda): carbon balance method or Brettschneider method (with O_2Measurement). AFR and lambda are calculated by the carbon balance method in standard configuration. The Carbon monoxide Hydrocarbon and Nitrogen oxide at full acceleration conditions and λ (Air fuel) at idling conditions for some selected gasoline vehicles were also monitored to access the change in emission characteristics. Figure 3 shows the experimental setup for the measurement of exhaust emissions.

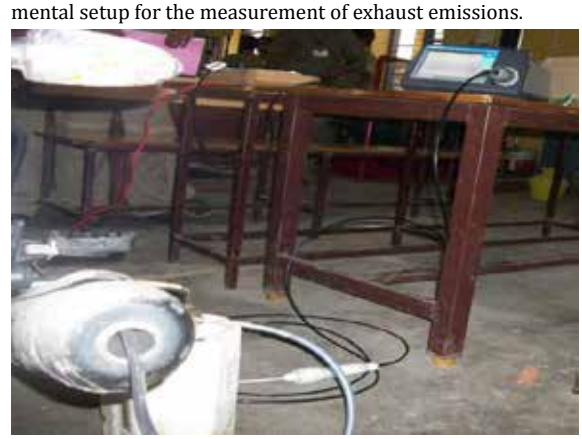

Figure 3: experimental setup for the measurement of exhaust emissions.

RESULTS AND DISCUSSIONS

5.1 CO and Hydrocarbon emissions

Variation in CO and Hydrocarbon emissions of two wheel vehicles (Two and Four stroke) and motor bikes at idling engine conditions are provided in table 5.1. and 5.2.About 90% of scooters and 85% of motor bikes were found to emit CO within the prescribed national standard of 4.5%. About 33% of scooters and 83% of motor bikes were found to emit Hydrocarbon within 2000 ppm.The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact that all scooters tested were having two stroke engines while a few models of motorbikes had four stroke engine as well which do not require pre-mixing of mobile oil in petrol as lubricant. No national standards are prescribed for Hydrocarbon emissions from vehicles at idling conditions. Vehicles of various makes and models are in use in Chidambaram. The most common among the two wheel gasoline vehicles are Hero Honda motor bike (4 stroke, 100cc), Yamaha motorbike (2stroke 100cc) Tvs jive motorbike**, Tvs** flamemotorbike125cc, Bajai platinum motorbike, Tvsxl motorbike, Apache motorbike, Bajai Discover 135cc motorbike, Bajaj Pulsar150cc DTS-I motorbike etc. The Percentage composition of various makes of vehicles in Chidambaram are shown in Figures 4 to 6.

During half throttling about 70% of scooters and 73% of motor bikes were found to emit HC within the prescribed national standard of 2000 PPM. The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact

that all scooters tested were having two stroke engines while a few models of motorbikes had four stroke engine as well which do not require pre-mixing of mobile oil in petrol as lubricant. During full throttling about 51% of scooters and 45% of motor bikes were found to emit HC not within the prescribed national standard of 2000 PPM. The low percentage of scooters emitting Hydrocarbon in the said range might be attributed to the fact that all scooters tested were having two stroke engines while a few models of motorbikes had four strokes engine as well which do not require pre-mixing of mobile oil in petrol as lubricant. Figures 7 to 11 shows the projection of CO (Carbon monoxide) emissions in Chidambaram during 1989-2013.

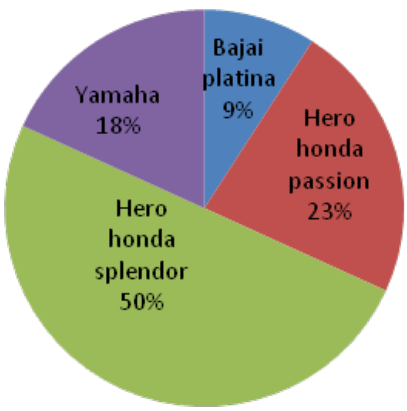

Figure 4: Percentage composition of various makes of vehicles in Chidambaram

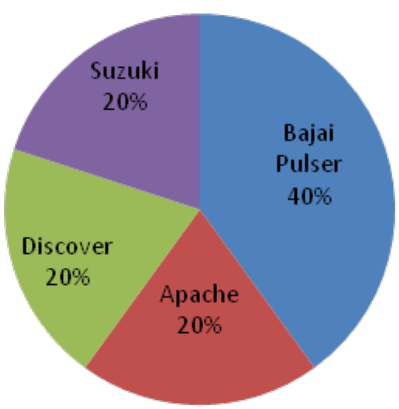

Figure 5: Percentage composition of various makes of vehicles in Chidambaram

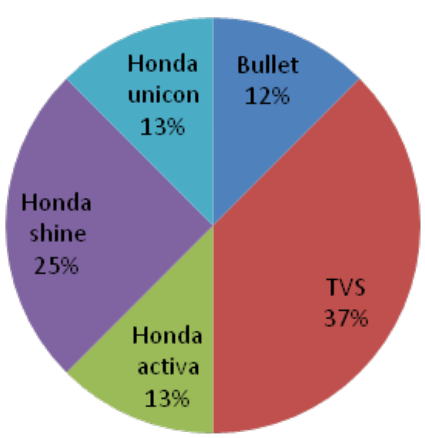

Figure 6: Percentage composition of various makes of vehicles in Chidambaram

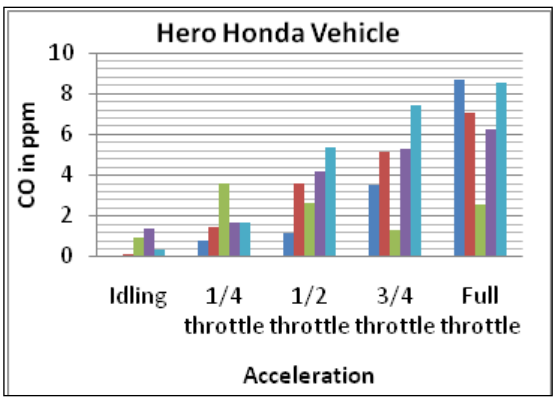

Figure 7: Projection of CO emissions in Chidambaram during 1989-2013

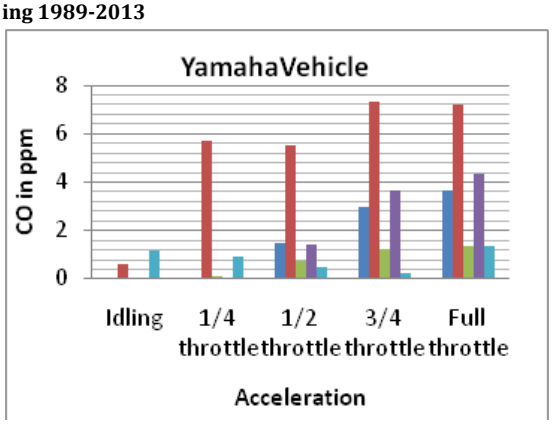

Figure 8: Projection of CO emissions in Chidambaram during 1989-2013.

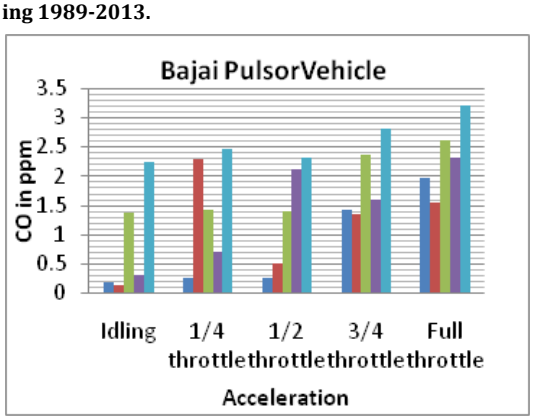

Figure 9 :Projection of CO emissions in Chidambaram during 1989-2013.

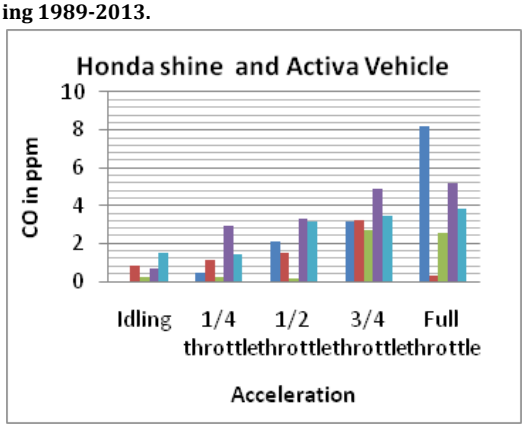

Figure 10: Projection of CO emissions in Chidambaram during 1989-2013.

Volume : 3 | Issue : 2 | February 2014 • ISSN No 2277 - 8179

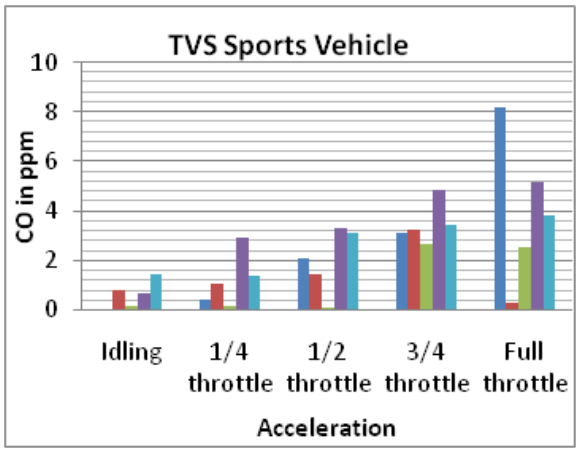

Figure 11: Projection of CO emissions in Chidambaram during 1989-2013

CONCLUSION

A very high percentage of two wheel gasoline vehicles (48%) was found not complying with the prescribed National Emission Standards. The increase in Carbon monoxide and Hydrocarbon emissions by two wheel gasoline engines at accelerated engine speed was quite significant. About 90% of scooters and 85% of motor bikes were found to emit CO within the prescribed national standard of 4.5%. About 33% of scooters and 83% of motor bikes were found to emit Hydrocarbon within 2000 ppm. During half throttling about 70% of scooters and 73% of motor bikes were found to emit HC within the prescribed national standard of 2000 PPM.During full throttling about 51% of scooters and 45% of motor bikes were found to emit HC not within the prescribed national standard of 2000 PPM.

It was observed that the Carbon monoxide emissions from two wheel vehicles increased from two to three times at the full acceleration engine conditions. It was observed that the Hydrocarbon emissions from two wheel vehicles increased from two to three times at the full acceleration engine conditions. Due to the exponential growth in the number of registered two wheelers, the result indicates that the emission of exhaust gases at ideal condition is rising rapidly in the years. It has been observed that the emissions of gases at cold condition are higher than the estimated emissions because the presence of old vehicle in the town and the vehicles coming from outside the town also contribute to the increase in emissions.

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