EMISSSION CHARACTERISTICS OF BI-FUEL MOTORCYCLE

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ABSTRACT

Motor vehicles generate three major pollutants; Hydrocarbons (HC), nitrogen oxides (NOx) and carbon monoxide (CO). Hydrocarbon reacts with nitrogen oxides in the presence of sunlight to form ground-level ozone (smog). Nitrogen oxides contributes to the formation of acid rain while carbon monoxide can impair mental functions and is deadly in high concentrations. Statistics in Malaysia show that from 8.9 million motor vehicles registered in 1998, approximately 2 million tonnes of carbon monoxide, 237,000 tonnes of oxides of nitrogen, 111,000 tonnes of hydrocarbons, 38,000 tonnes sulphur dioxide and 17,000 tonnes particulate matters were emitted into the atmosphere. Concurrent with the increasing awareness of the impact of vehicular emissions on the global environmental quality, the industry concerned has invented many new technologies in reducing the emission level. These include catalytic converters, reformulated fuels and natural gas vehicle. Malaysia is promoting the use of cleaner fuel (natural gas) in power vehicle. Combustion from natural gas produces cleaner emissions, and thus providing the inhabitants of city centres a cleaner environment. The first project in Malaysia that utilized natural gas for motorcycle was carried out by the Gas Technology Centre (GASTEG) NGV Research Group from Universiti Teknologi Malaysia. This project is directed towards the study on the performance and exhaust emission of motorcycles using natural gas and gasoline. In this paper the emission characteristics of exhaust gases from the combustion of both natural gas and gasoline will be discussed. The major difference between the two fuels is that the exhaust emissions from natural gas give a complete combustion, which decrease 99.6% of carbon monoxide, 72.5% of unburned hydrocarbon and eliminate nitrogen oxide emission at a speed of 70km/hr.

Keywords: natural gas; motorcycle; emission.

INTRODUCTION

The major source of air pollutants is from motor vehicles. Rapid urbanization within this country, with the associated growth in industry and transportation systems, has increased regional concerns with regard to emissions of carbon monoxide, unburned hydrocarbon, nitrogen oxides and particulate matters. The primary man-made source of these types of pollutant in Malaysia is fossil fuel combustion in the energy, industry and transportation sectors. The use of low quality fuel, inefficient methods of energy production and use, the poor condition of vehicles and traffic congestion are the major causes of increasing emissions of these pollutants.

Among all types of vehicles, motorcycle became the second large contributor of the pollutants. In Malaysia, statistics have shown that nearly five million units or over half of the motor vehicles in Malaysia are motorcycles. These are mostly small capacity, two or four-stroke engine motorcycles owned by the lower income group. The Malaysia government has been very pro-active in attempting to control vehicle emission pollution. Measurement steps such as phases out of existing two-stroke motorcycle and new models have to comply with emissions regulations in the future. Besides, several actions have been taken to support the use of clean fuels and natural gas vehicles, namely incentive policies, mandates, financial support for research and development of vehicle emission standards.

Bi-fuel motorcycle is a new technology introduced to alleviate emission problems and became as an option for the present system available with the usage of natural gas as alternative fuels. This motorcycle can run either with gasoline or natural gas. This type of motorcycle gives mono flexibility in term of fuel usage. As its has been established that natural gas give cleaner combustion and this paper will describes the emission characteristics of the above said of bi-fuel motorcycle.

EXPERIMENTAL EQUIPMENT

The motorcycle used for this study is MODENAS KRISS 110cc, 4-stroke single cylinder. The specifications of the motorcycle are listed in table 1.

Table 1: Specification of MODENASS KRISS 110cc motorcycle

Type		4-stroke, 1 cylinder, SOHC
Bore x stroke	mm	53.0 x 50.6
Displacement	cm^3	111
Compression ratio		9.3
Carburettor type		KEIHIN PB18 x 1
Diameter of throttle valve	mm	18
Diameter of ventury	mm	18
Type of choke valve		Butterfly
Lubrication system		Forced lubrication wet
Engine oil rating		SF OR SG
Viscosity	SAE grade	20W – 40
Capacity	L	1.1
Cooling system		Air cooled
Ignition system		Magneto to CDI
Ignition timing angle	^{o}/rpm	6.5 BTDC/1200 ~ 27 BTDC/4000
Spark plug type		NGK C6HAS
Gap	mm	0.7
Regularity		C
Air cleaner type		Wet element air filter

The engine can operate on either gasoline or natural gas. A complete chassis dynamometer system and emission analyser is used to simulate a road operating condition to measure the performance and the exhaust emission. A data translation converter and an IBM computer are used to record data such as engine speed, torque, power, exhaust temperature, engine temperature and etc-. The test data is converted to standard operating conditions using ECE Code. The schematic diagram of the experimental equipment is shown in Figure 1.

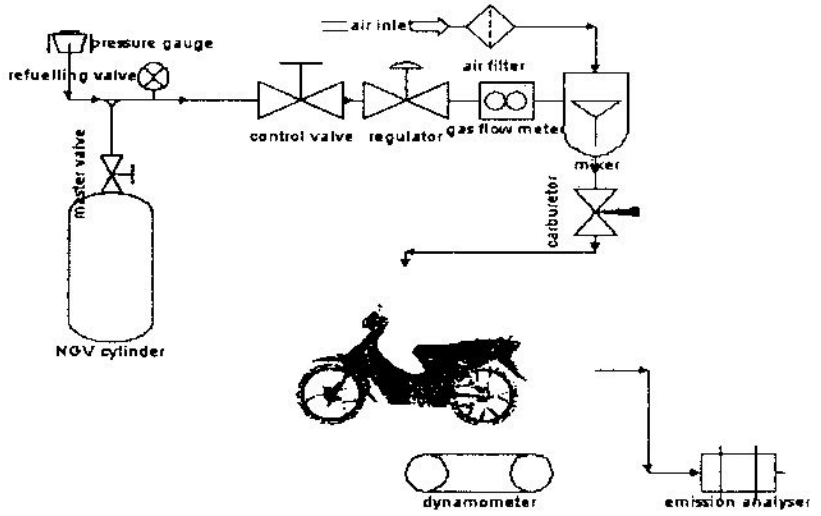

Figure 1: Schematic diagram of the experimental equipment

RESULT AND ANALYSIS

Exhaust Emission Tests

Emission test were carried out in accordance with the ISO 3929, ISO 6460 and ISO/TR 6970 test procedure. The exhaust emission for both gasoline and natural gas was analysed at idle speed and average speed of 40 – 90 km/hr. The motorcycle was tested on a chassis dynamometer at various constant speeds: 0, 40 to 90km/hr, respectively. (The amounts of composition exhaust emission gases are summarised in figure 2, 3, 4, 5, 6, and 7). This test was conducted using Horiba MEXA 324J Infrared emission analyser to detect CO and HC emission while ENAREC 2000 emission analyser used to detect NO_x.

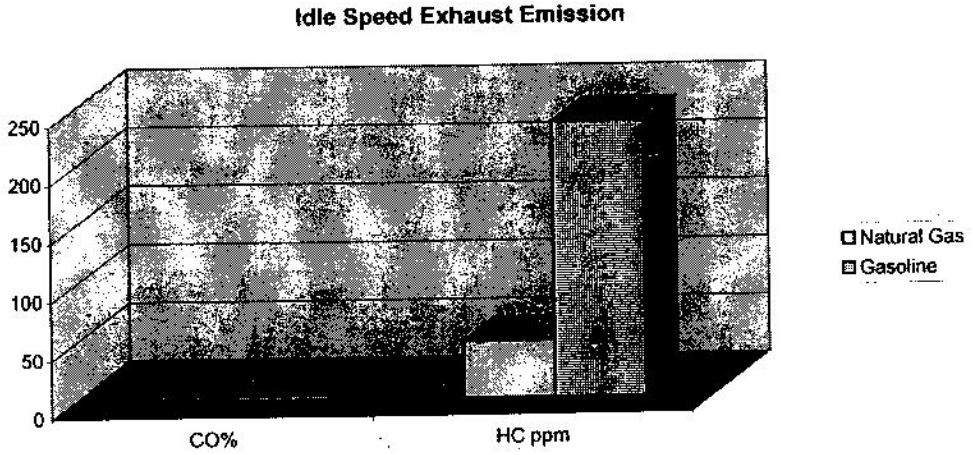

Figure 2: Idle speed exhaust emission

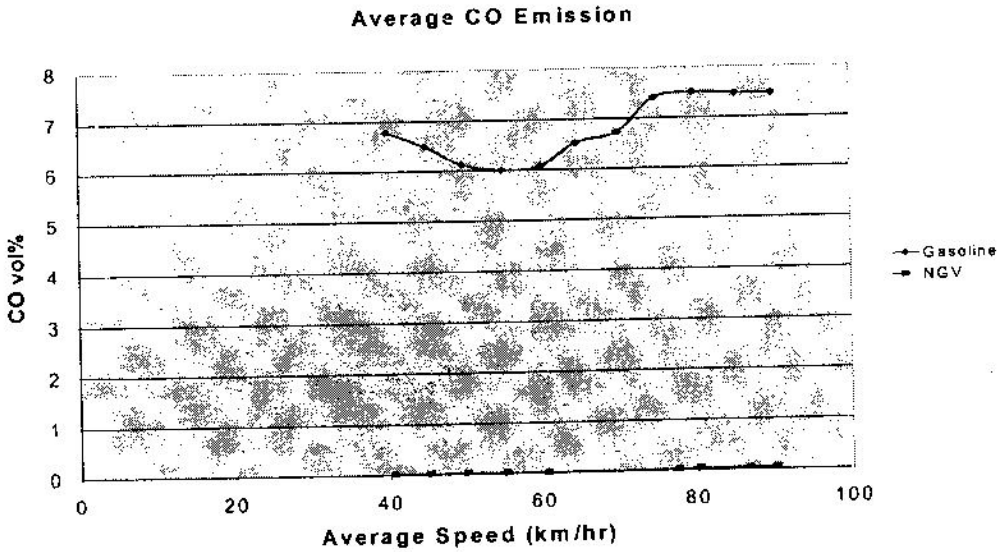

Figure 3: Average Carbon Monoxide Emission

Carbon Monoxide (CO).

At idle speed, it was found that CO emission from natural gas powered motorcycle was at an average of 0.02% vol. compared to 3.998% vol. for gasoline powered motorcycle which is lower by 99.7%. At constant speeds of 40 km/hr to 90 km/hr, the amount of CO from natural gas powered motorcycle was between 0.02% - 0.06% due to complete combustion of natural gas compared with gasoline.

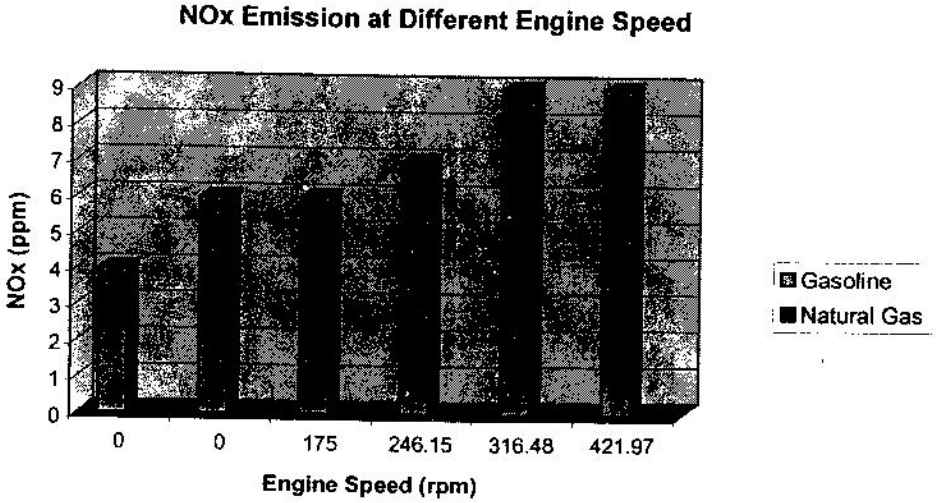

Figure 4: NOx Emission at Different Engine Speed

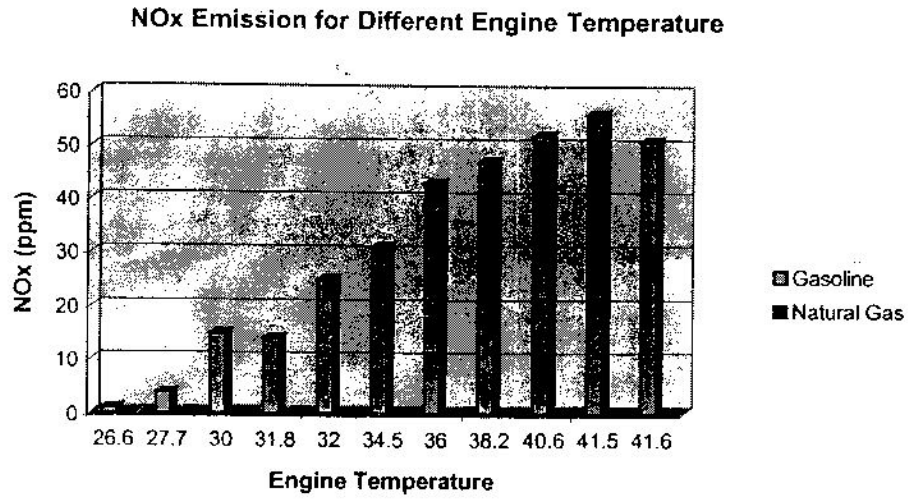

Figure 5: NOx Emission at Different Engine Temperature

Nitrogen Oxides (NOx).

Natural gas bi-fuel motorcycle is really effective to eliminate nitrogen oxides. According to the testing on bi-fuel motorcycle while using gasoline and natural gas clearly show that nitrogen oxides was totally eliminate when operates using natural gas compared to gasoline at different operation conditions. ENAREC 2000 emission analyser used to detect NO_x cannot give any reading during the bi-fuel motorcycle testing while using natural gas compared to average of 6.8 vol. ppm and 30.8 vol. ppm for gasoline at different engine speed and temperature respectively.

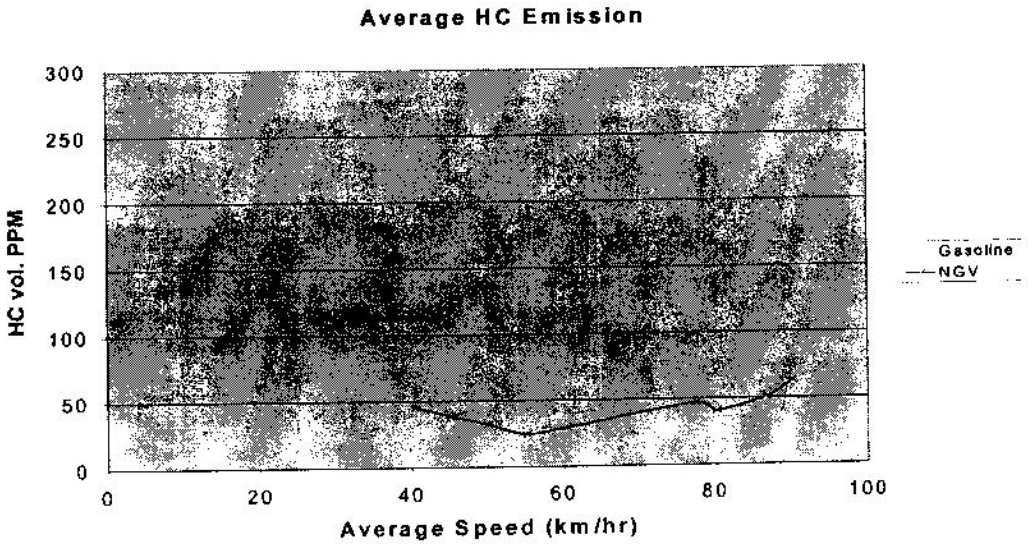

Figure 6: Average Hydrocarbon Emission

Hydrocarbon (HC).

The amount of HC emitted by natural gas motorcycle was 79.3% lower than gasoline powered motorcycle, which is equivalent to 48.875 vol. ppm at idle speed. Similar result was obtained for constant speed of 40 km/hr to 90 km/hr where the natural gas powered motorcycle produces HC at approximately 48 ppm.

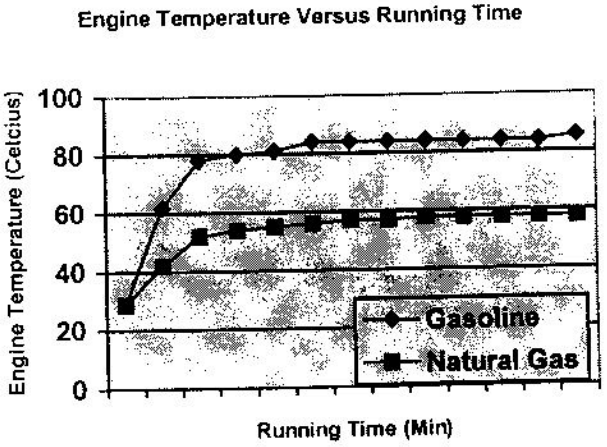

Figure 7: Engine Oil Temperature Vs Running Time

Engine Oil Temperature.

Figure 7 shows the engine oil temperature while running both gasoline and natural gas. Engine oil temperature for gasoline-fuelled motorcycle is higher (85.5°C) than the engine oil for natural gas fuelled for the same motorcycle. It shows that the temperature in the combustion chamber is higher when using gasoline as a fuel. This is because gasoline has much higher calorific value compared to natural gas. The

impact of this fact is more significant. The higher operating temperature when using gasoline encouraged much easier for the formation of NOx as compared to when using natural gas.

CONCLUSION

Since the pollution is quite critical to environment and human health especially in Kuala Lumpur, the natural gas motorcycle is one of the measures to solve this problem. On the basis of the emission tests conducted by Gas Technology Centre, NGV Research Group for compressed natural gas and gasoline, the natural gas powered motorcycle totally eliminate nitrogen oxides and give a significant decreases on CO and HC emission. Therefore, natural gas motorcycle is the key of the next millennium with clean city transportations.

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