

THE DEVELOPMENT OF NATURAL GAS MOTORCYCLE IN MALAYSIA

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Abstract

The invention of automobile has greatly changed the human's life. Transportation has an enormous impact to the economy and environment. Due to the decreasing supplement of petrol source and the pollution brought by the combustion of petrol, several efforts have been taken to replace petrol vehicle. Natural gas vehicle had been invented as well as electrical car. However, hitherto, none of a research team has come out with a 4-stroke natural gas motorcycle.

The first project in Malaysia, which utilized natural gas for motorcycle, was carried out by the GASTEG Research Group from University Technology of Malaysia started in June 1997. Sponsored by Ministry of Science, Technology and Environmental and University Technology Malaysia, natural gas motorcycle now is at the commercial development stage. Malaysia Gas Association, PETRONAS NGV Sdn. Bhd. and MODENAS, major motorcycle producer in Malaysia, are supporting this project respectively.

Background

Countries that undergo rapid growth in industrialization and urbanization programmers will experience the deterioration of environmental quality. As the result of these development activities, pollutants are emitted into the atmosphere, thereby deteriorating the quality of the air. Pollutants are also generated as waste products during combustion or manufacturing process. In Malaysia, air pollution generally comes from mobile emissions, non-mobile and non-point sources (open burning activities). Pollution from mobile sources, such as vehicle is dominant in city centres throughout Malaysia. There was an increase of local sources of air pollution, where in 1997 there were 8.5 million motor vehicles compared to 5.9 million in 1993, with the highest vehicle population found in the Federal Territory.

From the total number of registered vehicles, 90% were petrol powered and 10% were using diesel.

In line with the public concern over the health effects of traffic pollution, regulatory bodies and the public at large have contributed significantly towards the progressive improvement of vehicular emission standards, which hopefully will alleviate the worsening air quality. With the increasing awareness of vehicular emissions to the global environmental quality, it has pushed forward many new technologies in reducing the emissions level. These include the catalytic converters, reformulated fuels and natural gas vehicle.

A significant change has occurred in the energy policies of many nations throughout the world, including Malaysia. The implement of new policies and programs begins with global transition away from oil as the dominant transportation fuel towards the usage of cleaner, more abundant and eventually sustainable energy resources. Natural gas has proven to be cleaner, cheaper, safer and more domestically abundant than gasoline or other transportation fuels. Propelled by favorable government policies and aided positive economic and environmental attributes, natural gas vehicles have a impressive growth in Malaysia.

Several actions have been taken to support clean fuels and natural gas vehicle, namely incentive policies, mandates, financial support for research and development groups and the development of standard. In 1998 Budget, the government allocated RM 142 million for stricter enforcement and control measures for conservation of the environment. Emission levels of new motor vehicle and industries will have to abide the regulation.

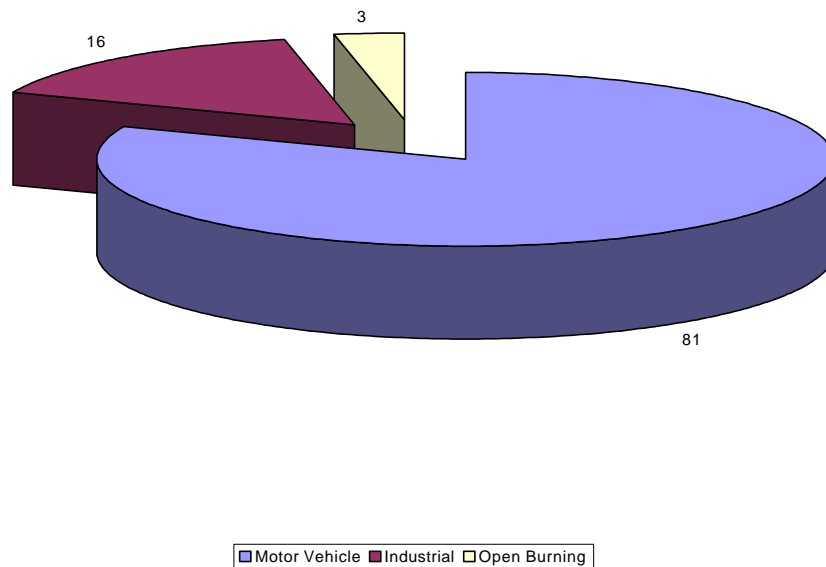
In Malaysia, pollution is not the only reason to introduce natural gas vehicles but economic value is another reason. The country has large natural gas reserve with four times larger than oil reserve. As such, a study has been conducted on bi-fuel (natural gas/gasoline) motorcycles. This is the first program in utilizing natural gas for motorcycles in Malaysia.

Air Pollution Load

Total amount of air pollutant emission load for Malaysia in 1997 is 2.9 million metric tonnes. Eighty one percent produced by motor vehicles whereas the industrial activities emitted 16%. Open burning practices only contributed 3% of the properties. (See Figure 1)

Figure 1

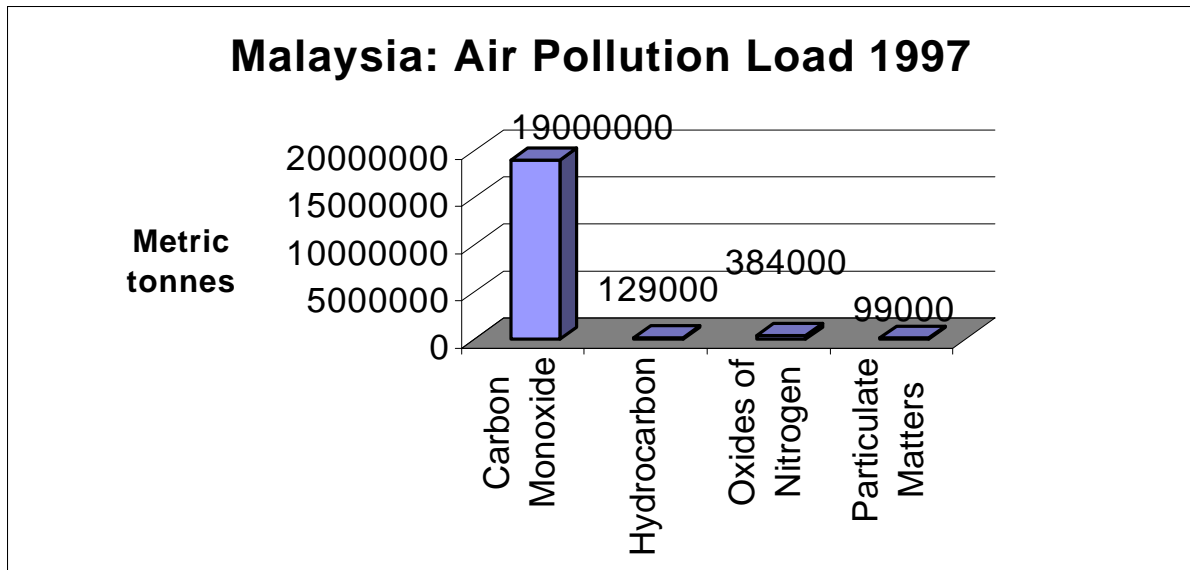
Malaysia Emission Load 1997



(Source: DOE, Malaysia)

As a result, 1.9 million metric tonnes of carbon monoxide; 129 thousand metric tonnes of unburned hydrocarbons, 384 thousand tonnes of oxides of nitrogen and 99,000 metric tonnes of particulate matters are emitted into the atmosphere. (See Figure 2)

Figure 2:



(Source: DOE, Malaysia)

Natural Gas Power Motorcycle

In general, the development of the 4-stroke natural gas motorcycle prototype can be divided into two main stages: The theoretical preparation and design stage and second stage is the procedure of testing and analysing. A whole new set of a conversion kit including a mixer in front of a carburettor, a regulator, control elements and measurement apparatus were designed. Followed by a composition test on the content of natural gas used. This test has been carried out at PETRONAS Gas Sdn. Bhd., Kerteh, Terengganu. A series of test has been undertaken. As a result of performance test, the power outputs of the engine and exhausts emission data have been successfully recorded. From the test, a comparison was made between the performance of petrol-powered motorcycle and of natural gas powered motorcycle.

In the second stage development, the motorcycle conversion kit as well as the natural gas cylinder were brought to MODENAS and assembled at site for the exhaust emission and performance tests. A complete sets of chassis dynamometer and emission analyser were used.

A new motorcycle was provided by MODENAS for this test. In a final stage, a prototype of the 4-stroke natural gas motorcycle were fabricated in University of Technology Malaysia. This prototype is able to run on roads similar to normal motorcycle and it is specially fabricated for the purpose of exhibiting its potential ability in the future. The vision of this project is to reduce the 50% of air pollution, which is contributed from the natural gas powered motorcycle.

Economical Benefit of Natural Gas Motorcycle

Currently, all alternative fuelled vehicles have a price premium over traditional fuelled vehicles (unless manufacturers have special promotional prices that they subsidised). The natural gas motorcycle has high potential economic value in the future. A study on the operation costs indicated that over a distance of 120km, the natural gas motorcycle required RM1.00 on fuel compared to RM4.00 for a motorcycle fuelled by petrol. This study has been based on the current petrol cost of RM1.10 per litre. Compressed natural gas costs RM0.565 per litre (energy equivalent).

Apart from the above, the Malaysian Government has given incentives to NGV users such as 25% reduction over the tax on bi-fuel vehicles. This is likely to be applied on natural gas motorcycle in future as well.

The safety aspects of converting vehicles to run on CNG are the concern to the public. Vehicles that run on clean burning natural gas are as safe as vehicles operating on traditional fuels such as gasoline. The low density of methane coupled with a high auto-ignition temperature (540°C compared with $227\text{-}500^{\circ}\text{C}$ for petrol and 257°C for diesel fuel) and higher flammability limits gives the gas a high dispersal rate and makes the likelihood of ignition in the event of a gas leakage is less than for petrol or diesel. Additionally, natural gas is neither toxic, carcinogenic nor caustic.

There are two fundamental reasons for this excellent natural gas motorcycle safety record: the structural integrity of the natural gas motorcycle fuel system and the physical

qualities of natural gas as a fuel. The fuel storage cylinders used are stronger than gasoline fuel tanks. Cylinders are tested before installation to a pressure of 3000 psi. The design of natural gas motorcycle cylinders are subjected to a number of federally required “severe abuse” tests, such as heat and pressure extremes, collision, fires and impact upon accident.

While fuel storage cylinders are stronger than gasoline fuel tanks, the composite materials used to encase the tanks are fundamentally more susceptible to physical damage than metals under abusive conditions. Natural gas motorcycle fuel systems are “sealed” which prevents any spills or evaporative losses. Even if leakage is occurring in a natural gas motorcycle fuel system, the natural gas will dissipate into the atmosphere because it is lighter than air.

The natural gas motorcycle is targeted at Malaysia, as well as international market for people of all ages. Because of its environmental friendly behaviour, the natural gas motorcycle is the motorcycle that is most sought after the cities are badly affected by pollution. By taking its size into consideration, it is the motorcycle with good accessibility for all kind of conventional purposes.

Emission and Performance of Natural Gas Motorcycle

The exhaust emission for both gasoline and natural gas was analysed at idle speed and average speed of 40 – 90 km/hr. This emission analysis is in accordance with the ISO3929 test procedure. 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 3, 4 and 5. This test was conducted using Horiba MEXA 324J Infrared emission analyser.

Figure 3:

Idle Speed Exhaust Emission

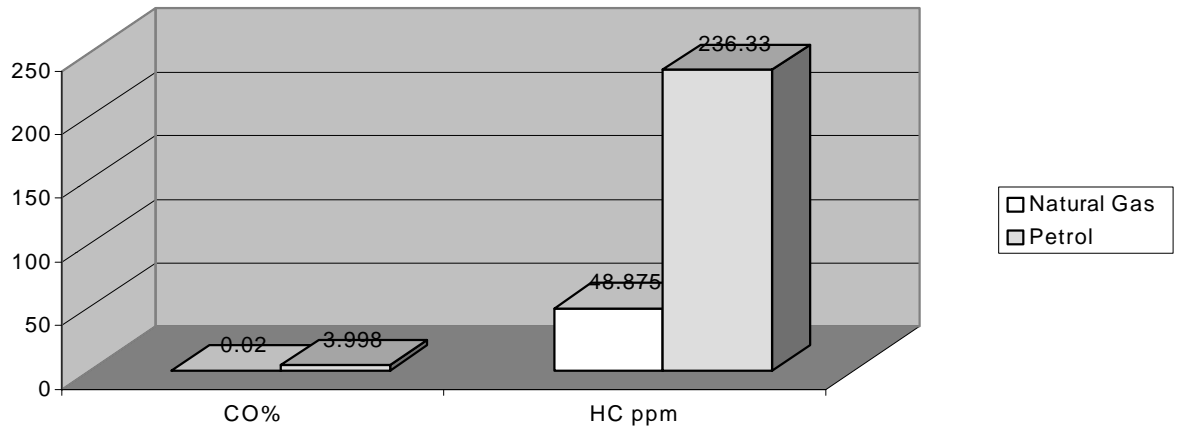


Figure 4

AVERAGE CO EMISSION

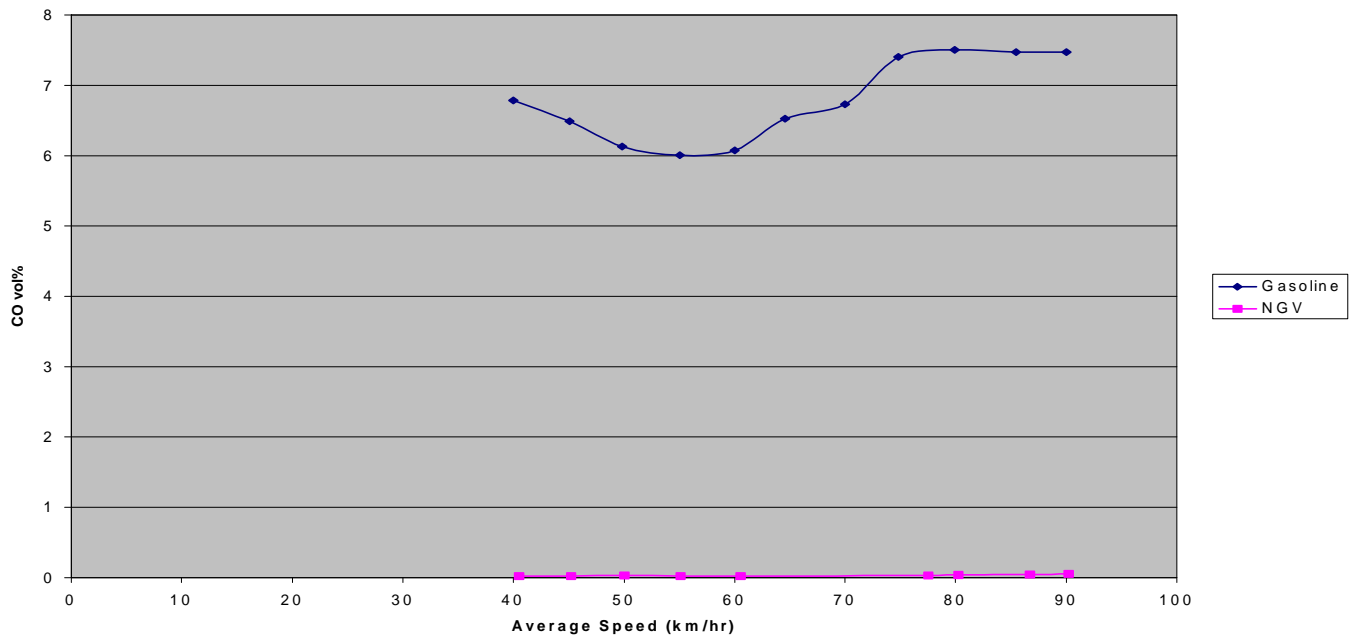
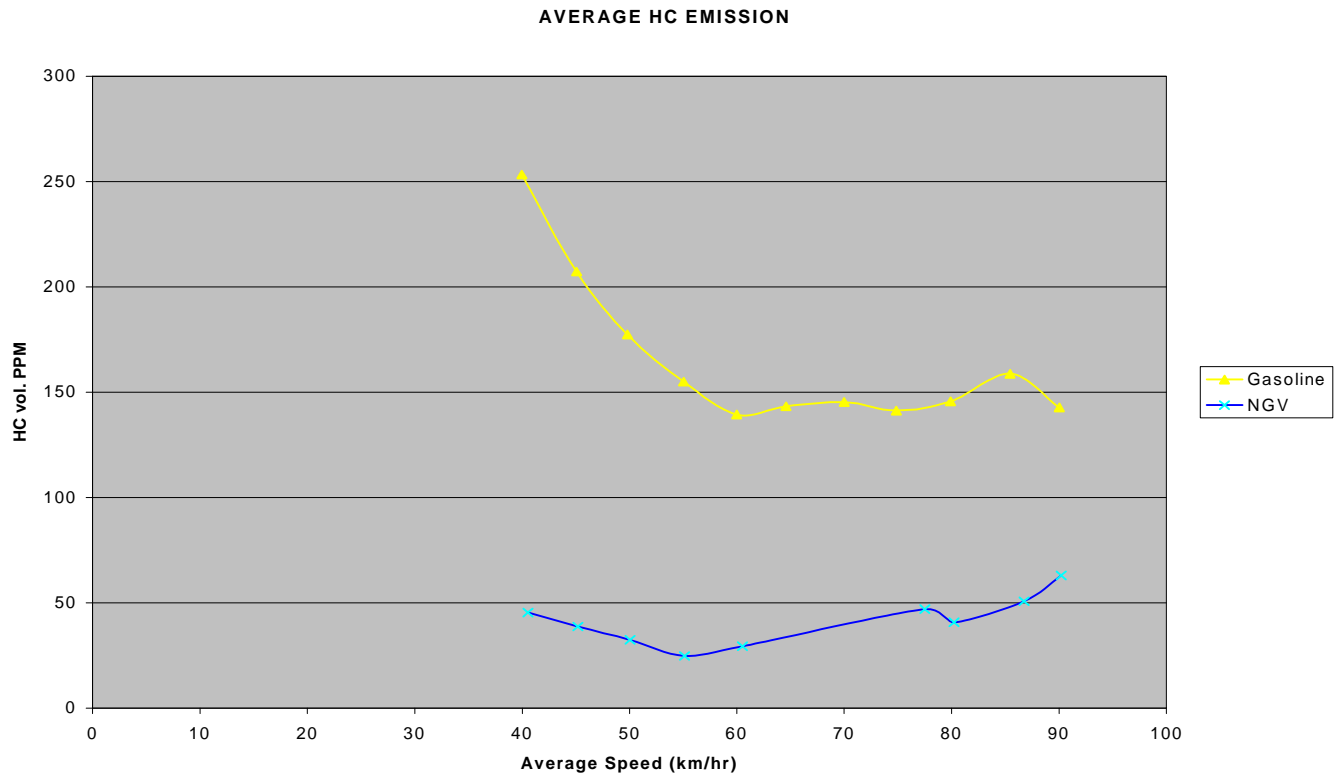


Figure 5



Carbon Monoxide (CO)

At idle speed it was found that CO emission from natural gas powered motorcycle was at an average of 0.01 %voles, which is equivalent to 99.7% decrease compared to gasoline powered-motorcycle (3.998 % vol.). At constant speeds of 40 to 90km/hr, the amount of CO from natural gas powered motorcycle was between 0.02-0.06% due to complete combustion of natural gas compare with gasoline.

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 40-90km/hr where the natural gas powered motorcycle produces HC at approximately 48 ppm.

Conclusion

Since the pollution is quite critical to environment and human health especially in Kuala Lumpur, the natural gas powered motorcycle is one of the measures to solve this problem. On the basis of the emission tests conducted by GASTEG Research Group for Compressed Natural Gas and Gasoline, the natural gas powered-motorcycle gives a significant decrease on CO and HC emission. Therefore, natural gas motorcycle is the key of the new millennium, the clean city transportation.

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