Proceedings of the Third International Symposium on Air Quality Management at Urban, Regional and Global Scales. pp. 1330-1337, 26-30 September 2005, Istanbul – Turkey

MOTORCYCLES EMISSION AND THE EFFECTS ON TEHRAN AIR QUALITY

***F. Halek, M. Keyanpour, K. Abbaspour and A. Kavousi**
Materials & Energy Research Center, P.O.Box 14155-4777,Tehran, IRAN, fhalek@yahoo.com

ABSTRACT

The motorcycles in Iran are not equipped with catalytic converters. The Idle emission tests were performed at 1000 rpm (low acceleration) and 3000 rpm (high acceleration), when performance of the engines was stabilized after 5 minutes.

Analysis of the emission were performed by gas analyzer model MGT5, Maha, Germany. Detail analysis of the total hydrocarbon (THC) emission was performed on GC, Perkin - Elmer, Sigma 3B, equipped with AP-L 15%, Chrom M 80/100 column .It is observed that CO and HC emission rates for 2-stroke and 4-stroke were 2-5 times higher than of the standards. It is also noticed that CO and HC pollutants vary in different models. The average HC emission for the 2-stroke motorcycles was approximately 14000 ppm for all brands, but, except for one of the brand of the 4-stroke motorcycles, the emission of hydrocarbons was less than 1000 ppm.

Keywords: Motor emission, Urban pollution, Tehran air pollution, Toxic gases

1. INTRODUCTION

Air pollution knows no boundaries. Local activities can not only lead to local problems, but can also lead to national and international consequences lasting from hours to decades.

Atmospheric pollutants are responsible for both acute and chronic effects on human health (WHO, 2000). Air pollution is a major environmental air problem, affecting developed and developing countries in the world. Increasing amounts of potentially harmful gases and particles are being emitted into the atmosphere at a global scale, damaging the human health and the environment.

Mobile sources are one of the major sources of air pollution worldwide. In many urban areas, mobile sources collectively produce 50 to 90 percent of local air pollution, depending upon the pollutant.(Alexopoulos et al., 1993).

Mobile sources can also produce a significant amount of the toxic or hazardous pollutants found in urban air.

Cars and light trucks continue to be a major source of air pollution all over the world. Emissions from these vehicles come from the tailpipe, as well as from evaporation

from fuel tanks, out of the oil reservoir and around engine seals. Refueling is also a significant source of emissions. Considerable progress has been made in reducing emissions from cars and light trucks, especially in the more developed countries. Most cars and light trucks are fueled with gasoline (Kalabokas et al., 1999).

Vehicle ownership is steadily increasing in developing countries, resulting in widespread congestion and increasing air pollution.

According to data compiled by the United Nations , some Asian countries , including Thailand ,Taiwan and republic of China are categorized as some of the most polluted countries in this continent (Sadullah et al., 2003).

However, the fuel consumption in urban centers is approximately 30% higher than in the rural regions, with driving conditions in the former usually poor compared to the latter. The main objective of the new European legislation is seeking to reduce motorcycle emissions over the next four years. By 2006,exhaust emissions from new motorcycles will be the same as for cars (Kassamenos et al., 1995).

The first objective of the new EU-legislation is reducing of 60%the Carbon monoxide (CO) and Hydrocarbons (HC) emissions of new four-stroke bikes. The second one, entering into force on 1st January 2006, will apply a further 50%reduction compared to the 2003 limits. 2-stroke engines will see their emissions output reduce by 30% for CO and 70%for HC. Motorcycles have a quite low level of oxides of nitrogen (NOx) (Tamanouchi, M. 1998) .

2. URBAN AIR QUALITY AND TRAFFIC

Motor vehicle emission has been recognized as one of the major sources of the air pollution, particularly in highly urbanized areas. The main traffic-related pollutants are carbon monoxide, nitrogen oxides, particulate matter (PM) and hydrocarbons (Noor Zaitun 2001).

Almost all present-day mobile sources get their energy from either gasoline or diesel fuel. Most nations are setting standards for both vehicles and their fuels in order to reduce air pollution (Hassan and Crowther ,1998) .

Based on 1997 study by the Japan international cooperation agency (JICA,1997), it was concluded that the air pollution problem in Iran is relatively serious when compared with accepted air quality standards. The annual and daily reading for PM-10 (figure 1) and CO have exceeded the standard.

Unfortunately follow-up studies in 2000 continued to shows serious problem, and motor vehicles were again found to be the air pollution. Studies around the world have indicated that PM is the most abundant pollutant per annum with practically 70 % of all PM produced solely by motor transport vehicles (Walsh, et al., 1997) .

Traffic density and flow condition in Tehran have become progressively worse and consequently, air pollution is getting more serious. As a result of severe traffic problems, motorcycles are coming a popular mode of transportation. The number of motorcycles has grown rapidly in Tehran over the past 3 - 5 years. A report indicates that approximately 1 million motorcycles are assembled from 75 factories in Iran each year, from which 500 of them are registered in Tehran everyday. Approximately 60 % of the motorcycles produced from these factories are 4-stroke and the rest are 2-stroke motorcycles (TTTO, 2000).

2-strock motorcycles are more commonly used than 4-stroke ones; because they are cheaper and also simple manufactured .Almost all of models were tested in this project.

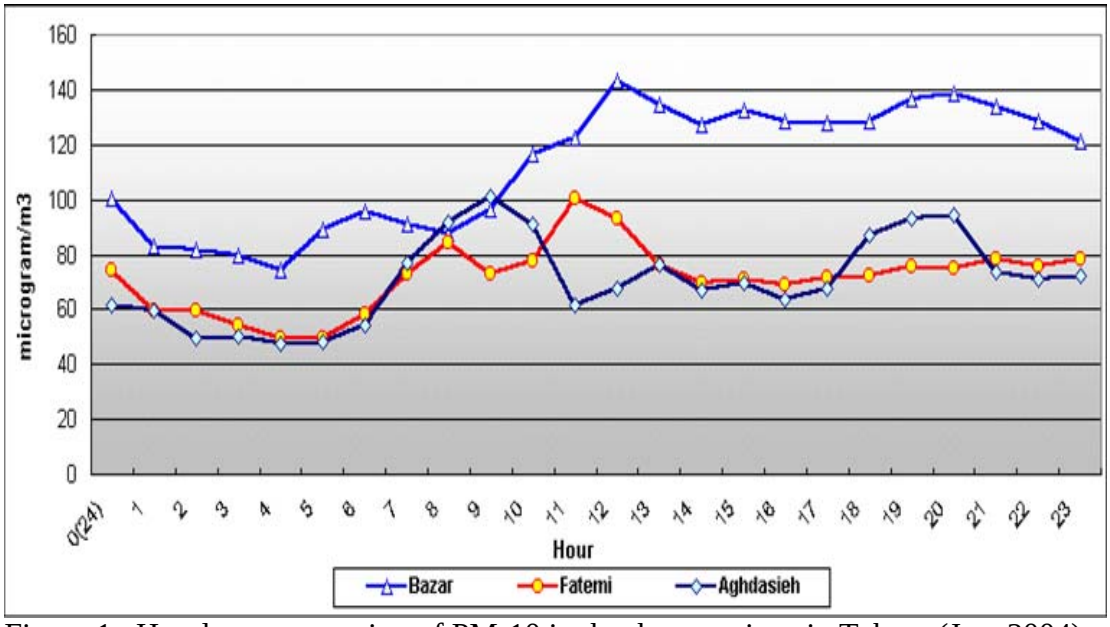

Figure 1. Hourly concentration of PM-10 in the three stations in Tehran (Jan. 2004) - cold season

3. METHODOLOGY

To assess tail-pipe emission of motorcycles in Tehran, some common brands of in-use motorcycles were selected randomly, while running in the city. The tested motorcycles were selected as representative of the Tehran motorcycle fleet in terms of manufacturer, capacity, model, year and mileage.

Analysis of the emission was performed by gas analyzer model MGT_5, Maha, Germany. Detail analysis of the total hydrocarbon (THC) emission was performed on GC , Perkin - Elmer , Sigma 3B ,equipped with AP-L 15% , Chrom M 80/100 column (NIOSH, 1997).

TABLE 1**.** Characteristics of the Test Vehicles

vehicle	year	make and model	engine size	mileage(km)
2-stroke motorcycles	1998	Yamaha 100	50cc	16000
//	1998	Yamaha 125	50cc	19500
//	2002	Vespa(Italian engine)	50cc	3400
4 -stroke motorcycles	1994	Safeer 150	125cc	2540
//	1995	Honda	125cc	20500
//	1998	Bravo	125cc	20000
//	2000	Pishro	125cc	18000
//	2000	Sahra	125cc	14500
//	2000	Kasra	125cc	8500
//	2000	Vespa	125cc	7800
//	2001	Hormoz	125cc	8000
//	2001	Yamaha	125cc	9800
//	2003	Shokooh 125	125cc	10000
//	2004	Safeer 125	125cc	4800

4. RESULTS AND DISCUSSION

Studies shows that factors such as road characteristics, traffic volume, vehicle type, driving conditions and driver behavior affect motorcycle emission levels in real traffic situations. Two-stroke motorcycles have considerably higher HC emissions and quite lower CO emissions than those of four-stroke motorcycles.
When considering gaseous pollutants it is apparent that the nature of the driving used during emissions measurement can have a significant influence on the results obtained. For the purposes of comparison this paper has considered the emission of two pollutants (CO and HC) for different motorcycles.
It is necessary to understand what is meant by environmental performance. Currently, due to the political focus on climate change, low CO2 emissions from transport are seen as a key environmental parameter. More traditionally however the effect of gaseous pollutants on air quality has been the key concern and, particularly in urban areas, this remains the case. This paper therefore considers both CO2 and gaseous pollutants.

4.1. Gaseous Pollutants

The use of two-wheeled transport in areas of high traffic density is seen by many as an effective means to reduce congestion and so speed the traffic flow. Some also argue that motorcycles offer an environmental advantage when compared to the passenger car. The gaseous pollutants for which regulation applies limit values, are carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx) and in the case of diesel vehicles, particulate matter (PM). The emission of these pollutants is determined by gas analyzer from the tailpipe.

First consideration of the comparative performance between the two transport categories may be a simple comparison of the regulated limit values that apply.

Whilst passenger car emissions have been regulated for many years, motorcycles only became subject to regulation in 1999.

Although there are only limited data available, it is worth considering the relative performance of motorcycles when tested over different driving cycles and with different interpretations. Figure 2-3 shows average values for CO from low and fast accelerations in two and four stroke motorcycles .

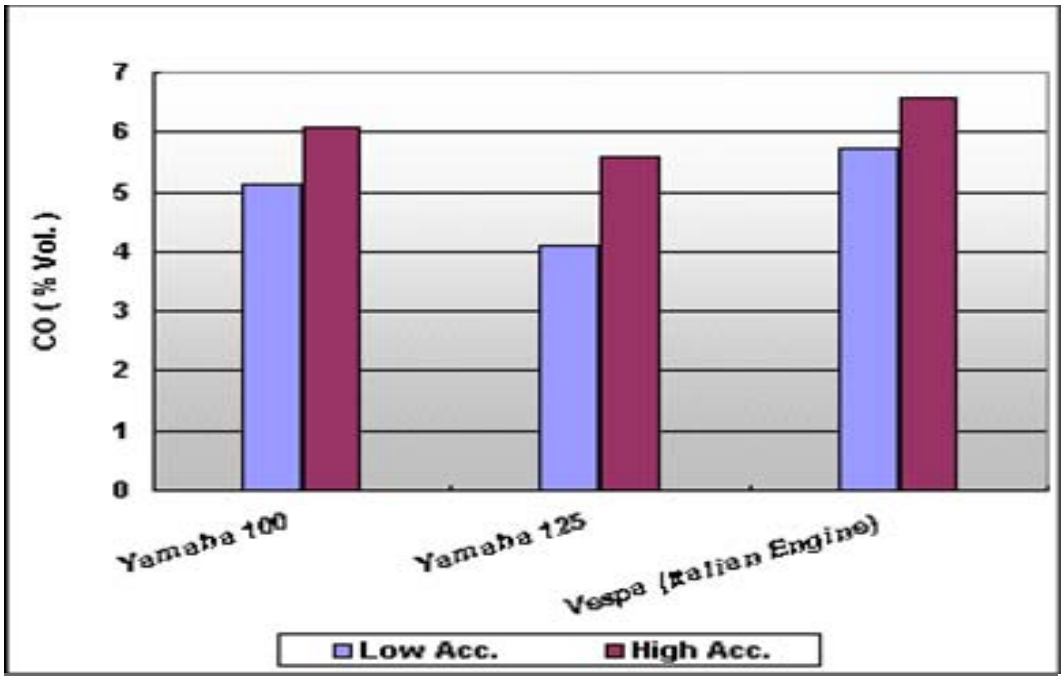

Figure 2. Average CO emission of 2-stroke Motorcycles for low and fast accelerations

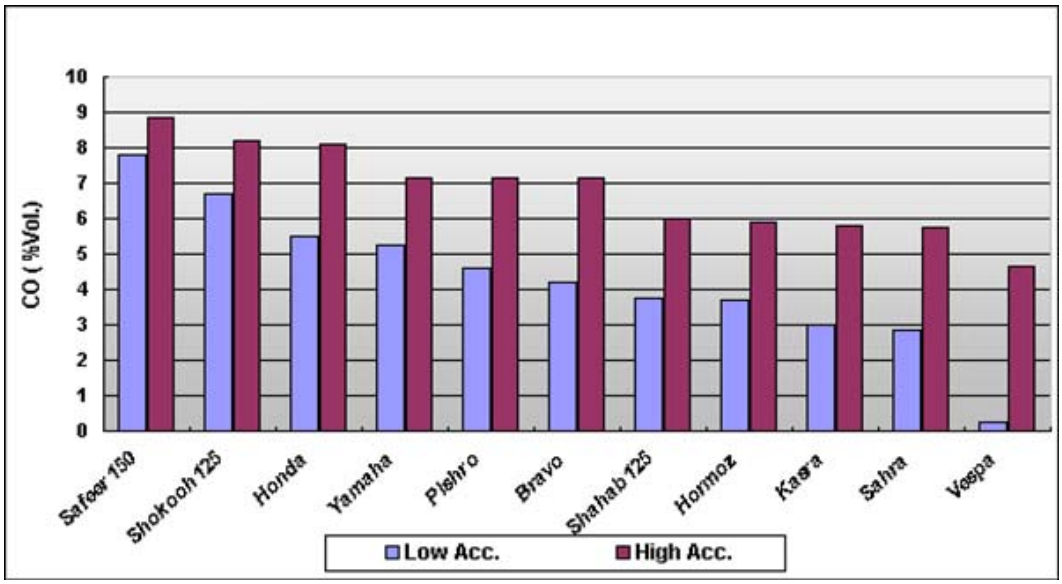

Figure 3. Average CO emission of 4-stroke Motorcycles for low and fast accelerations.

A similar comparison of HC emissions from the same vehicles is shown in Figure 4.

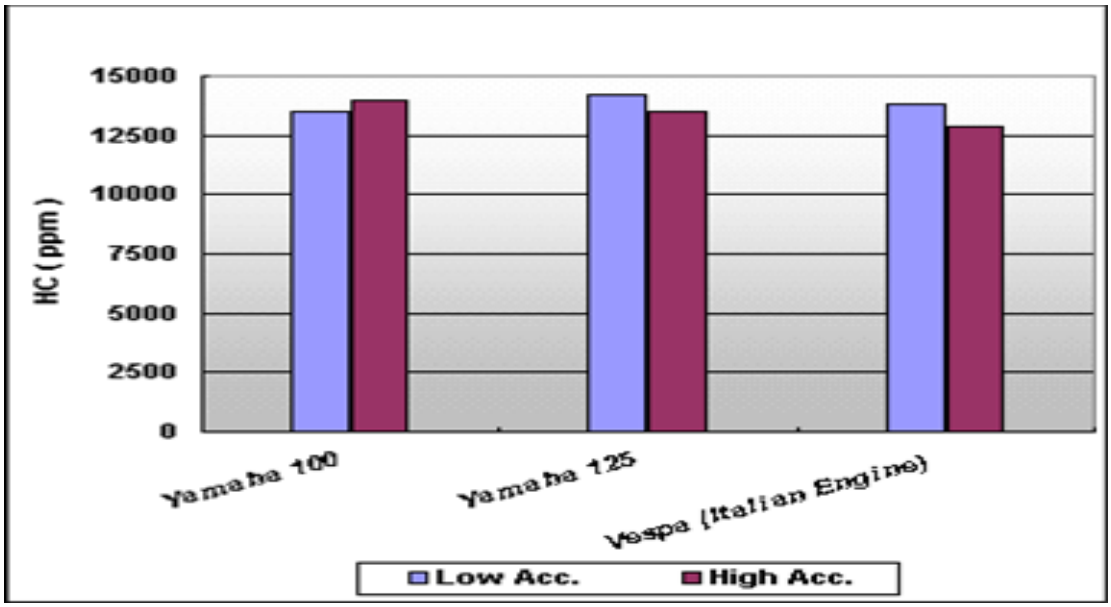

Figure 4**.** Average HC emission of 2-stroke Motorcycles for low and fast accelerations

This indicates that HC emissions from 2-stroke motorcycles are however worse than of 4-stroke .There is evidence from the test data that much of the HC emission is related to carburetor technology which is still reasonably common on motorcycles .

4.2. Carbon Dioxide

In 1997 the European type-approval procedures for passenger cars was amended to include the measurement of CO2. There is now therefore a considerable database from which to derive the CO2 performance of the fleet. The European Union has also entered into a Voluntary Agreement with motor manufacturers that will see the average emission of CO2 from new vehicles in 2008 reduced by 25% as compared to the emission in 1995. Motorcycle CO2 emission data is therefore limited to that measured in recent programs associated with the development of new type-approval standards.

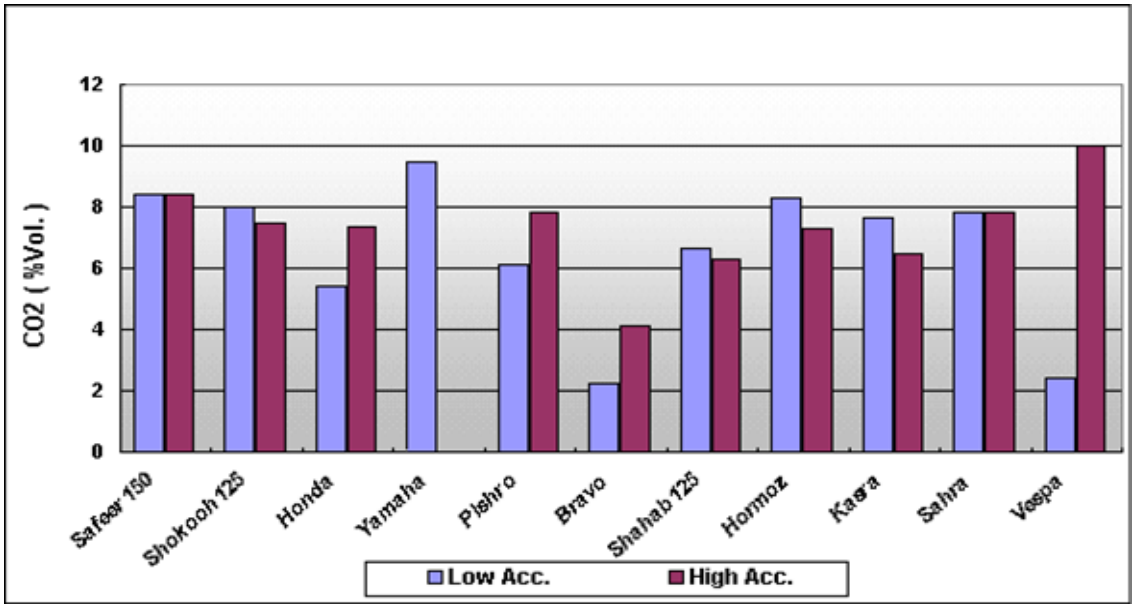

Figure 5. Average CO_2 emission of 4-stroke Motorcycles for low and fast accelerations.

In so far as climate change is a consideration, motorcycles have a clear advantage over passenger cars. The maximum emissions of CO2 from motorcycles recorded in recent tests, fall below the average values recorded from the passenger car fleet.

Average emissions of CO and HC from motorcycles are approximately one Euro standard behind that from petrol fuelled passenger cars. However, the CO performance from motorcycles is generally better than that from diesel fuelled cars that are increasing in popularity because of their fuel efficiency.

5. CONCLUSION

The results also revealed that motorcycles emission, the narrow streets with tall buildings, the meteorological factors such as weak winds and also other vehicles emission dangerously pollute the Tehran atmosphere.

Good traffic management can reduce environmental impact as well as congestion. Inspection and maintenance programs, if undertaken by technologically efficient instruments in a low-corruption context, can have great impacts, as can the replacement of two-stroke motorcycles with four-stroke motorcycles. It is generally recommended to act by providing economic incentives at various group of actors, but in critical situations it may be necessary to reach for prohibitions, e.g. the forced scrap page schemes. Tax structure reform can encourage the use of cleaner fuels and stimulate better vehicle maintenance. This reform, however, requires the design of fiscal measures to handle problems associated with the multi-purpose use of fuels (kerosene and diesel, for example, are both used in several sectors), and to handle the associated conflicting policy objectives, such as road system objectives and redistributive ones associated with the taxation of diesel fuel.

The technical requirements set for new bikes produced from 2006 can be achieved quite easily with current technologies, such as fuel injection systems and catalysers.

Future emission standards have been agreed for motorcycles and these are almost certain to cause the use of carburetors (a major cause of high HC emission) to cease. It is also expected that catalyst technology will be far more widespread in the motorcycle fleet providing further improved emission control. In addition, the complexity of the test cycle over which future motorcycle emissions will be measured should reduce the possibility for disparity between regulated and "real world" emissions.

It is expected that the legislated limits for motorcycles such as other motor vehicles legislative requirements for motorcycles from 2006 will cause this situation will change.

REFERENCES

Alexopoulos ,A.D .Assimacopoulos ,and E.Mitsoulis ., 1993 .Model for traffic emissions estimation ,Atmosph .Environ. 27 B ,435-446 .

Hassan, A.A., Crowther, J.M. 1998a. A simple model of pollutant concentrations in a street canyon. *Environmental Monitoring and Assessment*, 52, 269-280.

JAPAN International Cooperation Agency (JICA) 1997. *The study on an integrated master plan for air pollution control in Tehran area ; final report.*

Kalabokas , P.D.,L.G.Viras ,C.C. Repapis, J. G.Bartzis ., 1999. Analysis of the 11-year record(1987-1997) of air pollution measurements in Athens ,Greece .Part 2 Photochemical pollutants. The International Journal ,1,169-176 .

Kassamenos ,P.,V. Kotroni and G .Kallos ., 1995 .Analysis of climatologically and air quality observations from Greater Athens area .Atmos . Environ .,29,3671-3688

NIOSH, 1997. *NIOSH Manual of Analytical Method ,US National Institute for occupation safety and health, Cincinnati. USA.*

Noor Zaitun Yahaya, 2001. A mathematical modeling of relationship between traffic volume and pollutant concentration level (CO, SO2) on urban streets. School of Civil Engeenering Saminar, University Science Malaysia, 21 September 2001.

Sadullah, A.F, Yahaya, N.Z. , Latif, S.R. , 2003. Air pollution from motor vehicles: a mathematical model analysis. *Journal of the Eastern Asia Society for Transportation studies*, 5 October.

Tamanouchi, M. 1998. Effects of fuel Properties and oxidation catalyst on Exhaust emissions for heavy duty diesel engines and diesel passenger cars. *SAE* 1326 : 167 – 180 .

Tehran Traffic Transportation Organization (TTTO), 2000. *Report.*

Walsh, Michael, J. Shah, J. 1997. Clean fuel for Asia, technical options for moving toward unleaded gasoline and low sulfur diesel, *World Bank Technology Paper*, no 377.

World Health Organization (WHO), 2000. Air quality guidelines for Europe, Copenhagen, Denmark.