

CARBON MONOXIDE AND HYDROCARBON CONTAINS OF MOTORCYCLES: DUMAGUETE CITY, PHILIPPINES

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ABSTRACT

Clean air is essential for being healthy. Data from the Department of Environment and Natural Resources' Environmental Management Bureau (DENR-EMB) revealed the Total Suspended Particles (TSP) in Metro Manila during the first quarter of 2015 reached 130 micrograms per normal cubic meter (ug/Ncm). The maximum safe level is 90 ug/Ncm. Since 80% of pollution load is contributed by vehicles, the study determined the amount of carbon monoxide (CO) and hydrocarbons (HC) during the smoke emission testing of motorcycles in Dumaguete City, Philippines. Random sampling and simple average formula were utilized in the study. Using the smoke test results from January to February 2015, it was found out that the average amount of CO is 1.45 ug/cm which is very low compared to DENR standard exposure value of 35 ug/cm for one hour and 10 ug/cm for 8-hour exposure. Also, the average amount of HC is 600.26 ppm as hexane which is low compared to DENR's maximum set value of 4500 ppm to 6500 ppm as hexane. Current findings indicate that the amount of CO of motorcycle emissions are insignificant while HC are low as compared to the standard value.

KEYWORDS: Environment, Smoke Emission, Descriptive Design, Philippines

INTRODUCTION

Air pollution is to large extent invisible in our day to day life. Many of the negative health effects of air pollution gradually deteriorate people's health.

World Health Organisation (WHO) focuses on four air pollutants, namely, particulate matter (PM), particles with an aerodynamic diameter lesser than 10 μm (PM10) and lesser than 2.5 μm (PM2.5), nitrogen dioxide, sulfur dioxide and ozone (TERI, 2015). Data recorded from regions of the world in different years in the period 2008-2012, highest annual mean concentration of PM₁₀ of 540 $\mu\text{g}/\text{m}^3$ was taken in Eastern Mediterranean Region from Reshawar station, Pakistan. The lowest recorded level of 8 $\mu\text{g}/\text{m}^3$ was recorded in Western Pacific Region in Illawana, Australia. While South-East Asia Region recorded 153 $\mu\text{g}/\text{m}^3$, the highest in PM_{2.5} was taken at Delhi station in India. The lowest was recorded at Powell River Station in Canada (WHO, 2014).

Urban air pollution resulted from combustion of fossil fuels that are continually used in transportation sector, power generation, industry, and other economic activities. United Nations Conference on Sustainable Development last July 2014 aims to decrease the number of deaths and illnesses from pollutions and contamination by 2030 (TERI, 2015). In 2012, 3.7 million died in the world due to ambient air pollution (WHO, 2015).

In “Lao Environmental outlook 2012”, data taken from Vientiane Capital in September 2002-to February 2003, indicated that total suspended particulate matter (TSP) has an average of $165 \mu\text{g}/\text{m}^3$ while WHO 24-hour guidelines for TSP in 1987 was at $120 \mu\text{g}/\text{m}^3$, particulate matter (PM_{10}) has an average of $68 \mu\text{g}/\text{m}^3$ while 2005 WHO 24-hour mean of $50 \mu\text{g}/\text{m}^3$. Sulfur dioxide (SO_2) has an average of $108 \mu\text{g}/\text{m}^3$ compared to WHO 24-hour mean of $20 \mu\text{g}/\text{m}^3$. This shows that SO_2 is a more serious problem in Lao. Economic growth in the country will result in an increase pollutant levels.

In the study of Velasco and Roth in 2012 entitled “Review of Singapore's air quality and greenhouse gas emissions: Current situation and opportunities” indicates that as a wealthy nation, Singapore have a very high per-capita carbon footprint. Through innovative practices integrated in their air quality management, emission of greenhouse gases decreases. The country’s contribution to global CO_2 emissions is only .11% as reported by United Nations in 2011.

“Opportunities to Reduce Vehicle Emissions in Jakarta” published by International Council of Air Pollution in 2014, suggested policy options in Jakarta, Indonesia to abate air pollution. This is to improve diesel fuel quality with mandatory standards, especially reduced sulfur content. Secure fuel with sulfur content <50 parts per million because advanced vehicle emission control technologies such as diesel particulate filters require ultra-low fuel sulfur content to function optimally.

The increase of the motorcycle population in many cities in developing countries resulted to an increase in air pollution (Hustim et, al, 2011; Hustim and Fujimoto, 2012).

Motor vehicles emit 14% of fossil-fuel-base CO_2 , 50% to 60% of carbon monoxide and hydrocarbons and about 30% of nitrogen oxides emissions (Hwang et al, 2007).

The 2014 Environmental Performance Index (EPI), showed the Philippines scoring 44.02 out of 100, ranks 114 of 178 countries. There was an improvement from 43.98 in 2013 score. The 2014 EPI report reveals Switzerland was on top of the list scoring 87.67 out of 100 and Somalia was at 178th (Business World Research, 2014).

In first quarter of 2015, the National Capital Region’s air pollutant concentration reached 130 micrograms per normal cubic meter ($\mu\text{g}/\text{cm}$). This is in terms of total suspended particles (TSP) which increased from $106 \mu\text{g}/\text{cm}$ in the last quarter of 2014. The maximum safe level is $90 \mu\text{g}/\text{Ncm}$.

Republic Act No. 8749, otherwise known as the Philippine Clean Air Act, is a comprehensive air quality management policy and program which aims to achieve and maintain healthy air for all Filipinos.

To decrease air pollution from motor vehicles, emission tests are required prior to renewal of registration. The Department of Transportation and Communication's (DOTC's) Land Transportation Office (LTO) operationalized its motor vehicle inspection centers to large transport groups, while the private emission testing centers (PETCs) were established to provide testing services to public transport vehicles, including private-owned vehicles.

“A car emits around 600 parts per million (ppm) of CO and HC, while a motorcycle can emit as much as 5,000 ppm,” the secretary said. “It is thus not difficult to understand the environmental impact of the emissions from the millions of registered and unregistered motorcycles, tricycles and scooters you see on the road every day.” -Department of Environment and Natural Resources Secretary Ramon Paje

Registered motorcycles and tricycles in the Philippines for 2013 is 4.25 million which 8.9 % from Region VII where Dumaguete City belongs (Land Transportation Office, 2016). This shows a 3.25% increase in 2012.

The primary focus of the study is to determine the amount of CO and HC of motorcycle during the smoke emission testing from January to February 2015 in Dumaguete City, Philippines.

OBJECTIVE

This study determines the amount of CO and HC of motorcycles during the smoke emission testing from January to February 2015 in Dumaguete City, Philippines.

METHODOLOGY

This study used the descriptive method of research. The research site is Dumaguete City. It is a component city in the Philippine province of Negros Oriental. It is the capital, principal seaport, and largest city of the province in terms of population. According to the 2010 census, it has a population of 120,883 people.

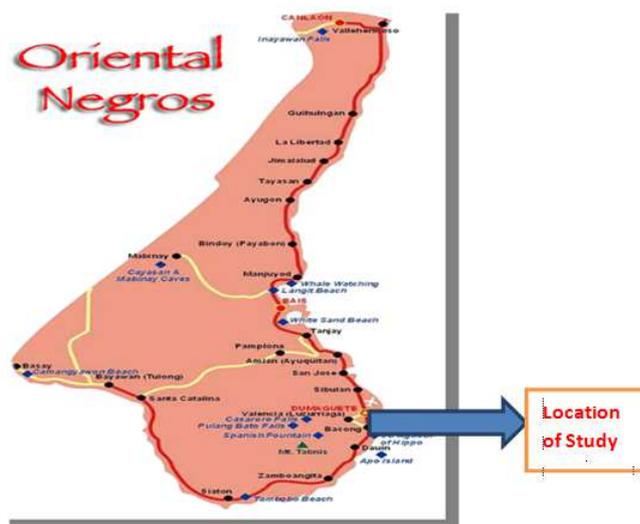


Figure 1: Location Map of the Research Environment

Random sampling was used in this study. HC and CO concentrations were measured from 767 motorcycles during the smoke emission testing from January to February 2015. The Test Equipment used in testing were carbon monoxide analyzer which is a non-dispersive infrared (NDIR) CO exhaust gas analyzer and hydrocarbon analyzer also a NDIR HC exhaust gas analyzer, HC as hexane (C_6H_{14}).

This study used simple average formula.

RESULTS AND DISCUSSIONS

Carbon monoxide and hydrocarbons are emission gases produced by vehicle exhaust fumes that can have negative effects on human health and the environment.

Motorcycles can produce several hundred times more hydrocarbon pollution than cars. Hydrocarbons cause cancer, breathing and heart ailments, and contribute to smog.

This study shows that the average amount of CO and HC are insignificant as compared to the standard value set by the DENR as shown in Table 1, 2 and 3.

The decrease of CO and HC emission is a result of the government's continued efforts to address air pollution, euro4 fuel compliance, consultations with the motorcycle industry and other stakeholders to give them sufficient time to plan and design vehicles to ensure conformity to standards set by the European Economic Commission.

Table 1: CO AND HC Motorcycle Emissions

	CO ($\mu\text{g}/\text{cm}$)	HC (ppm as hexane)
Motorcycle emissions (January to February 2016)	1.45	600.26

Table 2: Emission Standards for in-Use Vehicles Motorcycle/tricycle and Moped

Vehicle Registration Date	CO (%)by volume)	HC (ppm as hexane)	White smoke (% opacity)
Registered for the first on or after time prior to July 1,2017	2.5	1000	20
Registered for the first time on or after January 1, 2012	3.5	4500	30
Registered for the first time before January 1, 2012	4.5	6000	30

DENR Administrative Order No. 2015-04, March 24, 2015

Department of Environment and Natural Resources

Table 3: National Ambient Air Quality Guideline Values

Pollutants	Short Term			Long Term		
	$\mu\text{g}/\text{Ncm}$	ppm	Averaging Time	$\mu\text{g}/\text{Ncm}$	ppm	Averaging Time
Suspended Particulate Matter- TSP	230		24 hours	90		1 year
	150		24 hours	60		1 year
Sulfur Dioxide	180	.07	24 hours	80	.03	1 year
Nitrogen Dioxide	150	.08	24 hours			
Photochemical Oxidants as Ozone	140	.07	1 hour			
	60	.03	8 hours			
Carbon Monoxide	35mg/Ncm	30	1 hour			
	10 mg/Ncm	9	8 hours			
Lead	1.5		3 months	1.0		1 year

Source: (Department of Environment and Natural Resources) DENR

The 4-stroke motorcycles in the Philippines contributed to low CO and HC emission levels. Two-stroke motorcycles require a mixture of gasoline and oil and are not equipped with enough systems to immediately burn the mixture for complete combustion, thus resulting in more smoke emissions. In the study of Vergel, K., et. Al., in 2013 entitled "Estimation of Emissions and Fuel Consumption of Sustainable Transport Measures in Metro Manila" shows that the switch to 4-stroke tricycles contributed to significant reductions in HC and PM emissions, however, overall emissions reduction was less than 10%.

New motorcycles have less CO and HC emissions. In this competitive market, motorcycles are affordable to all walks of life through trade-in, installment basis and “sabut-sabut lang” scheme. In the study of Arafah, M., et al, in 2013 entitled “The Motorcycle Emission Characteristics in Developing Countries: Logit and Regression Analysis of I/M Data in Makassar City, Indonesia”, shows that CO and HC emission levels increase in following the motorcycle age increasing.

Because of competitive market, there are modes of acquisition that gives an individual an opportunity to own a new unit as depicted in Table 4 and 5.

Table 4: Schedule Change of Unit

	Every 5 years (%)	Less than 10 years (%)	More than ten years (%)
Change of Unit	10	70	20

Table 5: Motorcycle Acquisition

	Cash (%)	Installment (%)	Trade in (%)
Mode of Acquisition	10	80	10

Quality engine maintenance can reduce emission. A study on “Analysis of Inspection and Maintenance Program for In-Use Motorcycles Emissions in Indonesia” by Nugroho, S., et al in 2010 shows that maintenance quality and running kilometer per year play significant role in determining the probability of emission test.

In the Philippines, motorcycle owners have access to small shops that can do some routine maintenance in their units as shown in Table 5.

Table 6: Motorcycles/Tricycles Maintenance Schedule

Type of Maintenance	Monthly (%)	Quarterly (%)	Every Six Months	Yearly (%)	More than a year (%)
Tuned-up				20	80
Change oil	75	25			

In Malaysia, a study on “Modification of Motorcycle with Hydrogen Mixture and Effect on Emission” by Razali H., et al in 2015 has shown that using hydrogen as a supplement fuel for gasoline engine is a better alternative in controlling air pollution which has become an increasingly critical aspect for the local and international motoring industry.

In an article published in 2014 by The International Council in Clean Transportation entitled “Opportunities to Reduce Vehicle Emissions in Jakarta”, it stressed that strict fuel quality and vehicle emission standards would be implemented nationally to address the worsening pollution from motor vehicles in Jakarta.

In Philippines, as shown in Table 7, as part of government efforts to clean the air of the country, DENR Administrative Order (DAO) No. 2015-04 provides the new vehicle emission standards to be complied with by new and in-use vehicles starting July 1, 2015. The order also enjoins the Department of Energy to ensure the availability of Euro 4 fuels by this date.

Table 7: EURO 4 Gasoline Compliance and Awareness

	Complied (%)	Not Complied (%)	Awareness (%)	Not Aware (%)
Dumaguete City, Gasoline stations	100			
Motorist			10	90

Euro 4 has sulfur content of only 50 parts per million (ppm) for both diesel and gasoline, compared with 500 ppm for Euro 2. Benzene in Euro 4 gasoline is only 1% by volume compared to 5% in Euro 2.

Low sulfur fuels will lead to reduced emissions of particulate matter. This particulate matter can penetrate deeply into sensitive parts of the lungs and can worsen existing respiratory and heart diseases.

CONCLUSIONS

Clean air is essential for being healthy. Urban air pollution resulted from combustion of fossil fuels that are continually used in transportation sector, power generation, industry, and other economic activities (TERI, 2015). In 2012, 3.7 million died in the world due to ambient air pollution (WHO, 2015). Motorcycle emits hundred times much more hydrocarbons (HC) and carbon monoxide (CO) compared to cars. Registered motorcycles and tricycles in the Philippines for 2013 is 4.25 million which 8.9 % from Region VII where Dumaguete City belongs (LTO,2013). This study mainly aimed to determine the amount of HC and CO during car emission testing in Dumaguete City, Philippines from January 2015 to February 2015.

Random sampling was used in this study. HC and CO concentrations were measured from 767 motorcycles during the smoke emission testing from January to February 2015. The Test Equipment used in testing were carbon monoxide analyzer which is a non-dispersive infrared (NDIR) CO exhaust gas analyzer and hydrocarbon analyzer also a NDIR HC exhaust gas analyzer, HC as hexane (C₆H₁₄).

That the average amount of CO is 1.45 ug/cm is very low compared to DENR standard exposure value of 35 ug/cm for one hour and 10 ug/cm for 8-hour exposure. Also, the average amount of HC is 600.26 ppm as hexane which is low compared to DENR's maximum set value of 4500 ppm to 6500 ppm as hexane.

The average amount of CO and HC are insignificant as compared to the standard value set by the DENR. The decrease of CO and HC emission is a result of the government's continued efforts to address air pollution, euro4 fuel compliance, consultations with the motorcycle industry and other stakeholders to give them sufficient time to plan and design vehicles to ensure conformity to standards set by the European Economic Commission.

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