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Carbon Monoxide and Hydrocarbon Contains of Motorcycles: Metro Dumaguete, Philippines

NARCISA T. MORALLO
http://orcid.org/0000-0002-5468-9179
narcisamorallo@gmail.com
Negros Oriental State University
Dumaguete City, Philippines

ABSTRACTS

According to the World Health Organization (WHO), almost 98% of low and middle-income countries' air fail to meet the United Nations (UN) body's standards. 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 Metro Dumaguete, Negros Oriental, 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 μg/cm which is very low compared to DENR standard exposure value of 35 ug/cm for one hour and 10 μg/cm for 8-hour exposure. Also, the average amount of HC is 600.26 ppm which is low compared to DENR's maximum set value of 4500ppm to 6500 ppm. Current findings indicate that the amount of CO of motorcycle emissions is insignificant while HC is low as compared to the standard value.

Keywords — Environment, smoke emission, descriptive design, Philippines

INTRODUCTION

Air pollution can personally and economically very damaging. People breathing poor quality of air are at risk of lung cancer and other diseases according to the WHO (2014).

In the second quarter of 2016, 80% of world's urban dwellers breathe poor quality of air. According to Maria Neira, the head of WHO's department of public health and environment, air pollution in the urban area is rising at an alarming rate. Carlos Dora, WHO's public health and environmental department, pointed to transportation as the first key factor that determines the quality of air in the urban area. 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. Data recorded from regions of the world in different years in the period 2008-2012, highest annual mean concentration of PM_{10} of 540 $\mu g/m^3$ was taken in Eastern Mediterranean Region from Reshawar Station, Pakistan. The lowest recorded level of 8$\mu g/m^3$ was recorded in Western Pacific Region in Illawana, Australia. While South–East Asia Region recorded 153 $\mu g/m_3$, 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.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 $\mu g/m^3$ while WHO 24-hour guidelines for TSP in 1987 was at 120 $\mu g/m^3$, particulate matter (PM_{10}) has an average of 68 $\mu g/m^3$ while 2005 WHO 24-hour mean of 50 $\mu g/m^3$. Sulfur dioxide (SO_2) has an average of 108 $\mu g/m^3$ compared to WHO 24-hour mean of 20 $\mu g/m^3$. 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", as a wealthy nation, Singapore has a very high per-capita carbon footprint. Through

innovative practices integrated in its 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. It was suggested to 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 & 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 & Tseng, 2007).

The 2014 Environmental Performance Index (EPI), showed the Philippines scoring 44.02 out of 100, ranks 114th out of 178 countries. There was an improvement from 43.98 in 2013 score. The 2014 EPI report reveals that 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 (µg/cm). This is in terms of total suspended particles (TSP) which increased from 106 µg/cm in the last quarter of 2014. The maximum safe level is 90 ug/Ncm.

Republic Act No. 8749, otherwise known as the Philippine Clean Air Act, 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) established Private Emission Testing Centers (PETCs) 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. 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 everyday"(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.

OBJECTIVE OF THE STUDY

The study determined the amount of CO and HC of motorcycles during the smoke emission testing from January to February 2015 in Negros Oriental, Philippines.

METHODOLOGY

The study used the descriptive method of research. The research site is Metro Dumaguete, which is composed of Valencia, Sibulan, Bacong and Dumaguete City.

Figure 1. Location Map of the Research Environment

Random sampling was used in the study. HC and CO concentrations were measured from 767 motorcycles during the smoke emission testing from January to February 2016. These results released by the different private emission testing centers (PETCs) in Metro Dumaguete. 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}). The study used simple average formula.

RESULTS AND DISCUSSION

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. The study shows that 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 effort 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 (µg/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

Source: 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		
	µg/ Ncm	ppm	Averaging Time	**µg/** Ncm	ppm	Averaging Time
Suspended Particulate Matter- TSP						
PM_{10}	230 150		24 hours 24 hours	90 60		1 year 1 year
Sulfur Dioxide	180	.07	24 hours	80	.03	1 year
Nitrogen Dioxide	150	.08	24 hours			
Photochemical Oxidants as Ozone	140 60	.07 .03	1 hour 8 hours			
Carbon Monoxide	35 mg/ Ncm 10 mg/ Ncm	30 9	1 hour 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 to more smoke emissions. The study of Vergel and Tiglao (2013) showed 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. The study of Arafah, Ramli, Aly, and Selintung (2013) revealed that CO and HC emission levels increase in following the motorcycle age increasing.

Table 4. Motorcycle acquisition

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

Quality engine maintenance can reduce emission. Nugroho, Junyi and Fujiwara (2009) found out that maintenance quality and running kilometer per year play significant role in determining the probability of emission test.

Table 4. 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			

Table 5. Schedule change of unit

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

In Malaysia, using hydrogen as a supplement fuel for gasoline engine is a better alternative in controlling air pollution which has become an increasingly critical aspect of the local and international motoring industry (Razali, Sopian, Mat & Ibrahim, 2015).

In the Philippines, 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 5. 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.

HC and CO concentrations were only measured to motorcycles during emission testing conducted by PETCs prior to renewal of registration for the month of January to February 2016 only. The area of coverage is Metro Dumaguete which is composed of Valencia, Sibulan, Bacong and Dumaguete City. In 2012, data from the LTO showed that there were more or less 378,250 registered motorcycles in Region VII which Metro Dumaguete belongs. Region VII in 2014 is composed of 4 provinces, namely, Bohol, Cebu, Siquijor and Negros Oriental. In 2015, the region was redefined, when Region VII lost the province of Negros Oriental to the newly formed Negros Island Region.

CONCLUSION

The average amount of CO and HC are very safe value as compared to the standard value set by the DENR. The amount of CO and HC emission is a result of the government's continued effort to address air pollution. Implementation of more stringent emission standards for in-use motor vehicles (DAO 2015-04) and the voluntary phase-out of 2-stroke motorcycles by the motorcycle manufacturers in mid-2006 contributed to abatement of air pollution.

TRANSLATIONAL RESEARCH

The study may be translated into use in the community by sending the information to the Land Transportation Office to continue on their intensified public awareness campaign on air pollution.

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