CHARACTERIZATION OF DIESEL EXHAUST GASES EMISSION AT CONSTRUCTION SITES

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ABSTRACT

Construction operations contribute to 6.8% of greenhouse gases (GHG) emissions globally, which is mainly due to the large number of heavy diesel-engine equipment involved in the construction industry. The equipment pollutants such as nitrogen oxides and carbon monoxide, endanger people's health and surrounding environment. This paper presents the diesel exhaust gases assessment at two selected construction areas located in Johor. The aim of this study is to analyze in detail the characterization of diesel exhaust gases emission at construction sites. The three main objectives are to identify the characteristics of diesel exhaust gases emission produced from some diesel heavy duty vehicles, to determine the relationship of the exhaust gases between two different conditions with different machineries age, and to compare the carbon dioxide emissions produced with the standard guideline of the emissions requirements recommended by the Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH). The exhaust gases emitted from the construction machineries were measured by using Exhaust Gas Analyzer. Once the analyzer has completed the warm-up, the sample hose is connected and the sample probe is inserted in the tailpipe to measure the emission readings. The relationship of the exhaust gases in different conditions with different machineries age were analysed. The results show the increasing of emission can cause by the increment of machineries age and depends on working operation. The results also shows that the recorded carbon dioxide emission levels for both machineries in Categories A and B has exceeded the Short Term Exposure Limits (STELs) for only in working condition with the highest recorded value of 51 000 ppm for Excavator B which exceeded by 21 000 ppm of the allowable STELs. Hence, it is a must to conduct regular check up on the machineries in order to control the emission levels which can be consider as concern of worry that may affect the nearby workers in terms of quality of life and health.

ABSTRAK

Operasi pembinaan menyumbang kepada 6.8% daripada pelepasan gas rumah hijau (GHG) secara global, dimana sebahagian besarnya disebabkan oleh sejumlah besar jentera berat berenjin diesel yang terlibat dalam industri pembinaan. Gas pencemaran berpunca dari peralatan seperti nitrogen oksida dan karbon monoksida, membahayakan kesihatan rakyat dan juga persekitaran sekeliling. Kajian ini membentangkan mengenai penilaian gas ekzos diesel di dua kawasan pembinaan yang terletak di Johor. Tujuan kajian ini adalah untuk menganalisis secara terperinci ciri-ciri pelepasan gas ekzos diesel di tapak pembinaan. Tiga objektif utama kajian adalah untuk mengenalpasti ciri-ciri pelepasan gas ekzos diesel yang dihasilkan dari beberapa jentera berat diesel, untuk menentukan hubungan di antara gas ekzos dalam dua keadaan yang berlainan, dengan umur jentera yang berbeza, dan untuk membandingkan pelepasan karbon dioksida yang dihasilkan dengan garis panduan piawaian pelepasan gas yang disyorkan oleh "Occupational Safety and Health Administration" (OSHA) dan "National Institute for Occupational Safety and Health" (NIOSH). Gas ekzos diesel yang dihasilkan dari jentera pembinaan diukur dengan menggunakan "Exhaust Gas Analyzer". Hubungan diantara gas ekzos dengan dua pemboleh ubah telah dianalisis. Hasil kajian menunjukkan peningkatan tahap pelepasan gas boleh disebabkan oleh peningkatan umur jentera dan bergantung pada keadaan jentera bekerja. Kajian juga menunjukkan bahawa tahap pelepasan karbon dioksida yang direkodkan untuk jentera-jentera di Kategori A dan B telah melebihi "Short Term Exposure Limits" (STELs) hanya dalam ketika keadaan jentera bekerja, dengan nilai tertinggi dicatatkan ialah 51 000 ppm untuk Ekskavator B, yang telah melebihi sebanyak 21 000 ppm daripada nilai yang dibenarkan. Oleh itu, pemeriksaan jentera secara berkala perlu dijalankan untuk mengawal tahap pelepasan yang boleh dianggap sebagai kekhuatiran kebimbangan yang boleh menjejaskan pekerja di kawasan berdekatan, dari segi kualiti hidup dan juga kesihatan.

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AFR	-	Air-Fuel Ratio
CKD	-	Cement Kiln Dust
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
DE	-	Diesel Exhaust
DPM	-	Diesel Particulate Matter
EMS	-	Emissions Systems
FID	-	Flame Ionization Detector
GHGs	-	Greenhouse Gases
HC	-	Hydrocarbon
IARC	-	International Agency for Cancer Research
IPCC	-	Intergovernmental Panel on Climate Change
LCA	-	Life Cycle Analysis
N_2O	-	Nitrous Oxide
NDIR	-	Non-Dispersive Infrared Detector
NIOSH	-	National Institute for Occupational Safety and Health
NOx	-	Nitrogen Oxides
O_2	-	Oxygen
OSHA	-	Occupational Safety and Health Administration
PELs	-	Permissible Exposure Limits
STELs	-	Short Term Exposure Limits
TSP	-	Total Suspended Particles
TWA	-	Time Weighted Average
WHO	-	World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

In Malaysia, construction industry is one of the industries that play an important role in developing and enhancing economic sector and also the development of the country. As the construction industry consumes of various materials and comes from many sources, thus this industry may be considered as a threat to the environment, especially in terms of emitting million tons of carbon emission annually, and as well as the consumption of the natural resources. Among the carbon dioxide emission sources, construction and building related activities consume a considerable amount of energy and produce a significant volume of greenhouse gases (GHGs) (Li *et al.*, 2017). Carbon and pollutant emissions from diesel-burned construction equipment are also of increasing concern for the government and general public. Many countries have made it a legal requirement for construction equipment to be in compliance with a stipulated set of emission criteria. In some countries and metropolitan areas, contractors have to submit annual carbon emission reports, and the developers have to submit environmental impact assessment and mitigation strategies in for large infrastructure projects.

Among all the emission reduction strategies, improving equipment maintenance and operations can be feasible, attractive, and cost effective approaches for implementation in emissions reduction (Fan, 2017). Despite the current efforts on the part of Malaysian government to curb emissions, Malaysia is ranks 30th in the world for the countries that have the largest amount of carbon emission. In terms of sectorial percentage, 24% of total carbon dioxide comes from the construction sector in the country (Klufallah *et al*., 2014).

Therefore, it is very important to analyze the characterization of carbon dioxide in diesel exhaust gases emission at construction sites in order to ensure the accurate, consistent and realistic quantification of carbon emissions at micro level thus maintaining good air quality towards the sustainable construction.

1.2 Problem Statement

Due to the increasing number of construction project throughout the world, it is logical that there was an increase in the carbon emissions, which is mainly from the construction and building related activities. This grow would enhance the need for having an effective mitigation plan and drive towards that as a requirement by all the contractors and construction firms. There are many problems with construction activities worldwide. One of the most critical problems in construction is the emissions related to the fuel consumption during construction, which leads to resource depletion (Marzuki *et al*., 2015). On the other hand, the fuel consumption in construction produces a large amount of emissions such as CO_2, and N_2O. Nowadays, global warming is one of the most important concerns worldwide. Greenhouse Gases (GHGs) are generated from human activities like construction and cause the greenhouse effect, which is the reason for global warming based on the Intergovernmental Panel on Climate Change (IPCC, 2007).

According to Ricardo (2016), total CO_2 emissions from Heavy Duty Vehicles (HDVs) equal 241 Mt. Buses and coaches are responsible for a relatively small share (14%), while trucks cause the remainder of 86% (207 Mt of CO_2). A more detailed overview of the shares of different HDV mission profiles is given in Figure 1.1. It shows that the main share of HDV emissions are caused by long haul transport, followed by regional, service, and construction. The large share for long haul is the result of the high share in the fleet and the relatively high CO_2 emissions per vehicle, most likely caused by a relatively high annual distance per vehicle.

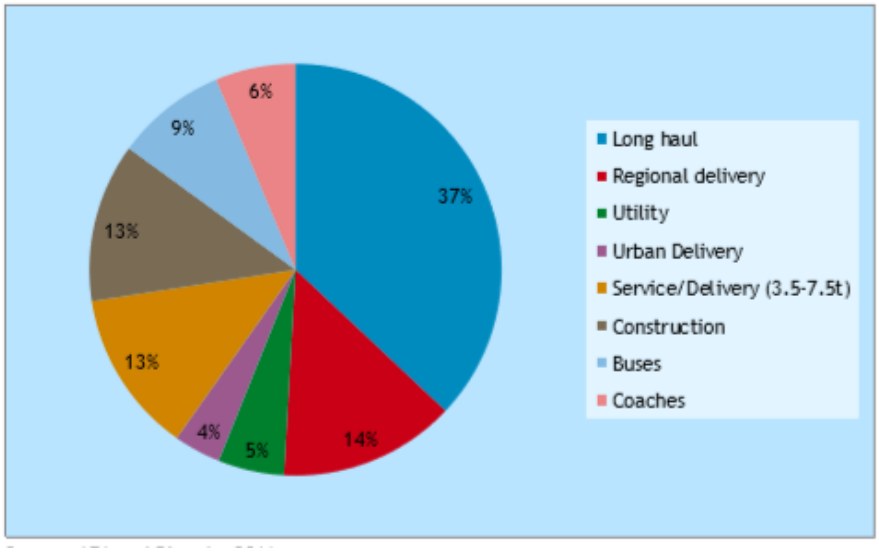

Figure 1.1: Mission Profiles in HDV CO_2 Emissions (Ricardo, 2016)

Improving the environmental problems such as global warming is a duty for human being to have a sustainable world in future. More fuels lead to more carbon emissions and more carbon emissions is the reason for many environmental indicators. One of these indicators is global warming which is a big concern in current century because when the temperature goes up, many disasters can occur.

All of these issues highlight the needs of diesel exhaust gases emissions management programs for construction companies and hence, this research is conducted in order to analyze the characterization of carbon dioxide in diesel exhaust gases emission at construction sites near Johor Bahru, Johor.

1.3 Aim and Objectives of Study

The aim of this study is to analyze in detail the characterization of diesel exhaust gases emission at construction sites near Johor Bahru. Therefore, in order to achieve this aim, the following objectives are carried out:

i. To identify the characteristics of diesel exhaust gases emission produced from some diesel heavy duty vehicles.
ii. To determine the relationship of the exhaust gases between two different conditions with different machineries age of the machineries.
iii. To compare the carbon dioxide emissions produced with the standard guideline of the emissions requirements recommended by the Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH).

1.4 Scope of Study

The research is mainly focusing on the characterization of diesel exhaust gases emission produced from diesel heavy duty vehicles at the construction sites which located at Taman Daya, Pasir Gudang (Site 1), and Medini Iskandar Malaysia, Nusajaya (Site 2). In order to suit the objectives of the research, this research is focusing on the diesel exhaust emissions among three type of machineries that are used for construction work. The scope of this study is to measure all five exhaust gases emission which are HC, CO, CO_2, O_2 and NOx emitted from mobile cranes, excavators, and backhoes under condition tropical climate. The measured emissions data are recorded by using EMS Portable Exhaust Gas Analyzer Model 5002. The collected data are rearranged and analyzed through content and critical analysis in order to determine its relationship between different operating condition and the

machineries age and thus to compare the carbon dioxide emissions produced with the guideline of the emissions requirements.

1.5 Significance of Study

Measuring the diesel exhaust gases emission in heavy machineries within construction industry will improve the quality of construction work. The study aim to provide useful information regarding diesel exhaust emissions in specific conditions. The research measure the exhaust emission emitted from mobile cranes, excavators, and backhoes used in construction activities. The data from this study presents the diesel exhaust gases emission produced from some machineries at the construction sites.

Hopefully it will be useful for future research in comparing the emission level by the machineries based on its working operation and also the machineries age, in order to control the diesel exhaust emissions during the construction activities at the construction sites. Besides that, the comparison of carbon dioxide emissions produced with the standard guideline of the emissions requirements recommended by OSHA and NIOSH is also determined in this study so that the parameters and results can be used by the construction players to estimate the lower emissions of carbon dioxide at the construction sites in the future.

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