

MOBILE SOURCE EMISSION INVENTORY IN MBMB AREA

MUHAMMAD SYAFIQ BIN SAFIZA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MUHAMMAD SYAFIQ

BACHELOR OF MECHANICAL ENGINEERING (AUTOMOTIVE) (HONS.)

2015

SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)”

Signature :

Supervisor : PM. DR. NOREFFENDY TAMALDIN

Date : 24 JUNE 2015

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MUHAMMAD SYAFIQ BIN SAFIZA

**This report is submitted in partial fulfillment of requirements
in order to be awarded with
Bachelor Degree of Mechanical Engineering (Automotive) with Honours**

**Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka**

JUNE 2015

DECLARATION

“I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged.”

Signature :.....

Author :MUHAMMAD SYAFIQ BIN SAFIZA

Date :24 JUNE 2015

Praise to Allah the Almighty and to my beloved father (Safiza Mahmud), mother (Sabariah Ibrahim), siblings and friends.

ACKNOWLEDGEMENT

Alhamdulillah, I am able to finish this thesis. I want to express my gratitude to my supervisor, PM. Dr. Noreffendy Tamaldin who supported me throughout the course of finishing this thesis. His guidance is very helpful and I could not have imagined having a better supervisor for my Final Year Project other than him.

Besides my supervisor, I would like to thank to my co-supervisor, Dr. Nona Merry Merpati Mitan, for her guidance and insightful comments.

Last but not least, I would like to thank my family: my parents Safiza bin Mahmud and Sabariah binti Ibrahim, my family, my friends, my classmate and anyone that help and support me during the progress of this project.

ABSTRACT

Mobile source is categorized as an anthropogenic source. It is one of the main reasons of air pollutant. In a place where the air pollutant is so bad, it can affect the many things at the area such as people health, local socioeconomic and the people lifestyle at the area. The increases of number of vehicle in the country can increases the total air pollutant which will affect the air quality. Air quality management is important for controlling the air pollutant at an area. Without a good management, the environment in that area can be polluted. Emission inventory is a tool for air quality management. The objective of this project is to analyze the emissions inventory for on-road mobile sources within MBMB area. Vehicle counting is done for obtaining the required data. The data from vehicle counting is then processed by using Mobilev 3.0 software. The model of emission inventory in the 1st quarter of MBMB area for CO, HC, CO₂, PM, SO₂ and NO₂ pollutant gas is developed. The result showed that CO₂ gases are the most contributors in the on-road mobile source (162,308.82 ton/year) and car type of vehicle is being the most contributors for emission of the on-road mobile source. As conclusion, the usage of more environmental friendly technologies such as hybrid car or electrical car can reduce the emission released by the vehicle, thus will increase the quality of air at an area.

ABSTRAK

Sumber Mobile dikategorikan sebagai sumber antropogenik. Ia adalah salah satu daripada sebab-sebab utama pencemar udara. Di tempat di mana bahan pencemar udara yang tidak baik, ia boleh memberi kesan kepada banyak perkara di kawasan itu seperti kesihatan penduduk, sosioekonomi dan gaya hidup rakyat di kawasan tersebut. Objektif projek ini adalah untuk menganalisa inventori pelepasan untuk di jalan punca bergerak dalam kawasan MBMB. Peningkatan bilangan kenderaan di negara ini boleh meningkatkan jumlah pencemaran udara yang akan menjejaskan kualiti udara. Pengurusan kualiti udara adalah penting untuk mengawal pencemaran udara di sesuatu kawasan. Tanpa pengurusan yang baik, alam sekitar di kawasan itu boleh tercemar. Inventori pelepasan adalah alat untuk pengurusan kualiti udara. Kenderaan pengiraan dilakukan untuk mendapatkan data yang diperlukan. Data dari kenderaan pengiraan kemudiannya diproses dengan menggunakan perisian Mobilev 3.0. Model inventori pengeluaran pada suku 1 kawasan MBMB untuk CO, HC, CO₂, PM, SO₂ dan NO₂ pencemar gas dibangunkan. Hasilnya menunjukkan bahawa gas CO₂ merupakan penyumbang yang paling dalam sumber di jalan mudah alih (162,308.82 tan / tahun) dan jenis kenderaan kereta menjadi penyumbang yang paling banyak untuk pelepasan sumber mudah alih di jalan raya. Kesimpulannya, penggunaan teknologi yang lebih mesra alam sekitar seperti kereta hybrid atau kereta elektrik boleh mengurangkan pelepasan yang dikeluarkan oleh kenderaan, oleh itu ia akan meningkatkan kualiti udara.

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LIST OF ABBREVIATIONS AND SYMBOLS

API	=	Air Pollution Index
CCTV	=	Closed Circuit Television
CO	=	Carbon monoxides
CO ₂	=	Carbon dioxides
DOE	=	Department of Environment Malaysia
EF	=	Emission Factors
GHG	=	Greenhouse Gases
HC	=	Hydrocarbon
HDV	=	Heavy Duty Vehicles
HO _x	=	Hydrogen oxide radicals
I/M	=	Inspection or Maintenance
IVE	=	International Vehicle Emission
LDV	=	Light Duty Vehicles
MBMB	=	Malacca Historical City Council
NO _x	=	Nitrogen oxides
NO ₂	=	Nitrogen dioxides
PM	=	Particulate Matter
VOC	=	Volatile Organic Compound

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

On the date of May 16, 2011, the YAB Datuk Seri Mohd Ali Rustam, Chief Minister of Malacca, had set a target to realize the vision “Melaka Maju Negeriku Sayang, Negeri Bandar Teknologi Hijau” by 2020. With this vision, Historical Malacca City Council support and give priority to sustainable development and green technology.

This research is a collaboration between Universiti Teknikal Malaysia Melaka (UTeM) and Majlis Bandaraya Melaka Bersejarah (MBMB). This research is a way of obtaining the data of air pollutant which later can be used by the Government of Malacca to control the rate of air cleanliness by planning the emission inventory in the state of Malacca.

1.1 PROBLEM STATEMENT

MBMB area is one of the busiest areas in Melaka. There are many on-road mobile entering this area every day. Based from Malaysia environmental Quality Report 2013, Malacca has air quality hovered between moderate to good most of the time, with the exception of a few hazardous days in Bukit Rambai (4 days) and Melaka (2 days), which from 15 to 27 June 2013, Malaysia had experienced short periods of severe haze

episodes due to trans-boundary pollution. Emissions produced by it can affect air quality worse, leading to air pollution. The impact of air pollution to human health is bad that may lead to many diseases.

Carbon monoxide (CO) is one of common and widely distributed air pollutants. It is a colorless, odorless, and poisonous gas. Carbon monoxide has a slightly lower density than air. Carbon monoxide is poisonous because when it get into a human body, it will react easily with hemoglobin in our blood. The result of the reaction is carboxyhaemoglobin (COHb). When carbon monoxide binds to hemoglobin, it cannot be released as easily as oxygen. Thus, less oxygen will be transferred into the body. Children, pregnant woman and babies are easily affected by this poisonous gas, which will result to neurological damage.

Nitrogen Oxide (NO_x) is a mixture of gases that composed of nitrogen and oxygen. Nitric oxide and nitrogen dioxide are two of most toxicological nitrogen oxides. Nitrogen oxide that is produced from the exhaust of motor vehicles are released to air will react to the air and produced nitric acid, which lead to the production of acid rains. Human exposure to high levels of nitrogen oxides can damage the respiratory airways. The skin or eyes can cause stinging if contacted with nitrogen oxide.

Hydrocarbon (HC), gases are a combination of hydrogen and carbon gas. The results from unburned or partially burned fuels that are diffused by the engine as exhaust and when fuel evaporate straightly into the atmosphere will produce HC pollution. There are many toxic compounds found in hydrocarbon gas, which may cause cancer.

Carbon dioxide (CO₂) is the primary greenhouse gas emitted through human activities. The concentration of CO₂ affects the temperature in the surrounding area.

This research is conducted as to provide better understanding of emission inventory of mobile sources within the state of Melaka (MBMB).

1.2 OBJECTIVES

1. To explore emissions inventory produce for small cities in the state of Melaka.
2. To apply the emissions inventory procedure to the MBMB enforcement area.
3. Develop the emissions inventory for on-road mobile sources within the first quarter of MBMB area.

1.3 SCOPE

1. The emission inventory for this thesis covers the road that in the first quarter of MBMB area which include roads at Sungai Udang, Tangga Batu, Tanjong Keling, Bukit Rambai, Klebang Besar, Bertam, Balai Panjang, Cheng, Tanjong Minyak and Paya Rumput.
2. The type of road is divided into 4 categories, which are industrial road, residential road, city road and village road.
3. The source emissions inventory only takes into account of the resources for the on-road mobile.
4. Conduct on-road mobile count using video recording at the selected area.
5. There are six types of pollutions that are involved in the emissions inventory, which are carbon monoxide (CO), carbon dioxide (CO₂), hydrocarbons (HC), nitrogen dioxide (NO₂), particulate matter (PM), and sulfur dioxide (SO₂).

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

The emission inventory process is a work of collecting data of emission from the pollution sources at a certain area. It is also a process to determine the pollution gases such as CO, CO₂, HC, NO₂, PM and SO₂ from on-road mobile source. Emissions inventory and air quality monitoring are valuable tools for identifying air quality which can help to reduce the global warming in the area.

2.1 POLLUTANT

Pollutant is a substance that makes land, water, and air become dirty and not safe. It can be in the form of chemical substances or energy such as light, noise and heat. Pollutant can be classified into two types which are primary pollutant and secondary pollutant.

2.1.1 PRIMARY POLLUTANT

The primary pollutant is substances that are emitted directly from the source into the atmosphere. Example of primary pollutant is smoke produce during open burning, exhaust gas from a car and gases released from a factory. The following pollutant is some primary pollutants that are harmful if the concentration of it are high enough:

1. Carbon compounds, such as CO, CO₂, and CH₄
2. Sulfur compounds, such as SO₂ and H₂S.
3. Nitrogen compounds, such as NO, and NH₃.
4. Particulate Matter (PM), such as PM_{2.5} and PM₁₀.

2.1.2 SECONDARY POLLUTANT

Secondary pollution is a pollution that produces directly from the source. It is a derivation from the primary pollutant. The following pollutant is the some of the main substance know that can cause harm if the concentration is high:

1. NO₂ and HNO₃ that produce from NO
2. Sulfates and nitrate aerosols formed from reactions of sulfuric acid and nitric acid in the air with NH₃, respectively
3. Ozone (O₃) produces from the photochemical reaction of nitrogen oxide and VOC_S
4. Organic aerosol formed from VOC_S in gas-to-particle reaction
5. Sulfuric acid formed from SO₂ and nitric acid (produce from NO₂)

2.2 AIR POLLUTANT SOURCE

Air is a composition of gases, including about 78 per cent of nitrogen, 21 per cent of oxygen and 1 per cent other gases. Air is polluted when the global concentration of greenhouse gases increased.

Pollutant source is divided into two categories which are anthropogenic source and natural source. Anthropogenic source is a source that is man-made. It started when a human began burning fuels. Anthropogenic sources can be divided into two main sources which are mobile source (on-road/non-road) and stationary source (point and non-point). Point stationary source is described as a source of air pollution that does not move from location to location. Examples of point stationary source are factory, fuel terminal and coal mines. As for non-point stationary source, it is a source that include several small stationary sources. Examples of it are parking area and gas station.

The mobile source is a source that originates from a vehicle or equipment that produce a pollutant when it moving. Mobile source also divided into two types of source which are on-road mobile source and non-road mobile source. Examples of on-road mobile source are car, motorcycle, van, and bus. Whereas non-road mobile source examples are locomotive, airplane and ship.

2.3 HUMAN IMPACT ON CLIMATE CHANGE

Malaysia is located in the equatorial zone. Malaysia undergoes warm and humid climate and usually has a high humidity, constant temperature, and plentiful rainfall. The average temperature in Malaysia is at 26°C ~ 32°C. Malaysia is a country that experience two monsoon seasons, which are the Northeast Monsoon and the Southwest Monsoon. The east coast of Peninsular Malaysia and western Sarawak will experience heavy rainfall during Northeast Monsoon. During the Southwest Monsoon, the rainfall in most state in Malaysia will be minimal. This is because the stable atmospheric condition in the region and the Sumatran mountain range brings the rain shadow effect.

Total annual rainfall in 34 selected meteorological stations, has decreased from 101,400 mm in 2011 to 91,700 mm in 2012. So also, within the first six months in 2012 and 2013, the amount of rain also declined from 39 700 mm to 37,900 mm. 2012a and 2013a data was taken from January to June

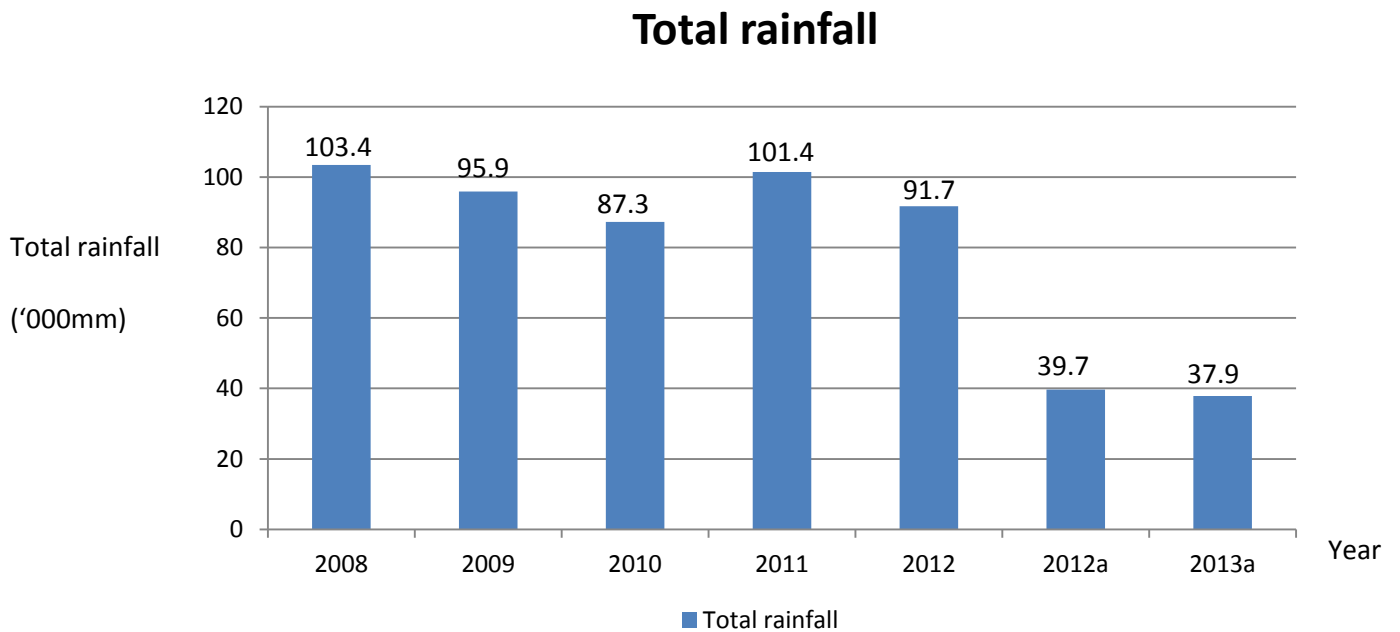


Figure 2.1: Total rainfall in Malaysia from 2008 to 2013
(Source: Compendium of Environment Statistics, 2013)

2.3.1 AIR POLLUTANT INDEX

In the year 1993, the Department of Environment (DOE) of Malaysia has developed the first air quality index system, known as the Malaysian Air Quality Index (MAQI). The Air Pollutant Index (API) was introduced in 1996 which replaced MAQI system. An index system is an important tool to determine the air quality from good to hazardous (Department of Environment, 2013). Table 2.1 below show the API status used in Malaysia.

Table 2.1: API status used in Malaysia (Department of Environment, 2013)

API	Status
0-50	Good
51-100	Moderate
101-200	Unhealthy
201-300	Very Unhealthy
>300	Hazardous

2.3.2 HUMAN ACTIVITIES

In 2012, 68.5 per cent of the emission of pollutant to the atmosphere in Malaysia was contributed by motor vehicle, while 26.4 per cent by stationary source, and 5.1 per cent by other sources. (Department of Environment, 2012).

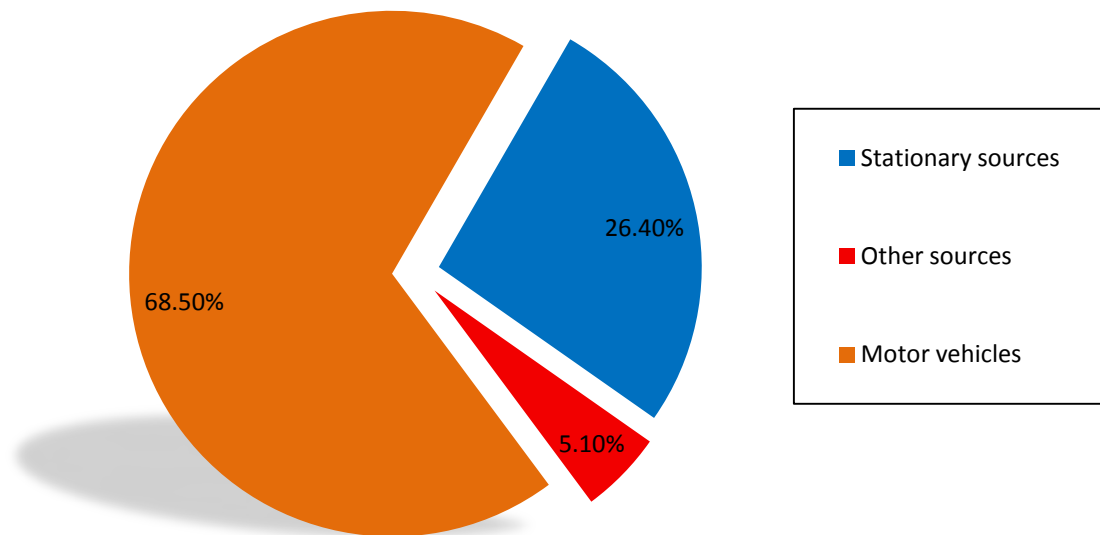


Figure 2.2: Emission discharge to the atmosphere by source in Malaysia for year 2012.

(Source: Compendium of Environment Statistics, 2013)

2.3.3 MOBILE SOURCE

Mobile sources account for more than half of all the air pollution in the United States and even more in Mecklenburg County. The emission from mobile source continues to increase at a faster pace than other sources. This is because the number of vehicle register in the country increases every year (Mecklenburg County, 2013).

Similar trend can be seen in Malaysia, in 2012, the total emission of CO, NO₂, SO₂, and PM to the atmosphere by motor vehicle in Malaysia is increase compared to 2011. The highest increased emission was CO gas, which are 6.5 per cent. SO₂ increase by 5.1 per cent, and 4.5 per cent for both NO₂ and PM. Figure 2.3 shows the comparison of CO, NO₂, SO₂, and PM between 2011 and 2012 (Department of Environment, 2012). The gases mention above is some of the greenhouse gases that are dangerous to human health.

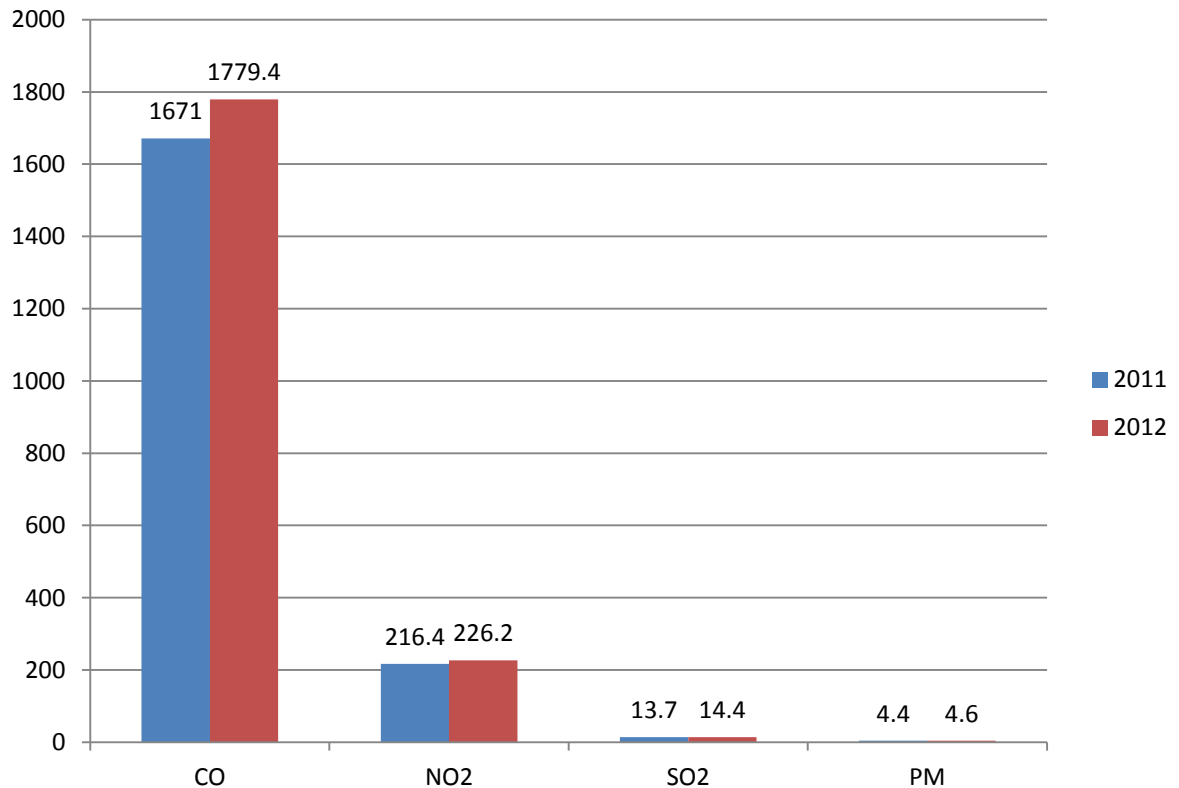


Figure 2.3: Total emission of CO, NO₂, SO₂, and PM to the atmosphere from motor vehicles in year 2011 and 2012.

(Source: Compendium of Environment Statistics, 2013)

2.3.4 THE EFFECT OF MOBILE SOURCE EMISSION LOAD

A mixture of liquid droplets and solid particles in the air will form a thing called Particulate Matter (PM). The components that were normally found in these particles are oxides of nitrogen, sulfur dioxide, ammonia, non-methane volatile organic compounds, and carbon particle (soot) (World Health Organization, 2013). Particulate matter can be measured by the diameter of the matter, for the diameter less than 10 micrometer the symbols used is PM₁₀ and it is called as “Inhalable Coarse Particles”, while for the