EMISSIONS OF GASEOUS AND PARTICULATE POLLUTANTS OF OCEAN-GOING VESSELS IN JOHOR PORT

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DEDICATION

Dedicated to my beloved family

Most generous Dad
Wahab bin Suhaili

Beloved and Understanding Mum
Badriah binti Ismail

Very much thanks and appreciation to mum and dad for all of your sacrifices, efforts, patience in raising me up to be a better person. Every happy and sad moment will not be forgotten forever

Also for Abang, Akak and Adik-Adik that will remain in my memory forever

The most Special
Natasha binti Ishak
For giving me the encouragement and valuable support

Special for Dr. Shamila Azman
Thank You for everything

Not to forget all Environmental Lab Staff especially to En. Azrin
Thank you for your time, help and guidance

Also not to forget friends that has lend me much helped in completing my theses
Wan, Midun, Fad and Rahmah
Thank You for all your help

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ABSTRACT

Increment of ship traffics and machineries could be a source of gaseous emissions and particulate pollutants. This study attempt to investigate the problems in Johor Port. Emission sources concentration of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon oxides (CO, CO_2) and particulate matter less than 10 μm (PM_{10}) in port were obtained. From the results obtained based on the comparison with Recommended Malaysian Air Quality Guidelines (RMAQG), NO_2 concentration surprisingly exceed the limit by 5.9 percent in sampling station 2 while highest SO_2 concentration were detected in sampling station 1 and 3 with a value of 0.2 ppm exceeding the RMAQG limits of 0.13 ppm by 53.8 percent for both stations. Other gaseous at station 1, 2 and 3 are still within the recommended guidelines. Based on the computation of Ocean-Going Vessels (OGVs) emissions estimate and later compiled as inventory, the results clearly shows that major pollutants contributor in Johor Port are oxides of nitrogen (NO_x) and sulphur dioxide (SO_2) with a percentage value of 60 and 27 percent for manoeuvring mode while 60 and 28 percent for hotelling mode. Other pollutants contribute below than 10 percent for both modes.

ABSTRAK

Pertambahan dalam lalu lintas kapal dan alat jentera boleh menjadi sumber bagi pembebasan gas dan partikel bahan cemar. Kajian ini cuba untuk mengkaji masalah di Pelabuhan Johor. Pengeluaran punca kepekatan bagi sulfur dioksida (SO_2), nitrogen dioksida (NO_2), karbon oksida (CO, CO_2) dan partikel jirim yang kurang daripada 10 μm (PM_{10}) di pelabuhan telah diperolehi. Daripada keputusan yang diperolehi berpandukan daripada perbandingan dengan *Recommended Malaysian Air Quality Guidelines* (RMAQG), kepekatan NO_2 melebihi had yang telah dicadangkan sebanyak 5.9 peratus di stesen persampelan 2 manakala kepekatan tertinggi bagi SO_2 telah dikesan di stesen persampelan 1 dan 3 dengan nilai 0.2 ppm melebihi had RMAQG iaitu 0.13 ppm sebanyak 53.8 peratus untuk kedua-dua stesen. Gas-gas lain di stesen 1, 2, dan 3 masih lagi dalam garis panduan yang dicadangkan. Berpandukan kepada pengiraan anggaran pengeluaran bagi *Ocean-Going Vessels* (OGVs) dan kemudiannya disusun sebagai *inventory*, hasil yang diperolehi jelas menunjukkan penyumbang terbesar bagi pencemaran di Pelabuhan Johor adalah nitrogen oksida (NO_x) dan sulfur dioksida (SO_2) dengan nilai peratusan sebanyak 60 dan 27 peratus bagi mod *manoeuvring* manakala 60 dan 28 peratus bagi mod *hotelling*. Lain-lain bahan cemar menyumbang kurang daripada 10 peratus bagi kedua-dua mod.

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CHAPTER I

INTRODUCTION

1.1 Introduction

In a world of globalization and growth of global supply chains, thousands of ships travel between the world's large ports transporting the manufactured goods, agricultural commodities and petroleum products that supply the world's stores, markets and gas stations. Ocean-borne commerce has been steadily increasing through the last two decades and is expected to continue to play a significant role in the globalised world economy. A growing fleet of ships, trains, airplanes and trucks along with the ports, train yards, airports and roads that support them are the backbone of global commerce.

In the era of logistics and global supply chains, the fast and efficient movement of goods is an economic imperative. Investments are currently being deployed to modernize and expand ports and intermodal facilities to accommodate growing cargo volumes. Growing ship traffic and machineries in ports will add significantly to local air

quality problems and global climate change risks unless ship and machineries emissions are further controlled (Friedrich *et al.,* 2007).

As one of the world's top twenty trading nations, the importance of the maritime sector to Malaysia cannot be underestimated. Besides housing some of the world's major ports, about 95% of the country's goods traded are also transported by sea. Malaysia is also strategically located along the Straits of Malacca, where more than 60,000 ships pass through annually, making it one of the busiest shipping lane in the world as shown in Figure 1.1 (DOE, 2006).

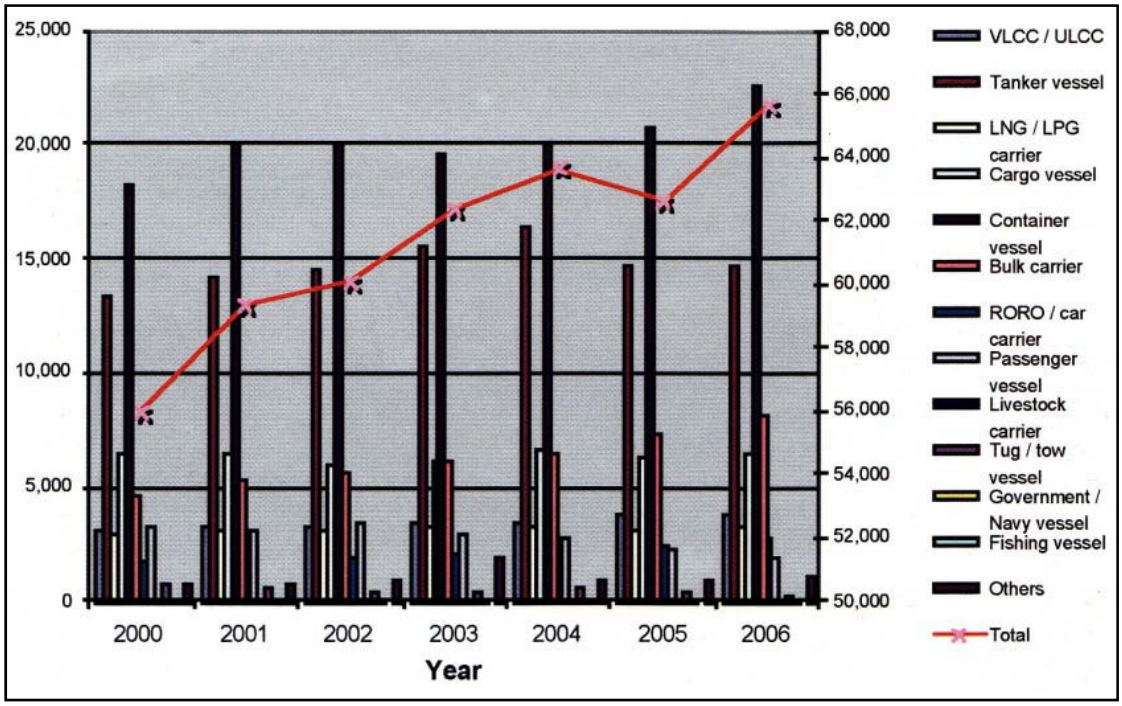

Figure 1.1: Total number and type of ships traversing the straits of Malacca (DOE, 2006)

Local and regional air quality problems associated with ship and machineries gaseous emissions are a concern because of their public health impacts. Several studies yield results that emissions from ships are affecting areas with dense shipping activities, including this region. For example, the study by Corbett *et* al. (2007), the global and regional mortalities were estimated by applying the ambient particulate matter increases due to ships, contributing to cardiopulmonary and lung cancer risks. The results indicate that shipping–related particulate matter emissions are responsible for approximately 60,000 cardiopulmonary and lung cancer deaths annually, with most deaths occurring near coastlines in Europe, East Asia and South Asia. Under current regulations and with the expected growth in shipping activity, it was estimated that annual mortalities could be increase by 40% by 2012.

It is apparent that air pollution from shipping activities is a growing problem that is drawing increased attention around the world. Furthermore, emissions from shipping activities are projected to continue to grow in tandem with the increasing shipping activities worldwide. In addition, global change in temperature and climate is currently one of the more complex and challenging issues facing the world at large. Emissions from ships have now been recognized as one of the important sources of air pollution.

1.2 Problem Statement

Johor Port Berhad (JPB) is one of the busiest ports in Asia. In Malaysia, emission inventories of air pollutants and systematic data for the use of scientific community is rather scarce. Usually emission inventories of air pollutants have been made on port mainly for general administrative and public information. Besides, data containing emissions gaseous in ports that can act as a baseline to improve and enhance the air quality are hardly found (Gupta *et al.,* 2002).

1.3 Objective

The objectives of this study are:

- To determine the emission sources concentration of SO_2, NO_2, CO, CO_2 and PM_{10} in Johor Port Berhad.

- To determine the emission estimation from ocean-going vessels (OGVs) source categories;

- To compile an air emission inventory of OGVs mode for Johor Port area

1.4 Scope of study

The study will be focusing on the level of air quality in Johor Port itself which the parameters involved are NO_2, SO_2, CO, CO_2 and PM_{10} where the study area will be concentrating at three sampling locations within the port area, mainly on the pier/wharf/dock, the nearest area to vessel emissions sources. The sampling stations are selected and studied in detail in order to obtain reasonable results from the real data sampling as well as to ease the comparison purposes for analysis. Apart from that, the sampling should only be conducted during shiny days.

As for the emission estimation and the inventory purposes, OGVs sources as described (section 2.11) are the one to be computed for its emissions estimate. The

inventory will be compiled based on the OGVs emission estimation. Methods and factors (section 3.6) that are described later on will be used. The computation of the emission will only be done for OGVs that are within the port area which is explained in detail (section 2.11). For this study, the emission estimation is computed only for OGVs that is maneuvering and hotelling within port boundaries. At sea emission estimation is beyond the scope of this study.

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