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CO2 Emission Along Ferry Route Batam-Johor

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ABSTRACT

Global warming and air pollution have become one of the important issues to the entire world community. Exhaust emissions from ships has been contributing to the health problems and environmental damage. This study focuses on the ferry routes from ferry terminal in Stulang Laut, Johor Bahru to Batam Island, Indonesia because it is one of the world's most congested straits used for international shipping where located on the border among three countries of Indonesia, Malaysia and Singapore. This study will identify and predict Carbon Dioxide (CO2) emission from the marine transport from ferry terminal in Stulang Laut, Johor Bahru along its routes to Batam Island, Indonesia.

KEY WORDS: *AIS, Carbon Dioxide, CO2, Emission, Distribution*

1.0 INTRODUCTION

The international shipping industry is responsible for the carriage of about 90% of world trade and is vital to the functioning of the global economy. Intercontinental trade, the bulk transport of raw materials and the import export of affordable food and goods would simply not be possible without shipping. It is the availability, low cost and efficiency of maritime transport that has made possible the major shift towards industrial production in Asia and other emerging economies (IMO 2006).

The Strait of Malacca remains as one of the world most congested straits used for international shipping which is a narrow stretch of water lying between the east coast of Sumatra Island in Indonesia and the west coast of Peninsular Malaysia, and is linked to Singapore at its southeast end. The Strait of Malacca varies in width from 200 miles to 11 miles with irregular depths from over 70 to less than 10 meters is one of the most important shipping channels in the world which is connecting the Indian Ocean with the South China Sea and the Pacific Ocean. (SJICL, 1998).

At approximately 805 kilometers long, the Strait of Malacca is the longest Strait in the world used for international navigation (Wikipedia, 2013). From the study by Jaswar (2013), it shows that daily 1500 vessels approximately pass through the Strait of Malacca which is 42 percent was under Singaporean flag. These consist of a wide spectrum of different types of vessels with 32 percent of Liquid bulk and 11 percent of container ships.

With this number of ship, it will leave environmental impact such as Greenhouse gas emission. Carbon dioxide emissions from shipping is estimated to be 4 to 5 percent of the global total, and estimated by the International Maritime Organization (IMO) to rise by as much as 72 percent by 2020 if no action is taken (Vidal, 2007). IMO (2009) study of greenhouse gas (GHG) shows total exhaust emission from shipping from 1990 to 2007 and can see that there are increases of exhaust emission every year.

2.0 AIS

Automatic Identification System (AIS) firstly has been used to comply with safety and security regulations, functioning as collision avoidance, vessel traffic services, maritime security, aids to navigation, search and rescue and accident investigation. The AIS is meant to be used primarily as a means of lookout and to

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determine the risk of collision rather than as an automatic collision avoidance system, in accordance with the International Regulations for Preventing Collisions at Sea (IMO, 1998).

Primary data of ships which obtained from an AIS receiver in the study are MMSI of the ship, IMO number, receive time, position of the ship (longitude and latitude), speed of ground (SOG) and COG. These all the data obtained from an AIS receiver installed in Marine Technology Laboratory (Marine Technology Center (MTC)), Faculty of Mechanical Engineering, Universiti Teknologi Malaysia (UTM). Information of ships based on AIS is not complete to use as the basis for calculation. AIS only provides several initial data such as MMSI, IMO number, position of ships (longitude and latitude), Speed Over Ground (SOG), Centre of Gratify (COG) and true heading of the ship. Gross Tonnage (GT) data for calculation of emission rate as explained by Trozzi C. (2010) is obtained from other references such as marinetraffic.com, maritime-connector.com, equasis.org, vesseltracker.com and Equasis.org. The combination of all the data will make a complete database that can be used for the calculation.

3.0 CARBON DIOXICE (Co2)

Carbon dioxide (CO2) is a colorless, odorless, non-flammable gas that is a product of cellular respiration and burning of fossil fuels. It has a molecular weight of 44.01g/Mol (NIOSH 1976). Although it is typically present as a gas, carbon dioxide also can be a solid form as dry ice and liquefied, depending on temperature and pressure (Nelson 2000).

In a natural carbon cycle, carbon dioxide is re-absorbed by plants and trees. However, the rate in which the burning fuels is way too fast for trees and plants to absorb and convert into breathable air. In addition to that, many rainforests have been lost because of the cutting down of trees, which doesn't help in the already existing problem. The effect of all this extra carbon dioxide in the atmosphere is that the overall temperature of the planet is increasing, resulting to global warming. Carbon dioxide is not only a gas which affects the heat flow to and from the atmosphere of the earth, but is also a serious pollutant in its own right (Robertson, 2006). The concentration of this gas in the atmosphere is not known to have risen above 320 ppm over the last 40,000 years (Neftal et al, 1982).

Evidence demonstrates this to be the case for the past 420,000 years (Petit et al, 1999). Several researches suggest that carbon dioxides also give effect to the Physiological. Although the safe working level of carbon dioxide is presently set at 5000 ppm for an 8 h day 40 h working week, no human ever endures such a level of carbon dioxide in the atmosphere for 24 h a day, 365 days a year, for an entire lifetime nor has any human ever bred offspring under these conditions. This includes workers in breweries and the greenhouse industry, where the concentration of carbon dioxide in the atmosphere either commonly reaches or is set at a maximum of 900 ppm (Robertson, 2006).

4.0 CASE STUDY

The study was conducted on 27 August 2014 on a ferry from ferry terminal in Stulang Laut, Johor Bahru to Batam Island, Indonesia. According to Jaswar (2013) here are 813 marine transport detected by Automatic Identification system (AIS) in the area from ferry terminal in Stulang Laut, Johor Bahru to Batam Island, Indonesia that is include the marine transport in Singapore area as shown in figure 1.

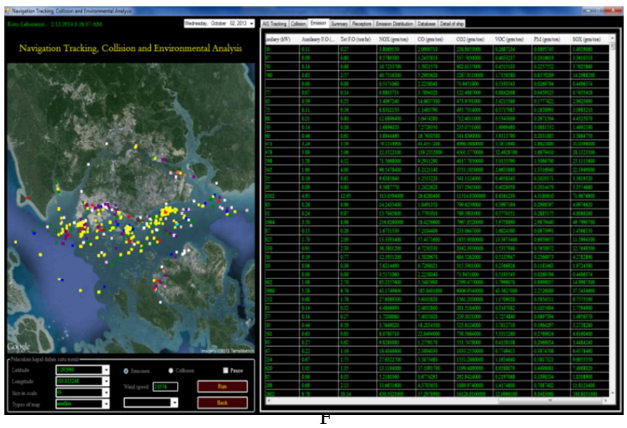

Figure 1: Routes taken by ferry (Jaswar, 2013).

The purpose of the study is to identify and predict carbon dioxide emission from the marine transport along the ferry routes from ferry terminal in Stulang Laut, Johor Bahru to Batam Island, Indonesia.

Table 1: Number of marine transport (Jaswar, 2013)

Code	Type	Number of Ship
SB	Solid Bulk	49
LB	Liquid Bulk	372
GC	General Cargo	51
CO	Container	124
PC	Ro-Ro Cargo	3
PA	Passenger	12
HS	Highspeed ferries	1
TU	Tugs	138
FI	Fishing	1
OT	Other	62
Unknown		360
Total Number of Ship		1173

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Total correspondent ship	813

From table 1, it is shown that the type of all 813 total number of marine transport. The highest of identify marine transport at the study area is Liquid Bulk ship that is 372 follow by Tug boat and container ship that is 138 and 124.

There is still higher number of unknown types of marine transport around the study area. 360 number of unknown ship has been recorded at the time of the study conducted. This number can be narrow down after another study with a completed Automatic Identification System (AIS) database.

Table 2 show 34 Latitude and Longitude within the routes taken by the ferry during the study conducted from Stulang Laut ferry terminal, Johor Bahru on 1.47109N 103.7849E to Batam Center ferry terminal, Batam Island, Indonesia on 1.13151N 104.0561E.

Table 2: Ferry routes.

No	Latitude	Longitude	No	Latitude	Longitude
1	1.47109	103.7849	18	1.13151	104.0561
2	1.47085	103.7926	19	1.42784	103.9119
3	1.47463	103.8142	20	1.42862	103.9255
4	1.46845	103.8409	21	1.42690	103.9458
5	1.45172	103.8651	22	1.42441	103.9843
6	1.43340	103.8880	23	1.41832	104.0002
7	1.42950	103.8967	24	1.39043	104.0101
8	1.42278	103.9596	25	1.38052	104.0239
9	1.40600	104.0060	26	1.36580	104.0386
10	1.36580	104.0386	27	1.34155	104.0607
11	1.30667	104.0694	28	1.30667	104.0694
12	1.25730	104.0672	29	1.25730	104.0672
13	1.23628	104.0635	30	1.23628	104.0635
14	1.22236	104.0617	31	1.19627	104.0566
15	1.19627	104.0566	32	1.16066	104.0631
16	1.16066	104.0631	33	1.13870	104.0586
17	1.13870	104.0586	34	1.13151	104.0561

The figure 2 below show the routes taken by the ferry from ferry terminal in Stulang Laut, Johor Bahru to ferry terminal in Batam Island, Indonesia. Along the routes, the ferry will pass through few places and area with high density number of marine transport such as Perlabuhan Pasir Gudang in Johor Bahru.

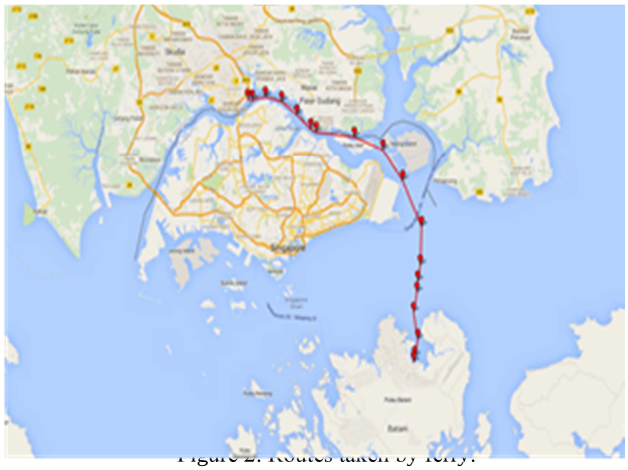

Figure 2: Routes taken by ferry.

In this study, carbon dioxide is measure in Parts per million (PPM). The measurement is taken for every minutes for one hour start from 6:55 PM and ended at 7:57 PM as shown in table 3 below.

Table 3: Carbon Dioxide (CO2) every 1 minute for 1 hour.

Time	CO2	Time	CO2	Time	CO2
6:55 PM	455	7:16 PM	461	7:37 PM	461
6:56 PM	451	7:17 PM	456	7:38 PM	461
6:57 PM	450	7:18 PM	453	7:39 PM	462
6:58 PM	451	7:19 PM	451	7:40 PM	463
6:59 PM	452	7:20 PM	451	7:41 PM	453
7:00 PM	453	7:21 PM	451	7:42 PM	449
7:01 PM	452	7:22 PM	451	7:43 PM	446
7:02 PM	453	7:23 PM	449	7:44 PM	445
7:03 PM	455	7:24 PM	449	7:45 PM	446
7:04 PM	457	7:25 PM	453	7:46 PM	448
7:05 PM	457	7:26 PM	458	7:47 PM	445
7:05 PM	457	7:27 PM	457	7:48 PM	445
7:07 PM	456	7:28 PM	457	7:49 PM	446
7:08 PM	455	7:29 PM	457	7:50 PM	438
7:09 PM	454	7:30 PM	457	7:51 PM	439
7:10 PM	455	7:31 PM	457	7:52 PM	458
7:11 PM	461	7:32 PM	457	7:53 PM	457
7:12 PM	478	7:33 PM	456	7:54 PM	458
7:13 PM	484	7:34 PM	456	7:55 PM	455
7:14 PM	488	7:35 PM	456	7:56 PM	449
7:15 PM	485	7:36 PM	458	7:57 PM	450

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The data shown that within one hour period the carbon dioxide level is range from 438 PPM to the highest point that is 488PPM. Still this level is still above the normal outdoor carbon dioxide level that is between 300 PPM to 400 PPM.

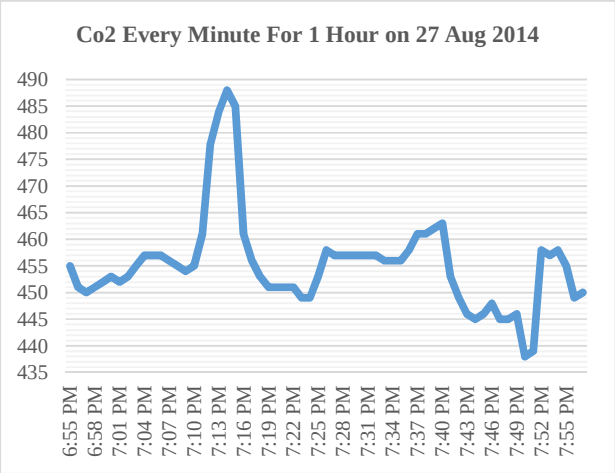

Figure 3: Carbon Dioxide level graph.

The highest level of carbon dioxide recorded is 488 PPM at 7:14 PM and the lowest level of carbon dioxide recorded is 438 PPM at 7:50 PM. The graph in figure 3 show that an increase of carbon dioxide concentration level from 7:11 PM to 7:14 PM.

As shown in figure 4 below, the highest level of carbon dioxide concentration recorded at Latitude and Longitude 1.42950E 103.8967N that is in the area of Pasir Gudang Port. From the Automatic Identification System data, there is known to be a lot of marine transport activities in the area of Pasir Gudang Port (Jaswar, 2013).

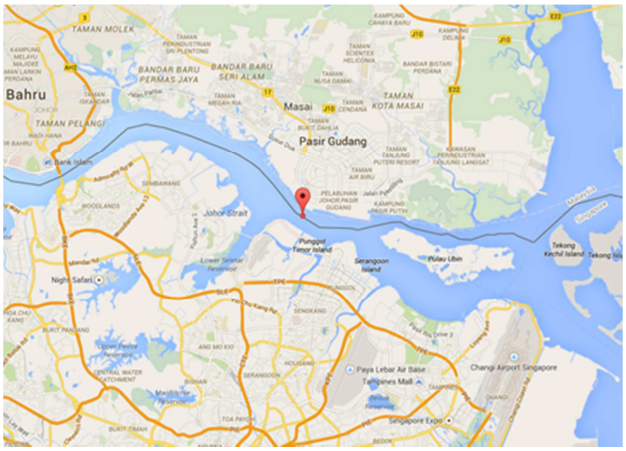

Figure 4: The highest Carbon Dioxide level recorded.

The data also shown that carbon dioxide concentration level most probably was contribute by the marine transport until further study will be conducted. The more activities by marine transport in the area, most probably the higher carbon dioxide concentration level will be recorded. Figure 5.1, 5.2, and 5.3, below also showing picture taken during the study. The high amount of marine transport can be sighted in the area where the highest carbon dioxide concentration level has been recorded.

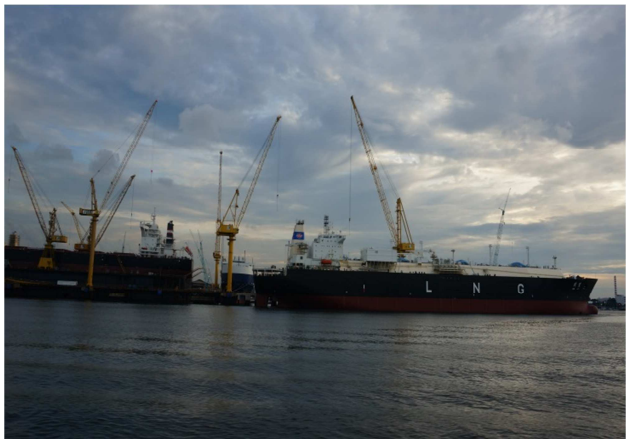

Figure 5.1: Sighted marine transport.

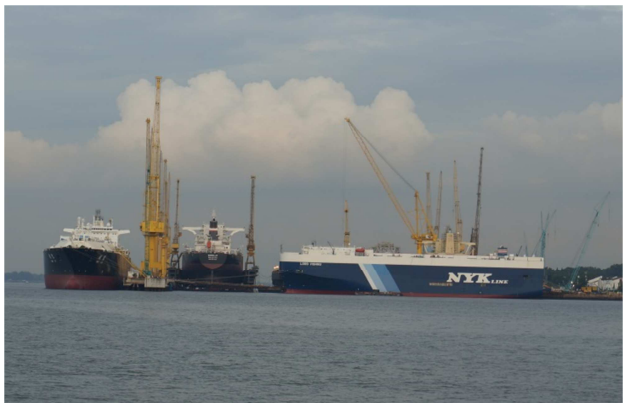

Figure 5.2: Sighted marine transport.

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Figure 5.3: Sighted marine transport.

In figure 6, latitude and longitude of 1.23628E 104.0635N show the location of the lowest carbon dioxide recorded in the study. From the Automatic Identification System (AIS) data also shown that there is less marine transport at the area (Jaswar, 2013).

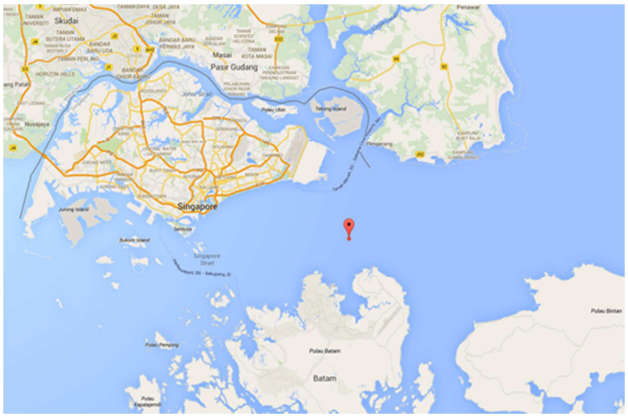

Figure 6: The lowest Carbon Dioxide level recorded.

Other than less activities of marine transport, the factor of natural carbon sinking by the ocean was probably another reason of the lowest carbon dioxide concentration recorded at the study area (Raven, 1999). Of all the area, it was located at the open sea far away from land and there also less activities of marine transport sighted (Takahashi, 2002).

5.0 CONCLUSION

In conclusion, this paper explained that marine transport do contribute to carbon dioxide pollutions. The highest level of carbon dioxide concentration was recorded on the area of high traffic of marine transport that is in the area of Pasir Gudang Port. Marine transport such as cargo ship still contribute low emission of carbon dioxide compare to other transport. This is because for equal weight and distance it is the most efficient transport method such as air freight.

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