CO₂ Emission Statistics for the World Commercial Fleet

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Abstract
The purpose of this paper is to present an analysis of carbon dioxide (CO₂) emissions of the world commercial fleet. The analysis is based on the Lloyds-Fairplay world ship database for 2007 and produces various emissions statistics of the following major ship types: bulk carriers, crude oil tankers, container vessels, product/chemical carriers, LNG carriers, LPG carriers, reefer vessels, Ro-Ro vessels and general cargo ships. A separate analysis is carried out for small vessels under 400 GRT and for passenger vessels. The main outputs from this analysis for each ship type-size bracket are the emitted grams of CO₂ per tonne-km and an estimate of the total CO₂ produced in a year. The methodology for estimating these statistics is described, and a comparison with other studies is made.

Key words: Ship CO₂ Emissions, Ship Air Pollution, Modelling of Ship Fuel Consumption and Emissions, Greenhouse Gases and Shipping.

1 Introduction
Carbon dioxide (CO₂) emissions from commercial shipping are currently unregulated. Nevertheless, they are a subject of intense scrutiny by the world shipping community. According to the Kyoto protocol to the United Nations Framework Convention on Climate Change – UNFCCC (1997), definite measures to reduce CO₂ emissions are necessary in order to curb the projected growth of greenhouse gases (GHG) worldwide. Shipping has thus far escaped being included in the Kyoto global emissions reduction target for CO₂ and other GHG, but it is clear that the time of non-regulation is rapidly approaching its end, and measures to curb future CO₂ growth are being sought with a high sense of urgency. CO₂ is the most prevalent of these GHGs, and it is therefore clear that any set of measures to reduce the latter should primarily focus on CO₂. In parallel, the broader analysis of other greenhouse gases (such as CH₄ and N₂O) and other, non-greenhouse gases, such as SO₂, NOₓ and others is already very high on the International Maritime Organization’s (IMO) agenda. Various analyses of many aspects of the problem have been and are being carried out and a spectrum of measures are being contemplated. It is clear that a reliable emissions inventory is essential for both scientists and policy-makers in order to formulate and evaluate the implementation of relevant regulations.

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To contribute to this debate and possibly complement other studies on the subject, the authors of this paper have conducted their own analysis on emissions of the world fleet database (as provided by Lloyds Fairplay for year 2007) and can herein present some preliminary results of the emissions statistics of the following major ship types: bulk carriers, crude oil tankers, container vessels, product/chemical carriers, LNG carriers, LPG carriers, reefer vessels, Ro-Ro vessels and general cargo ships. A separate analysis was carried out for small vessels under 400 GRT and for passenger vessels. The study was conducted by the National Technical University of Athens (Laboratory for Maritime Transport) for the Hellenic Chamber of Shipping (HCS).

The study had the following original objectives: (a) develop a web-based tool for calculating the exhaust gas emissions (CO2, SO2 and NOx) of specific types of ships under a variety of operational scenarios, and (b) produce various statistics of CO2 emissions, based on data from the world fleet database.

Reporting on objective (a) is outside the scope of this paper and is done elsewhere. The reader is referred to the study’s public final report for more details (see Psaraftis and Kontovas, 2008). The emissions web tool is freely available on-line1 and is the analogue of what some airlines have available on their web sites (tools available on-line) and of what some container lines have available for their customers (tools not available on-line).

One main output statistic of the world fleet analysis of this paper is the ratio of emitted grams of CO2 per tonne-km of transported cargo. The authors of this paper consider this statistic (which has been used for other transport modes as well) as reasonably representative of a vessel’s environmental performance in an operational setting. Another emissions statistic is an estimate of total CO2 emitted (in million tonnes per year) per size bracket for the above ship types (as compared to billions of tonne-kilometers carried by the same size bracket). Such statistics have been estimated for a variety of ship types and sizes and under a variety of scenarios as regards sea-to-port time, ship speed and fuel consumption at sea and in port. Some sensitivity analysis of these results has also been conducted. The description of the methodology and the results of this analysis are included in the rest of this paper.

The rest of this paper is organized as follows. Section 2 reports on relevant literature. Section 3 describes the methodology used in the paper. Section 4 describes the runs performed on the world shipping database. Section 5 comments on comparison with other studies and other modes. Finally Section 6 presents the paper’s conclusions.

2 Relevant Literature
Looking at the literature on the broad area of this paper (including both scientific work and regulation-related documents), it is no surprise that the relevant material

1 For the on-line Ship Emissions Calculator, please go to http://www.martrans.org/emis.