Vessel Emissions Guide

How-to-guide to determine your vessel emissions

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Vessel Name	**Boaty McBoatface**
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Source	**Sustainable Ships**

Contents

EXECUTIVE SUMMARY

This is a step-by-step guide on how to determine vessel emissions based on fuel consumption. The below three steps are to be taken. Go to Sustainable Ships for a tool that automatically calculates your emissions. For the native word file of this document, or to create a report using your company layout, talk to an expert on Sustainable Ships.

Step 1. Determine fuel consumption
Step 2. Determine emission factors
Step 3. Calculate emissions
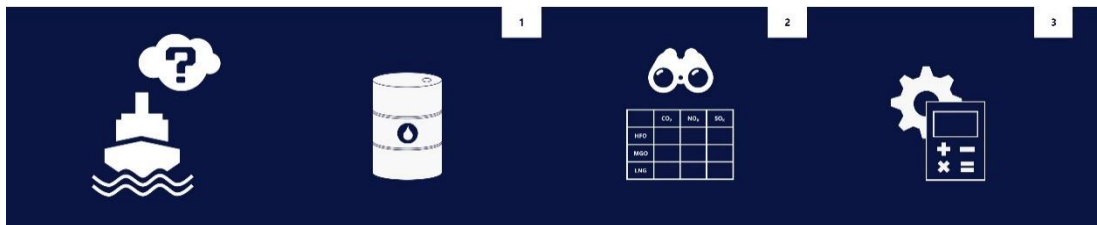
1.1 References

IMO – Fourth IMO GHG Study 2020
IMO – MEPC.281(70)
ISO 8217 – Fuel standard for marine fuels

1.2 Disclaimer

It is assumed that for this guide, the reader is equipped with general knowledge on offshore and maritime industry, power generation on-board vessels and emission calculation methodology. Always take good care in verifying the emissions yourself, Mr. Sustainability cannot guarantee the outcome for your vessel. No rights can be derived from the information provided in this document.

1.0 DETERMINE FUEL CONSUMPTION

The first step is to determine the type of fuel that is used, and the fuel consumption of your vessel in metric tons. For most companies operating vessels, fuel type and consumption can be taken from daily progress reports or bunker fuel notes.

1.1   Calculate mass based on volume

In case only the volume of fuel is known to you, weight can be determined by multiplying the volume times the density of the fuel type. For example, 1 m^3 of MDO equals 0.89 metric tons of MDO.

Table 1. Marine fuel density.

Fuel	Average Density [mT/m^3]	Source
HFO	0.92 – 1.01	ISO 8217
MDO	0.89	ISO 8217
LNG	0.45	MEPC.281(70)

2.0 DETERMINE EMISSION FACTORS

Each type of fuel has associated emissions, the most important being CO_2, NO_x, SO_x, PM (Particulate Matter) and CH_4. Table 2 shows the amount of emissions in kilograms when 1 metric ton of fuel is burned (source: IMO GHG Study 2020 table 53). With fuel consumption and emission factors known, you can now calculate emissions.

Table 2. Marine fuel emission factors in kg per metric ton of fuel.

Fuel	Pollutant	Emission Factor*
HFO	CO_2	3114
	NO_x	77.26
	SO_x	47.73
	PM	7.25
	CH_4	0.05
MDO	CO_2	3206
	NO_x	54.88
	SO_x	2.15
	PM	0.95
	CH_4	0.05
LNG	CO_2	2750
	NO_x	8.28
	SO_x	0.03
	PM	0.11
	CH_4	8.27

* The averages of IMO GHG Study have been taken.

3.0   CALCULATE EMISSIONS

You can determine emissions by using the following equation:

Emission [kg] = Fuel Consumption [mT] x Emission Factor [kg/mT fuel]

3.1   Example (1)

Larry has a crane vessel called Crany McCraneface that consumes 10 metric tons of MGO per day. He wants to know the carbon footprint of Crany McCraneface. Table 2 shows him that the emission factor of CO_2 for MDO is 3206, resulting in 32,060 kilograms of CO_2 emissions per day, or 32.06 metric tons.

3.2   Example (2)

Mary has an LNG tanker called Tanky McTankface that consumes 10 cubic meters of LNG per day. She would like to know the CO_2 and CH_4 emissions. Table 2 shows her that the emission factors of LNG for CO_2 and CH_4 are 2750 and 8.27 respectively, resulting in 27,500 kilograms of CO_2 and 82.7 kilograms of CH_4 per day.

4.0   ADDITIONAL BACKGROUND INFORMATION

4.1   What happens when fuel is burned?

Upon combustion of any fuel, its constituents are combined with oxygen from the air and form several types of emissions. The chemical content of the fuel determines the resulting emissions: each type of fuel emits different amounts of carbon dioxide (CO_2), nitrous oxide (NO_X), sulphur oxide (SO_X) and many other types of emissions when burned. Generally speaking, a 'clean' fuel with the least amount of contaminants combined with a high temperature create the 'cleanest' emissions.

FOSSIL FUELS

Carbon
Hydrogen
Nitrogen
Sulfur
Oxygen

COMBUSTION

Primary Pollutants
CO - Carbon Monoxide
CO_2 - Carbon Dioxide
SO_2 - Sulfur
NO_X - Nitrogen Dioxide
N_2O - Nitric Oxide
VOCs - Volatile Organic Compounds
or
HCs - Hydrocarbons

Particulate Matter
PM_{10} - Course Particles - less than 10 microns
$PM_{2.5}$ - Fine Particles - less than 2 microns
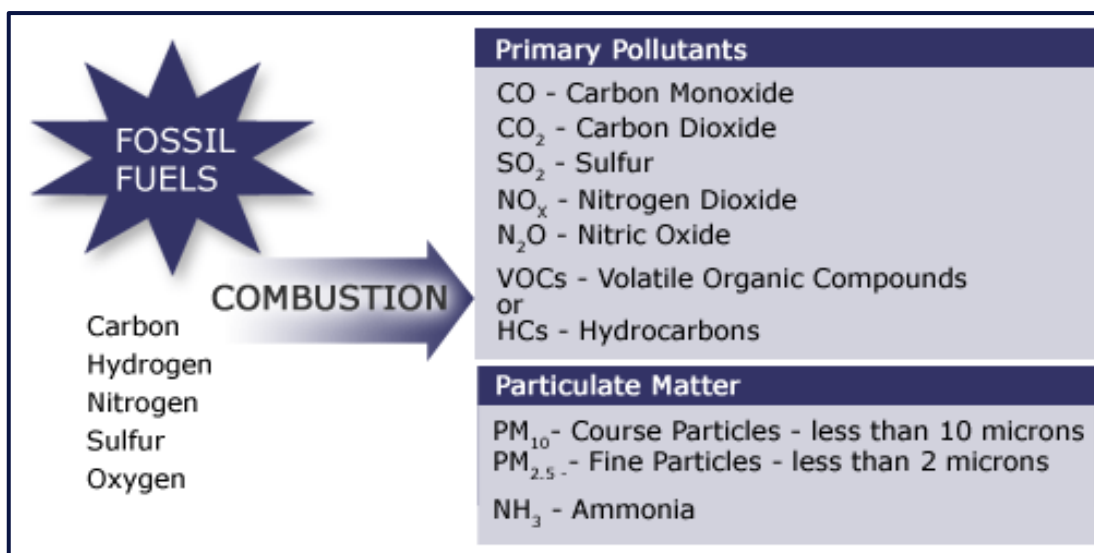NH_3 - Ammonia

Figure 1. When fossil fuels are burned, numerous pollutants are produced. A few of them are the primary pollutants and constitute the majority of emissions.

4.2   Engine Settings affect emission factor (!)

It should be noted that these emission factors are (in some cases) heavily influence by engine settings. In the case with NO_X for example, the amount of emissions can vary significantly. The variation for CO_2 is much less and is primarily based on the carbon content of the fuel. Another factor to be taken into account, is methane slip for LNG engines, which could increase carbon equivalent footprint. In order to effectively and truly measure emissions, it is advised to install a continuous emissions monitoring system (CEMS).