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Comparison on functioning between bio-fuel and marine gas oil

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Abstract. These contributions presents practical aspects regarding utilization of bio-fuel, type FAME (Fatty Acid Methyl Esthers) in marine diesel engines, highlighting emissions polluants. Nowadays, marine industry is looking for alternatives in order to comply with more stringent MARPOL requirements with regards to fuel emission polluants and utilization of bio-fuels can be an option.
Keywords: pollution, marine environment, bio-fuel

I. Organizational aspects

For experimental determinations it was used two types of fuels: regular marine gas oil and FAME, which was obtained from two sources: Exxon Rafinery in port of Antwerp and one local company in charge with sample analysis of liquid cargoes onboard ships. FAME is a fuel obtained by esterifying vegetable oils and is ussually produced by a wide variety of vegetable fats or even recycled oils. Physical properties are similar to fossil fuels, the differences being:

- Higher viscosity
- Lower energy content resulting in higher fuel consumption
- Low oxidation properties and thermal stability
- High pour point
- Not compatible with several materials, such as plastic.

II. Equipment used

All the experimental determinations were carried out in the laboratory of Electromechanical Systems Department of “Mircea cel Batran” Naval Academy. The equipment used:

a) Four stroke diesel engine CT151, manufactured by GUNT Hamburg, one cylinder engine, air-cooled.
b) Load Unit HM365, its main function being to provide all necessary power for starting of CT151 engine. This is generated by an asynchronous motor which works as generator or motor as needed.
c) Test bench CT 159
d) Seitron 504 gas analyser, using calibrated gas sensors for measuring concentration of oxygen, carbon monoxide, nitrogen oxide, nitrogen dioxide and sulphur dioxide.

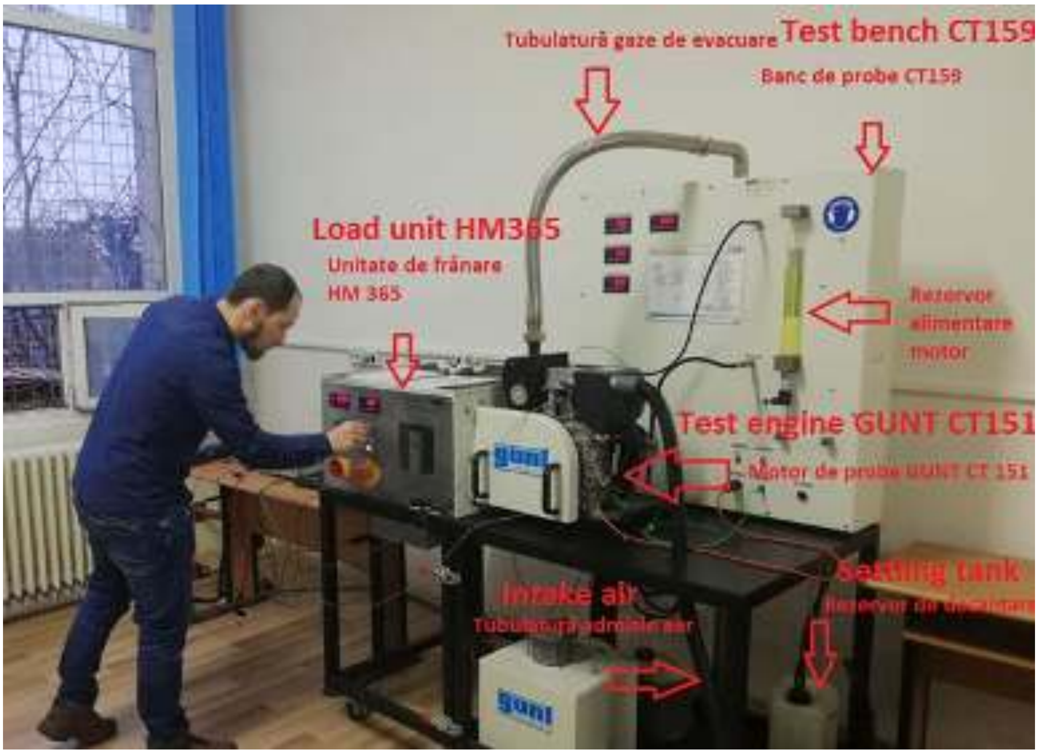


Figure 1 – Test bench including load unit, engine, test bench and other appliances

III Methodology of testing

Prior to the start of testing, the engine was cleaned with marine gas oil to remove any residues and deposits left over from other testing which might have been carried out. The analyser was calibrated to 0, following the steps in the instructions manual, being allowed to intake clean air for 5 minutes and than the probe of device was inserted into the exhaust pipe.


Figure 2 – Localization of gas analyser and exhaust pipe

During the first determinations, settling tank was filled with marine gas oil and later transferred to service tank, located on the test bench CT159. The test engine was started and engaged with the load unit HM365 at an initial torque of 3 Nm. The diagrams of gas exchange, P-V and P-T were taken using the software of CT 151 engine, which allows the possibility to analyse data in real time. After drawing the indicated diagrams, the gas analyser was used to analyse and print the pollutant emission information corresponding to the 3 NM load. This operation was repeated for loads of 5Nm, 6Nm,, 8Nm and a maximum of 10Nm. After finalizing the testing using marine gas oil, subsequently, the engine was allowed to consume all the gas oil in the service tank, until it stopped. FAME fuel was added to service tank and procedure and operations for drawing the diagrams and values of pollutant emissions was repeated for each load from 3Nm to 10Nm. In the images below, there is a sample of engine gas exchange diagrams at 5 Nm.

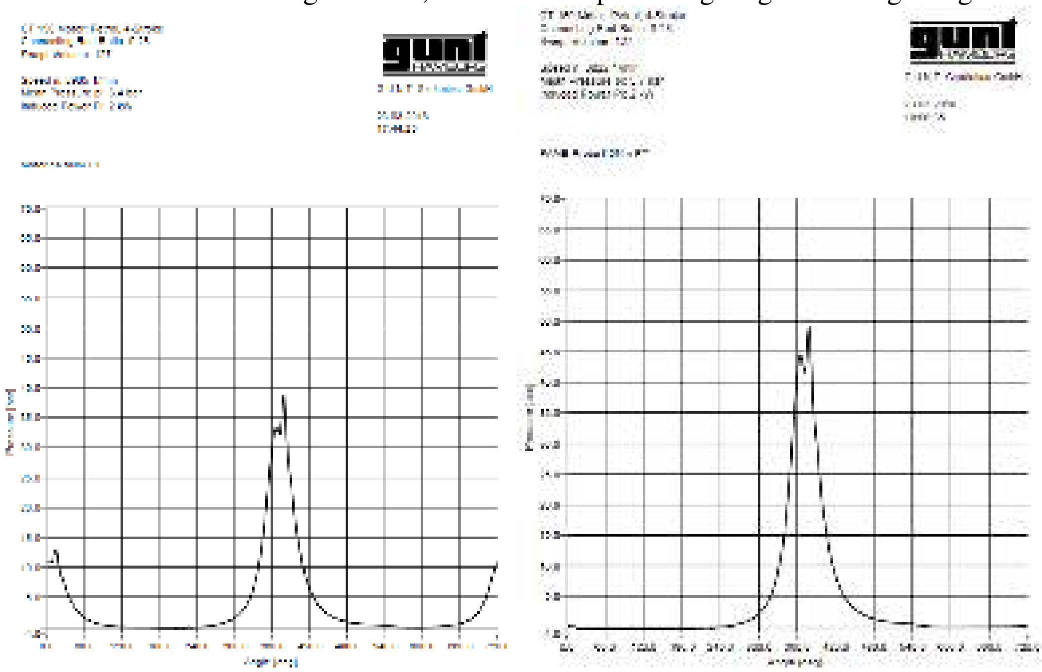


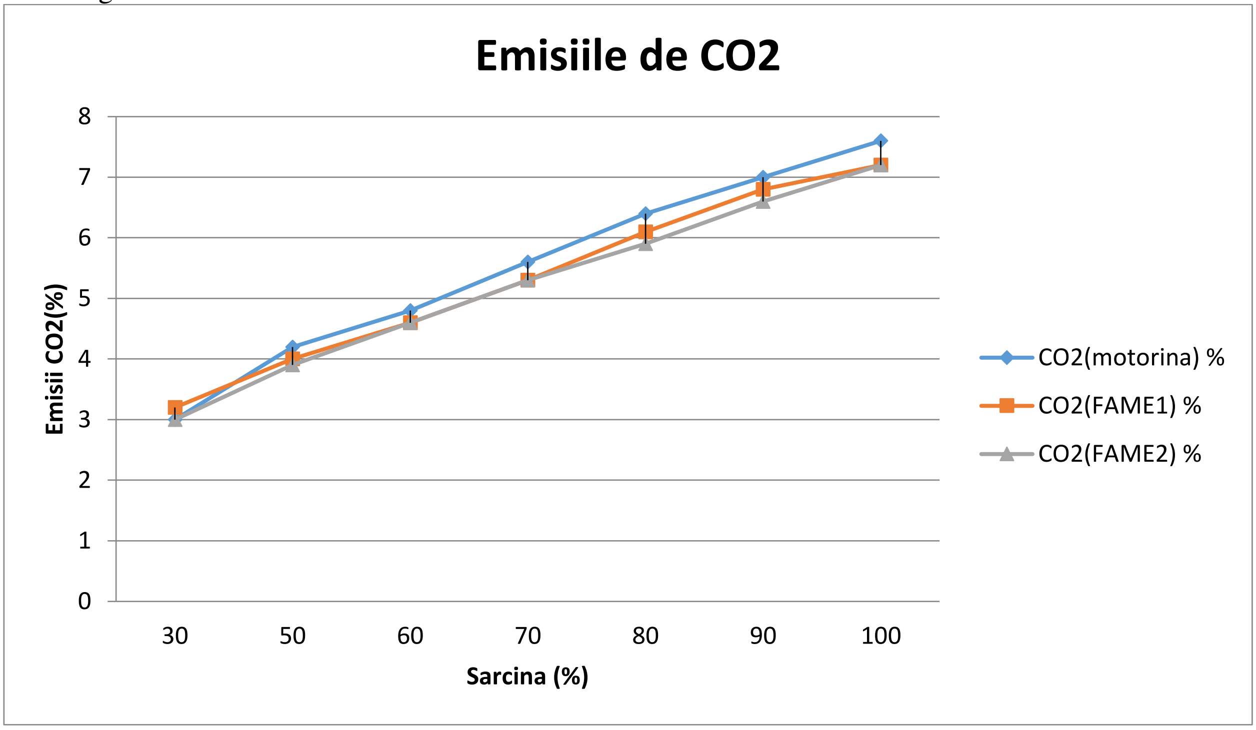
Figure 3 – Pressure-temperature diagram for marine gas oil and FAME

Figure 4 – Reports obtained from gas analyser Seitron 504S.

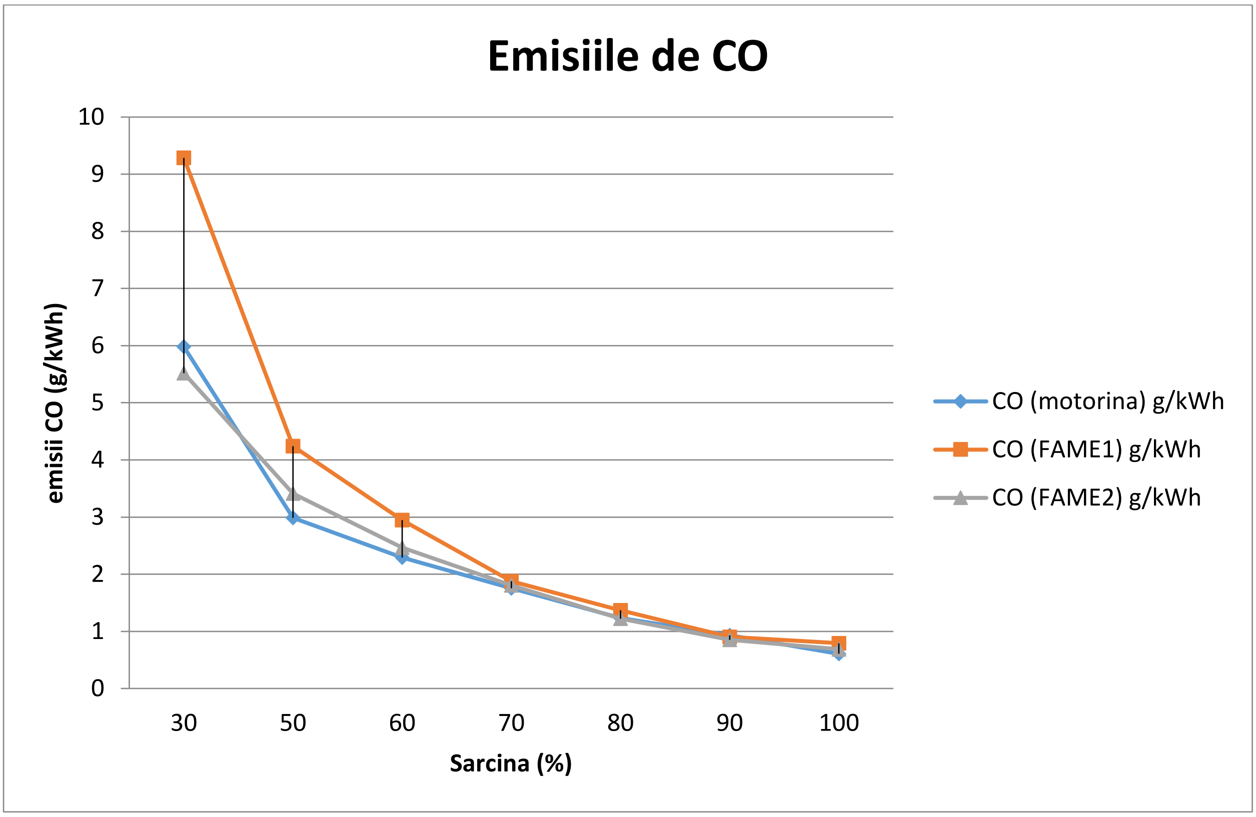
IV Test results and conclusions

All the results related to emissions were plotted in the diagrams listed below. Analysing the emission diagrams and gas exchange diagrams obtained from CT159 software, we draw up several conclusions:

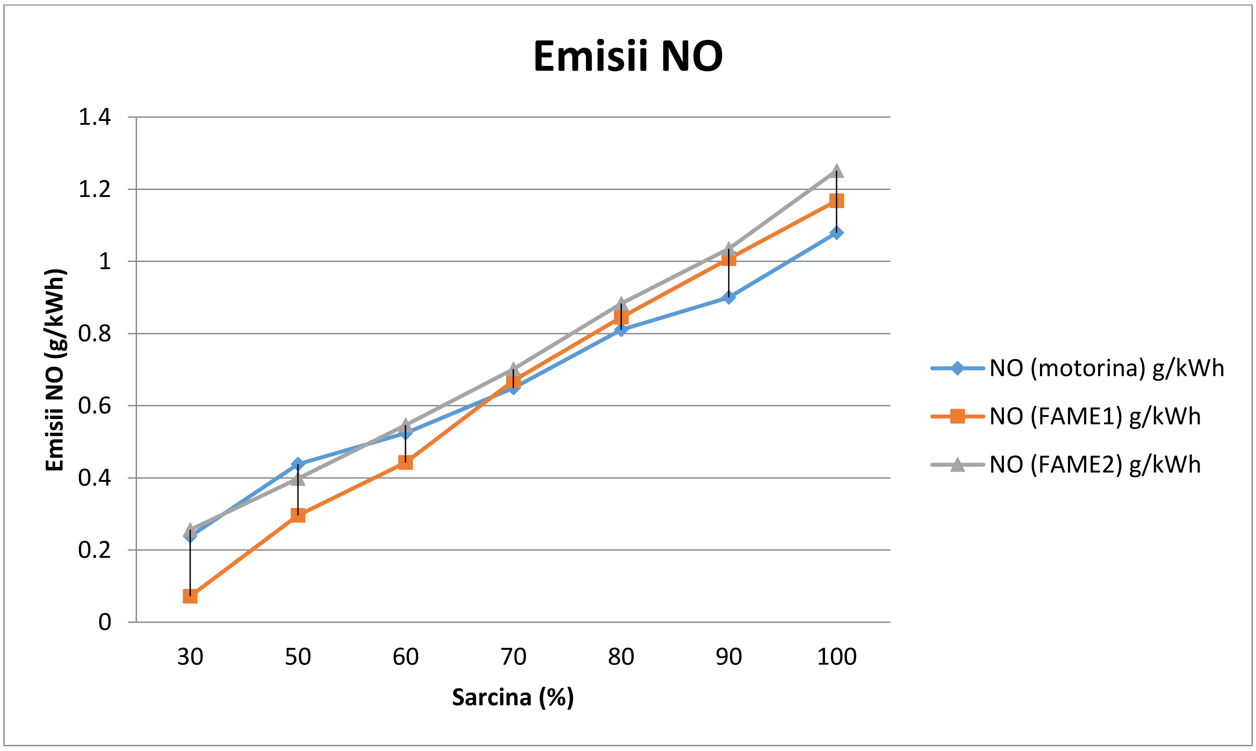
- Emission variation of CO_2 is increasing with engine load for marine gas oil and FAME fuel. From 30% to 50% of engine load, the emissions are identical and over 50%, the CO_2 emissions for diesel has a slight increase over biodiesel fuels.



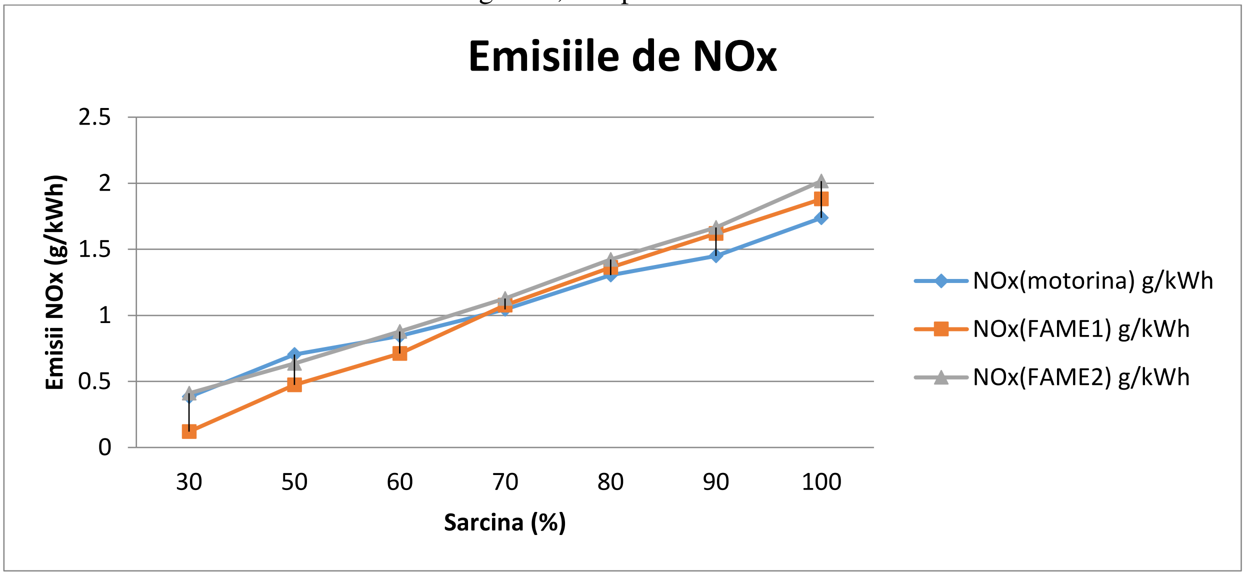
- CO emissions have a decreasing variation with increasing engine load throughout the range analysed. At load between 30% and 70% the CO emissions of FAME fuel are significantly higher than CO emissions of FAME. From 70% to 100% of the engine load, the curves which describe the variation of CO emissions of the two types of fuel, almoast overlap, emissions being identical.



- For NO emissions, their variation is proportional with engine load for all types of fuels tested. At load from 30% to 70% the NO emissions of FAME are lower than the emissions for marine gas oil. Above 70% load, the NO emissions of marine gas oil, decreases compared with NO emissions for FAME fuels.



- Variation of NOx emissions are represented in diagram below. As a general rule, NOx emissions, depend on the combustion temperature, engine running time and amount of oxygen. It can be observed that the emission of nitrogen oxides are slightly higher than in the case of marine gas oil and at several engine load, the amount of emissions becomes approximately equal for all samples analysed. As the density of the FAME samples used is higher than the marine gas oil, the injector will spray a higher mass of bio-diesel required for combustion, and the presence of oxygen in this type of fuel can cause the increase in NOx emissions. Between 30-70% load, it can be seen that for FAME fuels, NOx emissions are lower compared with marine gas fuel. Over 70% load, NOx emissions are reduced in case of marine gas oil, compared with FAME fuel.



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