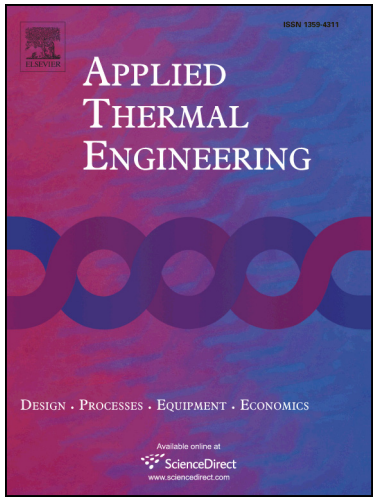


Research Paper

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# Combustion characteristics and NOx emissions of a waste cooking oil biodiesel blend in a marine auxiliary diesel engine

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Abstract: The International Maritime Organization (IMO) has enacted the Maritime Agreement Regarding Oil Pollution (MARPOL) VI to regulate the ship emissions. In the large ocean-going ship, the marine auxiliary diesel engine **is** widely used to produce electricity, and it could also generate large amounts of harmful emissions. In order to reduce these emissions, some alternative fuels were used in the marine diesel engine. In **term of this**, the combustion **and emissions** characteristic**s and emissions** of a 6-cyclinder turbocharged inter-cooling direct-injection marine auxiliary diesel engine **was investigated in this study when using** Ultralow Sulfur Diesel (ULSD), B70 (diesel containing 70 vol.% of biodiesel), B90 and neat waste cooking oil biodiesel (B100), **respectively**. **T**he influence of high biodiesel to diesel ratio on the combustion characteristics and NOx (NO and $NO_2$) emissions **was studied**, under 25%,50%,75% engine **load at 1050rev/min and 1500rev/min (Rated speed) conditions**. The experimental results indicated thatthe cylinder pressure decreases slightly with **increasing the** biodiesel content in the test fuels, while the ignition advances, ignition delay reduces and combustion duration become**s** longer. **When the test engine operated at low load, the maximum percent peak heat release rate(HRR) decreases is about 14.3%, while the maximum percent can reach to 21.3% at high load condition.** For each test fuel, the cylinder pressure and peak heat release rate increase significantly with the increase of engine load. The temperature of the exhaust manifold decreases with the increases of biodiesel content in the test fuels. Moreover, the NOx emissions decrease significantly **when using the** high substitution ratio of biodiesel, **which is** due to the decrease of the cylinder temperature in the **diffusion** combustion mode. The NO emission increases with the increases of the engine torque, while the $NO_2$ emission decreases. **Consequently**, the ratio of $NO_2$ to NO decreases **sharply** with the increases of engine load, due to the increase of the cylinder temperature.

Keywords: Marine auxiliary diesel engine; **waste cooking oil**; **biodiesel**; combustion characteristics; NOx emissions

## 1. Introduction

Large ocean-going ship is the main power source of the logistics, passenger transport and national defense. Moreover, more than 90% of international trade is now conducted via the ocean-going shipping [1,2]. The large ocean-going shipping has three typical characteristics, which are the high fuel consumption **rate**, the long operation and the high **level of** harmful emissions [3]. Compared with the vehicle, the shipping would lead to **worse** environmental pollution [4,5,6]. In order to decrease these harmful emissions, the IMO (International Maritime Organization) has