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Study of the performance and pollutant emissions of a new paraffinic fuel –Farnesane– compared to other alternatives in a Diesel engine

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This work focuses on the effect of alternative fuels (biodiesel and paraffinic) on the injection and combustion processes, on the regulated pollutant emissions (NOx, THC, PM) and the characterization of the particulate material generated from a physic-chemical point of view (morphology, oxidation, chemical reactivity) and biological (genotoxicity and mutagenicity).[b]

Biodiesel and Gas to Liquid (GTL) are the fuels most used as alternative to diesel fuel. Reductions in terms of carbon monoxide (CO), hydrocarbons (THC) and particle matter (PM) are obtained with these fuels while nitrogen oxides (NOx) emissions used to (in some engine load modes) be higher compared to reference fuel. However, while the study of the effect of these alternative fuels on the injection and combustion processes must be enlarged, the information about the morphology and reactivity of PM and its biological impact (genotoxicity and mutagenicity) is scarce.

In the different studies carried out in this research line, four fuels were selected: i) a diesel fuel considered as reference, without biodiesel, ii) a biodiesel and iii) a GTL fuel and iv) Farnesane, other paraffinic fuel obtained from the fermentation of sugary biomass by means of genetically modified microorganisms. This is a fuel traditionally used in jet engines.

Results

From the engine tests carried out at different engine load, it was obtained: i) information about how the fuel delivery occurs inside the cylinder from the injection rate and momentum flux, from the properties of the fuels and the geometric characterization of the injector, ii) values of regulated gaseous pollutant emissions as well as the amount of particulate matter (PM) (distribution and mass). The PM collected was analyzed from 3 points of view: morphology, chemical reactivity and biological analysis in terms of mutagenicity and genotoxicity.

The results obtained related to the experimental injection rates and the determination of the momentum flux (CDM) allow developing a simple 0D rate model. This tool is useful for those researchers who do not have the facilities to evaluate these parameters [1]. Also allowed develop alternative techniques for determination injection rate if only the equipment to determine momentum flux is available [2].

The thermodynamic diagnosis indicated that the start of combustion occurred before with paraffinic fuels but their combustion, duration was longer compared to diesel and Biodiesel fuels [3]. Despite these results, NOx emissions with Farnesane and GTL were similar to those observed with diesel, being results from Biodiesel the highest as is shown in Figure 1. Notable reductions in CO, THC and PM emissions were obtained with alternative fuels, being the highest benefits associate to Biodiesel. while results obtained with Farnesane were slightly lower than GTL (also paraffinic hydrocarbon) [4].

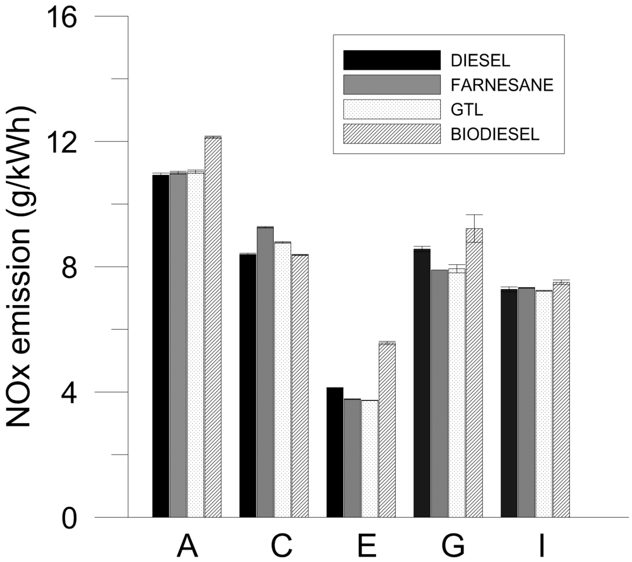

Figure 1: NOx emissions of alternative fuels tested compared with diesel.

In some engine load conditions, the PM is high enough that allowed to collect some samples to analyze its structure and reactivity in more depth. The chemical reactivity with the Biodiesel PM was the highest followed by GTL and Farnesane [5]. This trend is obtained by means of parameters such as Active Surface Area or Volatile Organic Fraction (VOF) and ashes content, results derived from TGA analysis of particulate matter (see Figure 2). Although the speed reaction and temperature in the case of biodiesel is lower (which indicates greater reactivity) two negative effects are associated to the Biodiesel PM: the formation of ashes which disables the particle traps and their smaller size which makes easier its incorporation into the respiratory system.