Statistical Analysis of the Droplet Size Distribution of Tire Pyrolysis Oil-Diesel Oil Sprays

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Abstract

The liquid product obtained from tire pyrolysis process, called tire pyrolysis oil (TPO), has a great attraction as an alternative fuel, as it has a viscosity of 5.43 cSt (Sharma *et al.*, 2016), density of 921 kg/m³ (Gamboa *et al*., 2020), surface tension of 0.028 N/m (Chumpitaz *et al*., 2019), and higher heating value of 46.32 MJ/kg (Das *et al*., 2017), which are similar to diesel oil. These physical and chemical properties have motivated research into its application in furnaces, boilers and compression ignition engines. Generally, TPO is blended with diesel or biodiesel in order to decrease the percentage of sulfur and improve the cetane number of the fuel blend (Sharma *et al*., 2016). However, the evaluation of the quality and applicability of TPO has been focused mainly on combustion emissions and the performance of thermal equipment fueled with this fuel (and diesel/biodiesel blends), where the atomization process has been ignored, which is closely linked with the efficiency of liquid fuel evaporation and combustion. Thus, in this work, an evaluation of the atomization quality of blends of tire pyrolysis oil and diesel oil was carried out based on the comparison of the uniformity parameters of the drop size distribution of fuel sprays. The distribution function used was the Log-Normal function, as it allowed reconstructing the droplet size distribution of the sprays with only the mass median diameter and Sauter mean diameter. These values were measured using the Malvern Spraytec laser diffraction system model STP5936 (Chumpitaz *et al*., 2019). The fuel sprays were generated with a twin-fluid atomizer (type Y-jet) operating at air-to-fuel mass ratio (RAL) in the range of 0.05 to 0.35. The results showed that the higher the percentage by mass of TPO in the fuel blend, the lower the uniformity of the spray. Furthermore, a uniform TPO-DO spray with smaller mean diameters (<30 μm) can be achieved if sufficiently high RAL values (>0.15) are applied and percentages of TPO in the blend less than 5% are used.

Keywords: tire, pyrolysis, atomization, spray.

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