Biodiesel with controlled physicochemical properties, a means to further reduce diesel engine particle emissions

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The issue of particle emissions from diesel engines is still a matter of concern due its deleterious effects both on human health and environment(Ristovski et al., 2012). Recently, International Agency for Research on Cancer (IARC) inclusion of diesel engine exhaust particles as carcinogenic to human health added a new margin on it. Apart from the use of after treatment technology, biodiesel is also considered as potential way to reduce particle emission alongside with other emissions(Xue, Grift, & Hansen, 2011). Global biodiesel production is still reasonably small compared to its counterpart fossil diesel, but even this small amount comes from a wide variety of feed stocks. Contrary to fossil diesel, the important physicochemical properties of biodiesel vary among different feed stocks(Hoekman, Broch, Robbins, Ceniceros, & Natarajan, 2012).

Keeping in mind the aforementioned circumstances, the aim of this study is to investigate the effect of biodiesel physical properties and chemical composition on particle emissions alongside with engine performance. Four biodiesels with controlled chemical composition and a low sulfur diesel fuel were used in a common rail turbocharged diesel engine. It was observed that biodiesel with shorter carbon chain length and higher degree of saturation can reduce particle emissions significantly. With the increase of carbon chain length and degree of unsaturation in biodiesel, particle emissions increase. The percent of fuel bound oxygen in biodiesel plays a major role in reducing the particle emissions. As shown in Figure 1. We observed strong correlation between both particle number (PN) and particle mass (PM) emissions with weight percentage of oxygen in the fuel. Increase of oxygen content to 10%, in the fuel, can reduce PM2.5 emissions 60% and PN almost by an order of magnitude.

Apart from the oxygen content and chemical structure of fatty acid methyl ester (FAME) in biodiesel, particle emission also fairly correlated with some of the physical properties of biodiesel. Among them viscosity, iodine value and saponification value are prominent.

Biodiesel also influenced particles size resulting in smaller count median diameter (CMD) of particles than particles from petro-diesel in scanning mobility particle sizer (SMPS) measurement. Among the biodiesels a similar trend as to PN and PM was observed for particle size as well. It was also found that the biodiesel produced less PM and PN resulted in a smaller CMD of particles.

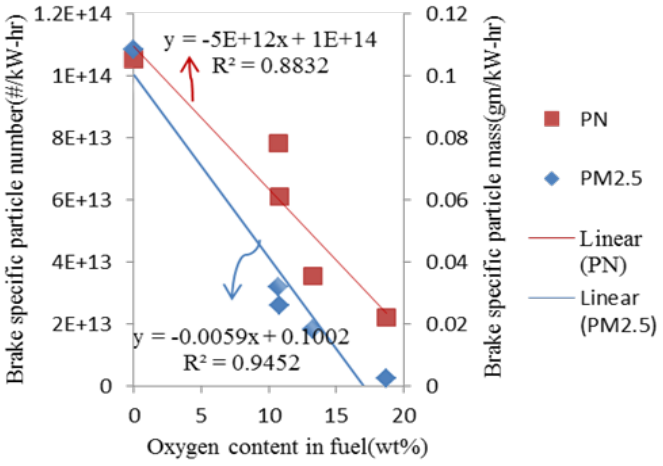

Figure1. : Variation in PN and PM with fuel bound oxygen content

The reduction of particle size for biodiesel was further revealed in Nano aerosol surface area monitor, where the overall surface area of particles from biodiesel was reasonably lower than the particles from petroleum diesel.

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