Reduction of PAHs emitted from a generator fuelled by waste-edible-oil-biodiesel with acetone and isopropyl alcohol addition

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Keywords: PAHs, waste-edible-oil-biodiesel, acetone, isopropyl alcohol.
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Diesel engine exhaust has been official classed by the International Agency for Research on Cancer (IARC) as carcinogenic to humans (Group 1) in June 2012 (IARC, 2012), and has been concerned worldwide for its adverse health effects. Diesel exhaust particles (DEPs) mainly consist of carbon particles, ash, SOFs (soluble organic fractions), and sulfur-containing compounds. Accordingly, the PAHs on the DEPs comprise mostly carbon particles, ash, and SOFs (Ning and Sioutas, 2010). The US EPA designated 16 non-substituent PAHs as major pollutants, and eight of these (BaA, BeP, CHR, BbF, BkF, IND, DBA and BghiP) are notable for their carcinogenic characteristics (Menzie *et al.*, 1992). Some report showed that adding an oxygen agent, such as ethanol or acetone or biodiesel, to pure petroleum diesel can improve engine fuel combustion efficiency and reduce the emissions of CO, HC, PM, and PAHs (Lin *et al.*, 2010; Tsai *et al.*, 2010; Lee *et al.*, 2011), and lower the biotoxicity of diesel particulate matter (DPM) (Tsai *et al.*, 2011; Tsai *et al.*, 2012). A type of blended fuel with biodiesel and solvent addition into fossil diesel has been proposed and it is called "Biodieselhol". In this study, a combination of acetone, isopropyl alcohol, and waste-edible-oil-biodiesel was added to conventional fossil diesel to investigate the PAH emission characteristics of a biodieselhol-fueled diesel engine generator and the feasibility of using the blended fuels as alternative fuels for diesel engines.

Different blended fuels were tested at the stable energy output (110 V/60 Hz, 1800 rpm) of a generator under varying engine loadings. The tested biodieselhols consisted of pure diesel oil (D100) with 1−3 vol. % pure acetone (denoted as A), 1−70 vol. % waste-edible-oil-biodiesel (denoted as W), and 1 vol. % pure isopropyl alcohol (the stabilizer, denoted as P). An auto-detector flow sampling system equipped with quartz fiber filters was installed on the downstream side of the diesel generator exhaust to determine suspended particles and particulate phase PAHs. Gas phase PAHs were collected by two connected cartridges (filled with XAD-16 resins).

Figure 1 shows that, regardless of the percentages of waste-edible-oil-biodiesel, acetone, and isopropyl alcohol, replacing D100 with biodieselhol reduced the emissions of Total-PAHs by 6.13–42.5% (average, 24.1%) and emissions of Total-BaP_{eq} by 16.6–74.8% (average, 53.2%)) from the diesel engine generator. Among these tested fuels, the one with waste-edible-oil-biodiesel = 20% exhibited the best emission reductions of Total-PAHs (average 41.3%) and Total-BaP_{eq} (average 72.0%). When the percentages of waste-edible-oil-biodiesel in fuel were less than 20%, the increase of waste-edible-oil-biodiesel in fuel could obtain more reduction in Total-PAHs and Total-BaP_{eq} emission. Although, in blends with percentage of waste-edible-oil-biodiesel higher than 20% (i.e., W30D70, W30A1P1D68, W30A2P1D67, W30A3P1D66, W50D50, and W70D30), the concentrations of emitted Total-PAHs and Total-BaP_{eq} increased with waste-edible-oil-biodiesel addition percentage, the concentrations of emitted Total-PAHs and Total-BaP_{eq} were still less than that using fossil diesel as the fuel, at waste-edible-oil-biodiesel ≤ 70%.

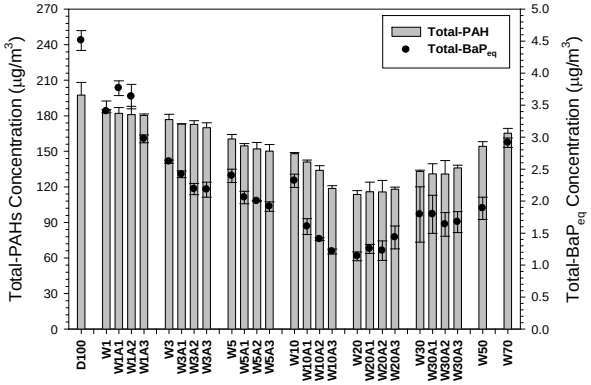

Figure 1. Total-PAHs and Total-BaP_{eq} emitted from the generator fuelled by biodieselhols.

This work was supported by the National Science Council of the Republic of China, Taiwan, under Contract No. NSC 100-2221-E-020-004-MY3.

IARC (2012) *Press Release*, available at: http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

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