# PCDD/Fs emissions from a diesel engine generator fueled with blends of waste cooking oil-based biodiesel and fossil diesel

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Numerous studies have focused on the polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs) emissions from various stationary sources, such as municipal solid waste incinerators (MSWIs) and metallurgical activities (Li *et al.*, 2007; Wang *et al.*, 2010a). Mobile sources are also of concern for emission of PCDD/F. Several studies show that the use of waste cooking oil biodiesel (WCO-biodiesel) as an alternative fuel for diesel engines can increase combustion efficiency and reduce emissions of CO, HC, PAH, and PM (Lin *et al.*, 2007; Tsai *et al.*, 2010). However, the possible high chlorine content of WCO is one uncertain factor that may increase the emissions of chlorine substituted pollutants (e.g. PCDD/Fs) from diesel-engine exhausts.

In order to characterize toxic organic pollutants (TOPs) emitted from combustion of conventional fossil diesel (as D100) mixed with waste cooking oil biodiesel (WCO-biodiesel), this study used D100 blended with 20 and 40 vol% WOC-biodiesel (as W20 and W40) as diesel engine generator used alternative fuels to investigate emissions of PCDD/Fs. Different blended fuels were tested at the stable energy output (110 V/60 Hz, 1800 rpm) of a generator under 3.0 kW load. An auto-detector flow sampling system equipped with quartz fiber filters was installed on the downstream side of the diesel generator tailpipe to determine particle-phase samples in exhaust. Gas-phase samples were collected by two-stage glass cartridges (filled with XAD-2 resins). The quartz fiber filter and two-stage glass cartridges from each exhaust sampling were combined for analysis to represent a whole exhaust sample. Each exhaust sample was extracted in a Soxhlet extractor with a mixed solvent (n-hexane and dichloromethane; vol/vol, 1:1; 250 mL each) for 24 h. The extracts were then concentrated by gently purging with ultra-pure nitrogen, and cleaned-up with a silica gel column. Then, the sample solution was treated with concentrated sulfuric acid, and this was followed by a series of sample cleanup and fractionation procedures, using a multi-layered silica column, alumina column and an activated carbon column. During the alumina column cleanup, non-planar PCBs were eluted with 25 mL hexane, and were then further eluted with 15 mL DCM/hexane (1/24, v/v) for activated carbon column use. Finally, the solutions in the vials were then analyzed for seventeen 2,3,7,8-substituted PCDD/F congeners. The detailed analytical procedures are given in our previous works (Wang *et al.*, 2010b).

Preliminary results showed that emitted PCDD/Fs mass and toxic equivalent (I-TEQ) concentrations decreased as the added WCO-biodiesel increased, compared with D100 at the 3.0 kW load (Fig. 1). When using D100, W20, and W40, the mainly emitted seventeen 2,3,7,8-substituted PCDD/Fs congeners were high-chloride species, including 8-chloride OCDD (34.6%) and OCDF (28.7%) as well as 7-chloride 1,2,3,4,6,7,8-HpCDD (7.20%) and 1,2,3,4,6,7,8-HpCDF (5.89%). These 4 congeners summed up to 76.5%. However, the I-TEQ concentration was mainly contributed from low-chloride but high I-TEF (1.0 and 0.5) congeners, such as 4-chloride 2,3,7,8-TeCDD, 5-chloride 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF. At 3.0 kW load, among the PCDD/Fs congeners, 2,3,7,8-TeCDD (49.3%) and 2,3,4,7,8-PeCDF (17.2%) had the two highest I-TEQ values for different fuels using D100, while they were 1,2,3,7,8-PeCDD (39.0%) and 2,3,4,7,8-PeCDF (25.4%) using W20, and 2,3,4,7,8-PeCDF (44.8%) and 1,2,3,4,7,8-HxCDF (13.7%) using W40. In conclusion, the use of WCO-based biodiesel not only alleviates the problem of waste oil disposal, but also reduces the PCDD/Fs emission from diesel engine generator.

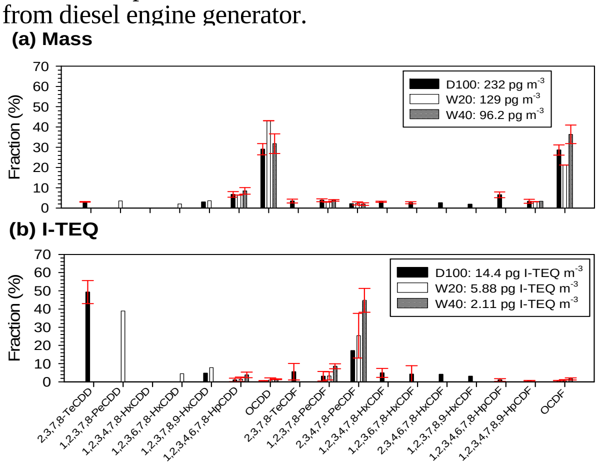


Figure 1. Congener profiles of (a) PCDD/Fs mass and (b) toxicity in the exhaust from the diesel generator fueled with varying blends of biodiesel and fossil diesel at 3.0 kW load.

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