

Health relevant compounds in wood combustion and ship diesel aerosols: Evaluation of the toxicity due to polycyclic aromatic hydrocarbons

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Keywords: toxicity equivalent, PAH, ship-engine emissions, wood combustion
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A globalization of trade is responsible for a steady increase of navigation on the seven seas. The ship engines are suitable to be operated with heavy fuel oil (HFO). HFO, more or less the residual of oil refining, contains high amounts of heavy metals and polycyclic aromatic hydrocarbons (PAH). The coastal regions are highly impacted by the emissions from shipping lanes near the coast and the use of HFO. In contrast, inner continental regions in Europe are suffering from wood combustion (WC) emissions. In Germany the consumption of wood for residential heating increased within eight years more than twice.

The Virtual Helmholtz Institute HICE addresses the health effects of anthropogenic combustion processes. This is performed by means comprehensive characterization of the chemical & physical properties of combustion aerosols as well as the biological effects on cell cultures. Here, for comparison of different combustion sources, PAH-related toxicity equivalents (TEQ) were calculated. It is based on the proposal of the German Research Foundation (DFG) that the health risk is proportional summarised by different PAH with different health risk potentials (Greim, 2008). PAH were weighted by their carcinogenic, mutagenic and gen-activating effects due to formation of toxic metabolites.

Experiments with a 4-stroke research engine were conducted at the University of Rostock. Emissions from a simple constructed log wood stove were collected at the KIT, Karlsruhe. Although the emissions of particle-bound PAH showed differences in pattern the total amounts emitted by WC and HFO-operated engines were comparable (figure 1). The emissions from one large cargo ship (up-scaled results) equates around 400 single-family houses heated with a log wood stove (figure 2) regarding TEQs. When referring these results to the energy output of the different energy sources it can be postulated that log wood stoves affect the human health about thirty-times more than ships operated with HFO. Moreover, cargo ships could be a comparative eco-friendly means of transportation, assuming that engines are operated with diesel-like light fuel oil (LFO).

Nevertheless, harmful carbonaceous contents of PM as well as hazardous heavy metals can still be found within the emissions of LFO-operated engines. Compared with WC higher alkylated PAH are highly expressed within ship engine emissions, whereas

Methylpyrenes (ship engine: $4.1 \mu\text{g m}^{-3}$, WC: $3.9 \mu\text{g m}^{-3}$) and Methylchrysenes (ship engine: $0.68 \mu\text{g m}^{-3}$, WC: $0.57 \mu\text{g m}^{-3}$) were found to have similar concentrations.

On the other hand dimethylated pyrenes were found only in emissions from the ship engine with concentrations of $3.9 \mu\text{g m}^{-3}$ when applying LFO.

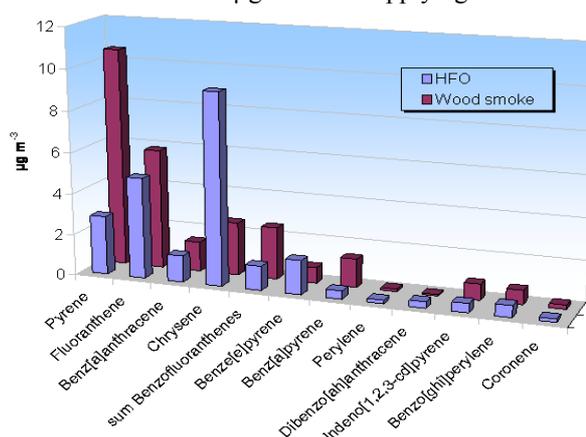


Figure 1. Particle-bound PAH – a comparison of wood smoke and HFO-operated ship engine exhaust.

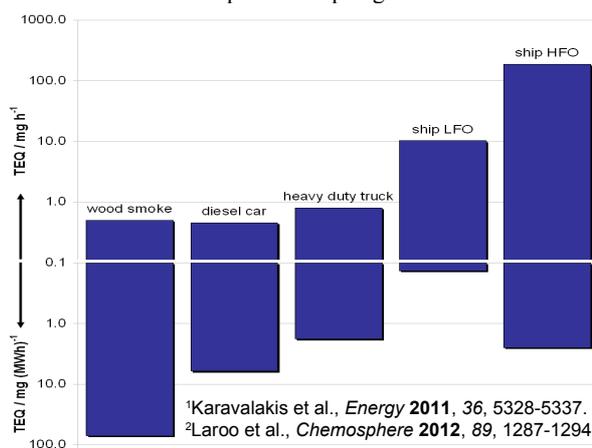


Figure 2. Comparison of TEQs (PAH) of different combustion sources, related to time and energy output, respectively.

This work/HICE (www.hice-vi.eu) is supported by the Helmholtz association (HGF).

Greim, et al.: Gesundheitsschädliche Arbeitsstoffe - Toxikologisch-arbeitsmedizinische Begründungen von MAK-Werten und Einstufungen, Wiley, 2008.