Effect of flue gas scrubber on the toxicological effects of particulate samples from a recovery boiler

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Air pollution is considered to be an important factor affecting public health negatively by causing reduced life expectancy (Directive 2008/50/EC). Additionally, it is expected that in the near future the amount of biomass used for district heating will be increasing due to (1) efforts to restrain ambient air pollution caused by burning heavy fuel oil and (2) due to efforts by the European Union to substitute fossil fuel with carbon neutral energy sources. These bio fuel power plants may have an effect on the fine particle pollution in Europe; hence it is necessary to investigate the potential health risks of the fine particle emissions caused by bio fuel power plants thoroughly.

Particulate samples were collected from a recovery boiler of a paper mill in Finland, two samples on consecutive days after the electrostatic precipitator (ESP), before the fluegas scrubber (FGS) and one sample after the fluegas scrubber (FGS).

The samples were collected using a Dekati® Gravimetric Impactor (DGI) as described previously and all fractions were pooled and extracted to form the total suspended particles (TSP) (Ruusunen et. al., 2011).

Chemical analysis of the TSP composition as well as their PAH content were conducted and the particles' ability to induce toxicological responses was tested using various markers of inflammation (cytokine and NO-production) and cytotoxicity (MTT, flow cytometry) in a mouse alveolar macrophage cell line (RAW 267.4).

Neither of the sample collected after the ESP of the recovery boiler induced a statistically significant reduction of the cell viability in TSP concentrations below 150 µg/ml. The sample collected after the FGS, however, reduced cell viability of RAW 267.4 cells significantly already at a concentration of 50 µg/ml.

Moreover, increased production of the pro-inflammatory cytokine TNFα and the chemokine MIP-2 were seen after exposing the cells to the TSP collected after the FGS.

The present study revealed that the chemical composition of the TSP samples collected before and after the FGS differs slightly. The FGS possibly enriches more cytotoxic coarse particles, which could provide an explanation for the different responses of the cells to the exposure of the samples. However, it is noteworthy, that the overall particle mass concentration after the FGS is significantly smaller than after the ESP only. Thus, even with the higher toxicological responses per the same mass, the smaller mass emissions should be recommended.

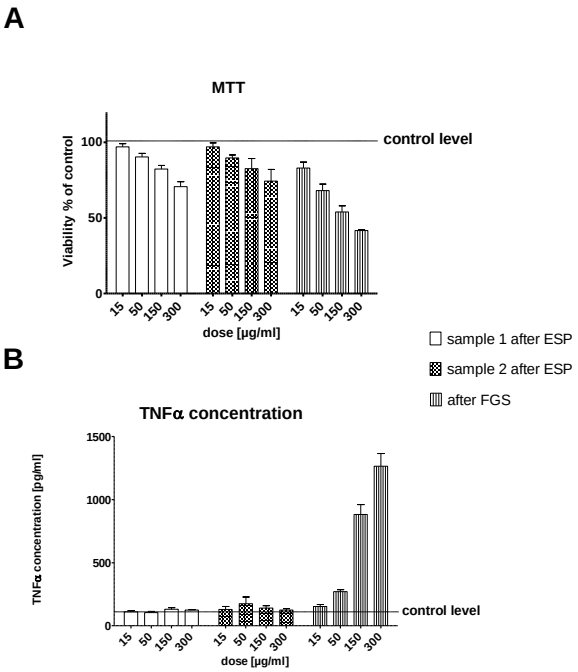

Figure 1: (A) Cell mitochondrial activity (MTT) of the mouse macrophage cell line and (B) TNFα concentration in the culture medium after a 24 h incubation of the cells with the TSP samples

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