

# Vehicle exhaust particle deposition in the human respiratory tract

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In this study the size-resolved deposited fraction and deposited dose of diesel engine exhaust particles were measured with the RESPI instrument (Löndahl et al. 2006). The measurements were done on 10 healthy subjects (5m/5f) and 10 subjects (7m/3f) with varying degree of COPD, from mild to moderate. A Volvo diesel engine (Volvo TD40 GJE, 4.0 L, four cylinders, 1996) with no exhaust after treatment was used with a typical MK1 diesel fuel (sulphur content  $\leq 10$  ppm). The engine was operated in a motor test bench to simulate different running conditions. The aerosol was extensively characterized: number size distribution (SMPS), organic/elemental carbon (OC/EC), elemental make-up (PIXE), electron microscopy (TEM), particulate matter (PM1, TEOM), hygroscopic growth factors (H-TDMA, remain to do), volatility (thermodenuder), particle mass and thereby particle density (APM), restructuring, PAH, NO<sub>x</sub> and CO. The deposited fraction was measured for two different aerosols; one during idling engine conditions and one during transient load conditions according to the urban driving part of the standardized European Transient Cycle (ETC) protocol. The deposited fraction according to the International Commission for Radiological Protection model (ICRP, 1995) was calculated for each subject and compared to the measured values. The deposited dose was calculated for one hour exposure to 100  $\mu\text{g}/\text{m}^3$  for both aerosols.

The average deposited fraction and dose for the two groups and aerosols are presented in Table 1. The study showed a statistically significant difference in deposited fraction between the groups. For both studied driving conditions, the deposited fraction is lower for the subjects with COPD compared to the healthy subjects, but the deposited dose is higher.

Table 1: Average deposited fraction (DF) and deposited dose for exposure to 100  $\mu\text{g}/\text{m}^3$  of diesel exhaust particles during one hour.

	Idle driving		Transient driving	
	DF	Dose ( $\mu\text{g}$ )	DF	Dose ( $\mu\text{g}$ )
Healthy	0.65	13.2	0.47	11.5
COPD	0.57	16.6	0.40	14.3

When comparing the measured size-resolved deposited fractions with those of the ICRP model, the measured deposition for the healthy group agrees well with the ICRP model but as in earlier studies with RESPI it shows a higher deposition. The measured deposited fractions for the group with COPD show a different pattern compared to the ICRP model, which indicates that the damages in the lung from the disease also affects the deposition and not only the difference in breathing patterns between the two groups. The difference in deposited fraction between the healthy group and the group with COPD is most significant in the particle size range between 20 nm and 70 nm where the deposited fraction is higher for the healthy group. In this size range, the ICRP model predicts the highest deposition to be in the alveolar region.

## References

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