PM_{10}-induced ROS generation up- and downwind of a motorway in North Rhine Westphalia, Germany

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The intrinsic generation of reactive oxygen species (ROS), often also named oxidative potential (OP), by particulate matter (PM) is nowadays accepted as a promising indicator for the adverse health effects that may result from the inhalation of these pollutants (Borm et al. 2007). PM represents a widespread mixture of particles varying among their sources. Hence, a variation of the potential PM-dependent ROS generation is also expected, where-upon anthropogenic sources (especially combustion processes by traffic or industry) are assumed to have both, an increasing influence on the ROS generation and a quenching potential.

In the present study ambient particulate matter (PM10) was sampled alongside a motorway in North-Rhine Westphalia, Germany during a one-year period. To point out the traffic related hydroxyl radical (OH·) generation potential of PM10 a total of 54 samples were taken at each side of the motorway during clear cross wind direction situations (upwind = background; downwind = background + traffic PM). The samples were analysed for their hydrogen peroxide dependent OH· generation by Electron Paramagnetic Resonance (EPR) spectroscopy using the spin trap 5,5-dimethyl-1-pyrroline-N-oxide (Hellack et al. 2014). Furthermore, the PM10 mass, inorganic chemical composition and NOx concen-trations were determined.

For typical traffic tracers like Sb, elemental and organic Carbon, NOx as well as for PM10 mass an additional contribution to the background concentration caused by the traffic was observed (factor 1.3 - 6.0). The ROS measurements for the downwind samples showed in 72 % of cases higher values with an average factor of 1.4. Significant correlations of the chemical content to OH· were especially detected for Fe and Cu ($r > 0.57$) at the upwind side. At the downwind side these correlations were absent and are assumed to be covered by the interferences with additional soot particles leading to a quenching of OH·. This assumption was, as a first step, confirmed via standard diesel soot (SRM 2975) measurements using the EPR approach in laboratory **(Figure 1)**. Additionally, correlation analysis of OH· to traffic data, distinguished into Heavy- and Light-Duty Vehicles was performed. Weak correlations became obvious for the entire fleet (complete) and the LDV vehicles but no correlations of OH· to HDV were found **(Table 1)**.

Figure 1 Radical scavenging effect of SRM 2975 at different concentrations (n = 4) in presence of 1.25 µM $CuSO_4$

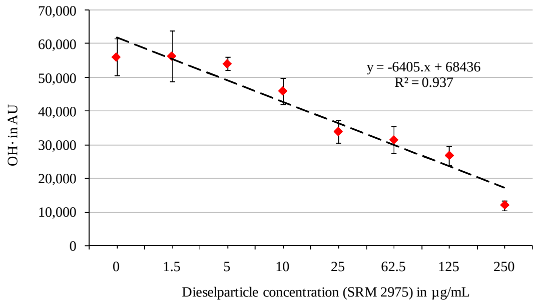

Table 1 Spearman correlation for the traffic intensity data to OH·; level of significance * < 0.05, ** < 0.01 (2-tailed)

	Overall (n = 108)	Upwind (n = 54)	Downwind (n = 54)
Entire fleet	0.325**	0.296**	0.378**
LDV	0.336**	0.318*	0.378*
HDV	0.158	0.201	0.132

[1]LDV = Light Duty Vehicle, [2]HDV = Heavy Duty Vehicle

In sum, the increase of OH· generation was less than expected in spite of the presence of extra amounts of traffic related metals which have otherwise been found to cause higher OH· generation potency. The OH· generation was probably disturbed (quenched) by the additional carbonaceous traffic related compounds. In consequence, for future studies which are linking the intrinsic OP and adverse health effects, we suggest to analyze the relation to EC/OC and in parallel further OP detection methods.

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Borm et al. 2007. Occup Environ Med, 64:73-74.
Hellack et al. 2014. J Aer Sci, 72, 47-55.