Air concentration of ultra-fine particles released from the Diesel engines

S. Bujak-Pietrek, U. Mikołajczyk, and I. Szadkowska-Stańczyk

Department of Environmental Health Hazards, Nofer Institute of Occupational Medicine, Lodz, 91-348, Poland
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Presenting author email: ulmik@imp.lodz.pl

Introduction

Diesel engines exhaust are a multi-component mixtures of various chemical compounds formed by incomplete combustion of diesel fuel and its pollution. They are a significant source of ultra-fine particles, with sizes ranged in tens to hundreds of nanometers, which contaminate living and working environment. Ultra-fine particles in diesel exhaust can be inhaled and easily transported to the alveoli. Occupational exposure to ultra-fine particles released from diesel engines concerning the workers serving the vehicles and devices with engines of this type. This group can include operators of excavators, cranes, forklifts, etc., bus depot workers, auto mechanics, railway workers.

Aim:

The aim of this project was the assessment of number, surface area and mass concentration of the particles less than 1000 nanometer in the workpost air during Diesel engine activity.

Methods:

Condensation Particle Counter (TSI model 3007-2) was used to determine the number of particles in a given volume of air in the 10-1000 nm range (in particles/cm3 - p/cm3). AeroTrak 9000 (TSI) was used to determine the surface area concentration of particles potentially deposited in the tracheo-bronchial (TB) and alveolar (A) region of lungs in the 10-1000 nm (in $\mu m^2/cm^3$). DustTrak (TSI, model 8534) was used to estimate the size segregated mass concentration (PM1, PM2,5, respirable, PM10 and total dust)

Following workposts were under measurements:

- bus repair workshop
- daily bus service depot

Air samples were taken by 16 minutes, with 2 minutes time intervals, at the height 1,5 m from the ground. Sampling strategy included the measurement before, during and after activity. Background was measured in the room without the source of Diesel exhaust particles.

Results:

The value of the particle number concentration observed in the bus repair workshop was increased from 7761 particles/cm^3 before diesel engines were working to the value of 16842 particles/cm^3 during engine operation. In the daily bus service depot this values were respectively 47998 particles/cm^3 before and 145094 particles/cm^3 during analysed activity. In the room without a source of emissions concentration was 7653 particles/cm^3.

Surface area concentration before the work shift in bus repair workshop were 246,4 $\mu m^2/cm^3$ for A region and 65,5 $\mu m^2/cm^3$ for TB. During the work shift, when the Diesel engines were turned on, the surface area concentration was 757,0 m^2/cm^3 for particles potentially deposited in A region, while in the region TB the value was 172 $\mu m^2/cm^3$. The background values were at the level of 35,0 $\mu m^2/cm^3$ (A) and 7,9 $\mu m^2/cm^3$ (TB) .

Before the work in daily service depot started, the surface area concentration was 121,9 $\mu m^2/cm^3$ for A region and 49,3 $\mu m^2/cm^3$ for TB. During the passage the busses by daily service hall surface area concentration was respectively 488,3 $\mu m^2/cm^3$ and 131,7. $\mu m^2/cm^3$ for A and TB region. In the control room, these values were as follows: A – 31,0 $\mu m^2/cm^3$, TB – 6,2 $\mu m^2/cm^3$.

Prior to starting the work shift the total mass concentration of the aerosol was 0,29 mg/m^3 in the workshop and 0,16 mg/m^3 in the daily service depot. While the engine of buses were turned on, mass concentrations on these workposts were 1,03 mg/m^3 (workshop) and 0,63 mg/m^3 (daily service) The background values were at a level of 0,05 mg/m^3 and 0,09 mg/m^3.

Conclusion:

- The number concentration of ultra-fine particles emitted from a diesel engine in the bus workshop was 22-fold higher and 3-fold higher in the daily service depot compared with the state before starting the engine
- During engine operation was observed 3 - 4- fold increase of the surface area concentration of the particles deposited in both the alveolar and tracheo-bronchial region
- Mass concentration of particles emitted during the process increased 3,5 - 4.times depending on the workpost.

Increase in number concentration and in particular surface area concentration of particles deposited in A region should be considered as a potential cause of respiratory disorders. Further studies of this issue are necessary.

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