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# Urban Air Quality Improvements through Vehicular Diesel Particle Filters

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## ABSTRACT

The project objective was to investigate the ultrafine solid particle emissions of the prevalent traffic, by performing field measurements at an urban traffic artery in Zurich/Switzerland. Subsequently, various scenarios were postulated to assess the potential of the diesel particle filters (DPF) to improve kerbside air quality. Soot aerosols are known to be carcinogenic [1]. If all heavy-duty diesel vehicles were equipped with DPFs, then the number of particles emitted from the entire vehicle fleet could be reduced by 75 to 80%. For PM10, the curtailment scope is considerably lower, around 20%, because more than half of those emissions are not from the exhaust and therefore would not be filtered.

## INTRODUCTION

Very fine airborne particles are toxic air contaminants [2]. Temperature inversions during winters can result in persistent fog that prevents pollutants escaping to higher altitudes. Urban residents then suffer from severe exposure to traffic generated particles. This has resulted in political pressure to mitigate the street-level toxic aerosols [3].

Fine particles are presently defined as PM10, i.e. the mass concentration of airborne particles having an aerodynamic diameter D smaller than 10 µm. This definition thus comprises a heterogeneous mixture of many different sources. The constituents are both primary emitted particles (natural as well as anthropo-genous) and also secondary particles formed in the atmosphere. The defined particle size spans four orders of magnitude.

Motorized traffic emits a significant percentage of these fine particles [4]. The overall size spectrum of vehicular originating particles range from a few nanometers till 10 µm [5].There is however a distinction between exhaust emissions and those from tire wear or road dust. Mechanically generated tire and other abrasion particles are in the size range of 1-10 µm.

Engine emitted solid particles are smaller than 1 µm (PM1). The PM1 mass is mostly soot particles, due to incomplete combustion from diesel engines. These soot particles have a size range of about 50 to 300 nm {6]. These aerosols, because of their physical attributes and the less efficient elimination mechanism, are retained in the ambient atmosphere for longer periods (many days and weeks) [7]. DPFs can very effectively remove solid particles in this size range, soot as well as ash (metal oxide) particles originating from lube oil and engine wear. [8].

Vehicular traffic is also responsible for the formation of ultrafine volatile nucleation and condensation particles with D approximately 1 to 50 nm. These form, under certain ambient conditions, through homogeneous nucleation, when the exhaust gas is rapidly cooled to ambient temperature [9]. The formation takes place downstream of the DPF. This volatile particle fraction has a critical role in air quality measurements [10].

Epidemiological and toxicological studies [11], [12], [13] indicate that ultrafine particles, particularly soot aerosols, are a very serious health risk and can generate many different deceases up to heart attacks and even cancer. They can enter the lungs and the nanosize fraction is reaching the alveoli. Studies show that these particles can then intrude into the blood circulation [14]. The black soot particles emitted from Diesel engines are also a very powerful global warming substance [5].

Technology is now available to curtail the particle emissions from road traffic. If all Diesel vehicles were fitted with a VERT (Swiss standard [16]) certified particle filter (filtration efficiency exceeding 99%), then the particles endangering health and climate would be practically eliminated. That was the motivation for a research project to investigate traffic emissions in Switzerland with respect to nanosize solid particles and not PM10 only. The environmental authorities of the city and the canton of Zurich and the AKPF (Working Group Particle Filters) sponsored the project.

The project objective was to investigate the direct improvements of the air quality, which would be obtained, if particle filters were compulsory for all Diesel vehicles or some vehicle categories only. Consequently, to forecast the pollution concentration of characteristic aerosol parameters (particle count, size distribution and