Emissions of carbonaceous aerosols and volatile organic compounds by light-duty vehicles on a chassis dynamometer

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While advances in engine technology have led to considerable improvements in emissions in recent years, particulate matter (PM) from motor vehicles, especially from diesel, continues to be a major source of urban aerosol pollution. PM has been identified as one of the priority mobile source air toxics. Motor exhaust also contains volatile organic compounds (VOCs) that have direct health implications and act as precursors to photochemical ozone formation.

In this study, a total of 8 light-duty diesel and gasoline vehicles representative of the Southern European fleet were tested on a chassis dynamometer. Sampling of vehicle exhausts was performed using two real-world driving cycles: the ARTEMIS Road (ArtRoad with cold and hot starts) and the ARTEMIS Urban (ArtUrb) (André *et al*., 2006). The organic and elemental carbon (OC and EC) content in the PM filters was determined by a thermal-optical transmission technique. VOCs sampled in sorbent tubes were analysed by a thermal desorption/cryogenic concentration method on a gas chromatograph equipped with a thermal desorption injector and a flame ionisation detector.

The particulate carbon emission factors were significantly lower under the ArtRoad compared to ArtUrb driving cycle with cold start. In general, hot start-up driving conditions produced the lowest emission factors (Fig. 1). A tendency to the decline of carbonaceous emissions from Euro 3 to Euro 5 diesel vehicles is observed, whereas this trend is not registered for petrol-powered cars. The fraction of TC composed of EC is much lower in particles emitted by petrol vehicles (< 10%) than by diesel engines (50-95%). However, the EC content in emissions from more modern vehicles equipped with DPF (diesel particulate filter) is almost negligible.

The measurement of unregulated pollutants comprised about 20 different VOCs in the C_5–C_{11} range. Among these, benzene, toluene and xylenes (BTX) were generally the dominant species. A significant decrease in emissions from Euro 4 to Euro 5 petrol-powered vehicles was observed (Table 1). The trend in VOC emissions is unclear when diesel engines are considered. During DPF regeneration cycles, emissions are several times larger than those during normal engine operation.

Taking into account the small number of vehicles per category, these results should be faced as indicative and complementary tests are strongly encouraged.

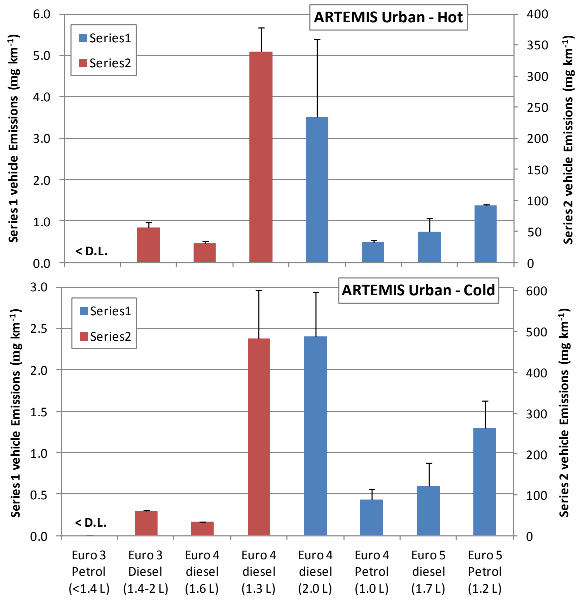

Figure 1. Total carbon (TC=OC+EC) emission factors (< D.L. means lower than detection limit)

Table 1. BTX emission factors (µg km^{-1}) for petrol-powered vehicles.

Compound	Vehicle	Art. Road	ArtUrb cold	ArtUrb hot
Benzene	Euro 4, 1.0 L	139	70.8	51.0
	Euro 5, 1.2 L	5.20	36.6	12.9
Toluene	Euro 4, 1.0 L	191	250	6.4
	Euro 5, 1.2 L	39.2	81.9	16.6
m,p-Xylene	Euro 4, 1.0 L	195	465	75.9
	Euro 5, 1.2 L	44.0	107	2.33
o-Xylene	Euro 4, 1.0 L	66.4	174	25.4
	Euro 5, 1.2 L	14.8	37.8	7.76

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