

Effects of severe congestion on PAH emissions from a heavy vehicle diesel engine

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Summary

The effects of severe congestion on heavy diesel particulate matter (PM) emissions were investigated in a laboratory experiment. Extended idling of a conventional diesel engine and subsequent operation at full load were found to produce higher levels of PM and polyaromatic hydrocarbons (PAH) and an order of magnitude higher levels of carcinogenic PAH compared to idling just after loaded operation and to stabilized operation at full load.

Introduction

Despite advances in engine technology, vehicular traffic remains to be one of the key sources of fine and ultrafine PM in urban air. This work investigates the effects of severe congestion, common for transit truck traffic in Prague and elsewhere, on PM emissions.

Experimental (see Fig. 1 for schematic)

A diesel engine (certified to 0.3 g/kWh PM) with a mechanical injection pump coupled to an engine dynamometer was run alternately at intermediate rpm and full load, and at idle rpm and 1-2% of rated power to simulate slow “creep”. Raw exhaust was diluted at nominally 10:1 dilution ratio and sampled by a Hi-Vol sampler (EcoTech 3000) with a PM_{2.5} impactor. A second Hi-Vol sampler was used to provide dilution air. Dilution ratio was verified by CO₂ concentrations measurements. Samples of PM taken on fluorocarbon coated and quartz filters were extracted and PAH content analysed by HPLC with fluorescence detection.

Results and Discussion

Emissions of benzo[a]pyrene, 7 carcinogenic PAH (cPAH) per US EPA (benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene), US EPA 16 PAH, and total particulate mass, expressed as mass per kg of fuel, are plotted in Fig. 2.

It appears that BaP and cPAH after tens of minutes of idling were an order of magnitude higher than during first several minutes following a higher load.

It also appears that BaP and cPAH during operation at full load were an order of magnitude higher during first several minutes after prolonged (one-hour) idling compared to “stabilized” operation at full load.

It thus seems that prolonged idling may substantially increase emissions of carcinogenic PAH not only during, but also after the idling episode.

Toxicity of extracts of particulate matter sampled from exhaust gases of heavy diesel vehicles under real-world urban operation is currently being evaluated.

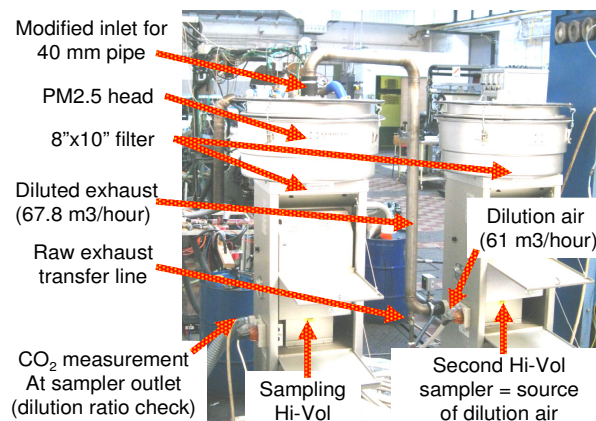


Fig. 1: Sampling setup

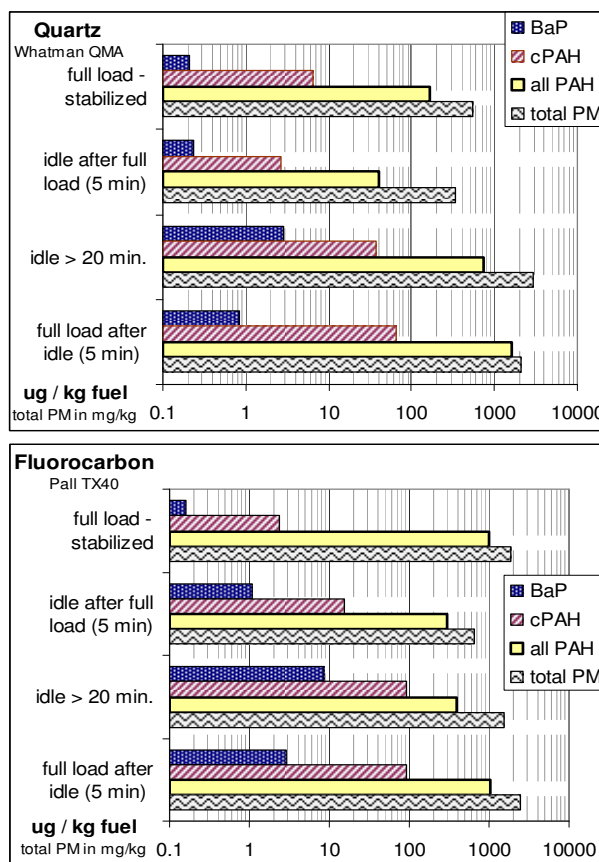


Figure 2: Benzo[a]pyrene, carcinogenic PAH and all PAH emissions in micrograms per kg of fuel

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