Comparative investigations into particulate matter cold start emissions from Euro 1–Euro 4 passenger cars

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Abstract

The paper presents the results of the measurements of particulate matter (PM – mass, PN – particle number, and size distribution) from passenger cars fitted with different types of engines. The purpose of the investigations was to verify the emissions of PM from vehicles of different powertrains and different wear and, at the same time, to classify the PM emissions against the Euro standards.

Introduction

The emission measurements were performed on an engine cold start (ambient temperature: 4–7^{o}C) in 20 vehicles fitted with diesel and gasoline engines. The vehicles selected for the tests were fitted with single point fuel injected gasoline engines (Euro 1) and multipoint fuel injected engines (Euro 2–Euro 4) and all of them were fitted with a catalytic converter. Diesel engines were fitted with an injection system with an in-line fuel pump (Euro 1), Common Rail (Euro 3–Euro 4) or pump nozzles (Euro 4) operating with the oxycat or diesel particulate filter.

The tests were performed in the morning hours in the ambient temperature of 4–7^{o}C after a 12-hour pause in vehicle operation. The measurements were made while cold starting the engine and while it was heating up for a period of 5 minutes. For the tests the following were used:

• systems for gaseous emissions measurement (CO, HC, NO_x, CO_2) using a heated line and enabling mass flow measurement of the exhaust gas (Semtech DS by Sensors Inc.); the values of the exhaust gas flow rate were used during the measurement of the PM mass;

• a system for the measurement of PM including a sample conditioning system – dilution system (Micro Soot Sensor by AVL);

• exhaust dilution system using mass spectrometer (Engine Exhaust Particle Sizer 3090 by TSI). The data related to the PN size distribution served as a basis for the quantitative evaluation of the PN emissions in specified measurement diameter ranges.

The performed measurements provided qualitative and quantitative information related to the PM emissions (mass, number, size distribution) while cold starting of vehicles of different power train configurations. The obtained data related to the PM mass emissions and referred to the engine specific capacity indicate that the emission from the diesel engines is 70 times higher than the emission from the gasoline engines (Euro 1) and 10 times higher (Euro 4 for an engine without diesel particulate filter). The quantitative PN emissions from the diesel engines are approximately 200 times higher than those from the cold started gasoline engines.

The PM emission values heavily depend on the vehicle mileage: as the vehicle mileage grows the mass PM emission increases; yet, for vehicles fitted with diesel engines this value is several times higher than for the vehicles fitted with gasoline engines. The quantitative emission of PN during a cold start takes a different trend: for vehicles fitted with diesel engines along with the growing mileage the higher particle number is observed (vehicles compliant with Euro 1 emit approximately 10 times more than the vehicles compliant with

Euro 4) while modern gasoline engines (Euro 4), owing to higher gasoline injection pressures, emit approximately 5 times less than the engines compliant with Euro 1.

Conclusion

As a result the paper classifies vehicles according to their PM emission level depending on the Euro standard complied with by a given vehicle, and, at the same time the PM mass and number characteristics are obtained in relation to the period of vehicle use. Differences were indicated in individual PM values between gasoline and diesel engines and the obtained results were synthesized.

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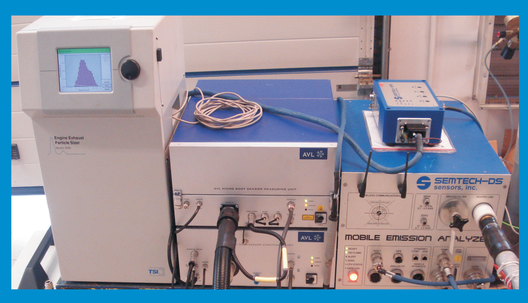
ABSTRACT

The paper presents the results of the measurements of particulate matter (PM mass, PN particle number, and size distribution) from passenger cars fitted with different types of engines. The purpose of the investigations was to verify the emissions of PM from vehicles of different powertrains and different wear and, at the same time, to classify the PM emissions against the Euro standards.

The emission measurements were performed on an engine cold start (ambient temperature: 4-7°C) in 20 vehicles fitted with diesel and gasoline engines. The vehicles selected for the tests were fitted with single point fuel injected gasoline engines (Euro 1) and multipoint fuel injected engines (Euro 2-Euro 4) and all of them were fitted with a catalytic converter. Diesel engines were fitted with an injection system with an in-line fuel pump (Euro 1), Common Rail (Euro 3-Euro 4) or pump nozzles (Euro 4) operating with the oxycat or diesel particulate filter.

METHODOLOGY



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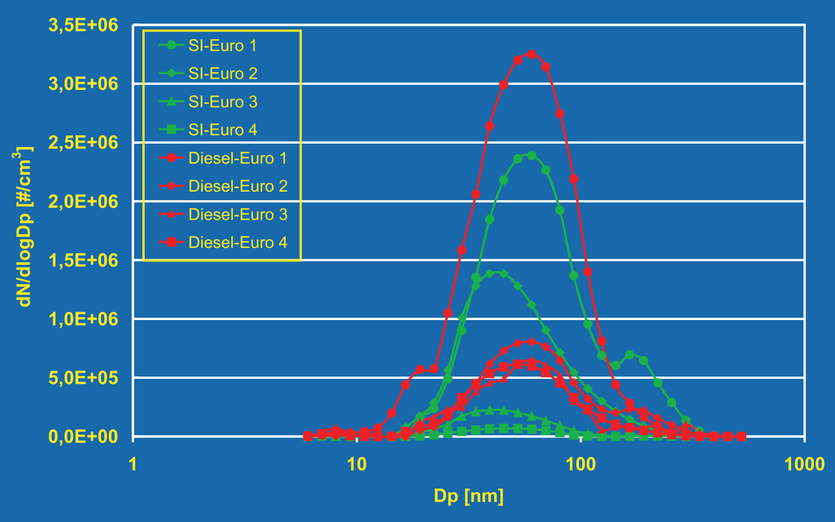
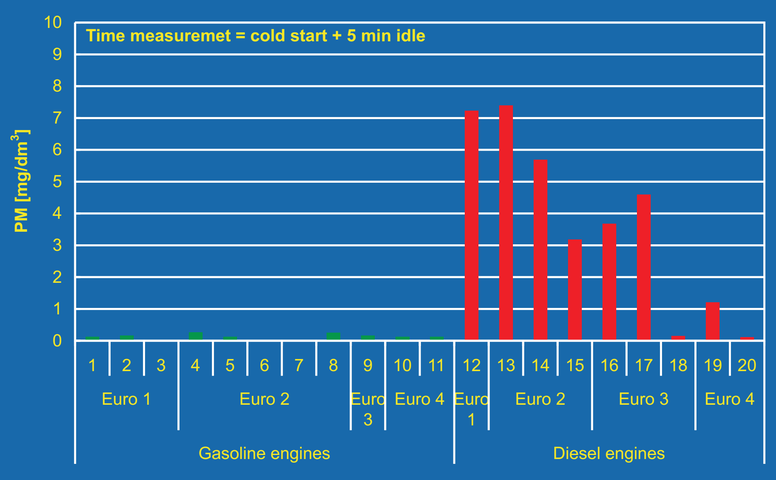
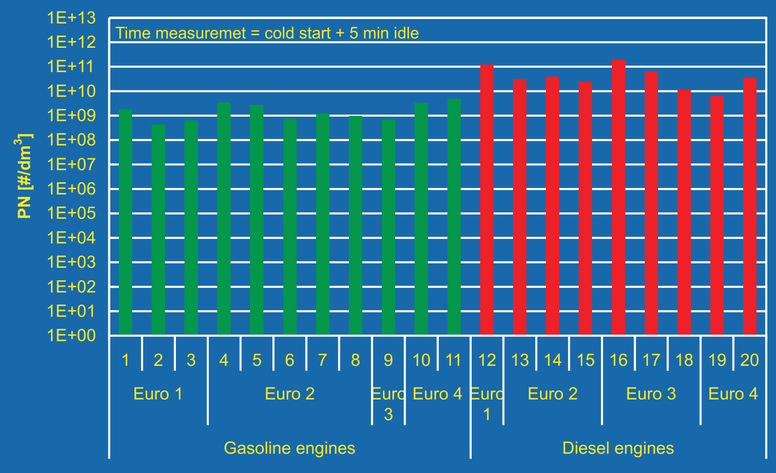
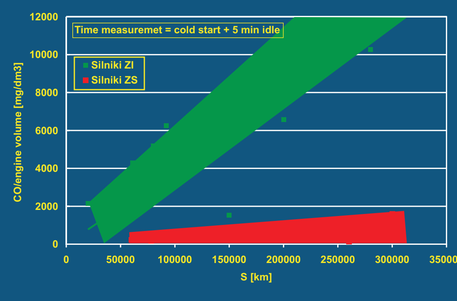
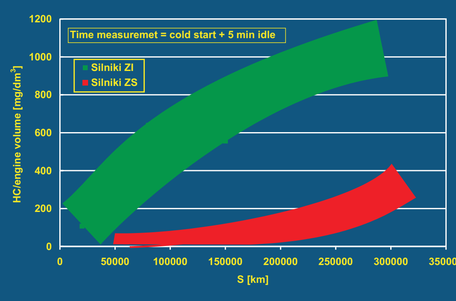


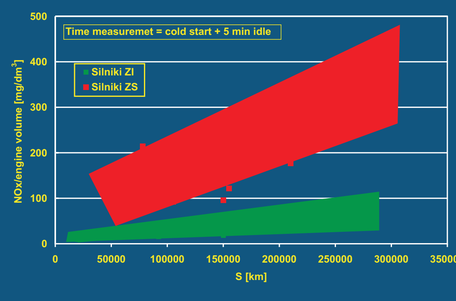


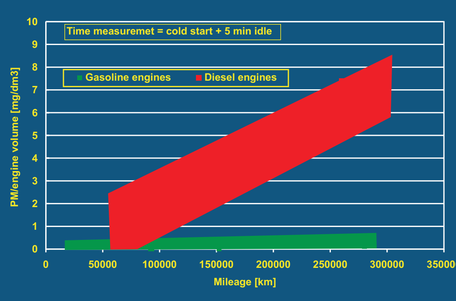


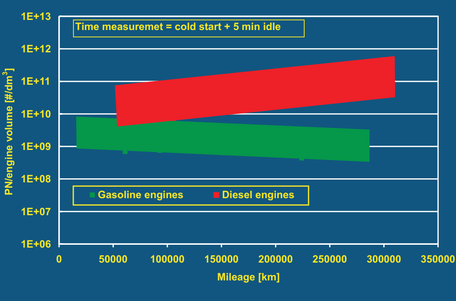
EMISSION ANALYSIS











CONCLUSION

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