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Particle Emissions of a Diesel Car During Real World Urban Driving

M Babaie[1], Ernest Deka[1], Reza Ameri[1], Stefano Siteisamtinieri[1]
Timothy Bodisco[2], Amir Nourian[1], Ghasem Nasr[1]

[1]Spray and Petroleum Research Group, Salford Innovation Research Centre (SIRC), University of Salford, Manchester, UK
[2]School of Engineering, Deakin University, VIC 3216, Australia

Abstract

Diesel engines are known to have good fuel economy that makes them to be the ideal source of power when it comes to mining, transportation, excavation, drilling and even for domestic use. The increase use of diesel engines has however introduced the need to pay attention to the NOx and Diesel Particulate Matter (DPM) Emissions emitted from the exhaust tailpipe. DPM mostly consists of carbonaceous soot and a volatile organic fraction (VOF) of hydrocarbons that have condensed on the soot. Studies show that these emissions are a major pollutant linked with acute health effects. This study discusses the measurement and analysis of DPM from a diesel vehicle in real world driving operations. The vehicle is in the Euro 5 vehicle classifications and was driven under a specified route and specified driving conditions for the urban, rural and motorway in simulating the real driving emissions (RDE) using Portable Emission Measurement System (PEMS). Furthermore, this investigation provides the particle mass (PM) and particle number (PN) in rural driving condition. It was found that PM and PN both remains below the limits of Euro 5b and Euro 6 for complete rural journey. However, the particles number during the cold is found to be higher than the standard level.

Motivation and Significance

Diesel particulate matter (DPM) is known for its environmental impact which are the cause of adverse health effects [1]. The role of ultrafine particles, smaller than 0.1 µm, which amongst others are emitted by diesel engines, are the subject of current health related studies. Due to increased scrutiny of PM emissions from domestic diesel cars, the legal PM emission limits from them continue to be reassessed and monitored throughout the world. Road transport is an important source of air pollution worldwide and particularly in urban areas. The European Topic Centre on Air and Climate Change (ETC/ACC) reported in 2009 [2] states that road transport contributes are about 42% of the total NO_x emissions, 47% of the total CO emissions and 18% of total PM emissions at EU25 level. Measuring and estimating the projected emissions of transport generated pollutants is pertinent in predicting the environmental impact and likely effects on human health. Continuous monitoring of vehicle emissions is essential as it can be used as a measuring tool in assessing the effectiveness of regulatory measures or emission standards set by governing bodies. In this study a diesel engine car (see Table.1) has been tested on a designated urban route (see Fig.1) utilising PEMS (see Fig.2).

Designated route and experimental set up and

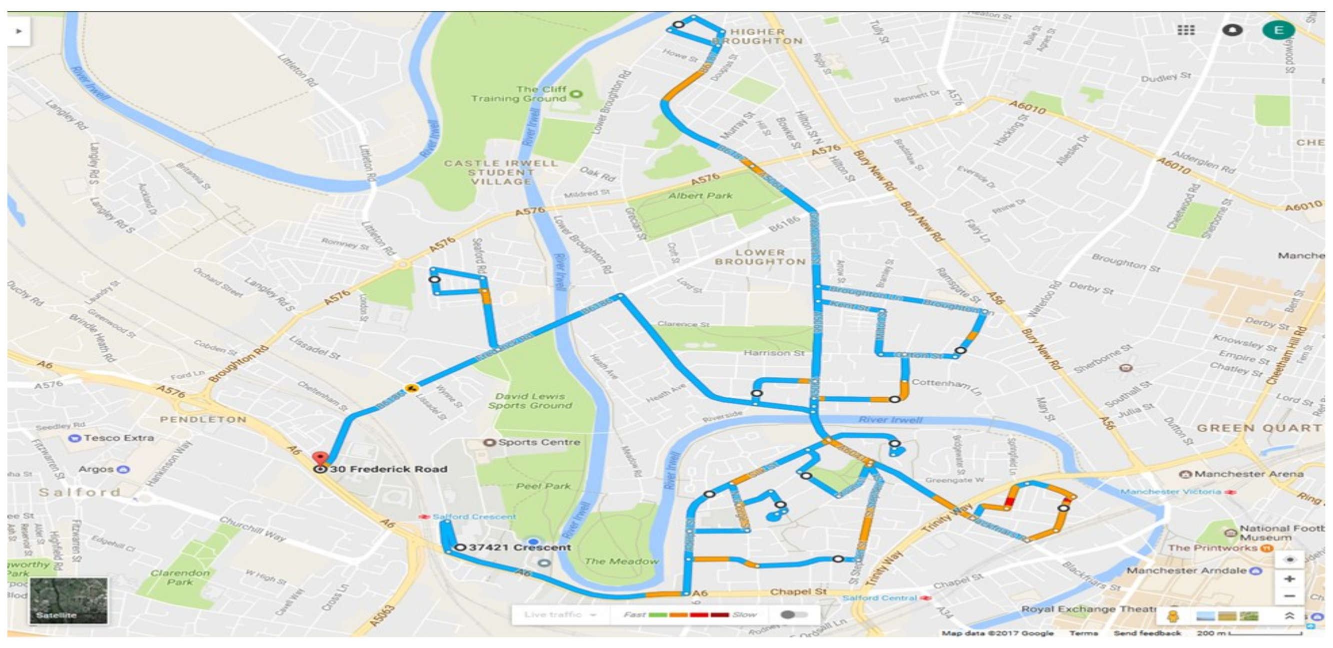

Fig. 1: Map of Urban Route covering 14.3 miles

Fig. 2: Apparatus setup in vehicle

Table. 1: Vehicle engine specifications

Engine size	2179 cc
Cylinder	4
Fuel	Diesel
Power	187 bhp
CO_2 Emissions	149 g/km
Euro Emission standard	5
Gearbox	6 Speed
Drivetrain	4 Wheel drive

Results

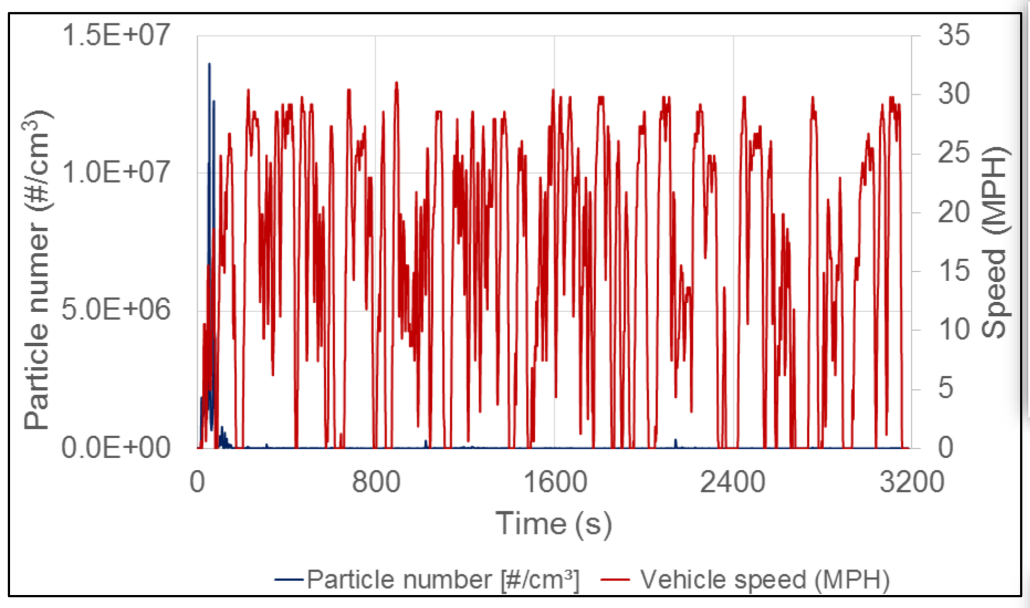

Fig 3.a: PN and Speed-Urban test

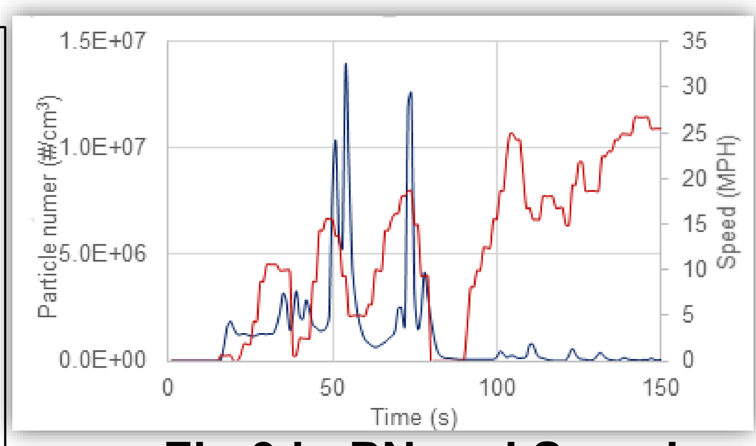

Fig 3.b. PN and Speed-Urban test-first 150s

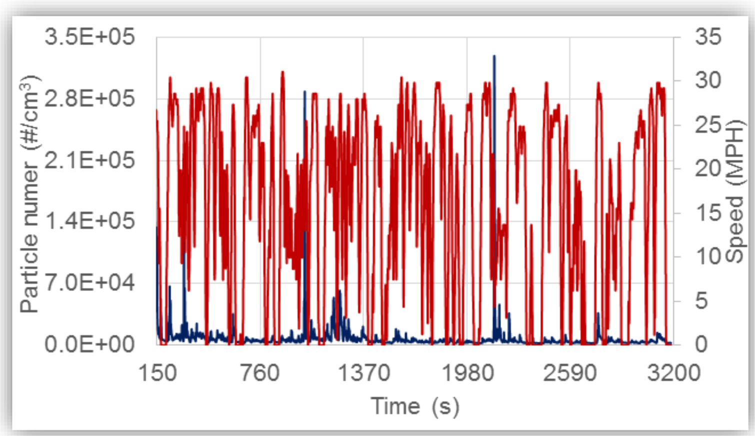

Fig 3.c. PN and Speed-Urban test-150s to 3158s

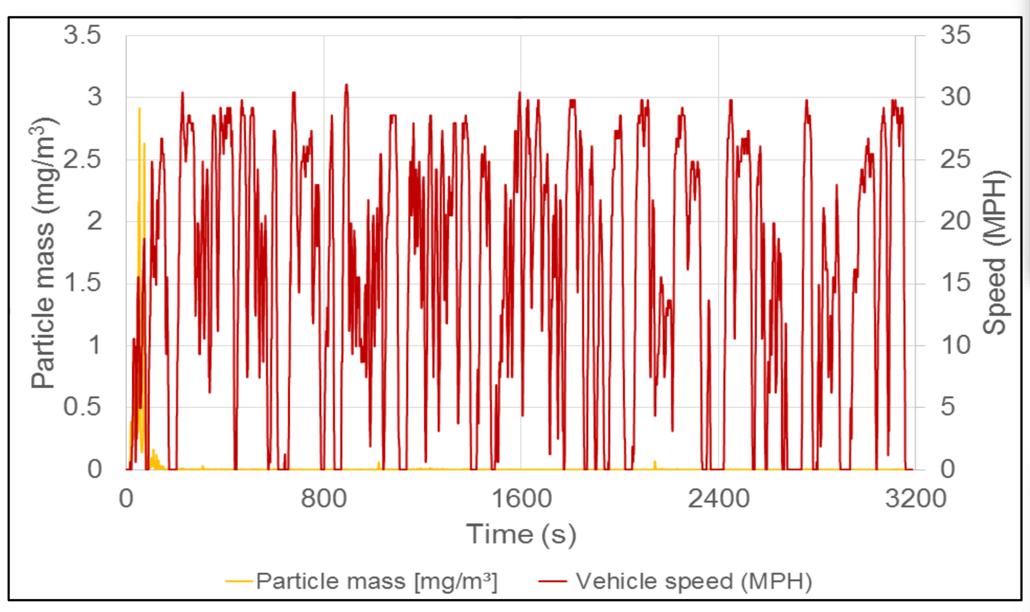

Fig 4. PM and Speed-Urban test

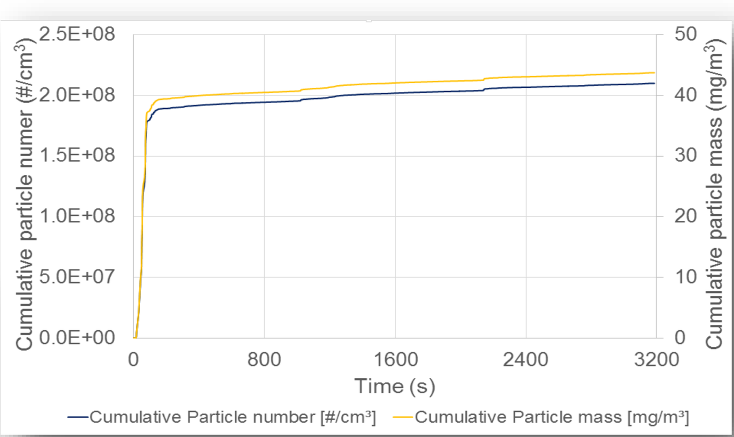

Fig 6. Cumulative PN and

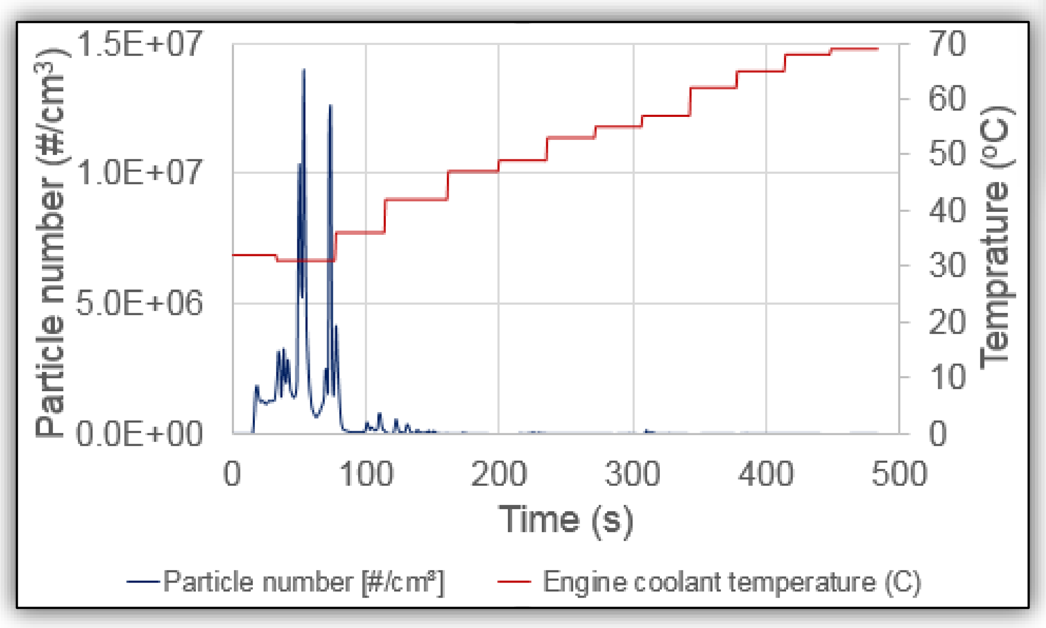

Fig 5. Cold Start PN-Urban Test

	Total Urban Journey	Cold Start	Euro 5b and Euro 6 limit
PN (#/km)	1.5×10^{11}	8×10^{11}	6×10^{11}
PM (gr/km)	0.00003	0.00017	0.005

Discussion

Using the designated urban route follows by international and governments guideline in covering certain speed (below 60 km/h for urban) , topography and human population parameters [3], the PN emissions are as shown in Fig 3.a to Fig. 3.c. As can be seen, The PN is high at the beginning of the experiments due to the cold start conditions. Similar trends can also be found with regards to PM levels as typified in Fig 4. The peak values of PM and PN emissions are 2.9 mg/cm^3 (0.0086 g/km) and 1.4x10^7 #/cm^3 (4.1x10^{13} #/km), respectively. The total average particle number emission during urban driving is 1.5x10^{11} #/km which is just 25% of the Euro 5b and Euro 6 limit (6x10^{11} #/km). This value for PM is 0.00003 g/km which is less than 1% of the limit. Considering the cold start condition (see Fig. 5), the situation is completely different. The PN number during cold start exceeds the standard limits and it becomes about 8X10^{11} #/km. However, the PM remains well below standard level (0.00017 g/km). This result shows that there are excessive particles emitted during cold start whilst their mass seems to be insignificant. This shows that most of these particles are in nucleation mode which can cause serious health and environmental problems [4]. The corresponding cumulative PN and PM concentration are also presented in Fig 6.

Conclusion

This research demonstrates that the tested vehicle could compel with particle emission standards. In addition, it has shown that particle emission vary with driving conditions. An increase in speed shows an increase in DPM. Cold start PM and PN were found to be significantly higher. This effect will be studied in more details particularly with the huge number of short travels that are happening in every day life.

References

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