

Characteristics of On-road Diesel Vehicles Black Carbon Emissions in Chinese cities Based on Portable Emissions Measurement

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INTRODUCTION

Black carbon (BC) is identified as the second largest contributor to current global warming and an essential indicator of diesel exhaust for many carcinogenicity studies, but characteristics of continued BC emissions from heavy diesel duty vehicles (HDDVs) on real-road are rarely reported in previous studies.

METHODOLOGY

We develop a portable emission measurement systems (PEMS) platform by integrating on-board measurement instruments, which allows investigating on-road BC emissions for HDDV. Eight heavy duty diesel vehicles were tested to assess the effect of emission control level on BC emission factors. All the tested vehicles are operated in different traffic conditions which are separated into two road types - congested roads and freeways.

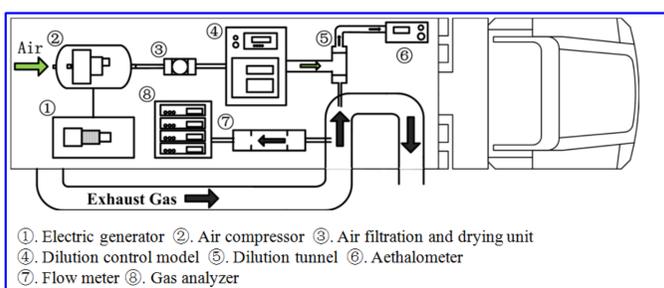


Figure 1. A schematic diagram of the PEMS platform.



Figure 2. the scene of the PEMS test.

RESULTS

3.1. Influence of emission standard on BC emissions.

Figure 3 presents that real-world emission factors of BC are substantially reduced with increasingly stringent emission certification levels from the Euro II to the Euro V, for both fuel-based and distance-based values. The most significant progress has been made by Euro III, because the application of high pressure common rail injection system provides precise fuel injection to reduce the incomplete fuel combustion.

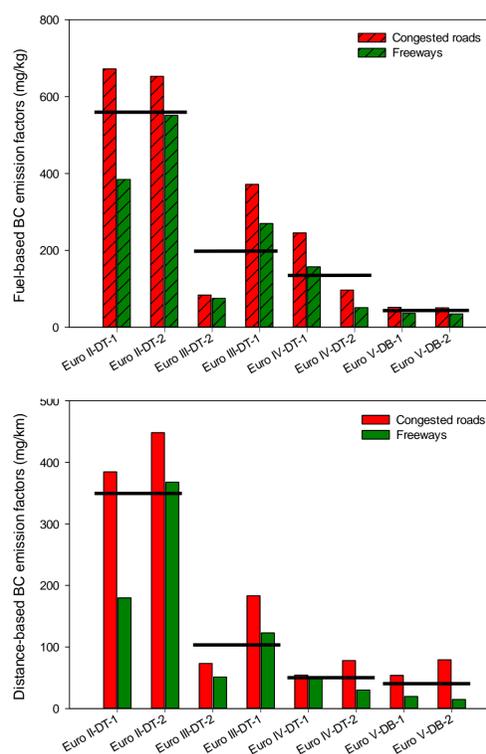


Figure 3. Average (a) distance-based black carbon emission factors and (b) fuel-based black carbon emission factors and for different emission standard vehicles on congested roads and freeways.

3.2. Influence of vehicle speed on BC emissions.

Figure 4 indicates that distance-based BC emission factors decreased with the vehicle speed increased and its reduction rate incline to drop. Good correlations were found between distance-based BC emission factors and vehicle speed for all vehicles ($R^2=0.58-0.92$).

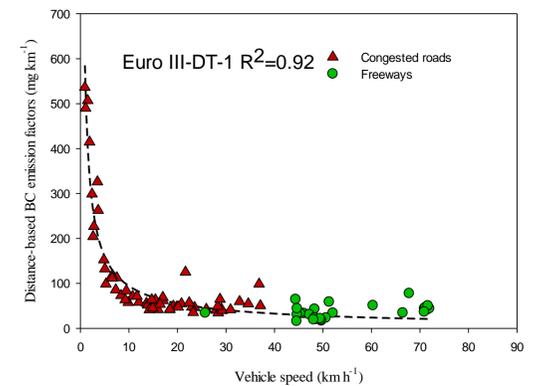


Figure 4. An example of relationship between distance-based black carbon emission factors and average vehicle speed.

3.3. Instantaneous emission rates by operating mode.

Figure 5 presents that average emission rates of BC generally increase with vehicle specific power (VSP) except for some operating modes with limited data, and the trend is similar to gaseous emission rates in previous PEMS studies. A significant emission reduction from Euro II to Euro IV trucks can be found for BC in all bins, especially for the higher VSP bins in three ranges (bin 16-18, 26-28 and 37-38). On the other hand, Euro IV trucks have significant decreasing average ER_{BC}/ER_{CO_2} with VSP for three speed range. That means the newer technology engine could improve combustion efficiency and burn fuel more completely.

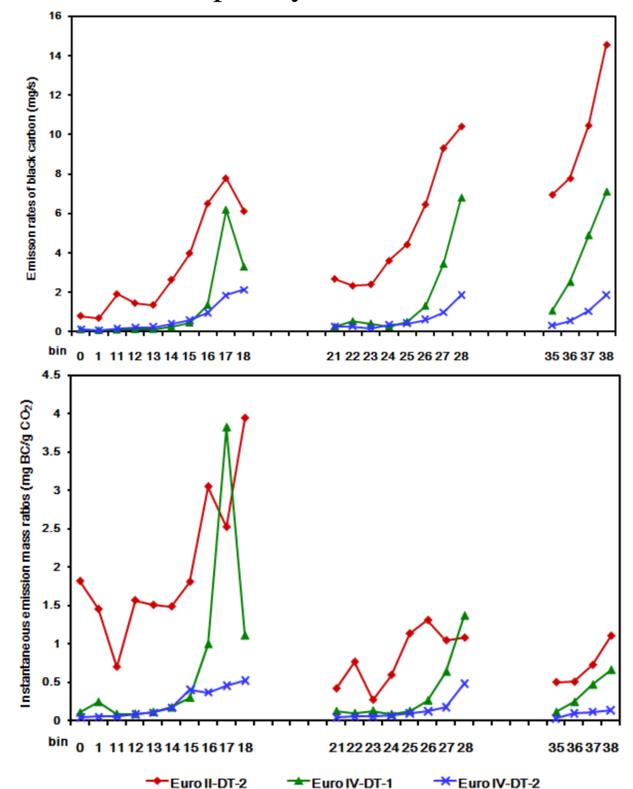


Figure 5. Comparison of average (a) BC emission rates and (b) instantaneous mass ratios of BC to CO_2 for three test vehicles by using bin methodology.