

# Exhaust Gas Particle Measurement. Evaluation of an Improved Gravimetric Method.

E. Zervas<sup>1</sup>, P. Dorlhène<sup>1</sup>, L. Forti<sup>2</sup>, C. Perrin<sup>2</sup>, J.C. Momique<sup>3</sup>, R. Monier<sup>3</sup>, D. Pingal<sup>4</sup>, B. Lopez<sup>4</sup>  
<sup>1</sup>Renault, <sup>2</sup>IFP, <sup>3</sup>PSA Peugeot Citroën, <sup>4</sup>UTAC

## Motivation and objectives

Current European regulations demand for a gravimetric measurement of particles emitted from Diesel passenger cars. The PMP/GRPE of the United Nations at Geneva, is mandated to work on the development of an enhanced method for the PM measurement. The French PMP subgroup (IFP, PSA Peugeot-Citroën, Renault and UTAC), evaluated an improved gravimetric method.

## Experimental Section

To achieve lower emissions, a Euro3 Diesel vehicle (Citroën Xsara, 2.0L) is used with disconnected EGR and fed with a sulphur free paraffinic fuel. The tests were performed on cold and hot NEDC, with a flow through the tunnel of 9 and 12m<sup>3</sup>/min, and a flow through the filters of 35-40L/min. As the four laboratories are well correlated (reproducibility RSD value of 15% for 0.028g/km of PM), the Lab1 is chosen to work at a flow of 80L/min. To increase PM collected mass, only one filter was used over the entire NEDC. The filter type were Pallflex TX40, Ø=47mm in the three Labs, and Pallflex T60A20, Ø=47mm (type with lower pressure drop) in Lab1. Two types of balance were used (0.1 and 1µg). The influence of multiple weighing is also examined. The reproducibility and repeatability is calculated according to the ISO 5725 standards, with a confidence interval of 63%.

## Results

### 1. Emission of regulated pollutants and CO<sub>2</sub> (figures 1, 2 in the case of CO and PM)

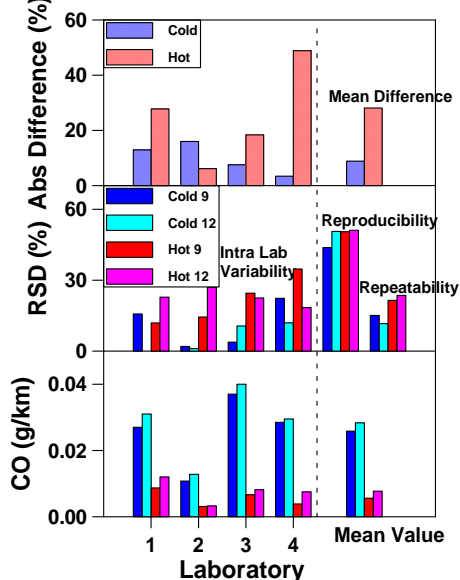


Figure 1. CO emissions

For all four regulated pollutants and CO<sub>2</sub>, a good agreement between the four laboratories is observed. The RSD values of hot tests are slightly higher of the RSD values of the cold

ones due to lower emissions in the case of CO, HC and PM emissions. The RSD values are very low in the case of NO<sub>x</sub> and CO<sub>2</sub>. A good agreement between 9 and 12m<sup>3</sup>/min at cold and hot tests in the case of NO<sub>x</sub>, PM and CO<sub>2</sub> is observed. No influence of the flow through filters (35-40L/min and 80L/min) on the concentration determination in the case of the four pollutants and CO<sub>2</sub>.

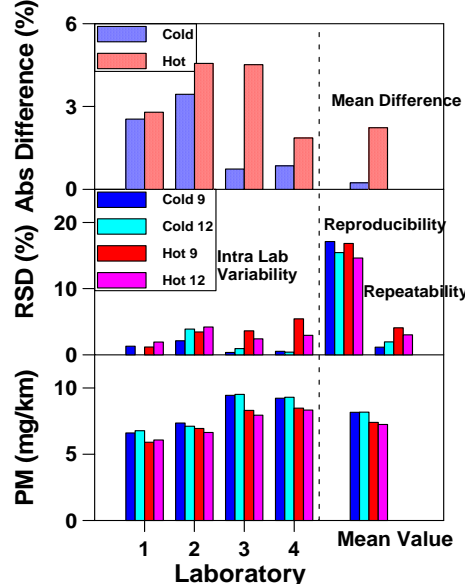


Figure 2. PM emissions

### 2. Multiple weighing of filters

Low RSD values are observed in the case of multiple weighing, with no differences between loaded and unloaded filters and no influence of balance accuracy. One weighing is sufficient (figure 3).

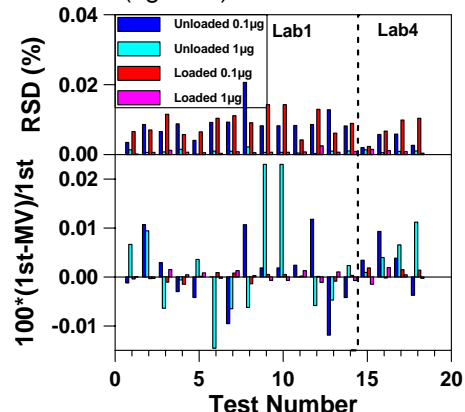


Figure 3. Multiple weighing of filters

### 3. Influence of balance accuracy

There is no difference between the balances of 0.1µg and 1µg. The

performances of the 1µg balance are sufficient (figure 4).

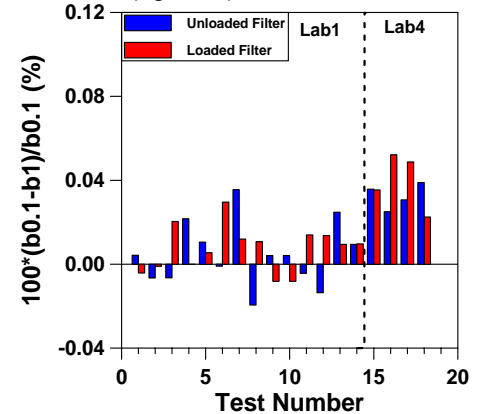


Figure 4. Influence of balance accuracy

### 4. Influence of flow through tunnel

A good agreement between the 3 labs used 35-40L/min is observed. The RSD reproducibility and repeatability values are quite low (figure 5).

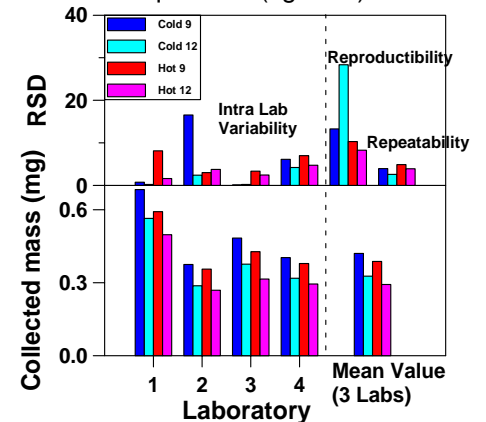


Figure 5. Influence of flow through tunnel

## Conclusions

- The proposed gravimetric method can measure precisely low PM concentrations, at least as low as 8mg/km.
- There is no influence of the flow through the tunnel between 9 and 12m<sup>3</sup>/min on the measurements of regulated pollutants and CO<sub>2</sub>.
- One filter weighing is sufficient.
- The repeatabilities of the 0.1 and 1µg balances are identical. The performance of the 1µg balance is satisfactory for regulatory purposes.
- The mean PM mass collected on the filters is 0.33-0.7mg with satisfactory levels of reproducibility (RSD of 25-29%) and repeatability (RSD of 3-7%).

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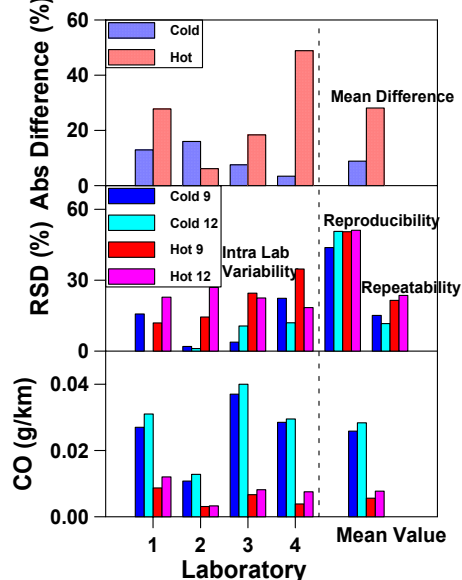


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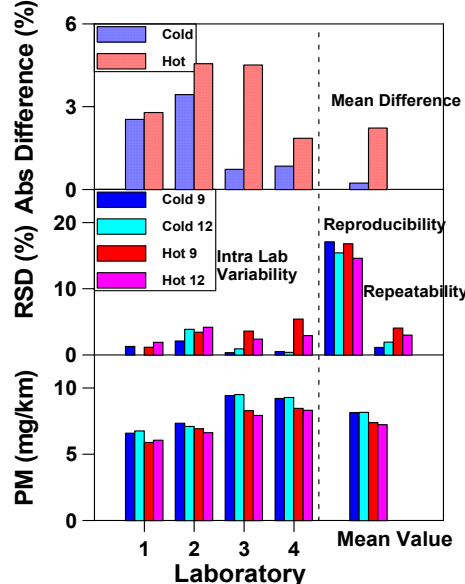


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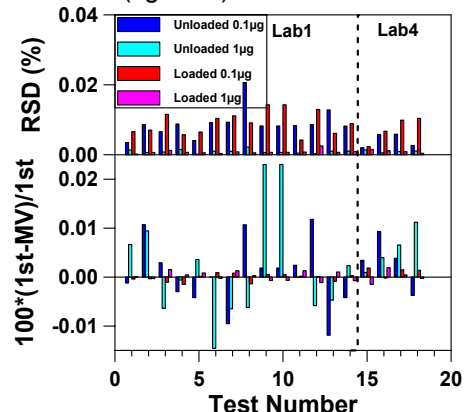


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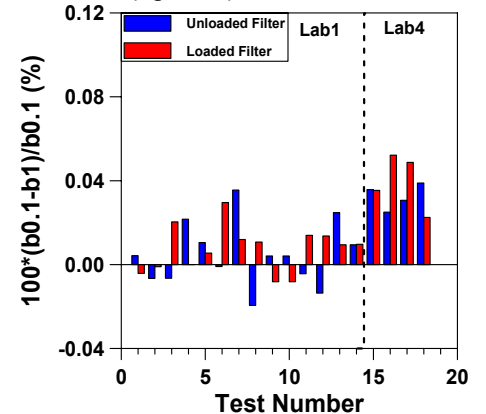


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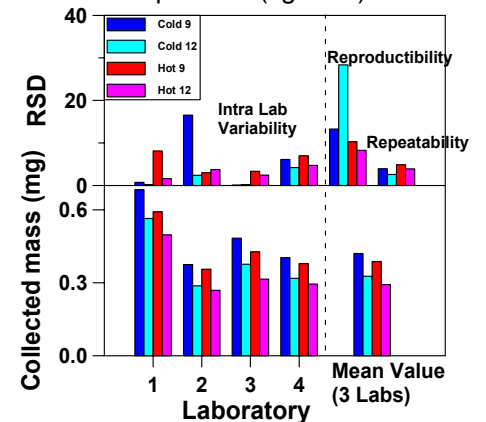


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