

## DMM-230 in UN GRPE Particle Measurement Program (PMP)

### Introduction

Swiss contribution to UN GRPE Particle Measurement Program (PMP) was titled "Comparison Study of Particle Measurement Systems for Future Type Approval Application". Twenty-one different particle measurement systems were thoroughly evaluated and compared against standard methods and against each other. Prototype version of the DMM-230 participated to the measurements at EMPA, Switzerland in summer 2002. A brief summary of the results and conclusions is presented in following.

### Method

Used engine was a 7-liter Volvo engine, equipped with a CRT (low emission level, ESC emission about 2.5 mg/kWh) and with a CRT bypass (high emission level, ESC about 10 mg/kWh). Dekati Double Diluter system was used for DMM sampling, connected directly to the tailpipe.

### Results

The following criteria were investigated:

- Robustness
- Repeatability
- Time response
- Linearity
- Sensitivity
- Detection limit
- Plausibility to absolute values

DMM gained good results in all topics; especially the sensitivity, linearity, time response and correlation to gravimetric method were impressive.

The following pictures are from the final report by EMPA:

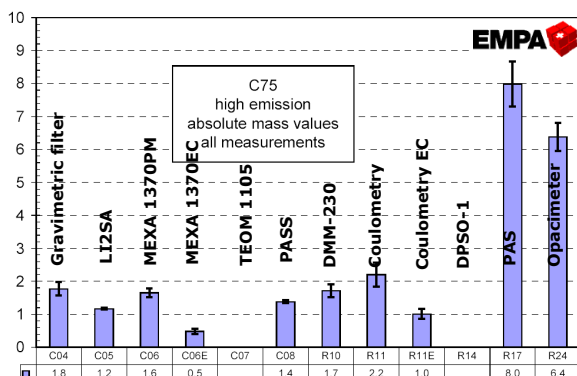


Figure 1: Measured mass emission from all mass measuring instruments. C04 is gravimetric measurement, R10 is DMM.

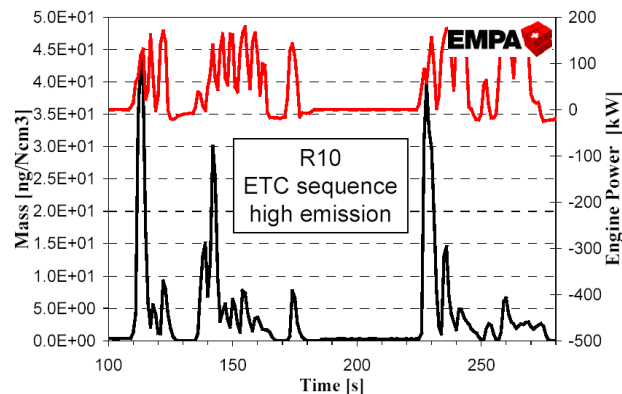


Figure 2: Transient response. Measured PM emission from the ETC driving cycle.

A conclusive table of results is seen on the next page, showing that the limit of detection (LOD) was found to be significantly higher than with a gravimetric filter or other mass measuring devices.

Instrument	Manufacturer	Real-time	Mass result <sup>3</sup>	Limit of detection <sup>4</sup>	Response time <sup>5</sup>
Gravimetric filter		No	1.8	0.189	N/A
<b>DMM-230</b>	<b>Dekati Ltd.</b>	<b>Yes</b>	<b>1.7</b>	<b>0.00359</b>	<b>5.3<sup>6</sup></b>
TEOM 1105 <sup>1</sup>	R&P	(Yes)	-	-	-
LI2SA	ESYTEC	Yes	1.2	0.037	2.2
MEXA 1370 PM	Horiba	No	1.6	0.0605	N/A
PASS	TU Munich / AVL	Yes	1.4	0.0294	2.2
Opacimeter	AVL	Yes	6.4	1.219	N/A
Coulometry	EMPA / SUVA	No	2.2	0.357	N/A
PAS <sup>2</sup>	Matter engineering	Yes	8.0	0.00197	6.2

<sup>1</sup> Data was not provided to EMPA

<sup>2</sup> Elementary carbon only

<sup>3</sup> Page 57, Steady-state, C75% load

<sup>4</sup> Page 42

<sup>5</sup> Page 44

<sup>6</sup> 5 second moving average

*Table 1: Comparison of mass-based instrument*

In the conclusion the DMM was described as follows:

"The instrument performed very well in repeatability and showed good correlation with other instruments for mass concentration. The sensitivity was found to be high in comparison with other mass-calibrated instruments. Although the MasMo (DMM) is a very new measurement technique, the instrument showed convincing performance." (M. Mohr, U. Lehmann: EMPA report n:o 202779, page 99)

**Further information:**

Mohr, M., Lehmann, U., 2003. Comparison study of measurement systems for future type approval application. EMPA report n:o 202779. Available at <http://www.empa.ch/pmp/>