47 MM PM FILTER HOLDER WITH REAL-TIME PARTICLE DETECTION

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Introduction

Particle mass (PM) emissions from vehicles and other combustion sources are commonly measured by weighing the particles collected on a 47 mm filter.

The method is laborious, it doesn't provide any real-time information on when the particles were produced and with current low-emitting vehicles its uncertainty and test-to-test variation is relatively high compared to other PM measurement methods. However, gravimetric method is still the basis of all PM mass emission regulations.

Dekati® eFilter™

In order to improve gravimetric PM measurement method and to overcome some of its disadvantages, Dekati Ltd. has developed a new tool for gravimetric PM emission measurements.

The system consists of a standard 47 mm gravimetric PM filter holder combined with an integrated miniature diffusion charger (DC) which provides second-by-second information on PM accumulation to a filter.

The real-time detector is equipped with its own pump so that normal PM filter flow is unaffected and the system is battery-operated and fully automated minimizing the required operator work. The assembly is approximately the same size as a normal PM filter holder and it fits directly into all existing PM filter sampling systems, CVS or partial flow diluters, and can be operated at 47C cabinet temperature.

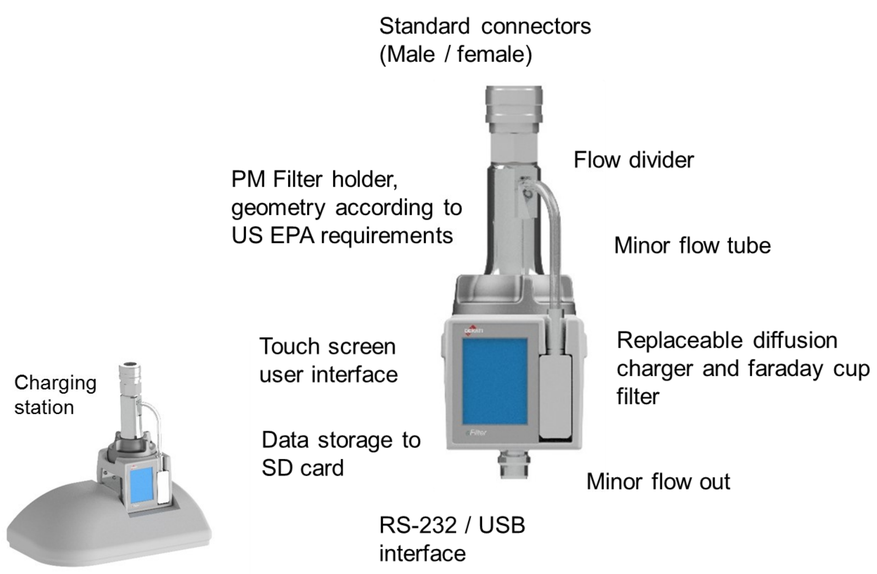

Figure 1. eFilter™ design (pat. pending)

Electrical detection sensitivity	About 3 fA electrical current With 70nm particles this corresponds to about 1000 #/cm^3,1 ug/m^3
Particle material	Total PM (Solid / semivolatile / liquid)
Battery life	About 7 hours
Minor flow rate	0.50 lpm, adjustable
Major flow rate	20 -100 lpm
Operating conditions	10-50°C
Filter holder specifications	US EPA 40 CFR part 1065/1066
Data transfer	SD card, USB port

Table 1. eFilter™ specifications

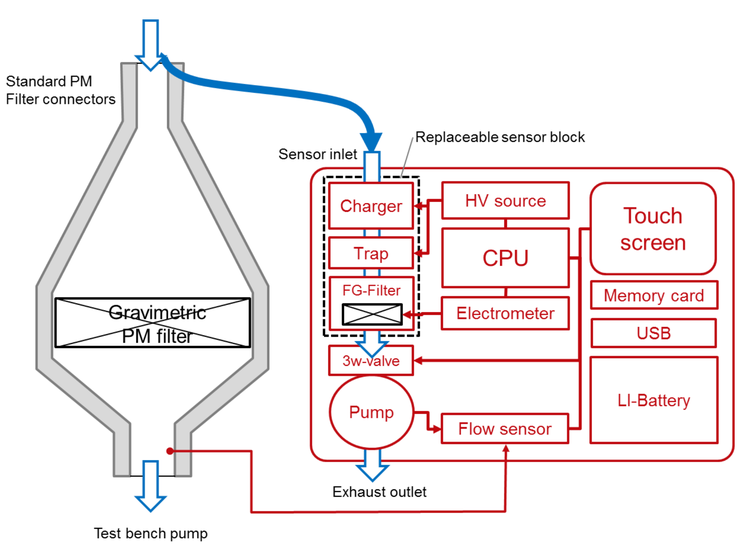

Figure 2. eFilter™ operation principle and components

Measurements

- Total of 88 test cycles at Ford RIC: (10 * EPA75, 40 * US06, 4 * 4BagFTP, 34 * NEDC)
- 8 different gasoline vehicles: 7 GTDI, 1 PFI ranging from about 0.1 to 5 mg/mile
- HF47 and room temperature sampling from CVS tunnel
- Instruments: Dekati eFilter, Dekati DMM-230, Gravimetric PM measurement, AVL CPC, AVL MSS, TSI EEPS

Results and discussion

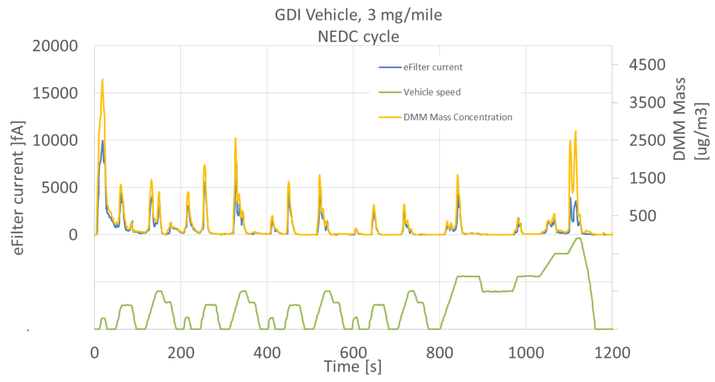

Figure 3. Real-time data over NEDC test cycle

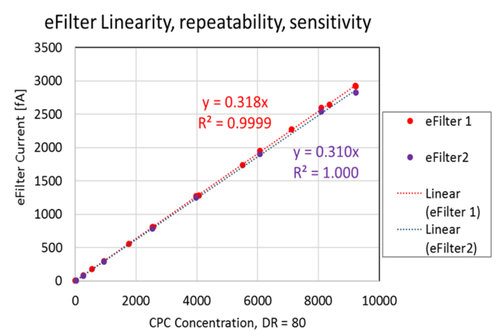

Figure 4. Linearity vs. CPC

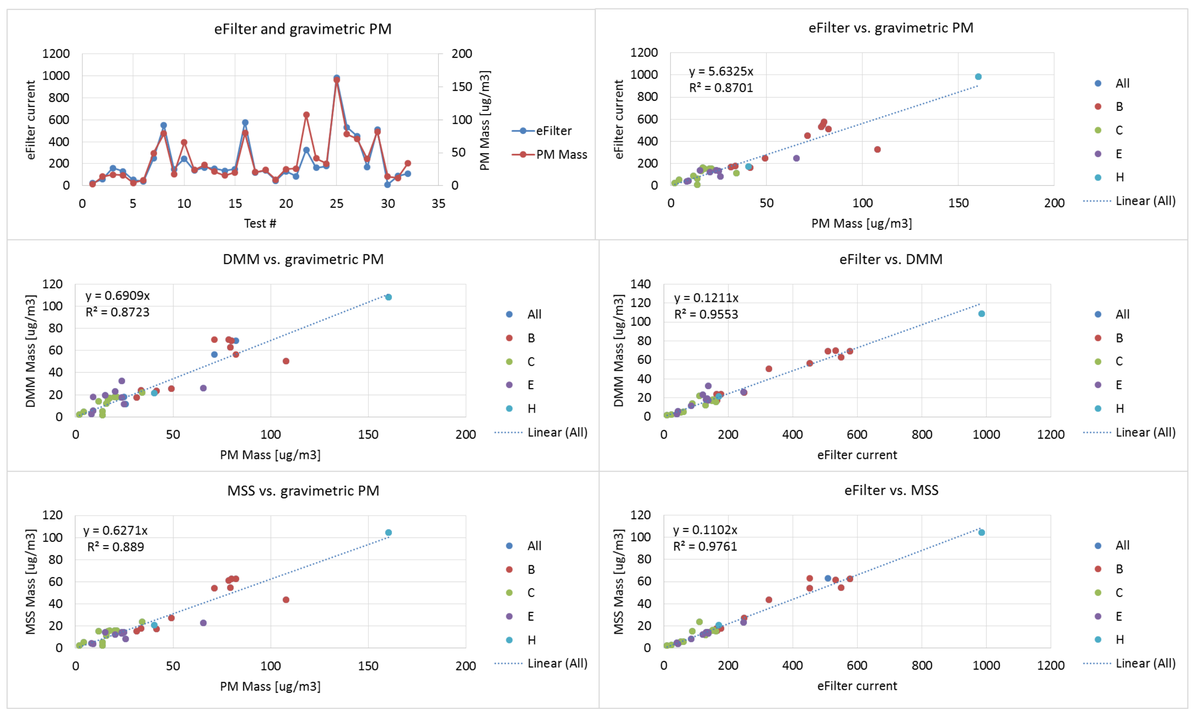

Figure 5. Vehicle tests: stability and correlation to other instruments, average over NEDC cycle

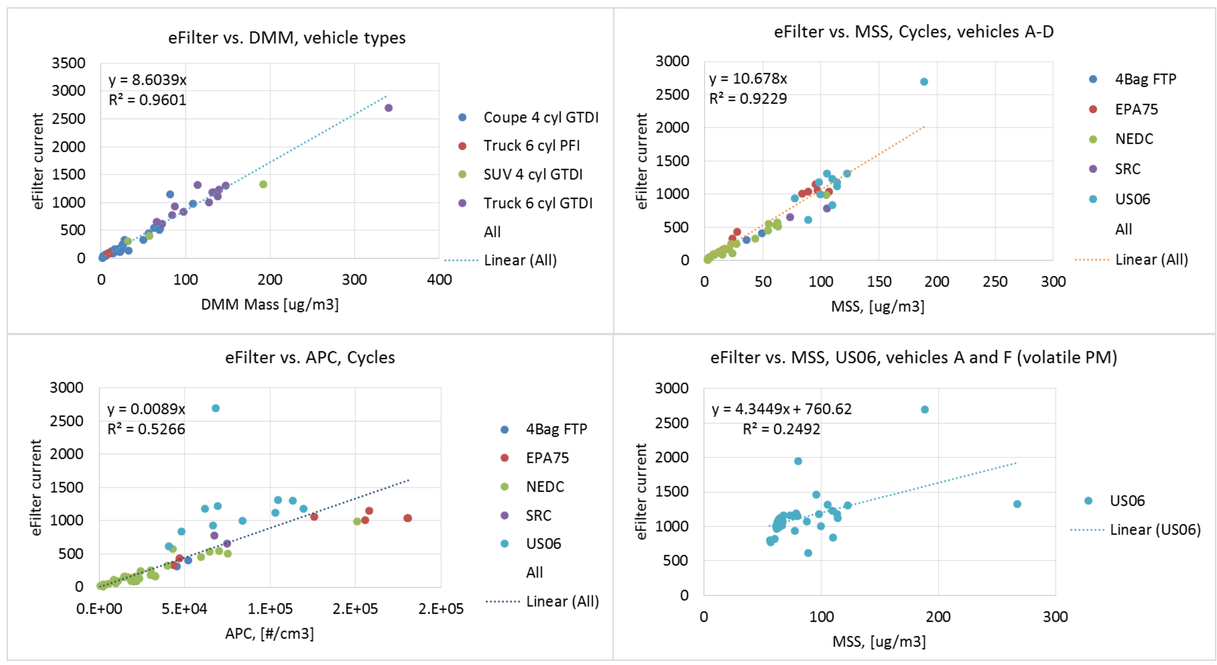

Figure 6. Vehicle tests: effect of vehicle, cycle type and PM volatile fraction

Conclusion

- A new gravimetric PM filter holder provides both standard gravimetric PM result and real-time information proportional to PM (solid+volatile) accumulation to a filter
- Filter holder integrated miniature diffusion charger provides repeatable, fast and sensitive signal about PM emission in different phases of the drive cycle
- Diffusion charger response remains stable over long periods of time, with different vehicle and cycle types
- eFilter, DMM or MSS real-time signal is more repeatable and more sensitive than gravimetric weighing result at low emission levels

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