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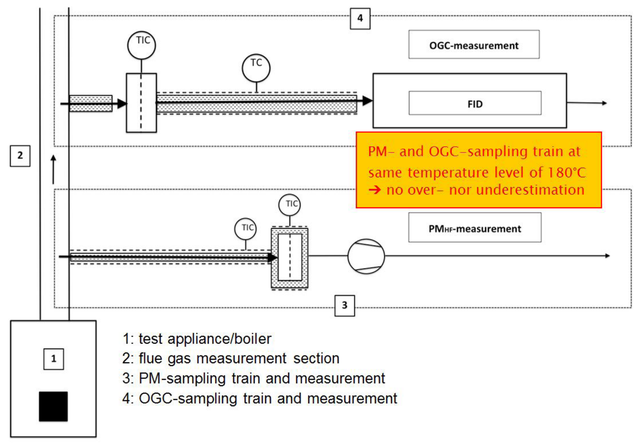
Determination of particulate matter emissions from solid biomass fuel burning appliances and boilers – Proposal for a common European test method

Introduction

The 20/20/20 target for Europe, i.e. to decrease the emissions of greenhouse gases by 20 % and to increase the use of renewable energy to 20% by the year 2020, will lead to an increased use of biomass combustion. Solid fuel burning appliances and boilers produce particulate matter emissions (PME) which are of concern to authorities and the public.

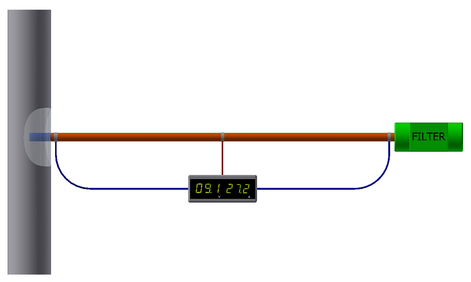
Many different methods have historically been used to measure PME from the flue gas of solid fuel-fired residential appliances and boilers. It became important to agree on a method with repeatable results that are of a guaranteed traceable accuracy applicable for all types of residential appliances and boilers burning solid fuels.



PME-measurement method: synoptic of simultaneous PM_{HF}- and OGC-measurement at identical temperature level (180°C) of PM_{HF}- and OGC-sampling train

Requirements for a unique European PME-Measurement Method

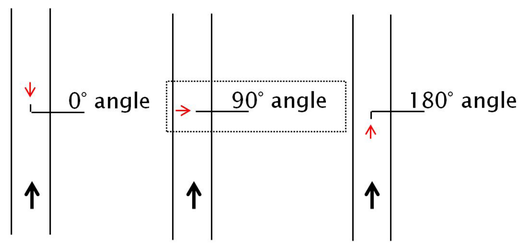
- low investment costs and easy incorporation in the already standardized test set-up, primarily intended for use in test laboratories
- taking into account the fraction of volatile organic compounds
- ability to be calibrated according to existing standard reference methods
- low limit of quantification (LOQ) and improved traceability



direct electrical heating (probe-tube is resistor) for fast reaction to temperature fluctuations in order to guarantee constant probe and sample gas temperature

Basic concept for improved traceability of the proposed European PME-Measurement Method

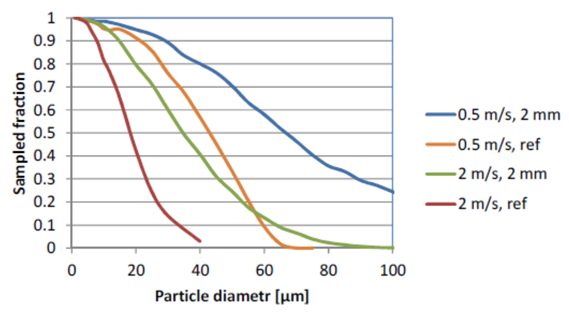
- PM_{HF} are determined as solids and condensed particulate matter in the flue gas at the sampling temperature by gravimetric filter.
- The measurement of OGC by FID is used as a guide value of the condensable fraction in the flue gas.
- PM_{HF} and OGC values are reported separately (there is no relevance to fix a PME value as a combination of solid fraction and OGC).
- In order to prevent overestimation or underestimation of organic species, the aerosols and OGC are sampled at the same temperature.



Nozzle orientation 90° is suggested to increase repeatability.

Key Elements of PME sampling train

- Probe has to guarantee the design temperature of 180°C+/-10 K of the sample gas at the end of the probe and at its inner surface for flue gas temperatures from 40 – 400°C.
- Nozzle orientation is set perpendicular to flow direction (90°-nozzle orientation) in order to increase the repeatability of PME-measurement by separation of larger particles (randomly coarse or re-entrained particles in flue gas).
- Probe deposits are taken into account (contrary to DIN+ method). They are directly added to gravimetric filter by blowing through the probe after each run. Allocation as defined in EN13284-1 is not optimal for wood combustion. Blowing removes more than 65% of the total deposit mass according to tests performed during the inter-comparison campaign.



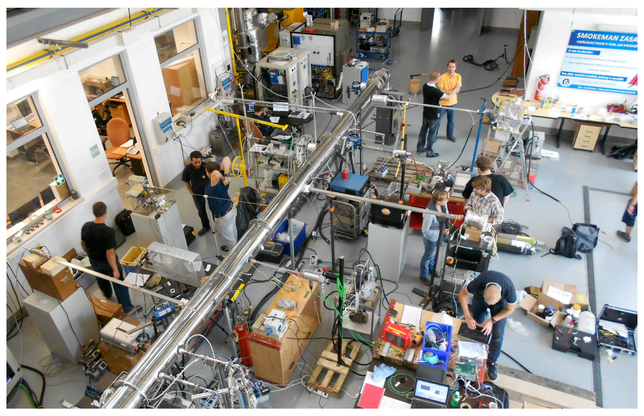
particle collection efficiency obtained using 90° sampling according to flue gas velocity in the duct (0.5 m/s and 2 m/s) and nozzle diameter (ref stands for 8 mm nozzle diameter) at a sample rate of 10 lstp/min

Results

The performance of the new PME-Measurement was determined by inter-comparison tests during which several sampling teams met and carried out simultaneous PME measurements from solid fuel burning appliances and boilers at INERIS (France) and VSB (Czech Republic).

The expanded uncertainty of the new method for particulate matter collected on the heated filter is 34 % for PM in the range between 6 and 42 mg/m³ STP determined on a pellet/woodchip boiler and 35 % for PM in the range between 41 and 104 mg/m³ STP determined on a wood log stove.

This was the first determination of uncertainties ever on PM measurement methods performed on real sources using simultaneous measurements.



inter-comparison tests at the Technical University of Ostrava (Czech Republic)

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