Discussion paper – The importance of sampling methodology on emissions from small combustion installations

There are several different methods available for measuring PM emissions. They can roughly be divided in the following categories (Winther, 2008):

- In-stack gravimetric methods (E.g. VDI2066 bl.2)
- Out-stack gravimetric methods without dilution tunnel (E.g. SS028426)
- Gravimetric methods with dilution tunnel (E.g. Force Technology/NERI, NS3058)
- Electrostatic methods (E.g. BS3841)
- Cascade impactors (E.g. VDI2066 bl. 5)
- Low pressure impactors (E.g. ELPI, DLPI)
- Optical scanners (E.g. LASX, SMPS).

The main difference is whether the emission measurement is carried out in the hot flue gas either in-stack or out-stack or if the measurements is carried out after the semi-volatile compounds have condensed.

Typically the Swedish laboratory measurements (E.g. Johansson et al., 2004) are based on Swedish Standard (SS028426), which is an out-stack heated filter meaning that the semi-volatile compounds will not have condensed. In the field measurements an in-stack filter was used to measure PM. (Johansson et al., 2006)

The measurements carried out in Denmark all use out-stack methods with dilution tunnel comparable to Norwegian Standard (Glasius et al., 2005, Glasius et al., 2007 and Winther, 2008). Therefore the measurement method can be the reason why the Swedish measurements show a significantly lower level compared to the Danish measurements.

A comparative study (Nussbaumer et al., 2008) of the sampling methods showed that the emission factors found when using a dilution tunnel are between 2.5 and 10 times higher than when only taking into account the solid particles measured directly in the chimney. This is illustrated in the figure below. This range is also reported by Bäfver (2008).

A test on a wood stove carried out by the Danish Technological Institute showed a ratio of approximately 4.8 between an in-stack measurement and a measurement in a dilution tunnel (Winther, 2008).

Based on the values of the current EFs in the GB, it can be assumed that they are based on a measurement method based on a dilution tunnel.

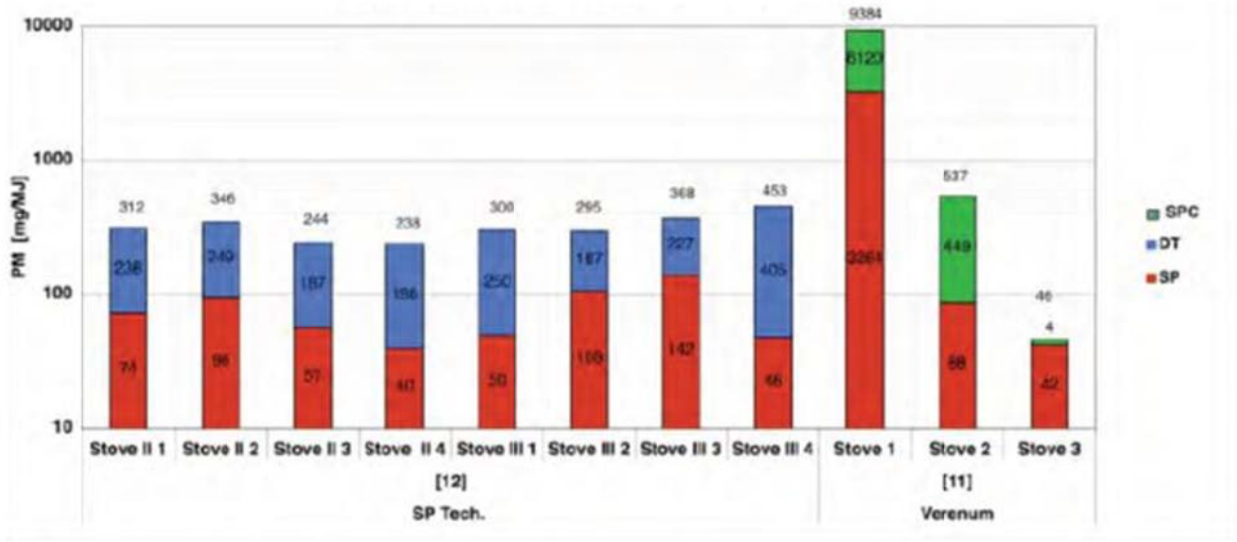

Figure 2: Comparison of PM emission factors on solid particles (SP), particles in dilution tunnel (DT), and solid particles plus condensables from impinger (SPC) for wood stoves.

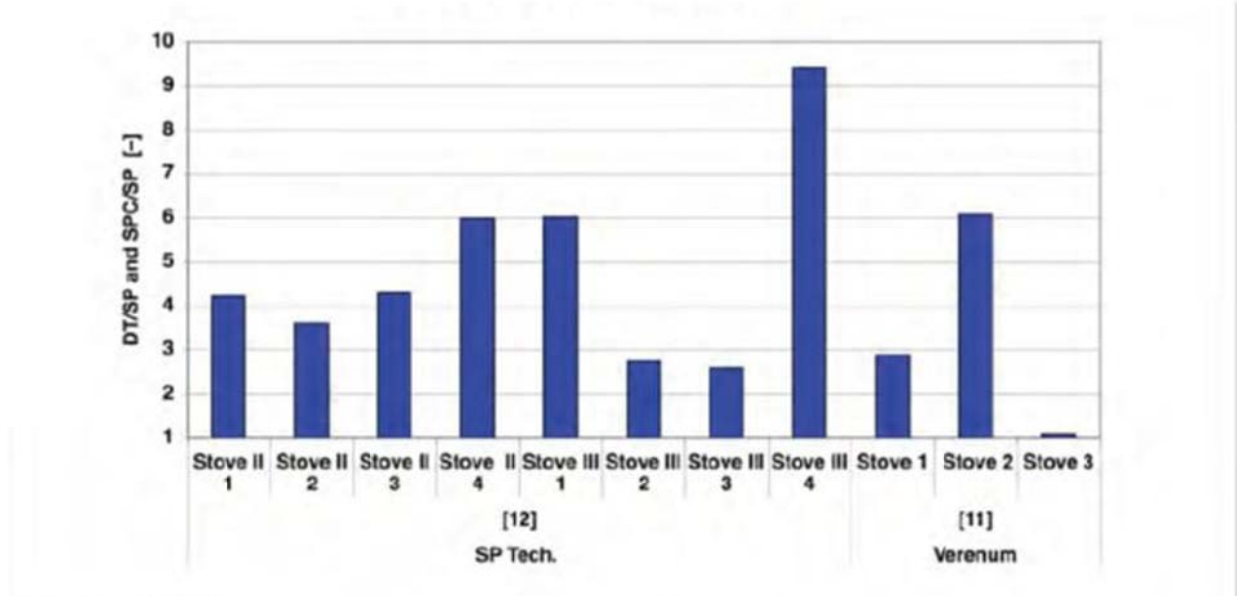

Figure 3: Ratio DT/SP and SPC/SP for wood stoves acc. to Figure 2.

Source: Nussbaumer et al., 2008

The proposal for a European standard for measuring particulate matter from residential solid fuel burning appliances was based on measurements of the particles in a dilution tunnel. (Gaegauf & Griffin, 2007) However, in the published standard (CEN/TS 15883:2009) three different methods are presented in annex A. These include both measurements in dilution tunnels (Norwegian standard) and in the stack (German standard).

In order to ensure comparability between emission inventories in the future there is a need to establish a common method for deriving emission factors since differences of up to a factor of 10 obviously makes it impossible to compare results.

The measurements carried out in a dilution tunnel best represent the actual emission of PM when the flue gas exits the chimney, whereas measurements done in the hot flue gas will neglect the contribution to the PM emission from semi volatile compounds that forms PM when the temperature decreases.

Recommendation

Based on the significant difference in EFs depending on the chosen measurement method, it is proposed to add in the GB that it is not considered good practice to use EFs for small combustion installations based on in-stack measurements, since it leads to a substantial underestimation of PM emissions.

References

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