Emission characterization of pellet stoves in non-standard operations

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Keywords: pellet stove, biomass combustion, emission factors, combustion aerosols, chemical characterization,
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Domestic pellet devices use as heating system strongly increased in Europe-28 in last years (Mantau *et al*, 2010). Since their use is becoming greater and greater, it is important to assess their impact on the environment. In fact, emission from residential wood combustion has been considered as a major contributor to ambient air pollution (Win *et al*, 2012). Household air pollution from incomplete combustion contains health-damaging pollutants such as carbon monoxide (CO), particulate matter (PM) and polycyclic aromatic hydrocarbons (PAHs) (Commodore *et al*, 2013).

Pellet devices are incentivized by European regulations for their known advantages (renewable energy and CO_2 neutral). Nevertheless, due to their disadvantages, some Italian regions (e.g. Lombardy and Marche) have banned biomass-based heating systems not complying with certain technical specifications or not fulfil quality standards for emissions and pellet, to prevent pollution and preserve air quality. Therefore, there is a strong ambiguity in Italian legislation and the study of these systems should be strongly deepened in order to have a clearer outline of the situation.

Emission factors for residential pellet heating systems are usually obtained from measurements during laboratory standard conditions, quite far from a realistic utilization. Therefore, there is a lack of information on the real emissions of pellet stoves. This work aims to fill this gap, by deepening two different aspects both influencing pellet stove emissions:

– Emission factors for residential pellet heating systems generated from measurements during stationary operation is a not realistic approach because, differently from industrial plant, non-steady conditions, i.e. start-up, shut-down and changes in power, are very recurring in an operation day in domestic use. For these reasons, emissions in all the operational conditions, and not only in steady conditions, were evaluated.

– Pellet certification is based on qualitative standard on row material and on pellet production and working processes. Combustion emissions are not taken into consideration at all. Therefore, emissions of pellets with different ash content were evaluated, not only from a quantitative point of view, but also from a qualitative one, as far as PM is concerned.

In this work, the emission factors of a pellet stove were measured for the different phases associated to pollutant emission (ignition, partial load (PL), increase in power and nominal load (NL)) and for pellets with different ash content, based on certification classes (A1, A2 and B). The flue gases composition was on-line analysed along the standard stack connected to the device. The total particulate emissions were collected in a dilution tunnel, to take into account the condensable fraction. The PM characterization includes several parameters, such as heavy metals, inorganic ions, PAHs, water soluble organic carbon (WSOC) and total carbon.

Results show that ignition emission factors are definitely higher for several determined contaminants: CO, TSP and its carbonaceous components, such as total carbon and PAHs. Moreover, not only non-steady state phases show higher PAH emission factors, but also the emitted compounds are more toxic. Emissions for lower quality class pellet are higher for TSP and for the most of the determined components. Nevertheless, WSOC shows a different behaviour. At PL, emissions factors are quite similar for all the pellet classes, while at NL, A2 and B pellets show lower emission factors (Figure 1).

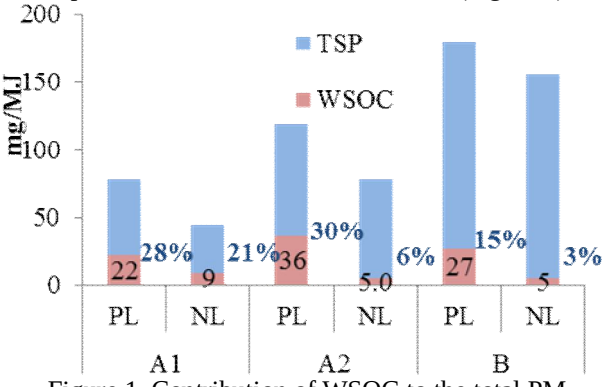

Figure 1. Contribution of WSOC to the total PM emission factor.

TCR TECORA is sincerely thanked for its technical and equipment support to the research project.

Commodore, A.A., Hartinger, S.M., Lanata, C.F,. Mäusezahl, D., Gil, A.I., Hall, D.B., Aguilar-Villalobos, M. and. Naeher, L.P. (2013) *Atmos. Environ.* **79**, 380-384.

Mantau, U. et al. (2010) *EUwood - Real potential for changes in growth and use of EU forests. Final report*, Hamburg/Germany.

Win, K.M., Persson, T. and Bales, C. (2012) *Atmos. Environ.* **59**, 320-327.