Effect of operating conditions of residential wood combustion appliances on $PM_{2.5}$ emissions

V. Tschamber[1], G. Leyssens[1], G. Trouvé[1], C. Le-Dreff[2], S. Labbé[3], S. Postel[4], S. Kohler[5]

[1]Laboratoire Gestion des Risques et Environnement, Université de Haute-Alsace, Mulhouse, 68093 Cedex, France
[2]Centre Scientifique et Technique du Bâtiment, Nantes, 44323, France
[3]LORFLAM, Caudan, 56850, France
[4]D2I/INVICTA, Viviers au Court, 08440, France
[5]MIPS Laboratory, University of Haute Alsace, 61 rue Albert Camus, 68093, Mulhouse, France

Keywords: residential wood combustion, $PM_{2.5}$ emission, realistic conditions, relationship with temperature.
Presenting author email: sophie.kohler@uha.fr

Although wood combustion is a renewable energy, it is well known that it is a source of fine particles ($PM_{2.5}$) and gaseous pollutants. In the last decade numerous studies were devoted to the evaluation of emission factors for gaseous compounds or PM from residential wood combustion appliances. Most of them have attempted to compare pollutant emissions as a function of the nature of the wood or the technology of the domestic heating appliances (Ozil *et al.*, 2011). Investigations on the influence of the operating conditions of the devices and pollutants emissions are scarce.

Appliances used are an inset and a stove, both equipped with high technologies in order to optimize the combustion and decrease its environmental impact. Normative and realistic conditions of use, as well as different stages of operation (ignition load, normal, reduced or extended paces), nature of the flue (isolated or not) and depression (natural 35 Pa and imposed 12 Pa) were considered. Effect of all these parameters on $PM_{2.5}$ (in number), total suspended particles (TSP) (in mass) and gaseous compounds was evaluated.

Compared to normal pace, the ignition load generates concentrations in $PM_{2.5}$ and TSP in the fumes two and five times higher, respectively. It was shown that this rate of increase is independent of the operating conditions used, i.e. normative or realistic conditions. In contrary, the impact of the ignition load in CO and THC emission is more important in realistic conditions than in normative ones. Among the different parameters analysed during ignition and normal paces, it was shown that the most sensitive one, to particulate emissions, is the temperature of fumes. A linear relation between $PM_{2.5}$ concentration (p/Ncm^3) and the flue gas temperature was established (Fig.1) while an exponential one is obtained for TSP (mg/Nm^3).

Reduced or extended paces are characterized by a progressively decrease of TSP and $PM_{2.5}$ emissions as a function of time.

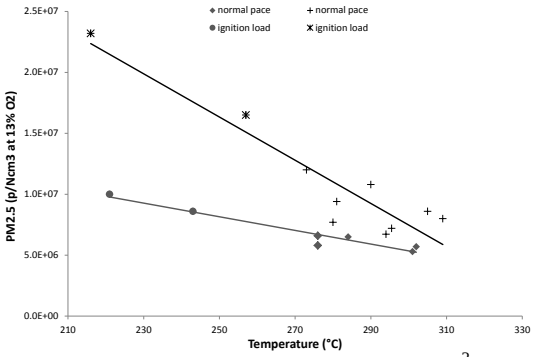

Figure 1. Relationship between $PM_{2.5}$ (p/Ncm^3) and the temperature of fumes in normative conditions (●,◆) or realistic conditions (+, ∗).

Realisation, for three consecutive days, of a representative scenario of a real heating day at home allowed us to assess the daily average emission factors of pollutants in the fumes (Tab. 1). The scenario is composed of an ignition load (~20min), followed by six normal phase (~40min each) and an extended one (4h).

Table 1. Daily average emission factors of pollutants in the fumes expressed in mg or particles per kg of wood

Pollutant	*units*	*Mean daily concentration*
CO	g/kg_w	45
THC	mg/kg_w	228
NO	mg/kg_w	611
TSP	mg/kg_w	108
PM2.5	p/kg_w	$8x10^7$

Investigation on the contribution of the different daily operation conditions to the pollutant emissions reveals that the ignition load involved to a large extent in TSP emissions (20 to 30%). Normal paces are particularly responsible of NO (~45%) and $PM_{2.5}$ (40 to 60%) emissions. CO and THC are essentially emitted during the extended pace (75%).

This work was carried out in the framework of the ESPACE Bois project supported by the Agence De

l'Environnement et de la Maitrise de l'Energie (ADEME).

Ozil, F., Tschamber, V., Haas, F., Trouvé, G. (2011) *Management Of Environmental Quality* **22**, 429-440