EFFECT OF WOOD PRE-TREATMENT ON OPERATING CONDITIONS AND PM EMISSIONS DURING COMBUSTION AT LABORATORY SCALE

G. SCHMIDT* (1), G. LEYSSENS(1), G. TROUVÉ (1), C. SCHONNENBECK (1), F. CAZIER (2), D. DEWAELE (2), P. GENEVRAY (2), S. LABBÉ(3), F. BALAY(3), Y. DENANCE (4), E. FAIVRE(4), C. LE-DREFF (5), N. ADAM(6).

(1) GRE Laboratory-UHA, Mulhouse, 68093, France, (2) CCM Laboratory-ULCO, Dunkerque, 59140, France, (3) LORFLAM, Caudan, 56850, France, (4) INOVALP, Susville, 38350, France, (5) CSTB, Nantes, 44323, France. (6) SundgauCompost, HIRSINGUE, 68560.

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Presenting author email: guillaume.schmidt@uha.fr

Wood pellets have become an important fuel in domestic heat generation, since the coasts of fossil fuels are rising and the emissions are nearly CO2 neutral. All households are incited to turn to the use of biomass as energy source for domestic heating. In contrast to other wood based fuels, the utilization of pellets is easy and automatic feeding to the boiler is possible. Furthermore, the pelletization densifies the wood and produces a fuel with high energy content. On the one hand, wood pellets are a convenient choice for domestic fuel because of its simplicity of implementation and its low cost. But on the other hand, wood pellets combustion is a source of fine Particle Matter (PM2.5) [1]. In the last decade, numerous studies were devoted to the evaluation of emission factors for gaseous compounds or PM2.5 from residential wood combustion appliances. Most of them have attempted to compare pollutant emissions as a function of both the nature of the wood and/or technologies of the domestic heating appliances [2]. Investigations on both influences of the wood preparation and pre-treatment on PM emissions are scarce.

An aerosol is composed by mineral and organic particles. The mineral part is principally metallic trace elements, sulphates, nitrates, ammonium and salts (KCl, K2SO4, CaCO3, CaO…). The organic part is itself composed by elemental and organic carbon. Elemental carbon (EC) is represented by black smoke and soot, so mostly carbon (close to 100%). Organic carbon (OC) is constituted by Polycyclic Aromatic Hydrocarbons (PAH), Volatiles Organic Compounds (VOC) and others organic molecules.

This work aims to study the influence of the nature of the biomass fuel and its pre-treatment on both emission factors of gaseous and particulate pollutants generated by new domestic heat generation in real use conditions. Indeed, these last years, domestic wood heating manufacturers have highly optimized combustion conditions, thanks to new technologies development, to respect the new European legislation proposed in 2022 [3]. To increase the environmental performance of these installations, this study aims to establish relationships between the properties of the biomass fuel used (type, size, chemical composition, moisture rate, ash content …) and the emission factors of gaseous and particulate pollutants generated by combustion in real domestic conditions.

Studies on pre-treatment of wood fuel have been conducted at laboratory scale by sawdust distilled water washing operation. Rinse water and dry biomass have been analysed by Atomic Absorption Spectroscopy (AAS) and results show that contents of elements as Potassium, Calcium and Magnesium could be mainly reduced in wood by washing operation with reduction yields ranging from 20% for Calcium and Magnesium and 60% for Potassium. The consequences of having less of these alkali and alkali-earth elements in the woody fuel would minimize particulate matter concentrations in the exhaust and dry corrosion phenomena in heat-exchangers. These points would be checked by performing burning tests of wood washed pellets in a domestic stove. Lixiviation of wood logs in external conditions by rainwaters would also be studied in order to point out chemical differences on biomass fuel and their impacts during domestic combustion tests in several appliances as insert and stoves.

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[1] K. M. Win, T. Persson, and C. Bales, "Particles and gaseous emissions from realistic operation of residential wood pellet heating systems," Atmos. Environ., vol. 59, pp. 320–327, Nov. 2012.
[2] C. Boman, E. Pettersson, R. Westerholm, D. Boström, and A. Nordin, "Stove Performance and Emission Characteristics in Residential Wood Log and Pellet Combustion, Part 1: Pellet Stoves," Energy Fuels, vol. 25, no. 1, pp. 307–314, Jan. 2011.
[3] Flamme Verte, "Le label Flamme Verte : un chauffage au bois écologique, performant, économique et contemporain !," Dossier de presse, 2015.