



Short communication

Pilot study on using an alternative method of estimating emission of heavy metals from wood combustion

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HIGHLIGHTS

- Research on alternative method of estimating emission of heavy metals from RWC.
- Mosses, cellulose and cotton wool as the potential indices for the elements emission.
- Mosses are more reliable as indices of metals emissions than cellulose or cotton wool.
- Correlation between the results obtained from the analysis of mosses and filters.

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ABSTRACT

This thesis presents pilot studies concerning the assessment of the possibility of using organic materials of vegetative origin as indices of heavy metals emissions (Cd, Cr, Cu, Ni, Pb and Zn) from domestic wood-fired fireplaces. Mosses of the *Pleurozium schreberi* species as well as cellulose and cotton wool were used during the study as the potential indices for the elements emission. It was proved that mosses are more reliable as indices of metals emissions than cellulose or cotton wool. It was found that the quantity of Ni accumulated in the moss tissue is comparable with the concentration of this compound in the dust assessed with the reference method. A correlation between the Ni, Cr, Zn and Pb concentrations defined in the mosses and dust filter was found. It was proved that mosses as adsorbers, more clearly than in the case of cellulose and cotton, react to the change of the size of the particulates emitted.

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1. Introduction

Wood incineration is one of the main sources of supplying heat to individual households all over the world (Hellén et al., 2008; Caseiro et al., 2009; Alves et al., 2011). As demonstrated in the study by McDonald et al. (2000), combustion of wood logs in fireplaces leads to a much higher level of dust emissions than the values obtained when combusting other types of biomass. Above all, the problem of significant air toxication affects rural areas, where the share of wood combustion in the emission of particulate matters is substantial (Jeong et al. 2008; Hellén et al., 2008; Caseiro et al. 2009; Borrego et al. 2010).

The reference method to determine dust emission is the gravimetric method, consisting of sucking up a representative sample of fumes and trapping the particulates on a filter (EPA, 2007). On account of the technical difficulties of carrying out a reference process of collecting samples directly from residential houses' chimneys, tests in real conditions of use are only sporadically conducted (Alves et al., 2011). In the alternative indication method adopted to establish the selected parameters that characterise the emissions from wood combustion, in the case of Residential Wood Combustion (RWC), materials of vegetative origin (mosses, cellulose, cotton) can be used.

During the literature study, no existing research projects concerning the possibility of using cotton and cellulose as emission indicators were found. Scientists were sporadically making tests to check mosses' usefulness as heavy metals emission indicators (Zechmeister et al. 2006; Giordano et al., 2010).

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Table 1

Analytical parameters for the method of the heavy metals determination and AAS data for reference materials.

Parameter	Material ^a	Pb	Cd	Cu	Zn	Ni	Cr
MQL [mg kg ⁻¹]	OM	2.5	0.3	1.0	0.5	1.0	0.7
	D	1.6	0.2	0.6	0.3	0.6	0.7
RSD [%]	OM	4.8	4.5	4.3	2.5	8.9	9.0
	D	3.9	3.2	4.0	5.1	6.7	4.3
U [%]	OM	13	11	21	21	20	10
	D	8	10	14	16	12	18
AAS SRM 1648a							
Mean [mg kg ⁻¹]		0.598	69.4	572	4591	74.6	374
Certified value [mg kg ⁻¹]		0.655	73.7	610	4800	81.1	402
Recovery [%]		91	94	94	96	92	93
AAS BCR-482-lichen							
Mean [mg kg ⁻¹]		34.14	0.53	7.75	90.09	2.26	4.02
Certified value [mg kg ⁻¹]		38.5	0.56	7.03	100.6	2.47	4.12
Recovery [%]		94	95	110	90	91	98

For gravimetric method the expanded mass concentration measurement uncertainty did not exceed 7.1%.

^a OM – organic materials (moss tissues, pure cotton, pure cellulotton), D – fibreglass filter.

The purpose of the study was to check the possibility of using mosses of the *Pleurozium schreberi* species, cotton wool and cellulose cotton wool as media permitting us to estimate the scale of heavy metals emissions from home heating wood-fired installations (RWC – fireplaces). The research results were compared with the results obtained using the reference method of measuring the extent of emissions and the chemical composition of the particulate matters in the fumes. The basic issue was to find an answer to the question whether, under completely adverse conditions, organic materials are able to accumulate heavy metals effectively. Additionally, the research hypothesises that; “organic materials exposition under conditions of intensified emissions and the increased presence of heavy metals in the fumes do not cause changes in the concentration of those elements in the tissues/on the surface of the organic materials” (No. 1) and “for sources of similar thermal power, heated with identical fuel, the scale of accumulation of heavy metals by individual organic materials is comparable” (No. 2) – were checked.

2. Materials and methods

2.1. Measurement site, combustion conditions and monitoring period

Experimental tests were carried out on two emitters of individual heating systems connected to a 16 kW (C1) and 14 kW (C2) closed-system fireplace TARNAVA. The inner diameter of the emitters is 200 mm. In the course of the experiment, fireplaces were heated with oak wood (*Quercus robur L.*) seasoned for 2 years under conditions of constant and stable combustion, at minimal air excess, conditioned by the technical solutions of the fireplaces. Within the period of measurements and the organic materials exposition, on average 11.5 ± 0.86 kg (C1) and 10.8 ± 0.57 kg (C2) of wood was incinerated. At both emitters, tests were carried out during 3 h a day for a period of 6 days (01–06.02.2013).

2.2. The sampling and analysis methodology

During the experiment mosses of the species *P. schreberi* and as a sorption material, clear cotton wool and cellulose wool were used. Prior to the exposition in chimneys, in order to determine the

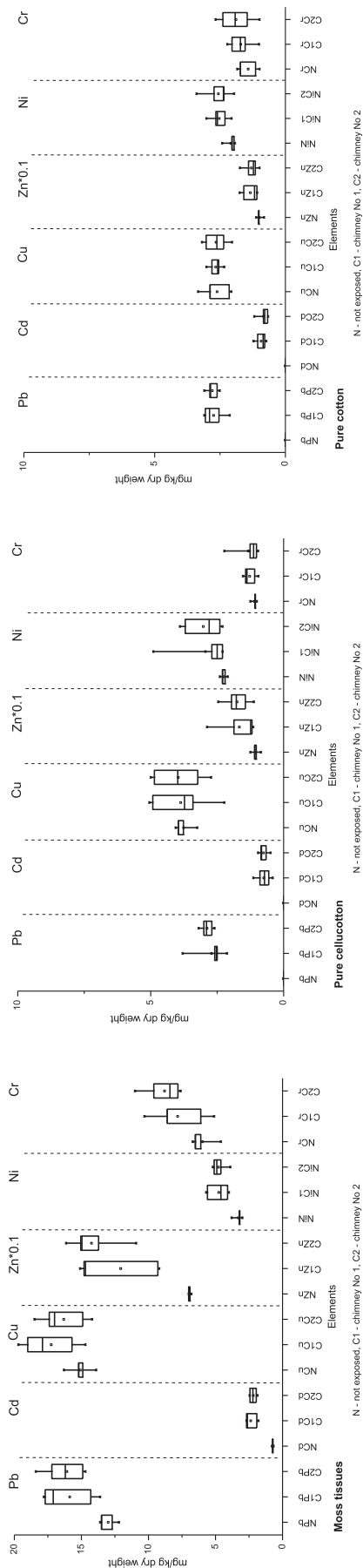


Fig. 1. Box plot of heavy metals indicated in moss tissues, cellulotton and cotton.

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