Emissions from residential combustion of several types of mineral coal

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1. Introduction

Despite the decreasing tendency in the use of coal for residential heating purposes in Europe (Kerimray et al. 2017), coal combustion is still a major source of atmospheric pollutants in several countries (e.g., Lin et al., 2019; Pandolfi et al., 2020). In Spanish cities, such as León, despite the government incentives to replace traditional and old coal-fired stoves and boilers, the use of this fuel for residential heating is still widespread (Blanco-Alegre et al., 2022). Considering that emissions from this source strongly depends on the combustion appliance design, combustion conditions, user practices, and type of fuel, this study intends to investigate the importance of the fuel type on emission of pollutants, covering the expected usage in real households.

2. Methods

Combustion Appliance

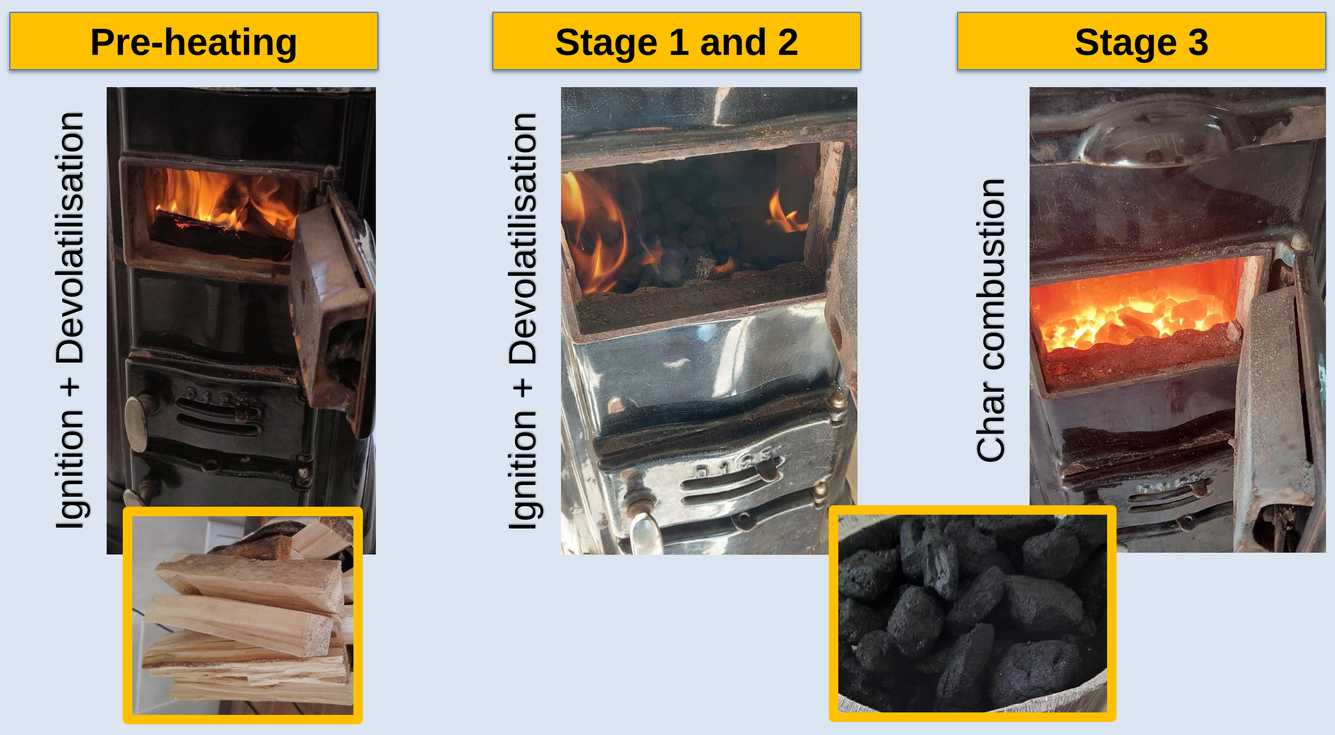
Cast iron stove
Height = 68 cm, Width = 32 cm, Length = 24 cm

Fuels

Table 1. Proximate and ultimate analysis of the coal types tested.

Proximate analysis	Unit	Coal A	Coal B	Coal C
Moisture	wt.%, as received	3.61	4.53	4.1
Ash	wt.%, dry basis	1.28	6.21	3.15
Volatile matter		36	11.9	1.89
Fixed carbon (by difference)		62.3	81.9	95.0
Ultimate analysis				
C	wt.%, dry basis	83.9	85.5	93.5
H		5.42	3.55	1.25
N		1.66	2.03	0.77
S		0.45	0.31	1.08
O (by difference)		7.29	2.4	0.25
Lower heating value	MJ kg^{-1}	33.2	32.7	32.7

Combustion Tests



TSP Emissions

Sampling : ISO 9096:2017

Gravimetric Quantification

Sample Analysis

Ion chromatography: Water-soluble ions

Thermo-optical method: OC and EC

Gaseous Emissions

NO_X, SO_2, CO_2, CO, O_2

Horiba PG350 gas analyser

VOCs

Signal Model 3010 FID

3. Results

Gaseous and Particulate Emission Factors

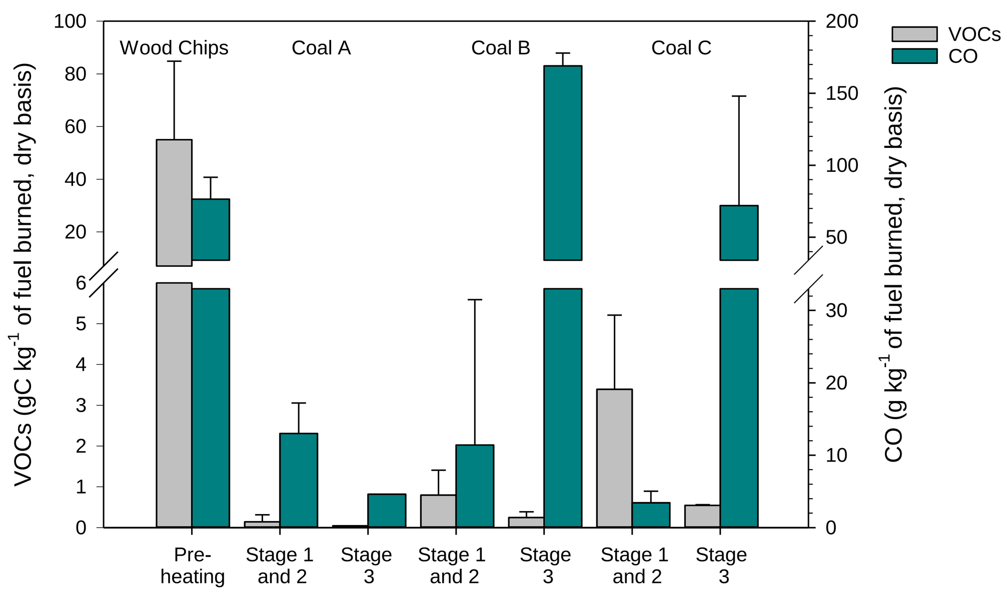


Fig. 1 VOCs and CO emission factors from wood chips and three coal types over distinct combustion stages.

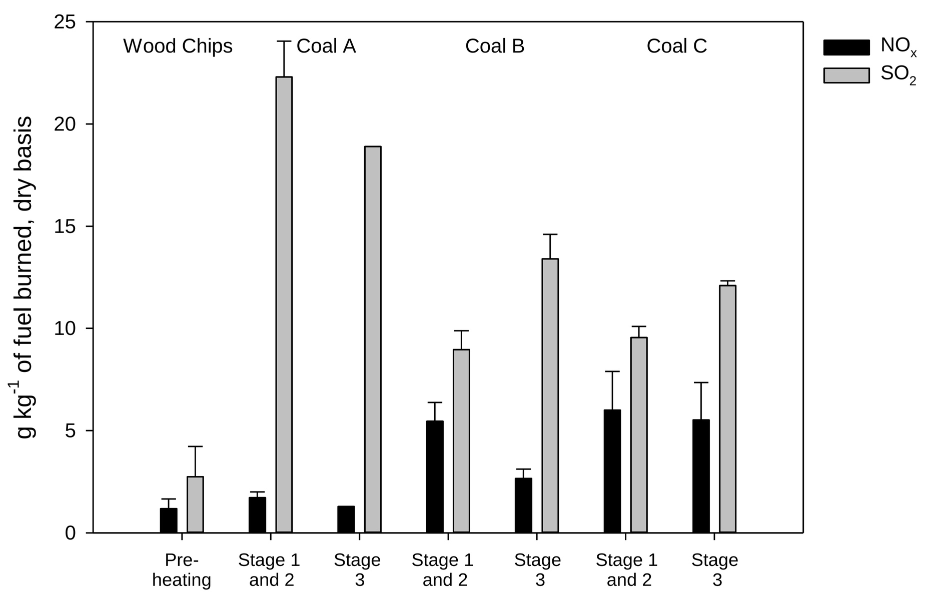


Fig. 2 NOx and SO_2 emission factors from wood chips and three coal types over distinct combustion stages.

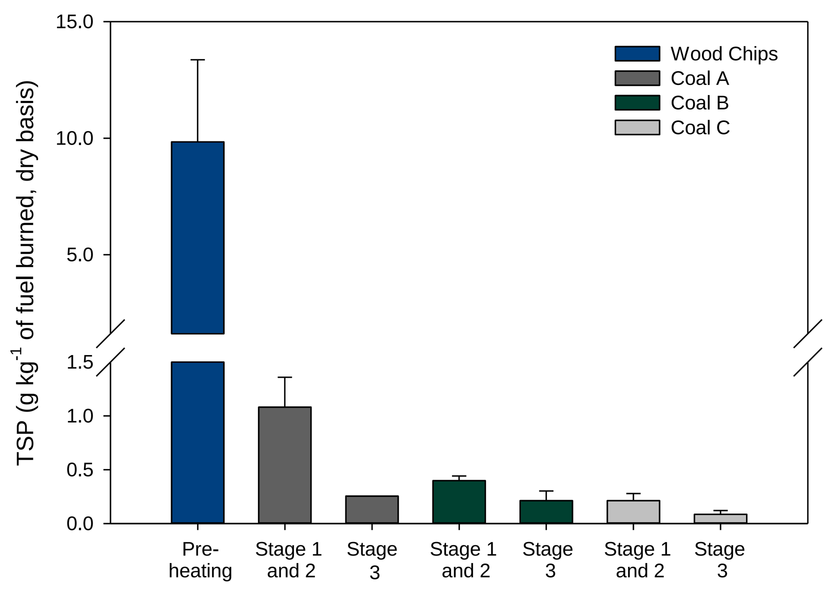


Fig. 3 TSP emission factors from wood chips and three coal types over distinct combustion stages.

TSP Composition

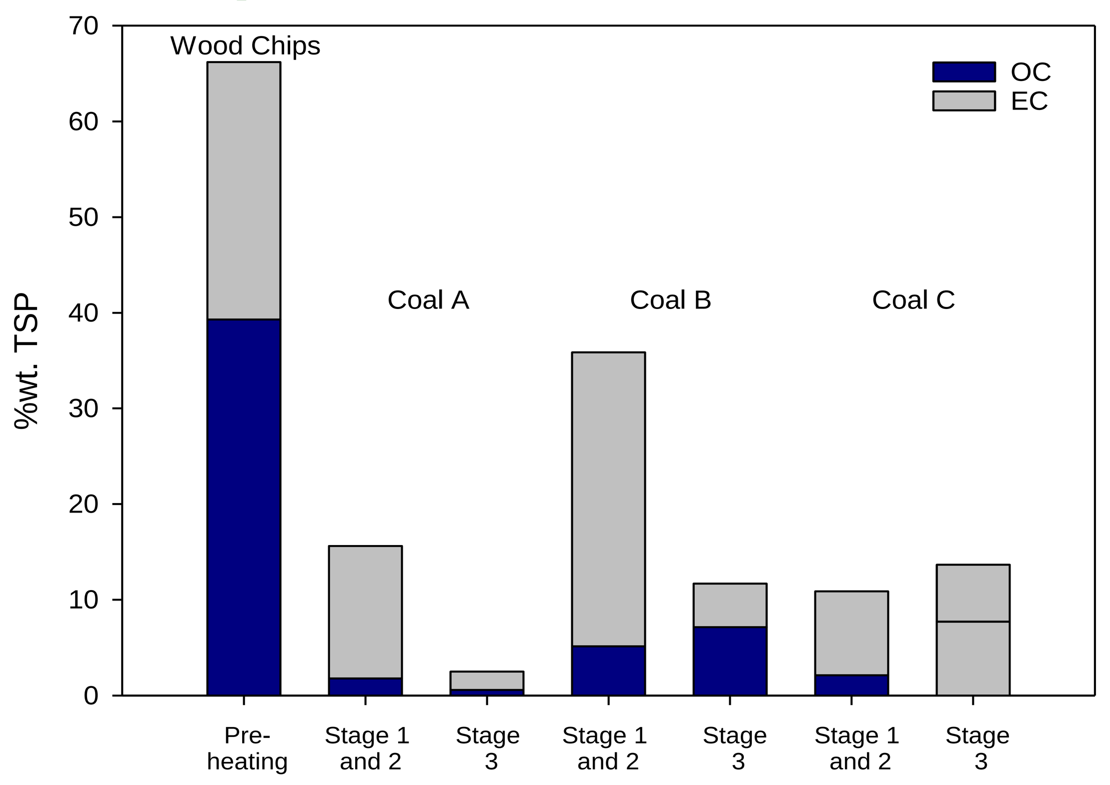


Fig. 4 Carbonaceous particulate mass fractions for wood chips combustion and three coal types over distinct combustion stages.

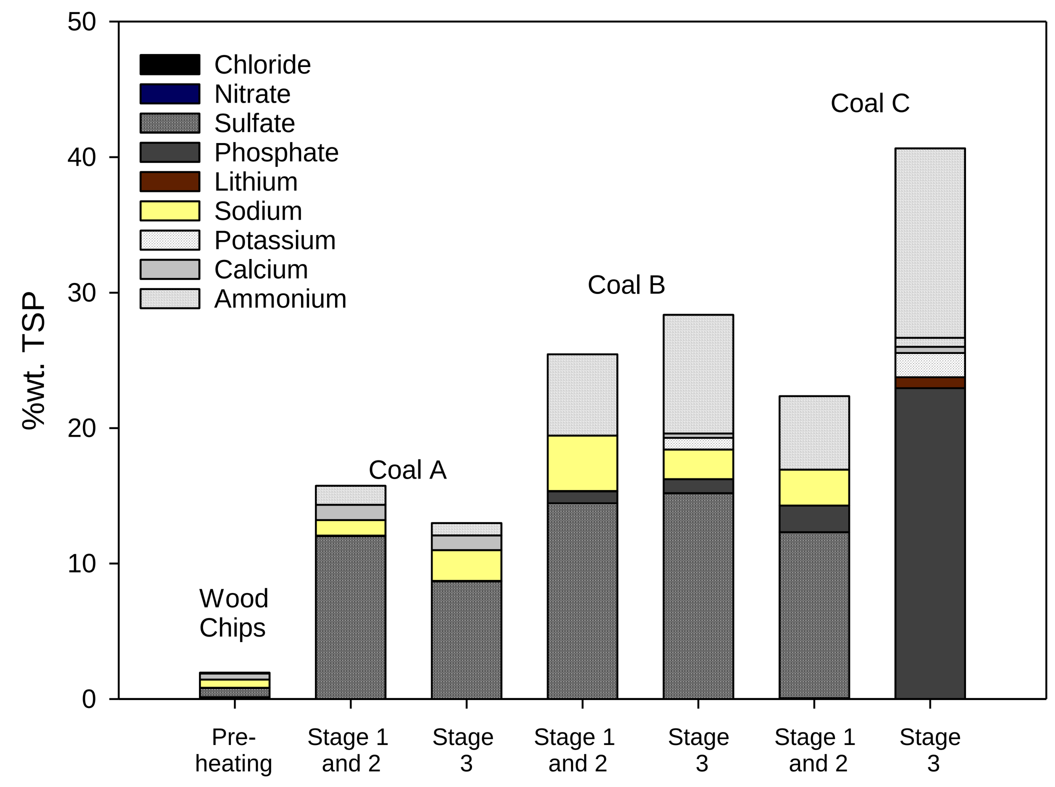


Fig. 5 Water soluble inorganic ions mass fractions for wood chips combustion and three coal types over distinct combustion stages.

4. Conclusions

- Striking differences among emissions from the tested fuels were recorded. Regarding CO, VOCs and TSP, the higher emission factors were recorded for coal B, C and A, respectively. SO_2 and NO_X emissions were higher and similar for coal type B and C.
- Regarding the combustion stage, distinct trends were recorded depending on the pollutant under analysis and type of coal tested.
- For coal combustion, the contribution of carbonaceous particles to the TSP mass ranged from 2.49 – 35.9 wt.% and was generally dominated by EC. Regarding the contribution of inorganic ions, sulphate was the major component (8.66 wt.% - 22.9 wt.% of TSP mass).

References
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