Aerosol from waste wood fires: number and volume size distribution

Jan Stefan Bihałowicz[1], Wioletta Rogula-Kozłowska[1], Adam Krasuski[1], Małgorzata Majder-Łopatka[1], Agata Walczak[1] and Tomasz Mach[2]

[1]The Main School of Fire Service, 52/54 Słowackiego Street, 01-629 Warsaw, Poland, jbihalowicz@sgsp.edu.pl

[2]Faculty of Environmental Engineering, Wroclaw University of Science and Technology, Plac Grunwaldzki 13, 50-377 Wrocław, Poland

Burning of household waste made of wood causes emission of the particulate matter (PM) to atmosphere. The size distributions of PM depend on the stage of the thermal degradation of wood.

We conducted experiment to determine the number size distribution (NSD) and volume size distribution (VSD) during burning of waste wood. We decided to analyze two typical materials which are most commonly used in the production of household equipment and as construction elements – pine wood and laminated particle boards. To determine NSD and VSD we used 14-stage low pressure electrical impactor designed to analyze hot aerosols Dekati® High Temperature ELPI®+ (Figure 1). The measurements were performed in the fire laboratory of The Main School of Fire Service, in the chamber designed to evaluate efficiency of fire detection systems, especially smoke detectors (Figure 2).

Figure 1. Dekati® High Temperature ELPI®+

Figure 2. Pinewood test fire

The size distributions during the fire are presented in Figure 3 (NSD) and in Figure 5 (VSD) while distributions after the fire are in Figure 4 (NSD) and in Figure 6 (VSD). All distributions except the Figure 6 are unimodal. The cumulative distributions for pinewood are presented in Figures 7 and 8, for particle laminated board in Figures 9 and 10. Figures 7 to 10 are plotted on log-normal probability scale and hence we can state that for the distributions for pinewood follow the log-normal distribution well while distributions after fire for particle boards not.

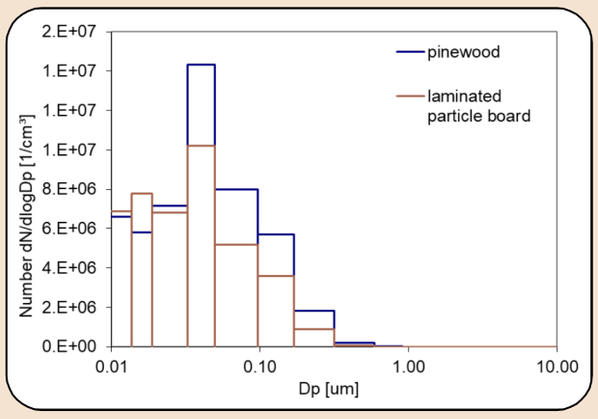

Figure 3. NSD during the fire

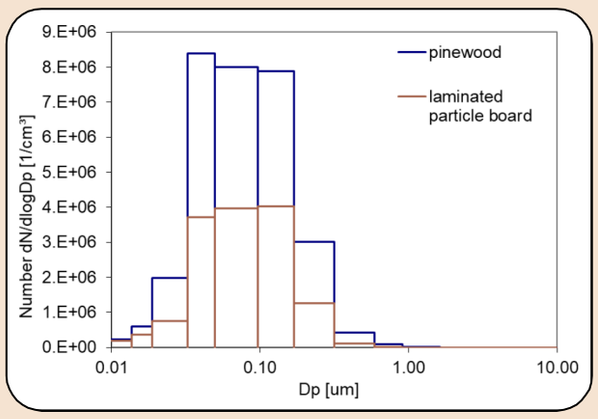

Figure 4 NSD after the fire

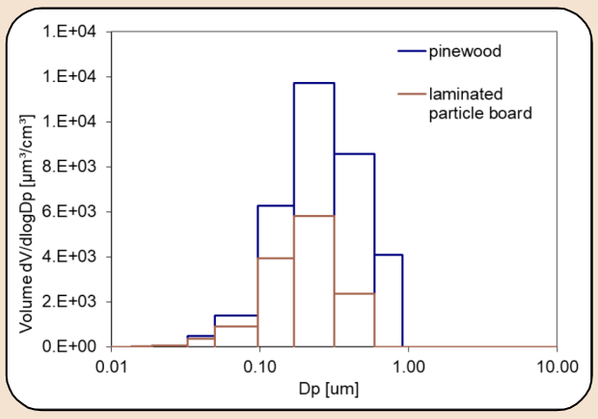

Figure 5. VSD during the fire

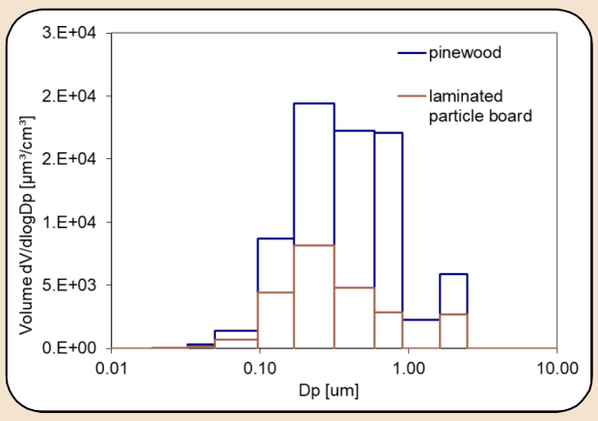

Figure 6. VSD after the fire

Concentration, number (NMD) and volume median diameter (VMD) are presented in Table 1. They are significantly increasing with the stage of experiment (before, during and after extinguishing fire). The NMD seems to be independent from burned material while VMD for pine wood is higher than for laminated particle board.

Table 1. Comparison of particles concentration (C), number (NMD) and volume (VMD) median diameter for number (NSD) and volume (VSD) size distribution before, during and after fire of pine wood and laminated particle board.

	pine wood			laminated particle board		
	C [m^{-3}]	NMD [µm]	VMD [µm]	C [m^{-3}]	NMD [µm]	VMD [µm]
before	0.014	0.015	0.194	0.014	0.015	0.194
during	11.743	0.036	0.253	9.649	0.029	0.193
after	7.346	0.077	0.367	3.478	0.076	0.303

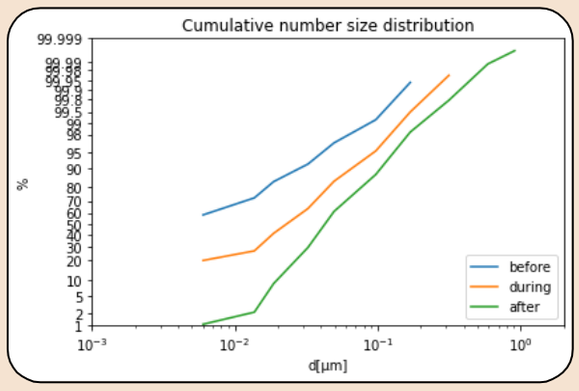

Figure 7. Cumulative number size distribution before, during and after fire of pine wood

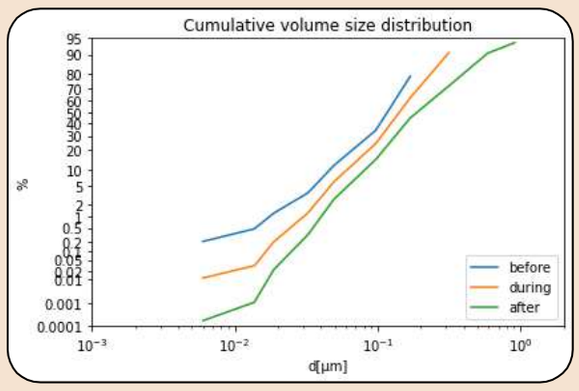

Figure 8. Cumulative volume size distribution before, during and after fire of pine wood

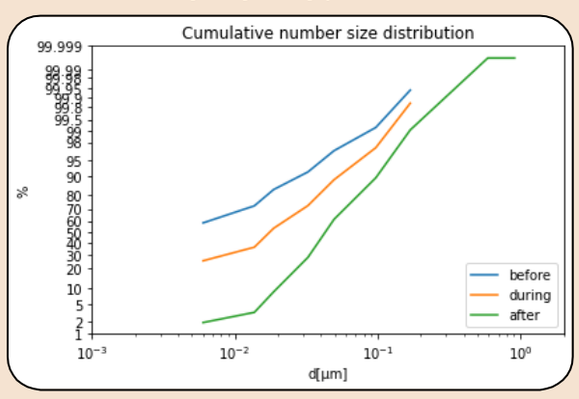

Figure 9. Cumulative number size distribution before, during and after fire of particle laminated board

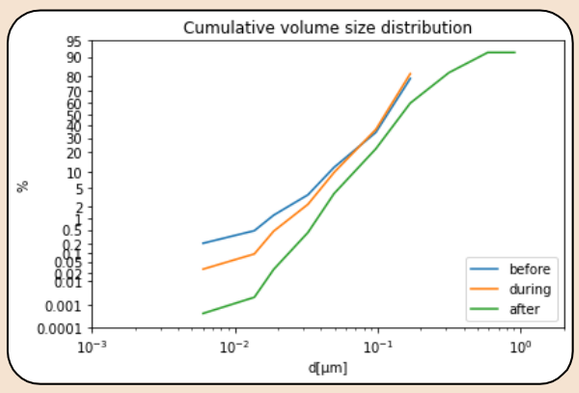

Figure 10. Cumulative volume size distribution before, during and after fire of particle laminated board

The further studies require verification of the particle mass obtained from the volume distributions with the masses obtained from weighting particles collected at each stage of impactor. It will allow to determine correct mass size distribution of particles emitted from fire of pine wood and laminated particle board and evaluate the density of particles in each analyzed fraction of the emitted particles.

REFERENCES

1. Axt, C., Pielsticker, S., Kreitzberg, T., Hatzfeld, O., Gao, Q., Li, S., & Kneer, R. *Fuel*, 10.1016/j.fuel.2019.116865 266, (2020) 116865.
2 Klejnowski, K., Pastuszka, J. S., Rogula-Kozłowska, W., Talik, E., & Krasa, A. *Bull Environ Contam Toxicol* 10.1007/s00128-011-0452-3 88.2 (2012): 255-259.
3. Klejnowski, K., Krasa, A., Rogula-Kozłowska, W., & Błaszczak, B.et al. *TheScientificWorldJOURNAL* 10.1155/2013/539568 (2013).
4. Zwozdziak, A., Gini, M. I., Samek, L., Rogula-Kozlowska, W., Sowka, I., & Eleftheriadis, K. *Journal of Aerosol Science* 10.1016/j.jaerosci.2016.10.004 103 (2017): 38-52.
5. Hinds, W. C. (1999). Aerosol technology: properties, behavior, and measurement of airborne particles. John Wiley & Sons.

NATIONAL SCIENCE CENTRE POLAND

The National Centre for Research and Development

The work was supported within PRELUDIUM 19: The impact of landfill fires on the atmospheric air quality - methodology and estimation of emission (National Science Centre, Poland, 2020/37/N/ST10/02997).

The research was also a part of the project "Implementation doctorate – edition II Faculty W-7 (03DW/0001/18)" financed by the National Centre for Research and Development, Warsaw, Poland.