Aerosol Measurements Before and During Combustion of Various Pellets from Spruce Sawdust and Face Masks FFP2

Nikola Čajová Kantová[1,*], *Alexander* Čaja[2], and *Peter* Hrabovský[1]

[1]Research centre, University of Žilina, Univerzitna 1, 010 26 Žilina, Slovakia
[2]Department of Power Engineering, Faculty of Mechanical Engineering, University of Žilina, Univerzitna 1, 010 26 Žilina, Slovakia

Abstract. Aerosols in the atmosphere affect our health and quality of life. The most commonly measured property is their mass concentration. In this work was measured the mass concentration of aerosols by optical particle sizer in the range from 0.3 µm to 10 µm. It was realized in the laboratory with an automatic heat source for pellet combustion. Aerosols were firstly measured before the combustion process, then during combustion of three types of samples: pellets from pure sawdust, pellets from 5 % of disintegrated face masks FFP2 blended with spruce sawdust and from10 % of disintegrated face masks FFP2 blended with spruce sawdust. The lowest total mass concentration was measured during the combustion of pellets from pure spruce sawdust. However, results indicate that the combustion process does not have an impact on aerosol mass concentration in the laboratory space for the particle range 0.3-10 µm when an automatic heat source for pellets is used.

Keywords: *aerosols, mass concentration, combustion, face masks, pellets*

1 Introduction

Aerosols are microscopic particles that float in the air, which can affect not only visibility and climate but also our health and quality of life. They represent two-phase systems, consisting of the particles and the gas in which they are suspended. Among the most important properties of aerosols is particle size, which is expressed mostly in µm. Another parameter is a shape and it is nearly always spherical for liquid aerosol particles. The most commonly measured property is just mass concentration. It is also most important for health and environmental effects [1, 2].

The primary sources of aerosols in urban regions are vehicle exhausts, airports, thermal plants, industries, and combustion processes [3, 4]. During winter, pollutants are closer to the surface of Earth caused of the lower height of the planetary boundary layer [5].

In the work of Pal et al. were real-time measurements realized by using Scanning Mobility Particle Sizer (SMPS) and Optical Particle Sizer (OPS). The SMPS measures aerosols in the

* Corresponding author: nikola.cajovakantova@uniza.sk

range from 10 nm to 400 nm and the OPS measures in the range from 0.3 μm to 10 μm [6]. Individual ranges and mean diameter of particles measured by OPS are shown in Table 1.

Table 1. Individual ranges and mean diameter measured by OPS.

Range (μm)	Mean diameter (μm)
0.3-0.374	0.337
0.374-0.465	0.419
0.465-0.579	0.522
0.579-0.721	0.65
0.721-0.897	0.809
0.897-1.117	1.007
1.117-1.391	1.254
1.391-1.732	1.562
1.732-2.156	1.944
2.156-2.685	2.421
2.685-3.343	3.014
3.343-4.162	3.752
4.162-5.182	4.672
5.182-6.451	5.816
6.451-8.031	7.241
8.031-10.0	9.015

In this work was measured the mass concentration of aerosols by OPS in mentioned ranges. The measurements were realized in the laboratory with an automatic heat source for pellet combustion. Firstly, aerosols were measured before the combustion process, then they were recorded during combustion. As fuel was chosen pellets consisted of pure sawdust and the other two samples from spruce sawdust blended with disintegrated waste from face masks FFP2. Face masks FFP2 were blended with their weight proportion of 5 % and then 10 %.

2 Material and method

The experimental setup is shown in Figure 1. OPS device was located before the heat source. As the heat source was used automatic boiler for pellet combustion with a heat power of 18 kW and a retort burner. OPS measured the mass concentration of aerosols before combustion and then during the combustion process. During combustion were combusted firstly pellets from pure spruce sawdust, and then pellets from 5 % of disintegrated face masks

FFP2 blended with spruce sawdust and 10 % of disintegrated face masks FFP2 blended with spruce sawdust. Each measurement was performed as a series of ten one-minute measurements. The resulting values of mass concentration represent average values from these series.

Fig. 1. Experimental setup with OPS device.

3 Results

Results are processed into graphs with the mean diameter of individual ranges and values of average values of measured mass concentrations. Results from the measurement of aerosol mass concentration before combustion are shown in Figure 2. The highest mass concentration was measured with the average value of 78.97 µg/m^3 for the range 8.031-10.0 µm. The total measured mass concentration was 198.67 µg/m^3.

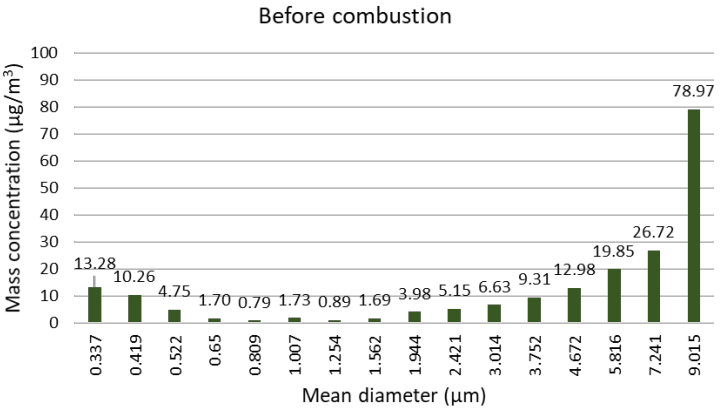

Fig. 2. Aerosol mass concentration before combustion.

Results from the measurement of aerosol mass concentration during combustion of pellets from pure spruce sawdust are shown in Figure 3. The highest mass concentration was measured with the average value of 31.57 µg/m^3 for the range 8.031-10.0 µm. The total measured mass concentration was 94.58 µg/m^3.

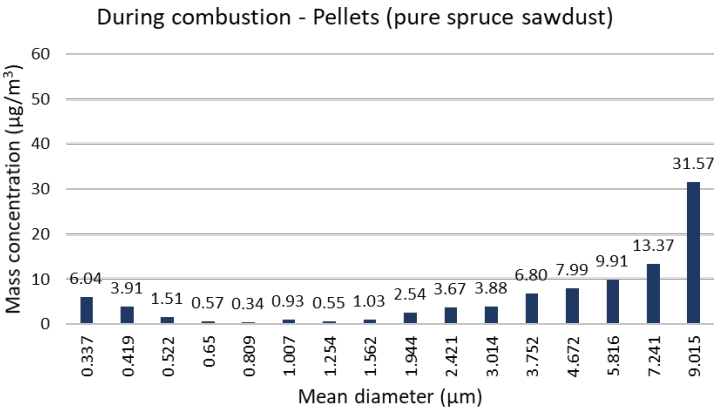

Fig. 3. Aerosol mass concentration during combustion of pellets from pure spruce sawdust.

Results from the measurement of aerosol mass concentration during combustion of pellets from 5 % of disintegrated face masks FFP2 blended with spruce sawdust are shown in Figure 4. The highest mass concentration was measured with the average value of 56.03 µg/m^3 for the range 8.031-10.0 µm. The total measured mass concentration was 164.82 µg/m^3.

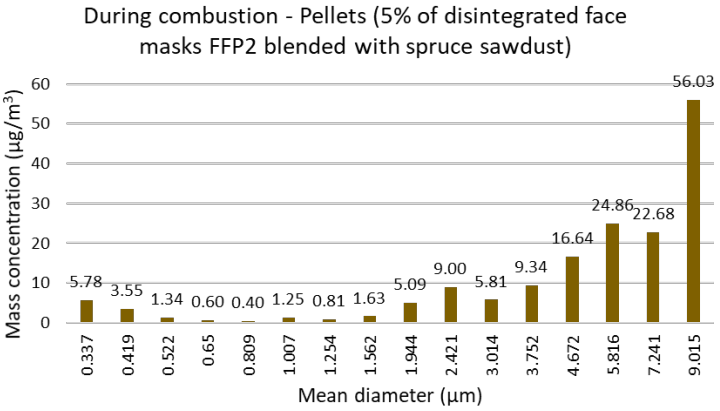

Fig. 4. Aerosol mass concentration during combustion of pellets from 5 % of disintegrated face masks FFP2 blended with spruce sawdust.

Results from the measurement of aerosol mass concentration during combustion of pellets from 10 % of disintegrated face masks FFP2 blended with spruce sawdust are shown in Figure 5. The highest mass concentration was measured with the average value of 52.80 µg/m^3 for the range 8.031-10.0 µm. The total measured mass concentration was 133.86 µg/m^3.

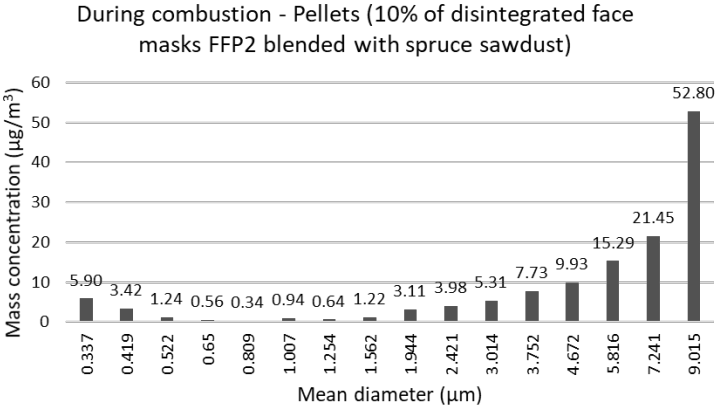

Fig. 5. Aerosol mass concentration during combustion of pellets from 10 % of disintegrated face masks FFP2 blended with spruce sawdust.

4 Conclusion

The most measured property of aerosol and important for health and environmental effects is mass concentration. In this work was mass concentration measured by OPS in laboratory space before and during the combustion process. The lowest total mass concentration was measured during the combustion of pellets from pure spruce sawdust. However, results indicate that the combustion process does not have an impact on aerosol mass concentration in the laboratory space for the particle range 0.3-10 µm when an

automatic heat source for pellets is used. It would be interesting to deal with aerosol mass concentration during the filling of pellet hopper or putting wood into fireplaces.

This publication has been produced with the support of the Integrated Infrastructure Operational Program for the project: Creation of a Digital Biobank to support the systemic public research infrastructure, ITMS: 313011AFG4, co-financed by the European Regional Development Fund and VEGA No. 1/0150/22: Energy utilization of produced waste in connection with the COVID-19 pandemic through pellets as an alternative fuel and KEGA No. 021ŽU-4/2021: Primary energy conversion into heat/cold using thermodynamic cycles and compressor cycle with working substance (refrigerant) CO2.

References

1. Hinds, W. C. (1999). *Aerosol Technology. Properties, Behavior, and Measurement of Airborne Particles. Second Edition*. A Wiley – interscience publication : John Wiley & Sons, inc.
2. Pospisil, J., Huzlik, J., Licbinsky, R., Spilacek, M. (2020). Dispersion characteristics of PM10 particles identified by numerical simulation in the vicinity of roads passing through various types of urban areas. *Atmosphere*, 11 (5), 454.
3. Ahlm, L., Liu, S., Day, D.A., Russell, L.M., Weber, R., Gentner, D.R., Goldstein, A.H., DiGangi, J.P., Henry, S.B., Keutsch, F.N. (2012). Formation and growth of ultrafine particles from secondary sources in Bakersfield, California. *Journal of geophysical research,* Vol. 117, 13 p.
4. Taušová, M., Mihalik, E., Čulková, K., Stehlíková, B., Tauš, P., Kudelas, D., Štrba, Ľ., Domaracká, L. (2020). Analysis of municipalwaste development and management in self-governing regions of Slovakia. *Sustainability*, 12 (14), 5818.
5. Järvi, L., Grimmond, C.S.B., Taka, M., Nordbo, A., Setälä, H., Strachan, I.B. (2014). Development of the surface urban energy and water balance scheme (SUEWS) for cold climate cities. *Geoscientific Model Development*, 7, 1691–1711.
6. Pal, D., Dastoor, A., Ariya, P. A. (2020). Aerosols in an urban cold climate: Physical and chemical characteristics of nanoparticles. *Urban Climate,* 34 (2020) 100713.