The effect of fuel applied on the chemical composition of PM generated in combustion processes – the preliminary case study

Katarzyna Szramowiat-Sala[1*], Katarzyna Styszko[1], Lucyna Samek[2], Magdalena Kistler[3], Mariusz Macherzyński[1], Anna Korzeniewska[1], Piotr Bielaczyc[4], Anne Kasper-Giebl[3], Janusz Gołaś[1]

[1] AGH University, Faculty of Energy and Fuels, Krakow, Poland
[2] AGH University, Faculty of Physics and Applied Computer Science, Krakow, Poland
[3] TU Wien, Institute of Chemical Technologies and Analytics, Vienna Austria
[4] BOSMAL Automotive Research and Development Institute Ltd., Bielsko-Biala, Poland
*corresponding author: katarzyna.szramowiat@agh.edu.pl

Introduction

It has been known for a long time, that alongside natural sources, combustion processes are the one of many human activities which emit solid particles. However, there is still at present no documented evidence for any relationship between specific stationary combustion technologies and the presence of particulate matter in the atmosphere. Similarly, the chemical composition of particles emitted from various sources has to be identified in order to properly apportion the ambient air pollution by particulate matter.

This paper aimed at the presentation of results obtained during preliminar studies on the chemical characterisation of solid particles generated during combustion process.

Methods and materials

The study presents the chemical characterisation of particles emitted during residential and industrial processes of combustion of solid fuels (representing the stationary emission sources) and particles emitted from Diesel engines for passenger cars and medium-duty vehicles. Particles from stationary sources were collected on quartz fibre filters. Particle samples from engines were collected on glass-fibre filters during the New European Driving Cycle and European Steady Cycle emission tests conducted in BOSMAL Automotive Research & Development Institute.

Results

8.0, 9.7, 1.3, and 56.9 and 58.5 mg of particulate matter were sampled during combustion of, respectively, soft wood, culm, eco-pea coal, hard coal in domestic heating units which contribute to 20.9, 36.7, 5.3 and 464.7 mg of PM per m^3 of flowing through the filter exhausts. During sampling of particles from industrial combustion of hard coal burning 58.5 mg PM were sampled which contribute to 5.9 mg of particles per m^3 of exhausts.

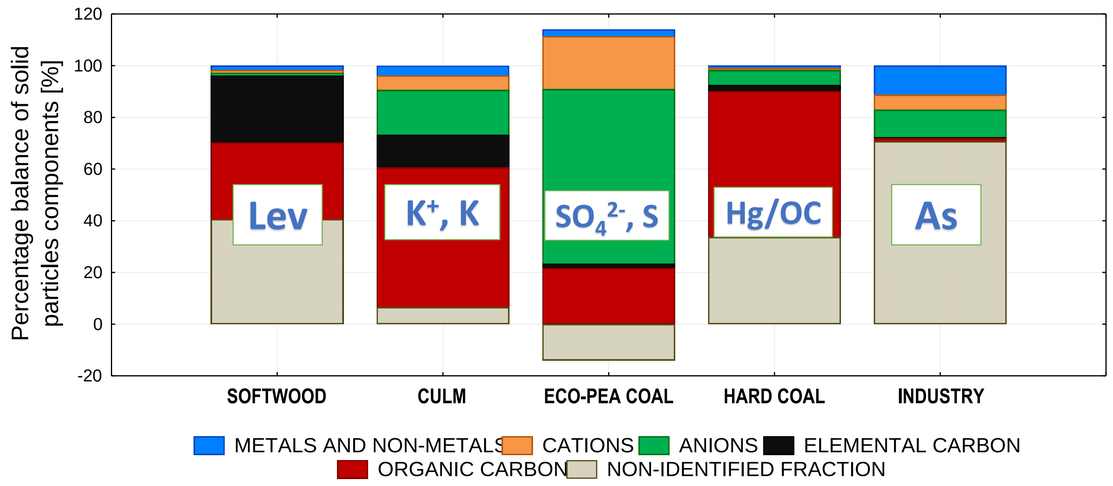

Figure 2. Chemical composition [percentage mass balance] of PM generated during combustion processes in stationary sources (Lev – levoglucosan, K^+ - potassium cations, K – metallic potassium, SO_4^{2-} - sulphate anions, S – elemental sulphur, Hg/OC – mercury to organic carbon ratio, As – metaliic arsenic).

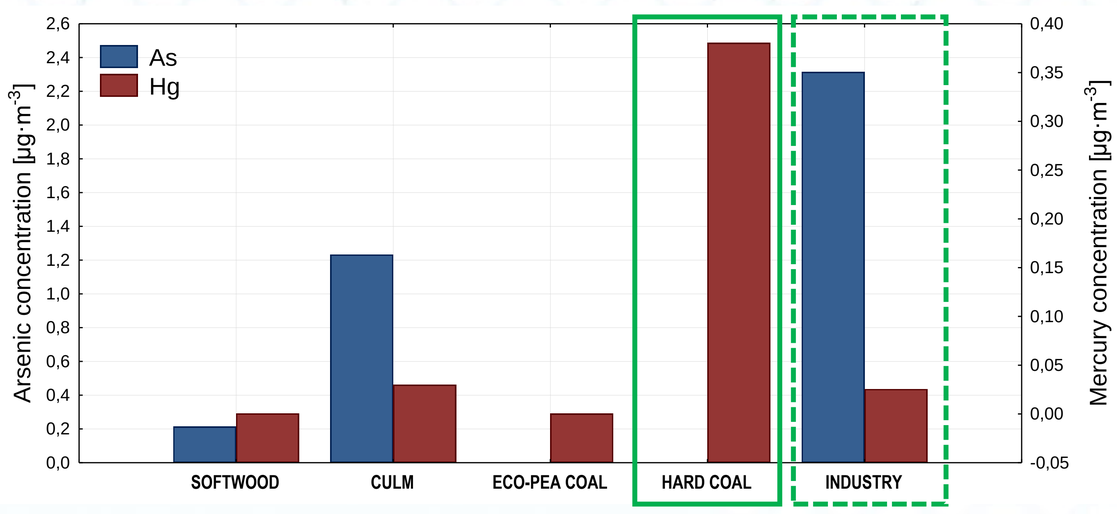

Figure 3. Differences in particulate bound arsenic and mercury emission from different stationary sources.

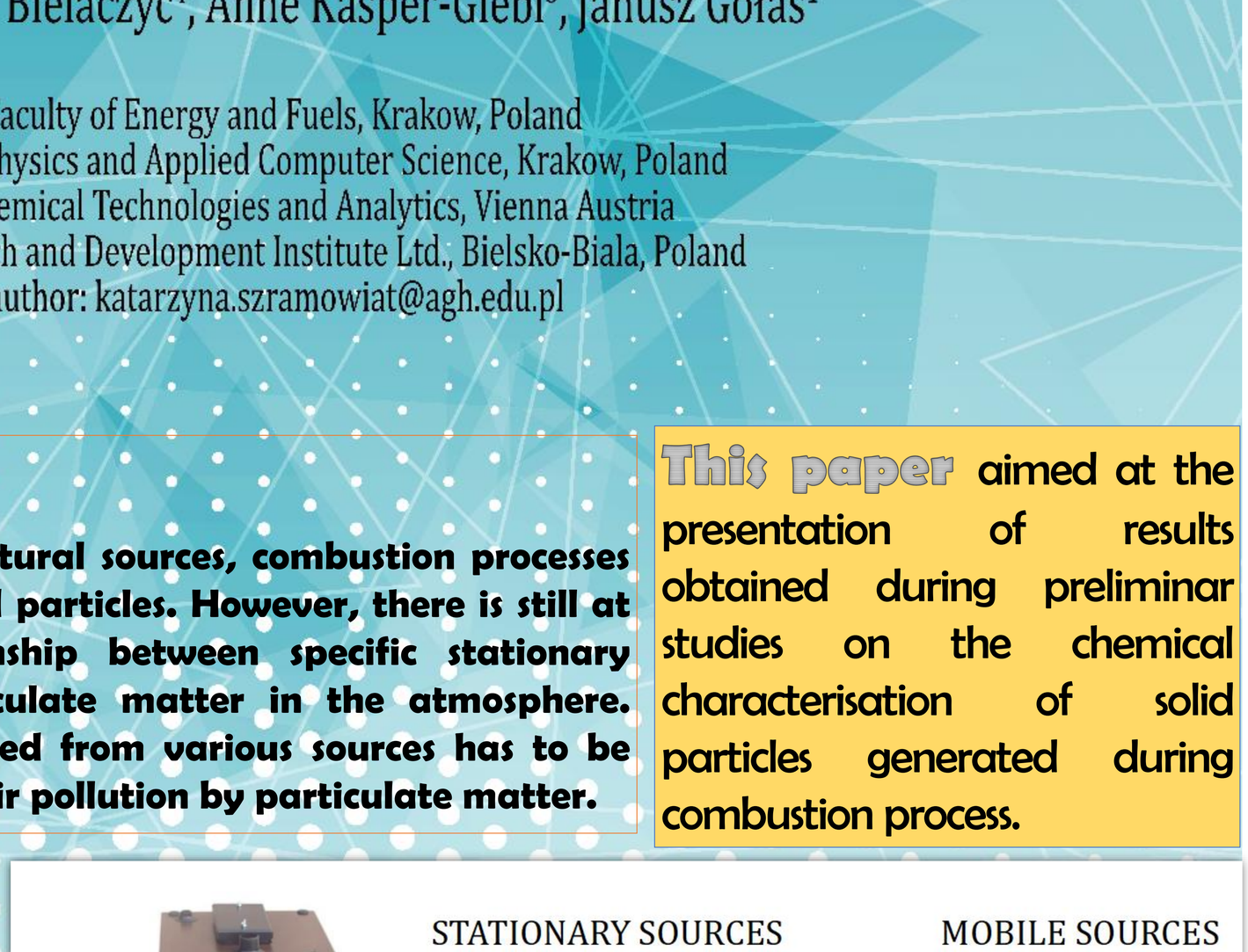

Figure 1. Sorts of combustion processes examined during the studies.

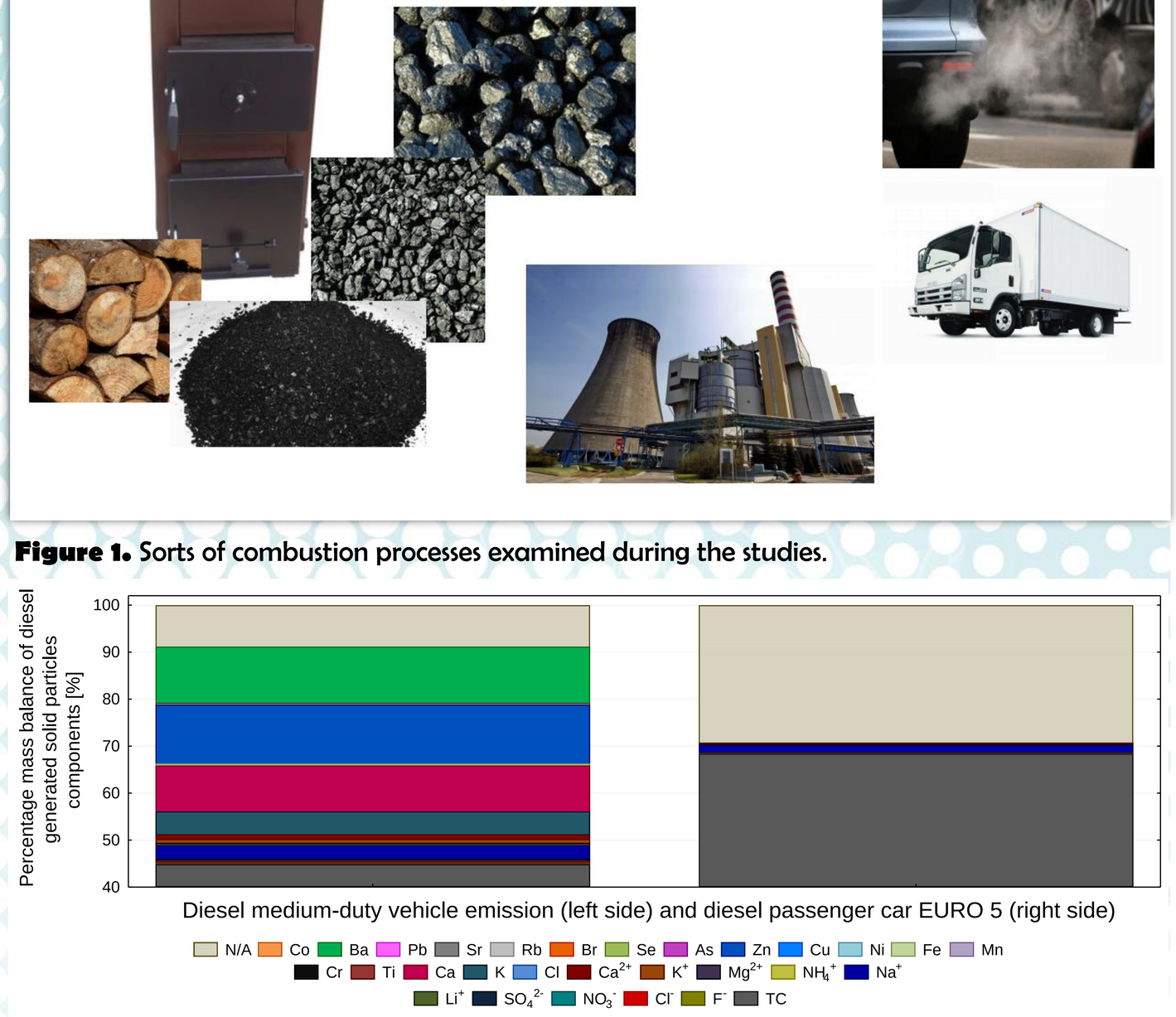

Figure 4. Differences in chemical composition of solid particles emitted from mobile sources.

Conclusions

The content of analysed chemicals differed depending on the emission source. With respect to stationary combustion sources, the main factor determining the emission of solid particles are related principally to the fuel quality. The duty of vehicles was also a factor influencing the chemical characterisation of particulate matter emitted from engines. The current efforts to control fine particulates also result in the appreciable reduction of the total number of particles emitted by both diesel and gasoline engines.

Acknowledgements

The authors acknowledge the financial support of the AGH UST (grant no: 16.16.210.246) and the usage of infrastructure of the Centre of Energy, AGH UST. The project was also financed under the PROM Program - International scholarship exchange for doctoral students and academic staff implemented by the National Academic Exchange Agency and the AGH University of Science and Technology. Contract number: PPI / PRO / 2018/1/00026 / U / 001. The samples of particles from engines were collected by BOSMAL Automotive Research and Development Institute Ltd what is highly acknowledged.