Nanoparticles Emissions from Pottery Manufacturing

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Airborne nanoparticles emitted from craftsmanship and industrial processes can have toxic effects upon human health (Brunekreef & Holgate, 2002). A good example of such craftsmanship, which in many places is embedded in local tradition, is pottery where high temperatures are required to fire the ceramics for producing the final products. Although the potential risk of nanoparticle emissions from industrial fabrication of ceramics has been addressed (cf. Minguillón *et al*., 2007), measurements of the exposure for small/medium-size traditional potteries have not been assessed to the best of our knowledge.

In this paper we report measurements of airborne particles emitted from firing ceramics in a small-sized pottery on Lesvos island in Greece. Size distributions of particles having diameters from 10.4 to 469.8 nm were recorded using a Scanning Mobility Particle Sizer (SMPS; TSI Model 3034). Particles having diameter > 300 nm were also measured using an Optical Particle Counter (OPC; Grimm Model 1.108). For all the measurements, air was sampled through a 6-m long copper tube (ID = 6.35 mm) with a sampling rate of 2 lpm. The inlet of the tube was placed 1 m above the furnace exhaust.

During the pottery fabrication process, hand-made ceramics are at first fired for half a day before the paintwork and glaze are applied. Then they are fired again for almost the same time to stabilize the surface of the pottery. In both firing processes, the furnace temperature rises almost linearly from ambient temperature to 980°C over a period of 11 hours. Repeated measurements were conducted for both firing processes, i.e. with unpainted/unglazed and with painted/glazed ceramics, over a period of one month.

Fig.1 shows the evolution of the size distributions of the particles during two characteristic runs of the oven. In the first run (Fig. 1a) ceramics fired without paint and glaze, whereas in the second run (Fig. 1b) they were painted and glazed. In both cases an increase in the concentration of particles smaller than 40 nm is observed after the 5th hour of the firing process, when the temperature of the furnace was about 580^{o}C. Interestingly, the concentrations of the particles sub-40 nm particles emitted from the painted/glazed pottery is more than double when compared to those of the unpainted/unglazed ceramics. This difference is not observed only between the 5th and 6th hour after the firing process started, but also for the entire duration of the experiment. In the first run for example, the maximum total number concentration was observed 10.5 hours after the initiation of the furnace was switched on, reaching 7×10^5 particles per cm^3. In the second run, the highest concentration was 1.8×10^6, and was observed 9.5 hours after the start of the firing process. In both cases the temperature of the furnace was between 920 and 970 °C.

The systematic difference in the concentration of the emitted nanoparticles between the two runs indicates that the paints and glazes applied on the ceramics give off material for nanoparticle formation. Because the materials used for the paints and the glaze contain toxic compounds (e.g., organics and heavy metals), these are very likely to be present also on the emitted nanoparticles. Given that the size of the particles is in the range that can allow penetration to the deepest part of the respiratory system, it is therefore mandatory to measure their chemical composition in order to fully assess their potential effects upon human health.

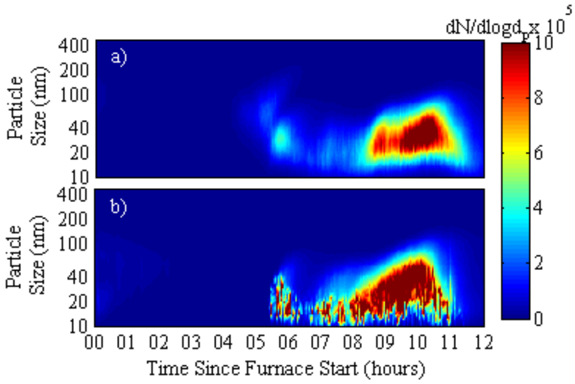

Figure 1. Evolution of the particle size distributions recorded during firing of (a) unpainted and unglazed ceramics, and (b) painted and glazed ceramics.

References

Brunekreef B., Holgate S. T. (2002). *The Lancet*, 360, 1233-1242.

de la Campa, A.M.S., de la Rosa,J.D., Gonzales-Castanedo, Y., Frenadez-Camacho R., Alastuey A., Querol X., Pio C. (2010). *Atmospheric Research*, 96, 633–644.

Minguillón M. C., Querol X., Alastuey A., Monfort E., Mantilla E., Sanz M. J., Sanz F., Roig A., Renau A., Felis C., Miró J. V., Artíñano B. (2007). *Science of the Total Environment*, 372, 382–396.