World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:9, No:03, 2015

Spherical Organic Particle (SOP) Emissions from Fixed-Bed Residential Coal-Burning Devices

Authors : Tafadzwa Makonese, Harold Annegarn, Patricia Forbes

Abstract : Residential coal combustion is one of the largest sources of carbonaceous aerosols in the Highveld region of South Africa, significantly affecting the local and regional climate. In this study, we investigated single coal burning particles emitted when using different fire-ignition techniques (top-lit up-draft vs bottom-lit up-draft) and air ventilation rates (defined by the number of air holes above and below the fire grate) in selected informal braziers. Aerosol samples were collected on nucleopore filters at the SeTAR Centre Laboratory, University of Johannesburg. Individual particles (~700) were investigated using a scanning electron microscope equipped with an energy-dispersive X-ray spectroscopy (EDS). Two distinct forms of spherical organic particles (SOPs) were identified, one less oxidized than the other. The particles were further classified into "electronically" dark and bright, according to China et al. [2014]. EDS analysis showed that 70% of the dark spherical organic particles balls had higher (~60%) relative oxygen content than in the bright SOPs. We quantify the morphology of spherical organic particles and classify them into four categories: ~50% are bare single particles; ~35% particles are aggregated and form diffusion accretion chains; 10% have inclusions; and 5% are deformed due to impaction on filter material during sampling. We conclude that there are two distinct kinds of coal burning spherical organic particles and that dark SOPs are less volatile than bright SOPs. We also show that these spherical organic particles are similar in nature and characteristics to tar balls observed in biomass combustion, and that they have the potential to absorb sunlight thereby affecting the earth's radiative budget and climate. This study provides insights on the mixing states, morphology, and possible formation mechanisms of these organic particles from residential coal combustion in informal stoves.

Keywords : spherical organic particles, residential coal combustion, fixed-bed, aerosols, morphology, stoves
Conference Title : ICEBESE 2015 : International Conference on Environmental, Biological, Ecological Sciences and Engineering
Conference Location : London, United Kingdom
Conference Dates : March 14-15, 2015