Contribution ID: **225** Type: **Oral Presentation**

Material composition and thermal analysis of bunker gears used by firefighters in the City of Johannesburg

Thursday, 11 July 2019 12:00 (20 minutes)

Firefighters are constantly exposed to open flames and extreme heated conditions during fires and as a result use firefighting protective clothing (bunker gear) for protection. Firefighting protective clothing derives its heat withstanding strength from the flame retardants added in the manufacturing process. However, some flame retardants, including chlorinated and brominated flame retardants, have been found to be harmful to humans and the environment. Five (5) new and three (3) used bunker gears used in the City of Johannesburg were investigated and found to contain brominated flame retardants (BFRs), particularly polybrominated flame retardants (PBDEs) and hexabromocyclododecane (HBCDD). X-ray fluorescence (XRF) scanning measurements showed that all the samples contained significant amount of BFRs. Bromine content in the XRF ranged from 444 to 20 367 µg/g. Gas Chromatography-Mass Spectrometer (GC-MS) was used to validate the XRF results. BFRs, particularly PBDEs and HBCDD, were detected in all samples with concentrations ranging from 261.61 to 1001.77 µg/g and 0.01 to 0.07 µg/g, respectively. The flame retardants' impact on thermal performance of the garments was investigated using the Cone Calorimeter under 50 and 75 kW.m-2 external heat fluxes. Measured Cone Calorimeter parameters were used to model indices such as the fire growth rate (FIGRA). The average FIGRA was found to be 1.88 ± 0.44 kW.s-1 (5 new bunker gears) and 2.63 ± 0.37 kW.s-1 (3 old/used bunker gears) for external irradiation flux of 50 kW.m-2. Smoke growth rate (SMOGRA) of the bunker gears were 3.12 ± 0.34 and 4.96 ± 0.59 m2.s-2, respectively for new and used gears under 50 kW.m-2 irradiation and 13.26 ± 3.63 and 14.60 ± 2.37 m2.s-2 under 75 kW.m-2 heat fluxes. Further links between the fire retardants and the measured thermal parameters will be presented.

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yes

Level for award
 (Hons, MSc,
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MSc

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Session Classification: Applied Physics

Track Classification: Track F - Applied Physics