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Kiah, HM, Mustafa, B, Andrews, GE orcid.org/0000-0002-8398-1363 et al. (2 more authors) (2017) Particle size emissions from PVC electrical cable fires. In: Cambridge Particles Meeting Book of Abstracts. Cambridge Particles Meeting 2017, 23 Jun 2017, Cambridge, UK. University of Cambridge , p. 33.

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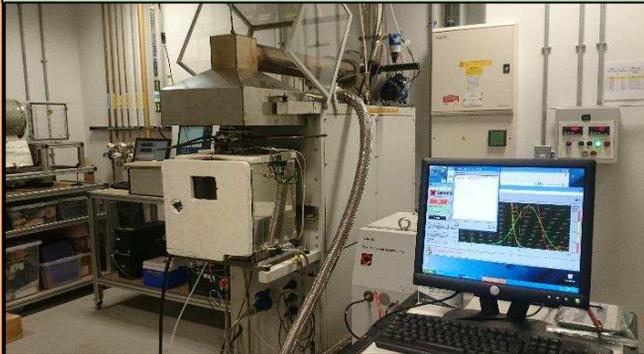


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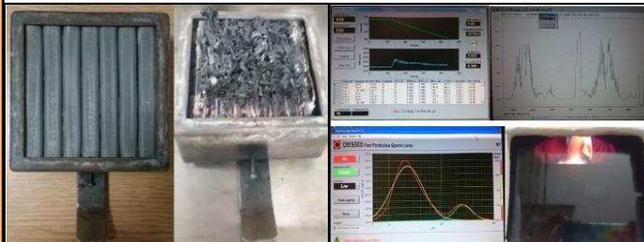
Introduction

PVC (Polyvinyl chloride) based electrical cable has high electrical strength and strong insulation resistance to flame, moisture and abrasion. However, PVC materials may produce highly toxic smoke when burned and can also form the toxic gas HCl. Previous studies mostly involve the measurement of toxic species from fires [1-14] but only a limited number of studies have focused on the ultra-fine particulate emissions [15-17] and none at all is found to focus on the electrical cable fires. There is also increasing concern over the health implications of exposure to nanoparticles in fires, both by fire fighters and by people exposed to fire smoke inhalation [18,19]. There is currently no requirement to measure particulate emissions in cable fire tests.

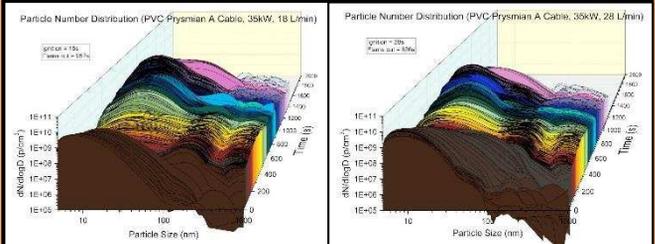
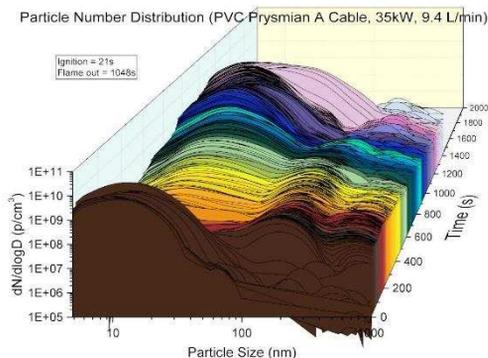
Methods



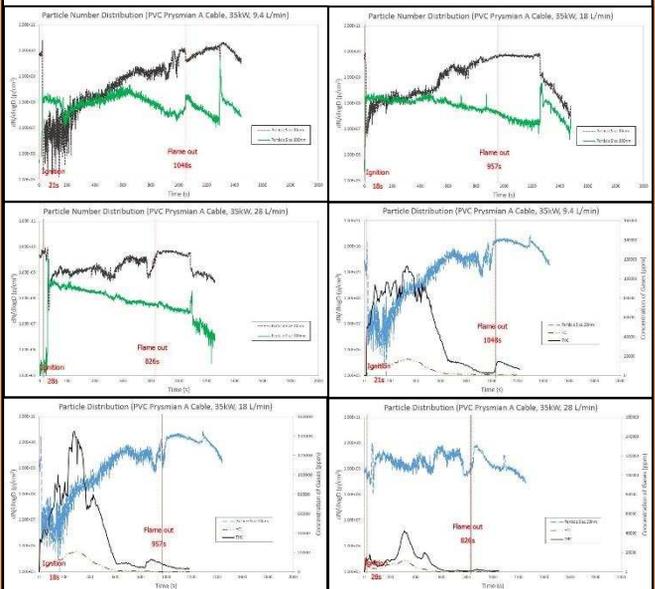
The present work investigated toxic species and particulates from the burning of PVC Prysmian A (BS6004 6242Y) cables in the Cone Calorimeter. Each test involves the combustion of a 100mm² test specimen at a constant irradiation level (35 kW/m²) and has been repeated at different initial air flow rates (9.4, 18 and 28 L/min). Composition of toxic gases from the cable fires were measured using the FTIR analyser and the particulate size distribution was determined using the Combustion DMS500.



Results and Discussion



There are two peaks observed which the first peak represents 10nm particles (nucleation mode) and the second peak represents 100nm particles (cumulative mode).



The number of 10nm particles increased from the start to the end of the fire. These fine particles are a health hazard and penetrate into the lungs and into the blood stream. The number of larger particles (100nm) decreased during the fire which was unexpected, as agglomeration of fine particles to form larger particles is expected. The fine particles could be HCl and future work will use a thermal denuder to determine this.

Conclusions

Fine particles are a toxic hazards in fires and must be measured for all materials used in fires and regulations need to be changed to make this compulsory. Particles below 100nm are a health hazard and the results from the present study show that these dominate the number of particles in PVC electrical cable fires.

References

- Andrews, G., et al. Toxic Gas Measurements Using FTIR for Combustion of COH Materials in Air Starved Enclosed Fires. In Proceedings of the European Combustion Institute Meeting, 2007.
- Andrews, G.E., et al. Aircraft Blanket Ignition and Toxic Emission in Simulated Aircraft Cabin Fires Using the Cone Calorimeter. Fire and Materials 2015, 2015; p. 724-748.
- Babrauskas, V. Effective measurement techniques for heat, smoke, and toxic fire gases. Fire Safety Journal, 1991. 17(1): p. 13-26.
- Grayson, S., et al. Assessing the fire performance of electric cables (FPEC). Fire and materials, 2001. 25(2): p. 49-60.
- Hakkarinen, T., et al. Smoke gas analysis by Fourier transform infrared spectroscopy. VTT Building Technology, Final report of the SAFIR project, 1999.
- Hirschler, M.M. and D.A. Purser. Irritancy of the smoke (non-flaming mode) from materials used for coating wire and cable products, both in the presence and absence of halogens in their chemical composition. Fire and Materials, 1993. 17(1): p. 7-20.
- Hull, R.T., A.A. Stec, and J. Robinson. Development of Standards for Assessment of Fire Effluent Toxicity and their Application to Cable Installations. 2008.
- Hull, R.T., et al. Comparison of toxic product yields of burning cables in bench and large-scale experiments. Fire Safety Journal, 2008. 43(2): p. 140-150.
- Purser, D., Influence of the retardants on toxic and environmental hazards from fires. Fire retardancy of polymers: new strategies and mechanisms. Royal Society of Chemistry, 2009. p. 381-404.
- Purser, D. and J. Purser. HCN yields and fate of fuel nitrogen for materials under different combustion conditions in the ISO 1970 tube furnace and large-scale fires. Fire Safety Science, 2008. 9: p. 117-128.
- Purser, D.A., Toxic product yields and hazard assessment for fully enclosed design fires. Polymer International, 2000. 49(10): p. 1232-1255.
- Stec, A. and T.R. Hull. Fire toxicity and its assessment. Fire retardancy of polymeric materials. Second edn. CRC Press, Boca Raton, FL, 2010: p. 453-477.
- Stec, A.A., et al. Analysis of toxic effluents released from PVC carpet under different fire conditions. Chemosphere, 2013. 90(1): p. 65-71.
- Yeh, A.I. and W.A. Hu. PVC Cable Fire Toxicity Using the Cone Calorimeter. In Fire Science and Technology 2015, 2017. Springer, p. 175-182.
- Go, J., Study on the real-time size distribution of smoke particles for each fire stage by using a steady-state tube furnace method. Fire Safety Journal, 2015. 78: p. 95-101.
- Hertzberg, T., et al. Particles and isocyanates from fires. 2003: SP Swedish National Testing and Research Institute, Fire Technology.
- Lingard, J.J., et al. Observations of urban airborne particle number concentrations during rush-hour conditions: analysis of the number based size distributions and modal parameters. Journal of Environmental Monitoring, 2006. 8(12): p. 1203-1218.
- CBS News - FDNY: 9/11 fires kills 3 retired firefighters in one day, 2014.
- Brandt-Rauf, P., et al. Health hazards of fire fighters: exposure assessment. British journal of industrial medicine, 1988. 45(9): p. 606-612.