Abstract for Burning material behaviour in hypoxic environments: An experimental study examining fire dynamics of composite materials in vitiated conditions issued on 30/04/20 by R J Bray

Abstract

The progression of fire safety research has contributed to improving the guiding principles of standardised building design. Research making use of pure materials, once common in homes and workplaces, are less relevant as such materials are no longer as prevalent. It is often newer, composite materials that are featured more prominently in building contents. The trend towards the evolution of commonly found materials introduces greater uncertainty into assumptions frequently made in simplified calculations methods.

Hypoxic conditions, where oxygen concentrations within an enclosed environment are lowered in order to reduce the ignitability and flammability of the room's contents, are less frequently tested. Systems that create hypoxic conditions, referred to as Oxygen Reduction Systems (ORS), are typically used to protect high value or high-risk contents. High-loss fire scenarios and less rigorously validated research data supporting system design introduce the need for further insight.

It is the primary intent of this thesis to contribute to the discussion of small-scale material testing in hypoxic conditions. Acrylonitrile butadiene styrene (ABS) samples of various thicknesses (20mm, 10mm and 5mm) have been compared to a composite mix of ABS with a surface layer of cardboard and secondary layer of bubble wrap. Tested materials were considered reasonable because they represent a plastic commonly used in the formation of high-end electronic devices whilst cardboard and bubble wrap layers represent common storage components. The samples have been tested with exposure to radiant heat fluxes, namely 25kW/m^2, and 50kW/m^2. The oxygen concentrations compared are 20.95%, 17% and 15%.

Analysis found that due to unique material behaviours in composite samples, caused by an ash forming top layer, heat release rates for hypoxic conditions could be greater than those in ambient conditions. It is argued that unique variations in composite material behaviour limit the validity of tests of pure materials in isolation from their wider application within an ORS design.