CONTROLLED FUEL/OXYGEN RATIOS IN MICROSCALE COMBUSTION CALORIMETER

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The microscale combustion calorimeter (MCC) has been used to assess the fire hazard materials present. Under standard conditions, the MCC works by decoupling sample pyrolysis from combustion by utilizing separate control of heaters used to thermally degrade a solid sample then thermally oxidize the volatile decomposition products. The pyrolysis temperature is programmed to heat the sample at a constant rate from a maximum range of 80°C to 1200°C. The combustor temperature is held constant and set to a maximum of 1000°C. This method has worked well for showing the total fire hazard due to the fuel load a material presents irrespective of toxicity. Different ventilation conditions in a fire will produce different hazards from the products of combustion. In this study the effect of ventilation on a mg sized sample was examined. Typically the most toxic decomposition products are produced in an under-ventilated fire.

This study introduces the development of a new hyphenated technique by coupling the MCC with an infrared spectrometer (FTIR) to evaluate combustion toxicity at different fuel/oxygen equivalence ratios, Φ. The MCC-FTIR enables the effect of vitiation on combustion gas yields to be measured. In practice, a preliminary test is conducted in excess oxygen introduced at the combustor inlet and a small internal volume analyzer monitors the effluent for oxygen depletion. The preliminary test is necessary to obtain an accurate oxygen uptake history in the combustor over the entire temperature range of the pyrolysis. This information is then used to generate a constant equivalence ratio in the combustor throughout the sample decomposition using mass flow controllers. This provides direct control of the fuel/oxygen ratio relative to the stoichiometric fuel/oxygen ratio, $\Phi = 1$. When Φ is less than one, the combustion is fuel lean (over ventilated). When Φ is greater than one, the combustion is fuel rich (vitiated). Measurements made at different Φ's will help to better understand the flame chemistry and the mix of complete/incomplete combustion products for various polymers.