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Design, Construction And Validation Of A Simple, Low-cost Phi Meter

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Abstract : The use of a phi meter allows for definition of equivalence ratio during a fire test. Previous phi meter designs have used expensive catalysts and had restricted portability due to the large furnace and requirement for pure oxygen. The new design of the phi meter did not require the use of a catalyst. The furnace design was based on the existing micro-scale combustion calorimetry (MCC) furnace and operating conditions based on the secondary oxidizer furnace used in the steady state tube furnace (SSTF). Preliminary tests were conducted to study the effects of varying furnace temperatures on combustion efficiency. The SSTF was chosen to validate the phi meter measurements as it can both pre-set and independently quantify the equivalence ratio during a test. The data were in agreement with the data obtained on the SSTF. It was also validated by a comparison of CO2 yields obtained from the SSTF oxidizer and those obtained by the phi meter. The phi meter designed and constructed in this work was proven to work effectively on a bench-scale. The phi meter was then used to measure the equivalence ratio on a series of large-scale ISO 9705 tests for numerous fire conditions. The materials used were a range of non-homogenous materials such as polyurethane. The measurements corresponded accurately to the data collected, showing the novel design can be used from bench to large-scale tests to measure equivalence ratio. This cheaper, more portable, safer and easier to use phi meter design will enable more widespread use and the ability to quantify fire conditions of tests, allowing for better understanding of flammability and smoke toxicity.

Keywords : phi meter, smoke toxicity, fire condition, ISO9705, novel equipment
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