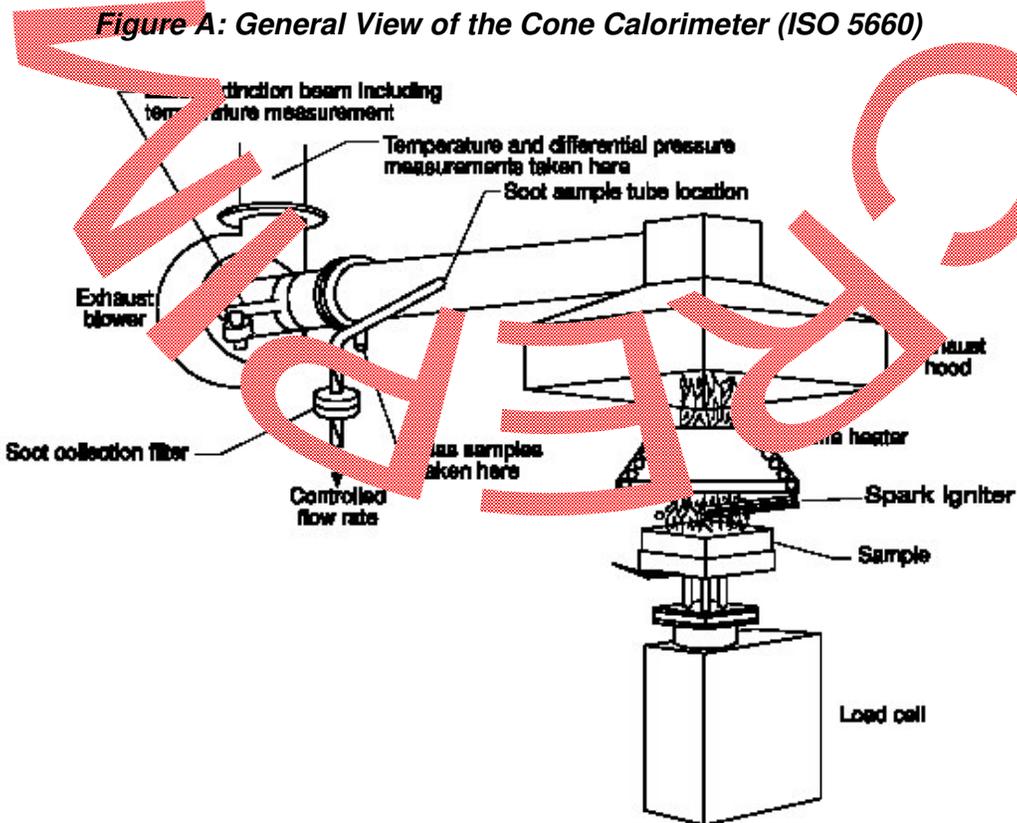




CONE CALORIMETER OVERVIEW

Measurement of heat release rate (HRR) in small-scale is not new. For instance, the OSU Calorimeter [1], which was originally developed around 1970, has been discussed earlier. Its results, however, when compared against other measurement methods, have been found to substantially underestimate the HRR [2]. A number of other instruments were also designed during the 1970s, but were limited because of either poor validity or practical operational difficulties. However, with oxygen consumption calorimetry coming into use, it became obvious that an entirely new instrument should be built which is specifically designed to make use of this principle. The development work led to a more practical instrument, known as the Cone Calorimeter. The apparatus (Figure A) makes use of an electric heater in the form of a truncated cone, hence its name. The apparatus is general-purpose and which may be used to test products for various applications. Thus, the heater had to be capable of being set to a wide variety of heating fluxes; the actual capability spans 0 to 100 kW/m².



The Cone Calorimeter represented such a significant step forward in fire testing instrumentation that it was awarded the prestigious R&D%100 award in 1988 [3]. The technical features are documented in several references [4][5][6][7].

Some of the most salient features include:

- horizontal or vertical specimen orientation,
- composite and laminated specimens can be tested,
- continuous mass loss load cell readings,
- feedback-loop controlled heater operation,
- HRR calibration using methane metered with mass flow controller,
- smoke measured with laser-beam photometer and gravimetrically, and
- provision for analyzing CO and CO₂.

The Cone Calorimeter is known as ISO 5660 [8].

The equipment is made by more than 10 manufacturers and is now used by over 100 laboratories worldwide. Data from small-scale HRR measurements are reported in kW/m². The extra m², compared to the real-scale results, comes from the fact that in the real-scale, one is interested in the total heat being produced by the burning object. In small-scale, by contrast, the area of the specimen has no intrinsic significance, and results have to be reported on a per-unit-area basis. To go from small-scale data to real-scale predictions, then, requires that an “m² factor” be supplied. This factor, in the simplest case of uniformly burning materials, is the area of flame involvement, at any given time of the fire. Today's methods for estimating the real-scale HRRs do not, typically, treat this area-of-flame-involvement factor explicitly, but rather include it in the predictive correlations.

Many older devices for assessing flammability were not based on realistic fire conditions, nor were measurements taken which have quantitative engineering significance. As a result, they could only be used to pass or fail a specimen according to some regulatory requirement.

Because its design and its data are firmly based on an engineering understanding of fire, the Cone Calorimeter has wider applicability. It can be used to:

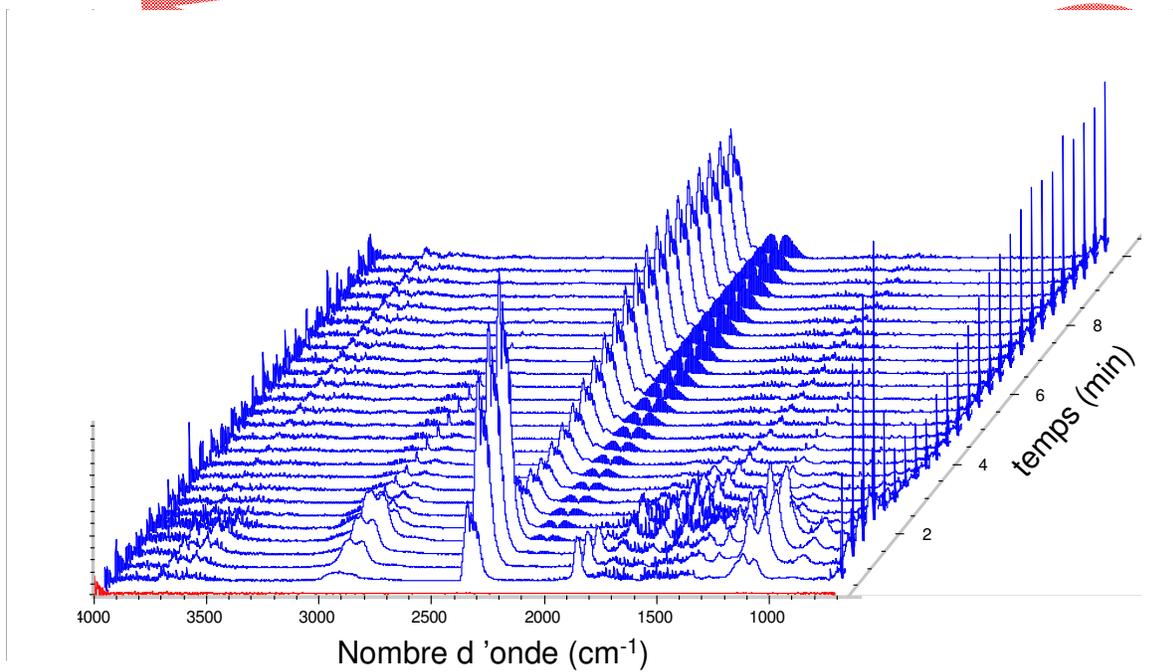
- Provide data needed for state-of-the art fire models;
- Provide data used to predict real-scale fire behaviour by means of simple formulas or correlations;
- Rank order products according to their performance; or, simply to
- Pass or fail a product according to a criterion levels.

The earliest applications of Cone Calorimeter data have been in the polymers industry. Manufacturers typically have relied either on limiting oxygen index (LOI) [9] tests or on UL94[10]. The former does give quantitative results and uses what would appear to be a suitable engineering variable. Moreover, a recent study has again clearly demonstrated that the results, while quantitative, are not capable of even correctly rank-ordering according to actual fire behaviour [13].

However, the latter is a simple Bunsen burner type-test which gives only pass/fail results; it is clear that quantitative information useful for polymer development does not come from such a test.



On line analysis of the degradation product with the IRTF



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