CONE CALORIMETRY AS A USEFUL TECHNIQUE FOR THE SCREENING OF COTTON FIBERS

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Abstract – Cotton biotechnology offers the potential for breakthrough developments in fiber characteristics. In this process, the early selection of fibers with the best performance is of utmost importance. However, due to the limited availability of these specialty fibers, the use of available test methods is limited and thus new test methodologies are needed. The aim of this paper is to study Cone calorimetry for the characterization of cotton fibers. One of the main aspects of the procedure, namely sample weight, is optimized to improve the reproducibility.

Text

Introduction

Cotton is the most important natural fiber used in textile industry. Despite increasing competition from synthetic fibers, cotton has maintained its importance and utility till now thanks to its superior fiber characteristics. However innovations in textile and clothing industry increased the demand of better fiber quality to produce cotton end products that exhibit improved functional characteristics such as easy care or flame retardancy.

Flame retardant cotton products are commonly produced by incorporating flame retardant chemicals or fibers. Alternatively, naturally flame-retardant cotton fiber has been described [1] or advances in biotechnology might eventually create new opportunities for novel cotton fibers with improved thermal properties [2]. An important obstacle to the further success of this approach has been the proper selection of novel fiber types with the best performance using small amounts of fiber. Current text methods, especially in the field of flame retardancy testing, require large quantities of materials, moreover mostly in a fabric form. Therefore novel instrumentations and test methodologies that use only a few grams of fiber are needed [3].

In this perspective, Cone calorimetry turns out to be a helpful instrumentation to measure the combustion behavior of cotton fibers. It is a relatively new, small-scale method that utilizes oxygen consumption principle and provides results with high accuracy in good agreement with large scale fire tests. For fabrics, the methodology has been optimized[4], [5] however, up to the authors knowledge, fibrous samples have never been studied. In the scope of this paper, an important parameter that can affect the measurements namely sample weight is extensively studied.

Materials and Methods

Raw cotton fibers (Micronaire: 4.0-4.5, length: 28-29 mm, strength:28-30 cN/tex) from Utexbel (Ronse, Belgium) were used in this study. A cone calorimeter made by Fire Testing Technology Limited model FFT was used for the testing of the samples.

Results and Discussion

For textile fabrics, especially for light weight samples, the thickness of the mono-layer specimen is about 0.5 mm and thus it remains lower than the sample-cone heater distance even if more layers are under study. On the other hand, for the fibers, the thickness depends on the amount of sample. Therefore the effect of sample weight has been investigated for three different weights while the rest of process parameters were kept constant. The thickness measured for 1, 2 or 3g of cotton fibers are 8, 12 and 16 mm, respectively. The individual heat release rate (HRR) data curves for each sample weight are shown in Figure 1.
Figure 1 HRR curves of cotton fibers obtained for 1 g (a), 2 g (b) and 3 g (c) sample weights

The most reproducible data were obtained when the sample weight was 2 g. For 1 g specimen, the weight is too low and even if the curves have the same profile, they are not overlapped. In addition, one of these repetitions resulted in the pyrolysis of the fibers instead of their combustion. For the 3 g specimen, the curves are shifted on the HRR axis. The difference of their peaks is around 12 kW/m² and thus these data cannot be estimated as reproducible. In this operative conditions, the problem is probably due to the volume of the sample at the fixed distance between specimen-cone heater.

Conclusions
Present work proves that fibrous samples can be tested using Cone Calorimeter. An important aspect of the procedure namely sample weight has been thoroughly investigated. It was clear that sample weight influence has a significant influence on reproducibility of the measurements. The best reproducibility was obtained when 2 g sample weight was used for the experiments.

References