DYNAMIC THERMAL RESPONSE OF BAST FIBER ASSEMBLIES

by

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Dynamic thermal response of several common bast fiber assemblies was investigated, the dynamic temperature curves of fiber assemblies under high temperature (100 °C) were measured and a dynamic heat transfer coefficient was proposed to elucidate the dynamic heat transfer performance during the initial unsteady heat transfer process. The result showed that the dynamic heat transfer performance of bast fibers was better than that of cotton fibers.

Key words: *unsteady-state condition, temperature curves, bast fiber assemblies, dynamic heat transfer coefficient*

Introduction

Multi-phase fibrous materials are not only widely applied in apparel field but also used in some industrial engineering areas. The dynamic thermal response of fibrous materials under unsteady-state conditions is commonly complex and changeable [1, 2]. Fibrous materials are usually deemed as the combination of conduction, convection and radiation [3]. Therefore, the dynamic thermal response of fibrous materials could be essentially investigated and assessed.

Experimental

Four bast materials (hemp, flax, jute, and ramie) used in our study were extracted by the microwave assisted alkali-H_2O_2 one bath degumming approach according to our previous work [4]. An apparatus was established in our lab to simulate the dynamic thermal response of fiber assemblies under high temperature condition. 10 g fiber assemblies were homogeneously laid in a flask and a thermometer was placed at the center of flask. Afterward, the filled flask was moved into drying oven at 100 °C from their initial temperature 20 °C, meanwhile, the fixed thermometer was ignited to measure the temperature curve and the data were recorded by a computer system at 1 minute interval.

Results and discussions

The temperature curves of the fiber assemblies were shown in fig. 1(a). Then, a dimensionless parameter – dynamic heat transfer coefficient was defined as:

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$$\omega_\tau = \frac{t_\tau - t_0}{t'_\tau - t_\tau} \tag{1}$$

where t_0 is the initial temperature (20 °C in this case), t_τ and t'_τ are the temperatures of samples and the naked thermostat at the time τ, respectively. Therefore, dynamic heat transfer coefficient as shown in fig. 1(b) can be used to determine the dynamic thermal response.

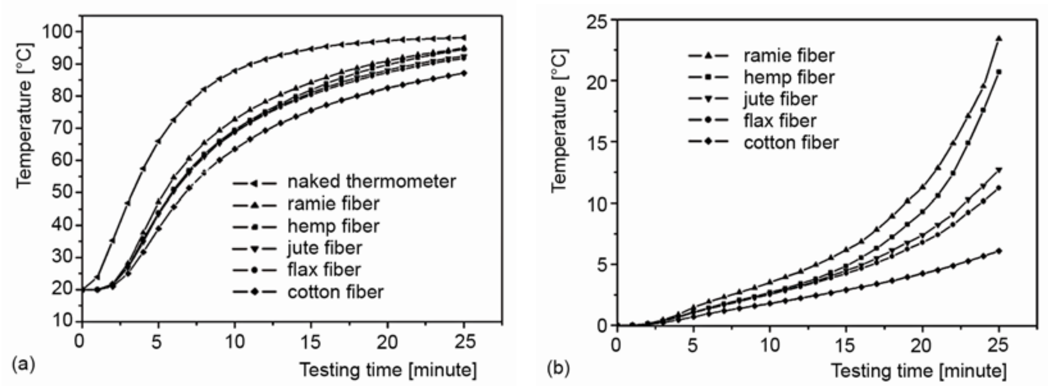

Figure 1. The temperature curves (a) and the dynamic heat transfer coefficient (b) of the samples

Conclusions

Dynamic heat transfer coefficient ω_τ was proposed to evaluate the dynamic thermal response of fibrous materials, and ramie fiber could reach the highest dynamic heat transfer coefficient (ω_τ = 24%) which was nearly 5 times higher than the cotton sample.

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