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STRUCTURAL INFLUENCE ON THE THERMAL BEHAVIOR OF JUTE FABRICS TREATED WITH PCMs

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Abstract: *Paraffin is often used as an organic phase change material PCM incorporated in textiles for enhancing said texiles' thermal behavior. This material is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy In this paper, two different densities of jute fabric was used. These phase changes take place at constant temperature and for certain materials the process of melting and crystallizing can be repeated over an unlimited number of cycles with no change to their physical or chemical properties. The aim of this work is to study the influence of structural jute fabrics treated with PCMs microencapsulated on thermal behavior, to carry aout the study two plain fabrics with different structural characteristics were used. Thermal behavior of both untreated fabrics was tested by balancing it above a heating plate. Consequently, the fabrics were measured with a TESTO 865 thermal imager. Afterwards, treated samples both with and without PCMs in printing paste were tested in the same way. The wanted effect was reached during cooling cycle of both textiles. Only the heating cycle of the treated lightest jute sample was found to be warmer than the untreated sample. More experimental testing is needed on this sample. Furthermore, the heating cycle of the densest jute sample was according to the expectations.*

Key words: *phase change material, paraffin, microcapsules, heating, cooling*.

1. INTRODUCTION

According to Iqbal et al. [1], phase change materials (PCMs) have the ability to store and release a large amount of energy in the form of latent heat. The materials absorb energy without any change in temperature when changing their physical state from solid to liquid. The same amount of energy is released when the material changes from liquid to solid state.

The PCM used in the experiments in this paper is paraffin. Paraffins are long-chain or branched saturated hydrocarbons. The general chemical formula for unbranched paraffin molecules is C_nH_{2n+2}. Because paraffin is not a pure substance, but rather a mixture of long hydrocarbon chains, the transition from solid to liquid has a large range of several degrees Celsius. Paraffin is prone to solid/liquid and solid/solid phase changes [2-5]

According to Erkan (2004) [6] humankind has developed several ways for keeping body temperature regulated, for example humans have been wearing clothes since prehistoric times, built shelters and ate food regularly. By applying PCMs on textiles the amount of thermal energy that can be stored in these textiles will increase. Because of the nature of PCMs and latent heat, when one is wearing clothes incorporated with PCMs, that person would feel cooler when his body temperature rises and hotter when his body temperature decreases. This is because the heat from his body will be used to melt the PCMs in the fabric, essentially cooling the person down. When the temperature around him decreases again, the energy stored as latent heat will release again, which in turn will keep the person warmer for a longer duration.

The aim of this work is to study the influence of the characteristics of jute fabrics treated with PCM's on thermal behavior.

2. EXPERIMENTAL

2.1 Materials

Plain jute fabrics were used as textile material in order to carry out the treatment. In table 1 the characteristics of these samples are shown.

Table 1: *Characteristics of jute fabrics used.*

Sample	g/m^2	Warp density (ends/cm^2)	Weft density (picks/cm^2)
Jute_220	220	4	4
Jute_300	300	6	5

To add thermal properties to the fabric microencapsulated phase change material (PCM's), Centerfinish C-25 (dust) provided by Color Center are used. Acrylic resin, STK-100 suministrated by Color Center, was used as a binder as PCM's don't show any affinity to textile fibers and Lutexal CSFN liq, provided by Archroma, was used as thickening agent.

2.2 Methods

PCM microcapsules were applied to the jute fabrics by coating. To carry out the process 100 g/Kg of PCM's, 10 g/Kg of acrylic resin and 30 g/Kg of thickener in order to increase the viscosity of the bath were used.

To study the influence of the characteristics of jute fabric treated on the thermal conductivity, samples were tested with a thermochromic camera. The tests were performed taking meassuarements each 15 seconds for 120 seconds of heating cycle and 120 seconds of cooling cycle.

3. RESULTS

In the introduction, the expectations of the results were stated as followed: during the heating cycle, the measured temperature will be lower on PCM treated samples than untreated samples. Consequently, during the cooling cycle, the measured temperature of treated samples will be higher, due to the latent heat being slowly released. In Fig. 1, this thermographic behaviour of jute_220 is shown. This sample does not follow the expected results completely. This might be due to the fact that the pores in a jute_220 sample because of its lower density.

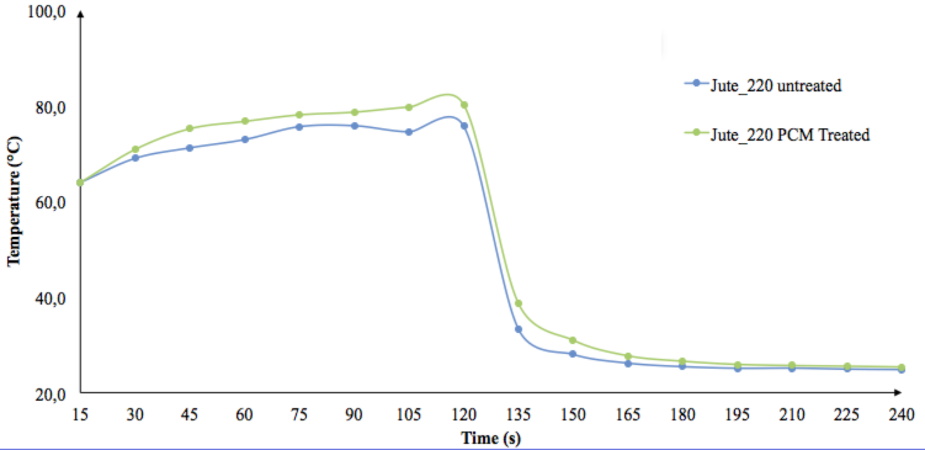

***Fig. 1**: Thermal behaviour of untreated and treated jute_220*

In the case of jute_300 sample, which results are showed in Fig. 2, this thermal behaviour follows the expected results completely. During the heating cycle, some of the energy is used to melt the paraffin. The energy is absorbed as latent heat, causing the jute to be cooler when fabric is treated with PCMs. When the fabric was laid to rest on a table, the heat was slowly being released again. The PCM treated sample holded on to this heat much longer thanks to the residual latent heat left in the PCMs. Consequently, jute_300 shows the most promising results.

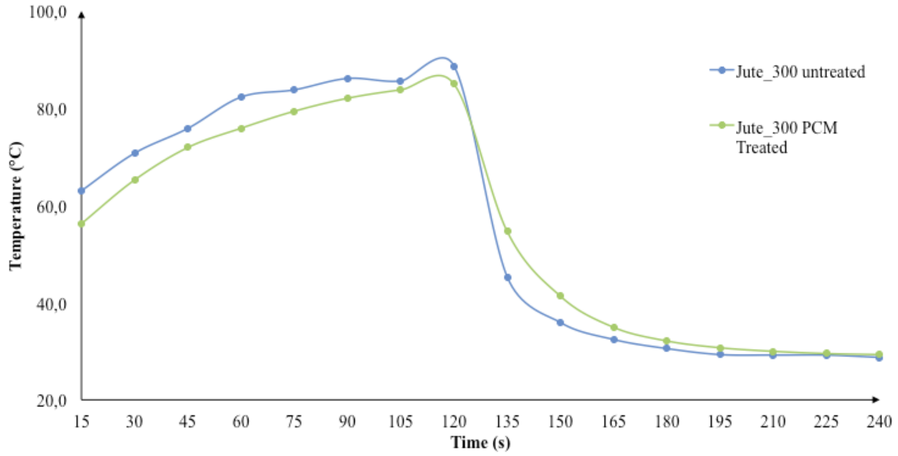

***Fig. 2**: Thermal behaviour of untreated and treated jute_300*

In Fig. 3, the measured temperatures of both untreated jute samples and PCMs treated samples are compared. The figure clearly shows that the denser jute sample naturally absorbs a lot more heat, with an average maximum temperature of 84.9 °C, while jute_220 only reached 77.9 °C. After the cooling cycle, the jute_300 sample was still an average of 3.9 °C higher.

If we compare samples treated with PCMs, even though PCM treated jute_300 starts off better than jute_220, after around 60 seconds the fabric gets warmer than jute_220. However, jute_300 holds on to this heat a lot better than jute_220 in the cooling cycle. The results of Fig. 3 show that the PCM treated samples are closer together during heating cycle and at the end of the cooling cycle.

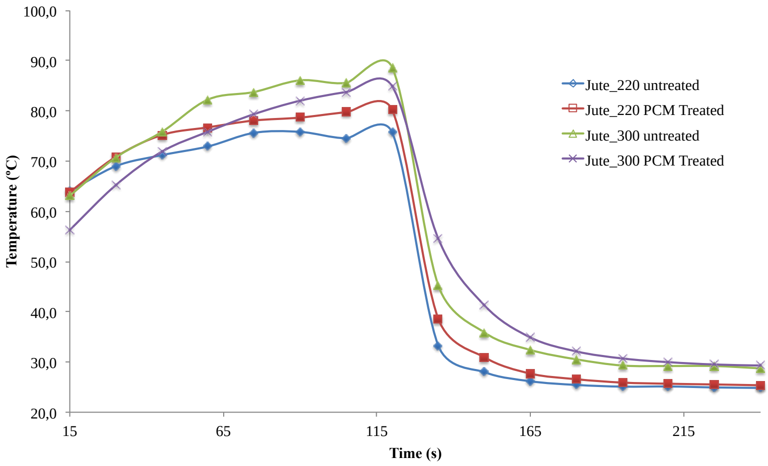

***Fig. 3**: hermographic behaviour of jute_220 and jute_300 untreated*

4. CONCLUSIONS

Applying paraffin PCMs to jute fabrics has the desired effect on its thermal behaviour during all cooling cycles. However, during the heating cycle of jute_220, the thermal behaviour showed counterproductive. More experimental research is needed to resolve this problem with measuring jute_220 during the heating cycle. However, the heating cycle of jute_300 showed the thermographic behaviour expected from paraffin PCMs.

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