THE INFLUENCE OF IONIZING RADIATION ON THE PHYSICAL PROPERTIES OF POLYESTER MULTIFILAMENTS

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Abstract – The polyester fibers stand out among the fibers used in the textile industry, due to their numerous factors that make them attractive in terms of cost-effectiveness. The interaction of ionizing radiation with the polyester substrate allows the formation of reactive species capable of stimulating structural modifications of the fiber and, consequently, altering its properties. In this sense, the present work proposes to analyze the influence of ionizing radiation on the physical properties of PES multifilaments. PES multifilament samples were exposed to Cobalt-60 gamma ionizing radiation, with doses ranging from 50 kGy to 200 kGy. The physical properties of tensile strength and elongation were verified. Gamma irradiation treatment proved to be effective in increasing the elongation and strength of the PES multifilament.
Key words: *elongation, ionizing radiation polyester, tenacity textile.*
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Introduction

In the 1920s, the concept of polymer served as the basis for the subsequent development of numerous products of synthetic origin obtained from petroleum, such as polyester. Due to its diversity, it is used in numerous sectors such as automotive, civil construction, packaging, medical equipment, consumer products, among others [1 – 3].

In the textile sector, numerous synthetic fibers were developed, such as polyethylene terephthalate (PET), known in Brazil as polyester (PES), whose production rose exponentially in the 1980s, currently making up 2/3 of the total products sold in the sector [4, 5]. The Brazilian panorama of consumption, in tons, of PES multifilaments in the last 5 years is shown in Fig. 1 [6].

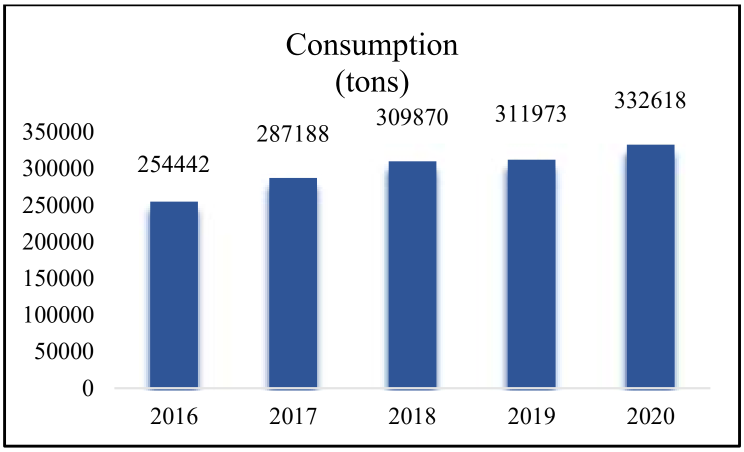

Figure 1. Overview of PES consumption from the years 2016 to 2020 [6].

In general, polymeric materials can be synthesized or adapted for numerous purposes, through processes such as ionizing radiation, whose interaction with polymeric materials allows changes in physical-chemical properties of interest to numerous areas, such as textiles. In this sense, the present work proposes to analyze the influence of ionizing radiation on the physical properties of PES multifilaments [7, 8].

Experimental

Samples of PES multifilament (192/40 Dtex) were exposed to gamma ionizing radiation through the Colbalt 60 Multipurpose Irradiator (IM – 60 Co), located at the Centro de Tecnologia de Radiação (CETER-IPEN), whose analysis took place by comparing samples without treatment and those irradiated with doses that varied between 50 kGy and 200 kGy. The physical properties of tensile strength, called toughness (cN tex^{-1}), and elongation (%) were verified using the STATIMAT 4U equipment by Textechno, located at the Faculdade de Tecnologia do SENAI "Antoine Skaf".

Results and discussion

The figures below represent the observed relationships between absorbed dose and elongation (Fig. 2), and between absorbed dose and tenacity (Fig. 3), of PES multifilament samples.

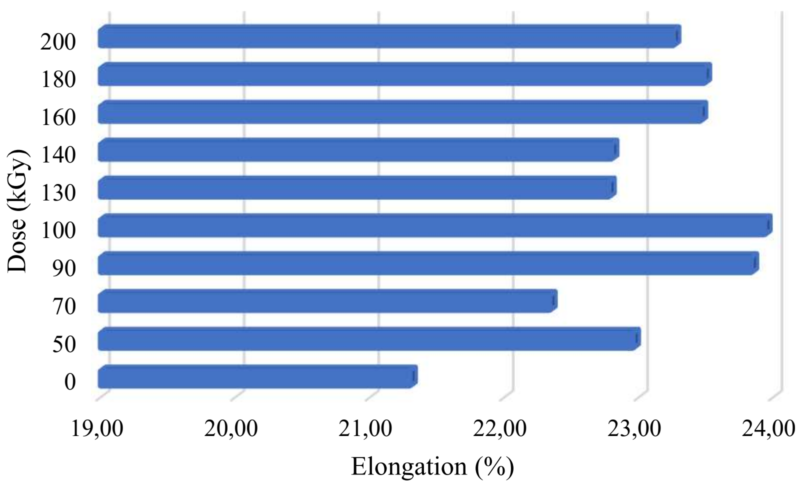

Figure 2. Elongation of the PES multifilament as a function of the absorbed dose.

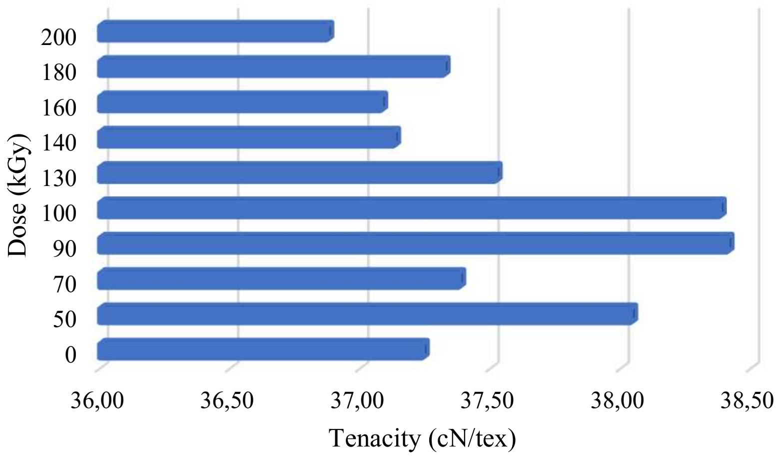

Figure 3. Tenacity of PES multifilament as a function of absorbed dose.

The samples showed a non-linear increase in the elongation of the PES multifilaments, reaching a maximum of 23.94% at 100 kGy, in other words, it elongated more than 10% compared to the untreated sample. The yarn tenacity increased up to a dose of 130 kGy, whose maximum value of 38.41 cN tex^{-1} was obtained at 90 kGy. Thereafter, there was a drop in toughness with the lowest toughness observed at 200 kGy. Due to the fact that the warp threads are exposed to attrition and tension, resulting from the comb hitting the weft thread in in weaving, for example, the elongation and resistance of the thread to breakage become important characteristics for a smaller number of breaksof and the consequent increase in weaving efficiency.

This elongation behavior was also observed by Gisbert et al. [9], when analyzing the effect of the electron beam in 100% PES tissues, whose maximum elongation was reached at 100 kGy. In a study carried out in 1989, Fadel, Abdel-Zaher and El-Messiery [10] when examining the effects of neutron fluences on the mechanical properties of polyester, they found that the minimum value of tensile strength corresponded to a maximum value of elongation, but that at fluences greater than 10 N $cm^{2\ -1}$ a slow decrease in both properties.

The mechanical properties of PES have been linked to changes in the crystallinity of the fiber, in which the higher the irradiation doses, the greater the degree of crystallization, resulting in the rearrangement of molecules and reduction of amorphous zones in the fiber [9, 11].

Conclusion

The cobalt-60 gamma irradiation process proved to be effective in altering the physical properties of elongation and tenacity of the analyzed polyester multifilament. After treatment, the sample increased elongation by around 12%, contributing to the increase in breaking strength and consequently increased efficiency in weaving machines.

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