AGING OF POLYETHYLENE TEXTILES FOR THE DESIGN OF MOSQUITO-PROOF SHIELD ADAPTED TO TROPICAL ENVIRONMENT

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This study is part of a project initiated by the French Agency, ARS (Agence Regional de la Santé) in Guadeloupe to fight against the spread of the mosquito Aedes aegypti in the past years. These mosquitoes are responsible for several major tropical diseases outbreaks such as the dengue fever, Chikungkunya and more recently Zika. The finality of this project is to design and manufacture a mosquito-proof shield product to prevent larvaes of mosquitos to develop in rain recuperation reservoir and thus to reduce the mosquito population and the infection risk. Such polymeric based screening needs to be mechanically resistant and durable under our tropical environment. Analysis of the durability of materials in natural conditions is very time-consuming therefore artificial aging is often used for material selection because of the shorter research time. However, in order to fully reflect the natural aging process, a good correlation between natural and artificial aging has to be established[1]. The use of aging chambers enables the control of UV radiation, temperature and humidity during artificial aging. Study of the effect of artificial aging requires careful design with regard to the environmental and operating conditions of the material. In Guadeloupe, materials are subjected to very severe tropical environmental conditions. In fact, these conditions are 80% more severe than Mediterranean climates and 40% more severe than subtropical climates (Florida). Therefore, reliable methods of accelerated aging to predict durability of polymeric materials in our specific severe environmental conditions needs to be developed.

In this work, we investigate two polyethylene nets, i.e. PEB (Black color polyethylene) and PEG (Green color polyethylene). These materials offer a high flexibility, are water permeable and have small enough meshes to prevent mosquitoes to reach the water contained in the reservoir. Artificial aging of these polymeric materials was realized using an accelerated UV aging chamber, the ARTACC[2] whereas natural aging was performed either in Guadeloupe. The chemical degradation of the polymer has been characterized by IRTF spectroscopy by following the evolution of the carbonyl ratio and oxidative index[3] at the wavelength of 1715 cm^{-1}. The mechanical properties have been measured using of a universal traction testing machine.

We found that the mechanical properties of the PEG material dropped by 80% after 32 days of accelerated aging (Figure 1). The IRTF analysis showed a progressive chemical degradation during the aging process (Figure 2). In the case of the PEB, no mechanical loss was observed after 62 days of artificial aging indicating a good chemical stability (Figure 1). For this PEB material, the black color is due to the presence of carbon black additives. These additives are responsible of the high absorption rate in the infrared spectrum and prevent the determination of the carbonyl ratio and the oxidative index. Natural aging data are in good agreement with these results. After 6 months of natural ageing no mechanical modification was observed for PEB samples. For PEG samples aged in natural environment, a 25% dropped of the mechanical strength was observed leading to an accelerated factor close to 9.

These combined results clearly indicate that PEB is the best net candidate for durable mosquito-proof shield.

REFERENCES

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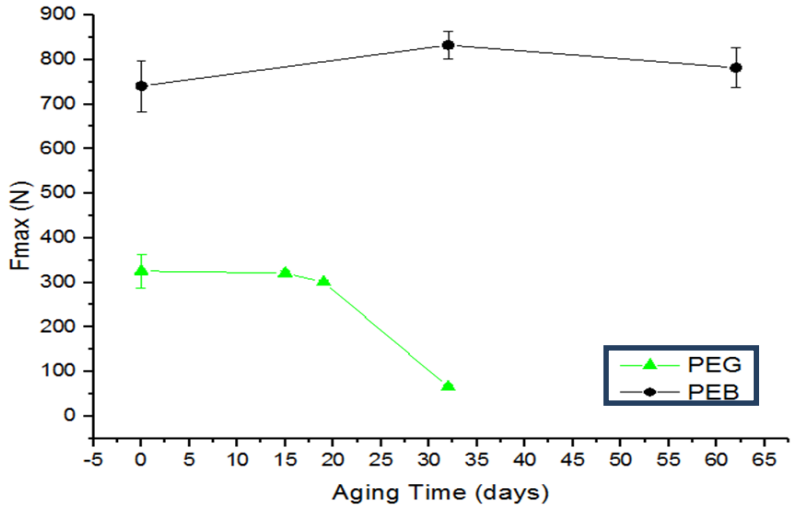

Figure 1. Evolution of rupture load as a function of aging time under artificial aging for PEG (green) and PEB (black)

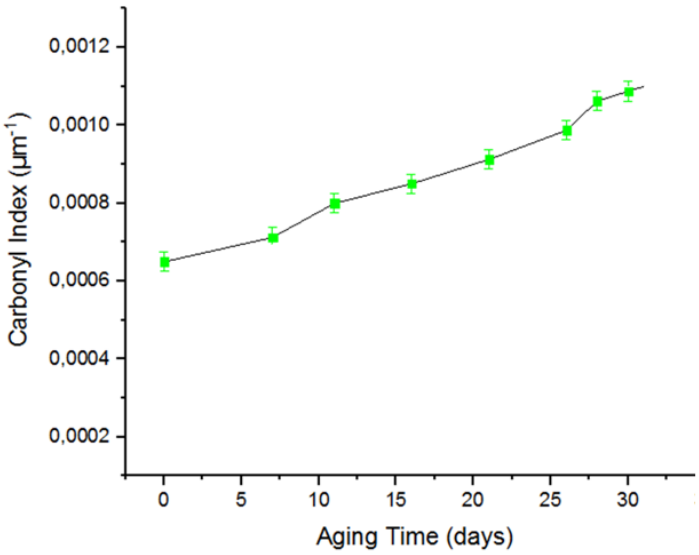

Figure 2. Evolution of carbonyl index as a function of aging time under artificial aging for PEG