11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Evaluation of degrability of HDPE films containing pro-degradant additive in various environments

L. P. Mazur(1), F. Amaral(1), R. V. V. Lopes(2), A.L.S. Schneider(1) and A.P.T. Pezzin(1)*

(1) Department of Environmental Engeneering, Universidade da Região de Joinville, Santa Catarina, Brazil, e-mail: anapezzin@yahoo.com.br
(2) Institute of Chemistry, Universidade de Brasília
* Corresponding author.

Abstract – Commercial HDPE packings containing pro-degradant additive have been exposed to degradation in accelerated aging, natural weathering and soil biodegradation. The effect of thermo-oxidative degradation was evaluated after various exposure times using DSC, TGA and FTIR. After 42 days of exposure to accelerated aging, the samples were completely fragmented. After 360 days of soil biodegradation, no visual change was observed and after 360 days of exposure to natural weathering it was observed the appearing of cracks (Fig.1). The CO_i confirmed the visual results, the more fragmented the sample that has released more carbonyl groups obtained the highest value of CO_i (Fig. 2).

It is generally recognized that PE are highly resistant to oxidation and biodegradation because of the presence of antioxidants and stabilizers [1]. However, major strategies to facilitate its disintegration are focused on direct incorporation of carbonyl groups within the backbone or their in-situ generation by addition of pro-oxidant [2]. Oxo-biodegradation denotes a two-stage process. In the first stage, occurs an abiotic oxidative degradation, followed by the biodegradation of the oxidation products [3]. The main goal of this work was to compare the degradation of commercial HDPE packings containing pro-degradant additive in various environments: accelerated aging, natural weathering and soil biodegradation. The effect of thermo-oxidative degradation was evaluated after various exposure times using DSC, TGA and FTIR. The carbonyl index (CO_i) was measured as the ratio of absorbance at 1716cm^{-1} (carbonyl peak), and the absorbance at 1463 cm^{-1} (CH_2 scissoring peak). The visual analysis shows that the samples exposed to accelerated aging were rapidly fragmented after 42 days of exposure and when exposed to natural weathering the fragmentation occurred slowly, taking 360 days (Fig. 1). However when the samples were not irradiated, as in soil biodegradation tests, did not showed degradation after 1 year, indicating that they were not bioassimilated by the microorganisms. These changes do not prove the presence of a biodegradation process in terms of metabolism, but the parameter of visual changes can be used as a first indication of any degradation process [4]. TGA curves were not sensitive to monitoring the degradation. As the carbonyl groups usually account for most of the products of thermooxidative degradation of polyethylene, their concentration, as determined by the CO_i can be used to monitor the progress of degradation [5]. The CO_i confirmed the visual results, the more fragmented the sample that has released more carbonyl groups obtained the highest value of CO_i (Fig. 2).

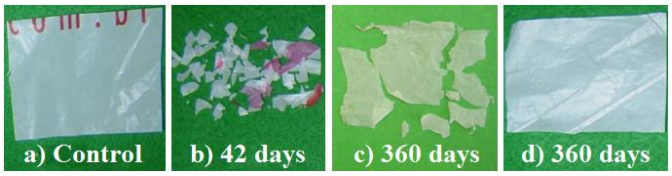

Figure 1: Visual analysis of a) control, b) 42 days accelerated aging, c) 360 days natural weathering, d) 360 days soil biodegradation.

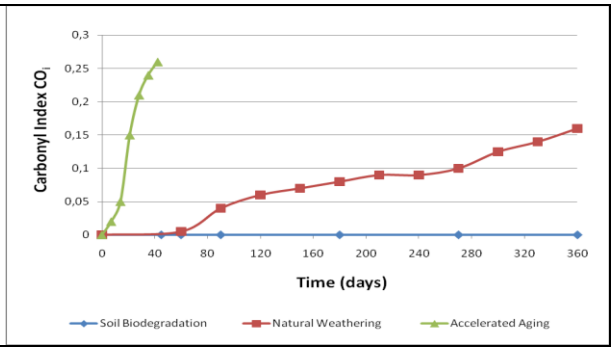

Figure 2: Carbonyl index: 42 days accelerated aging, 360 days natural weathering and 360 days soil biodegradation.

References

[1] I. Jakubowicz, N. Yarahmadi, H. Petersen, Polym. Degrad. Stab. 91 (2006) 1556.
[2] P.K. Roy, S. Titus, P. Surekha, E. Tulsi, C. Deshmukh, C. Rajagopal, Polym. Degrad. Stab. (2008) 6.
[3] G. Scott, Polym. Degrad. Stab. 91 (2006) 1581.
[4] A. Shah, F Hasan, A. Hameed, and S. Ahmed, Biotechnology Advances. 26 (2008) 265.
[5] E. Chiellini, A. Corti, S. D'Antone, and R. Baciu, Polymer Degradation and Stability. 91 (2006) 2747.