Mechanical Study of the degradation of HDPE packaging by seawater

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Abstract

The increase of plastic waste in the marine environment raises several ecological, human and biological problems. In this work, an accelerated artificial aging study was conducted in seawater after immersing samples of high-density polyethylene bottles for several aging times and at three different temperatures. The deterioration of the mechanical properties of HDPE under different aging conditions was investigated using tensile tests.

Fig.1. Example of Oceans plastic pollution.

Methodology

Aging tests were performed at a temperature of 23°C ± 1°C and 43°C±1°C .

HDPE samples were totally immersed in glass jars filled with seawater.

Samples were isolated in a dark place.

Aging tests were conducted for 9, 18, 27, 36, 54, 72 days and 3 months according to ASTM D543 with sampling every 9 days.

Fig.2. Example of samples undergoing tensile testing by the MTS Machine.

Results

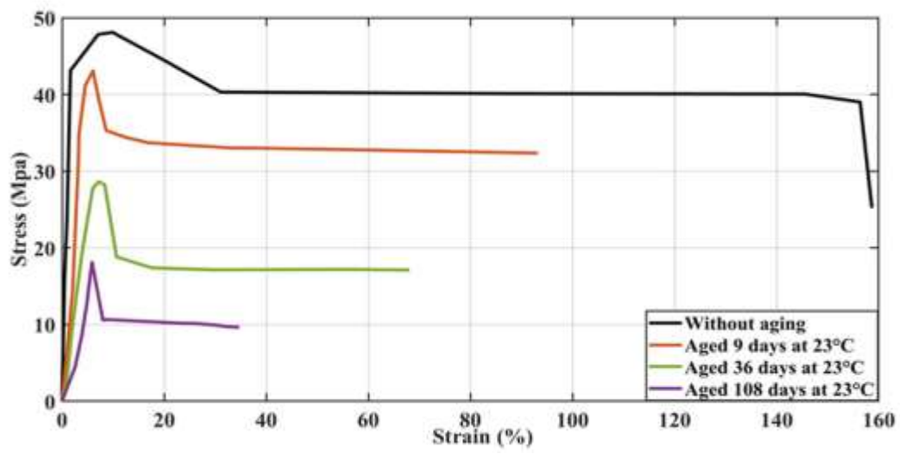

Fig.3. Stress-strain curve of HDPE samples aged in seawater at 23°C.

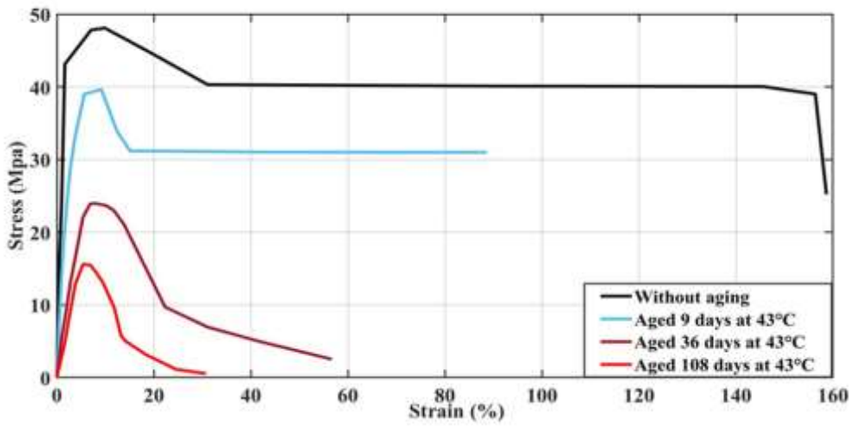

Fig.4. Stress-strain curve of HDPE samples aged in seawater at 43°C.

Discussion

Unaged specimens all exhibited ductile behavior with a 4% yield strain and yield strength of 39.8 MPa. The behavior remained ductile at 23°C (Fig.3) at different times of aging, with a decrease in strength at break and tensile strength observed. After aging at 43°C , the specimens did not show the same behavior. After 9 days of aging (Figs. 3-4),the specimens fractured in a ductile manner with a clear elastic limit. After 9 days there was no region of constant stress with strain. For longer aging times in seawater beyond 9 days, the tensile strength decreases from 39 MPa (9 days) to 15.58 MPa (108 days) at a temperature of 43°C (Fig.4).

Conclusion and perspectives

The knowledge of HDPE life cycle and the degradation process remains important to minimize marine pollution. The obtained results have shown that HDPE degrades for a long time and for years at normal temperature, so it is concluded that the temperature rise during accelerated aging is an important phenomenon to accelerate the degradation of HDPE.

References

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