



STATION D'ESSAIS DE VIEILLISSEMENT NATUREL DE BANDOL

OUTDOOR AND ACCELERATED AGEING TESTS ON POLYMERS AND OTHER MATERIALS

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Bandol, 22/08/2016

V / Réf.

N / Réf. REs 160801

TEST REPORT

Comparison of behaviour of low density polyethylene films containing oxo-additive or not, when submitted to wet environment (sea water)

This test report concerns only the samples effectively submitted to test

The writer : Flore Bouillet, person in charge

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FTIR TEST REPORT

Client : Symphony Environmental Ltd
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Test methodology : Natural ageing in specific wet conditions
Determination of carbonyl index by FTIR spectroscopy

Samples : Polyethylene film containing oxo-degradable additive + control

I. TEST PROTOCOL

1. Samples

Table 1 : Samples description

Reference	Supplier	Polymer type	Oxo-additive system	Thickness (*)	Date received
FA6224 A	Symphony	Borealis LDPE/CLEAR	1% DG 12-08	20 µm	16/11/2015
FA6224 NA	Symphony	Borealis LDPE/CLEAR	-	27 µm	16/11/2015

(*) micrometer measurement

These films are prepared in specific floating holders (dimensions 20 cm x 10 cm), fitted to our exposure system.

2. Ageing test

The test is of surface weathering on sea water, in outdoor conditions of Bandol.

A tank filled with sea water, of capacity 70 liters and height 40 centimeters is used for the experiment (the water level, decreasing by evaporation, is adjusted by adding fresh water, thus the salinity in sea water tests remains constant).

The films are floating on the surface of sea water throughout the test.
The UV rate received by the samples is the sun's one.

The exposure began on 16/11/2015 and lasted 236 days.

3. Carbonyl Index measurement

The polymer oxidation is determined by FTIR spectroscopy in transmission mode, according to ISO 10640. The spectrometer used is an Avatar 360 (Nicolet) working with the following conditions :

- Scans number : 16
- Resolution : 4 cm⁻¹

The carbonyl index is measured once a week, as the delta of the ratio of the carbonyl peak at 1713 cm⁻¹ and the thickness of the sample in micrometers.

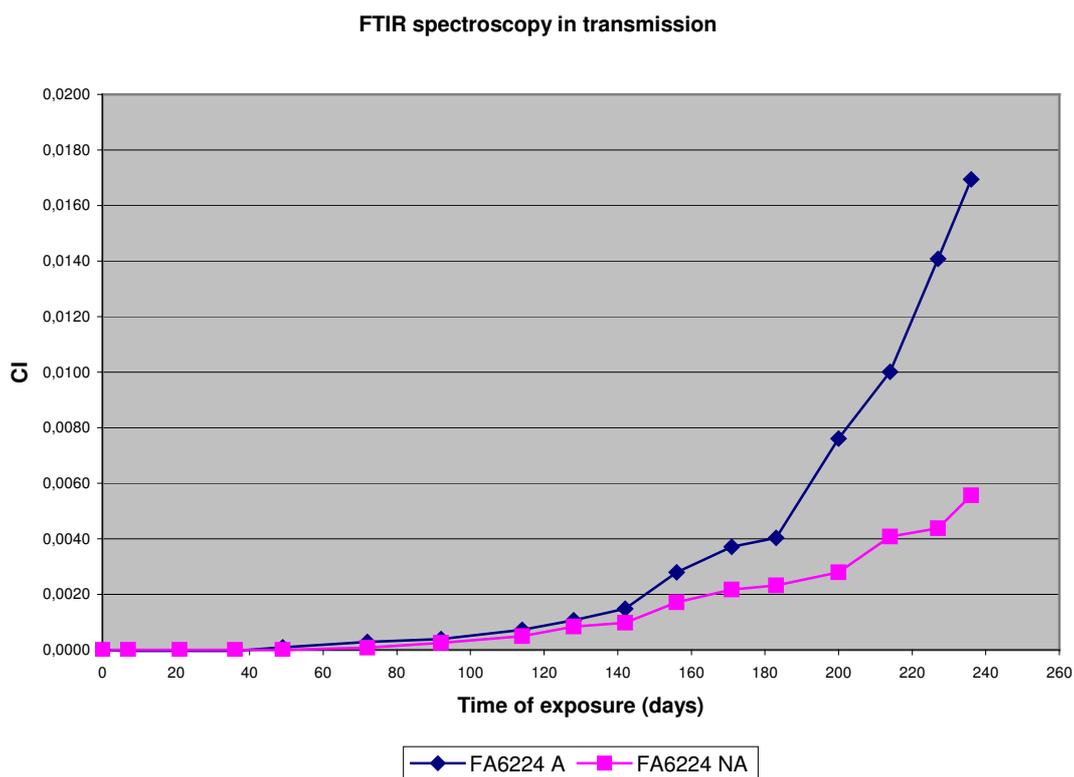
$$CI = \Delta (DO_{1713}/e)$$

Notice that all the samples have been washed once a week before FTIR measurement.

II. RESULTS

Figure 1 shows the evolution of carbonyl index during natural ageing at the surface of sea water, for the two samples FA6224 A/NA.

Figure 1 : Outdoor ageing on surface of sea water (beginning : 16/11/15)



Induction period is similar for the two samples (70 days).

Lineic oxidation rate of 0,001 (corresponding to 50% loss of elongation at break) is reached after 125 days by the oxo-degradable additivated film (FA6224A) and 140 days by the control one (FA6224 NA).

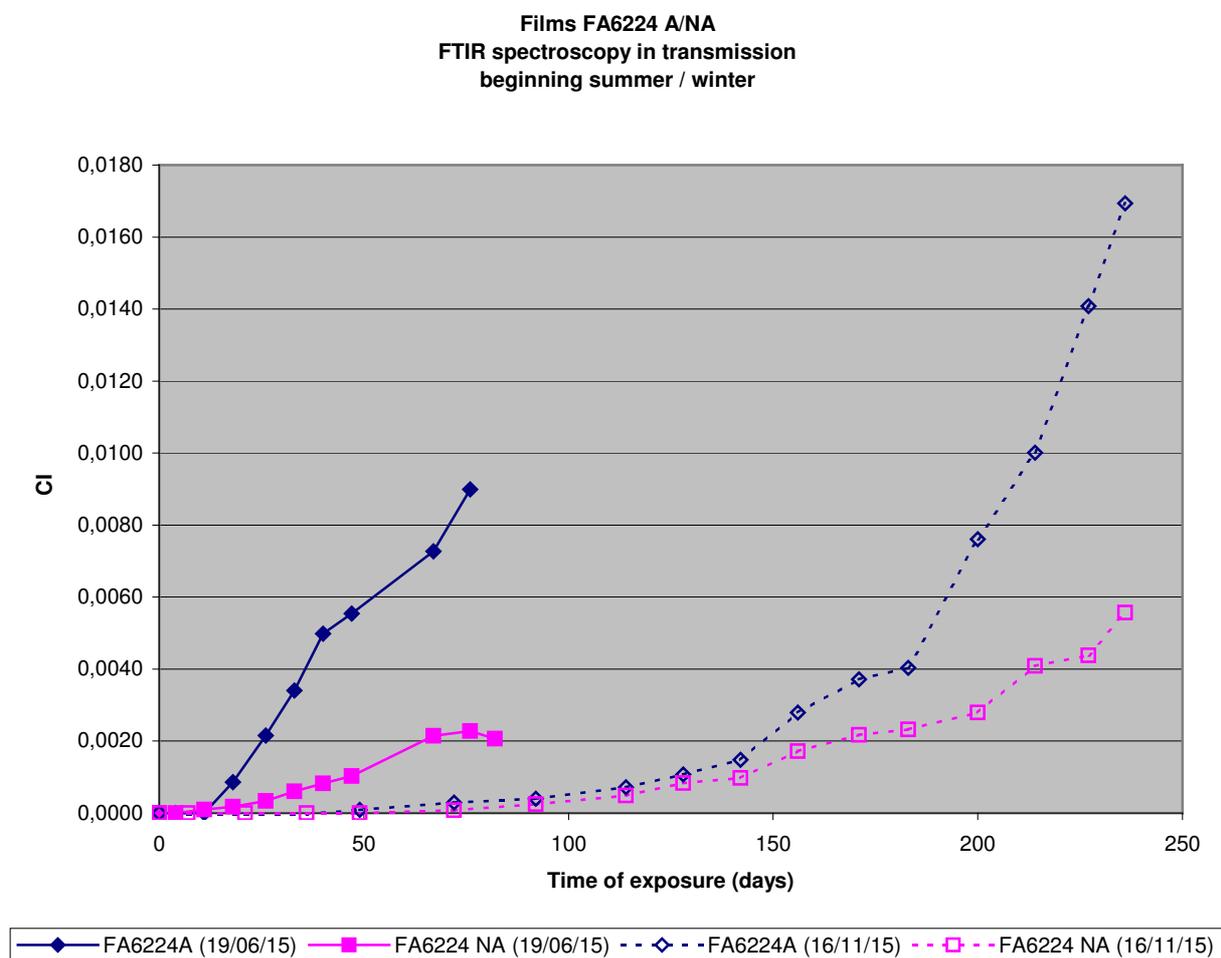
Lineic oxidation rate of 0,01 (corresponding to total loss of elongation at break) is reached after 210 days by the oxo-degradable additivated film (FA6224A), and is not reached by the control one (FA6224 NA) after 236 days of exposure.

After 236 days of surface weathering on sea water, FA6224 A presents a lineic oxidation rate of 0,017 and shows dramatic mechanical failure.

These FTIR results can be related to the same test beginning in summer (see test report REs 151101).

Figure 2 shows the evolution of carbonyl index during natural ageing at the surface of sea water, for the two samples FA6224 A/NA, beginning summer and winter.

Figure 2 : Outdoor ageing on surface of sea water (beginning : 19/06/15 and 16/11/15)



III. OPINION AND INTERPRETATION

FTIR analysis points out the capability of LDPE film to degrade quickly in outdoor wet environment when containing 1% DG 12-08 additive.

The weathering test on sea water surface, performed to show the behaviour of samples containing prodegradant d2w[®] additive in wet environments (films and bags accidentally released in oceans or lakes), points out very promising behaviours.

Assuming that there is correlation between oxidation rate and elongation at break, film FA6224 A would present a 50% loss of mechanical properties in three weeks, and a total loss in three months, when exposed in summer period in Mediterranean climate.

These durations are extended to four months and seven months respectively, if the exposure begins in winter period.