

SUMMARY REPORT

Purpose

To test degradable TNT courier bag (Date of Production: May 4, 2004) incorporated with Ecoshield for degradability.

Sample Description

Manufacturing Company : Cybershield Plastic Sdn. Bhd.
Sample Composition : 65.2% LLDPE/4.8% HDPE / 3.2% LDPE
TDP : Ecoshield
Samples Provided : TNT Courier bags:
a) Control: Non-ecosshield
b) Degradable: Ecoshield

Lab. Tests Performed

- QUV (Accelerated Weathering ASTM D5208-91)
- Tensile Elongation (ASTM D882-97 & D3826-98)
- FTIR (Fourier Transform Infra-red Absorption Spectrometer)
- Melt Index (ASTM D1238-95)
- Heat-Aging (ASTM D-5510-94)

Laboratory Tests Method

1. QUV (Accelerated Weathering Tester ASTM D5208-01)

The Q-Panel Company, the leader in reproducing the outdoor weather conditions in an accelerated manner, developed equipment that can produce results in a few days or weeks similar to the damage that occurs outdoors over months or years. The samples are exposed to UV radiation, heat and moisture replicating the effect of sunlight, rain and dew in the day/night cycles. The machine is set-up to work in cycles that can be programmed (i. e. UV irradiance, temperature, condensation and the timing for each cycle). These test parameters are set according to ASTM D 5208-01.

Samples are exposed to different time periods and the physical, chemical, and mechanical characteristics of the polymeric material (film in our case) are tested before and after QUV exposure.

The physical characteristics and chemical composition of a film material exposed to weather conditions will change in time. Physical characteristics are tested by Tensile Elongation and Melt Index whereby the change in chemical composition is tested via FTIR.

Both Control and Samples with Ecoshield were pre-aged in the QUV for different periods of time (48hrs, 96hrs, and etc.) prior testing the changes in their physical properties and chemical composition. The weathering data obtained represents *comparative data* measuring the difference in degradability between the samples with Ecoshield versus the Control.

2. Tensile Elongation Test (ASTM D882-02 & D3826-98)

The test characterizes the film from the mechanical performance point of view. The length stretched to break the specimen is measured. Test parameters are set according to ASTM D882-02 (i. e. Specimen 0.5” wide/Speed 2” per min. and 4” in length).

The Elongation at break data showed a decreased trend when the time exposed in the QUV increased. As expected, the integrity of the polymer structure decreased when degradation process occurred in the QUV. At 240 hours QUV exposure, TNT courier bag with Ecoshield was degraded showing a broad difference in elongation compare to control (Control = 789%, Sample with Ecoshield @ 2% = 8%).

3. Melt Index (ASTM D1238-01)

The Melt Index is determined by using an Extrusion Plastometer. The melt index is an indirect relationship to the molecular weight of the polymeric material tested. The higher the melt index value (Melt Flow rate, g/10min), the lower the molecular weight of the sample tested.

Test parameters are set according to ASTM D1238-01. Test parameters on the condition used were 190°C/2.16kg.

A comparative test was done between the melt index of the sample before exposure to QUV and after exposure to QUV. If the melt index increases significantly after exposure in the QUV, the test shows that the polymeric chain has been broken down hence the material is totally degraded.

Melt index was tested at 0h and 240hrs of QUV exposure for TNT courier bags (both Control and the Sample with Ecoshield). Data showed that after QUV exposure, high Melt-Flow values were obtained showing degradation for Ecoshield samples (Control = 2.2g/10min., Sample with Ecoshield @ 2% = >200g/10min.). However, Control remained with a low MI value showing no degradation.

4. FTIR

FTIR (Fourier Transform Infra-red Absorption Spectrometer) test is a newly incorporated test method that is able to determine the chemical changes occurring in the polymeric structure of the film.

The chemical change of interest is the detection of ketonic group in the Carbonyl region $1715 \pm 5\text{cm}^{-1}$. In general, when degradation process occurs for Polyethylene material, (hence chemical oxidation occurs), the polymeric chain will be oxidized generating end fragments of carbonyl group ($>\text{C}=\text{O}$), ketones in specific. The $>\text{C}=\text{O}$ stretching frequency (saturated open-chain ketones) can be detected via Infrared absorption spectra.

Further oxidation will also show the existence of alkyl and ester groups. Both have absorption at around 1725cm^{-1} and 1740cm^{-1} respectively.

Based on the FTIR data, oxidation found at 96hrs of QUV exposure for courier bag film with Ecoshield and the degree of oxidation/degradation gradually showed the increase of peak area. However, no sign of oxidation detected for Control sample. This showed that the oxidation/degradation for the sample with Ecoshield took a shorter time to degrade and it also acted as a catalyst whereby expedite the oxidation process.

5. Oven Heatage 71°C (Heat-Aging ASTM D5510-94 (2001))

The Heat-Aging test is intended to define the exposure conditions of plastics at various temperatures when exposed solely to hot air for intended periods of time.

ASTM test method D5510-94 (2001) procedure B was used to prove the thermal degradation of films manufactured with Ecoshield. Film samples were hung on oven's rack and exposed to 71°C . Samples are evaluated by visual inspection checking signs of degradation, which include: tears, rips, holes, flaking, and fragmentation.

According to the test data for heat-aging test, TNT courier bag with Ecoshield took 21 days to fragment. As for Control, no fragmentation found after 21 days of heat-aging process.

Conclusion

1. The Ecoshield used for the TNT courier bags proved excellent degradability performance. As shown, degradation initialized at 4 days (96hrs) of QUV exposure for courier bag with Ecoshield @ 2% and degradation end-point was achieved after 10 days (240hrs) of QUV exposure. Control (with Non-Ecoshield) did not show any sign of degradation.
2. The correlation results obtained from Tensile Elongation, FTIR, Melt index, and Heat-aging showed consistent figures, supporting in all aspects that TNT courier bags with Ecoshield proved degradability compared to Control with Non-Ecoshield.