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ENVIRONMENTAL TECHNOLOGY VERIFICATION (ETV)

VERIFICATION STATEMENT (PART I: PHOTODEGRADATION)

TECHNOLOGY TYPE : **Plastic Carry Bags with Degradable Additive**

APPLICATION : **Solid Waste Management**

TECHNOLOGY NAME : **Plastic Bag (High Density Polyethylene) with MB Biomate *BM*-205 as Additive (ETV 08-014)**

COMPANY : **Licton Industrial Corporation**

DATE: **September 2009**

Disclaimer

This ETV Statement is the result of an impartial, consensus-based approach to evaluating innovative environmental technology in accordance with the ETV Technical Protocol. The data presented are believed accurate and the analyses credible. The statements made and conclusions drawn regarding the product evaluated do not, however, amount to an endorsement or approval of the product in general or for any particular application nor a warranty to the performance of the technology that it will always operate as verified.

This ETV Statement is based from an evaluation activity supported by the DOST-ITDI ETV Group, the Panel of Experts, First in Colours, Inc. and Licton Industrial Corporation. The implementation of this ETV was a joint undertaking with Licton Industrial Corporation, as manufacturer of plastics containing the additive, MB Biomate BM-205.

Mention of commercial product name does not imply endorsement.

This ETV Statement is a summary of the ETV Report of the *MB Biomate BM-205* (ETV 08-014).

ETV TEST DESCRIPTION

The ETV Panel of Experts, First in Colours, Inc. and Licton Industrial Corporation agreed to validate the claim that the addition of two percent (2%) *MB Biomate BM-205* in the formulation for the manufacture of high density polyethylene (HDPE) plastic carry bags will accelerate the degradation of the plastic bags under the degrading elements of the environment particularly ultraviolet (UV) light, temperature and water as compared to plastic carry bags that do not have *MB Biomate BM-205.*

The technology proponent claims that the sequential steps in the degradation of the plastic carry bag occur at a much faster rate with the addition of *MB Biomate BM-205* than the conventional plastic bags without the said additive.

This ETV Verification Statement is focused on the first stage of degradation, which is photodegradation.

VERIFIED TECHNOLOGY DESCRIPTION

The following description of *MB Biomate BM-205* was provided by the proponent and does not represent verified information.

> "*The MB Biomate BM-205 is a unique concentrate designed to make polyolefins degradable. It contains a proprietary mixture of pro-oxidant catalysts such as metal salts and rare earth compounds.*
>
> *Polyolefins formulated with MB Biomate BM-205 undergo two-step degradation. Initially, degradation occurs by an oxidative process and subsequently by biodegradation. Oxidative process or photo degradation is the breakdown of the plastic product by UV light and thermal energy from the sun. After undergoing degradation, further breakdown of the plastic occurs through the second stage, biodegradation. This is brought about by its exposure to different naturally produced substances by microorganisms and other living organisms. The end products are H_2O (gas) and CO_2 (gas).*
>
> *MB Biomate BM-205 should be used locally at a dosage of 2%. It is suitable for use in contact applications, is non-toxic and free from heavy metals including cobalt. Unlike cobalt based pro-oxidants, MB Biomate BM-205 – containing products that undergo degradation does not generate foul, offending odors."*

VERIFICATION OF PERFORMANCE

The accelerated weathering exposure test following ASTM D5208-91 was adopted. Plastic bags with 2% *MB Biomate BM-205*, of size 12, with a thickness of 30 microns

and printed with the SM plastic bag label were used as the experimental test materials The control samples used in the validation were of the same size, thickness and color but without the *MB Biomate BM-205*. Plastic samples with 250 millimeters (mm) x 15 mm sizes were subjected to the Accelerated Weathering (UV) Conditions using the Suga Dew Panel Light Control Weather Meter, Model DPWL-5R under the following weathering conditions:

Table 1. UV Exposure Testing Parameters

Parameter	Conditions
Duration (UV)	20 hours @ 50°C ± 3 (UV lamps ON)
Duration (Condensation)	4 hours @ 40°C ± 3 (UV lamps OFF)
Duration of Test	Up to 96 hours (4 days); 4 cycles (24 hr-cycle)
UV lamp	Type A (340 nm)
Irradiance	0.72 W/m^2/nm or equivalent
Cycle	24-hour cycle: 20 hours UV, 4 hours condensation (dew)

Test samples were retrieved after 6, 24, 48, 72, 96, 120, 144 and 166 hours of exposure. Four to five replicates of film strips were tested for actual tensile-elongation test.

Photodegradation was assessed by measuring the change in mechanical properties, specifically tensile strength and elongation of the plastic films. The tensile test was done using a Universal Testing Machine, where the test specimen is gripped at either end. An axial pull is slowly exerted to stretch the plastic samples until it breaks.

A correlation between the degradability of the plastic bag with its exposure to UV/condensation conditions was obtained by the variation of tensile strength and elongation of the plastic films with respect to exposure time.

In order to determine whether the tensile strength of plastic samples with and without *MB Biomate BM-205* are significantly different, the t-test for paired data was calculated 95% confidence level under the assumptions that the paired differences are independent and identically normally distributed.

The results of the tensile and mean elongation are tabulated in Table 2.

Table 2. Tensile strength and % elongation of plastic film samples with and without additive before and after UV exposure tests

Sample	Retrieval Time, hours	Mean Tensile Strength, N/mm^2	Mean Elongation,%
SMB unexposed*	0	**28.68**	**248**
SMB 16*	6	**23.15**	**60**
SMB 124*	24	**18.65**	**3.20**
SMB 248*	48	**19.15**	-
SMB 272*	72	**17.66**	-
SMB 396*	96	**18.24**	-
SMB 3120*	120	**9.92**	-
SMB 8144*	144	**8.98**	-

Sample	Retrieval Time, hours	Mean Tensile Strength, N/mm^2	Mean Elongation,%
SMB 4166*	166	**5.87**	-
CSM unexposed**	0	**28.49**	**310**
CSM 124**	24	**22.97**	**452**
CSM 272**	72	**23.03**	-
CSM 3120**	120	**19.47**	-
CSM 4166**	166	**6.93**	-

* with *MB Biomate BM-205*
** without *MB Biomate BM-205*
(-) means no elongation result due to the brittleness of the specimen

Figures 1 and 2 show the effect of the accelerated weathering test to the tensile and elongation properties of the plastics at various exposure periods. The first retrieval of samples was done after 6 hours. The longest exposure period was 166 hours.

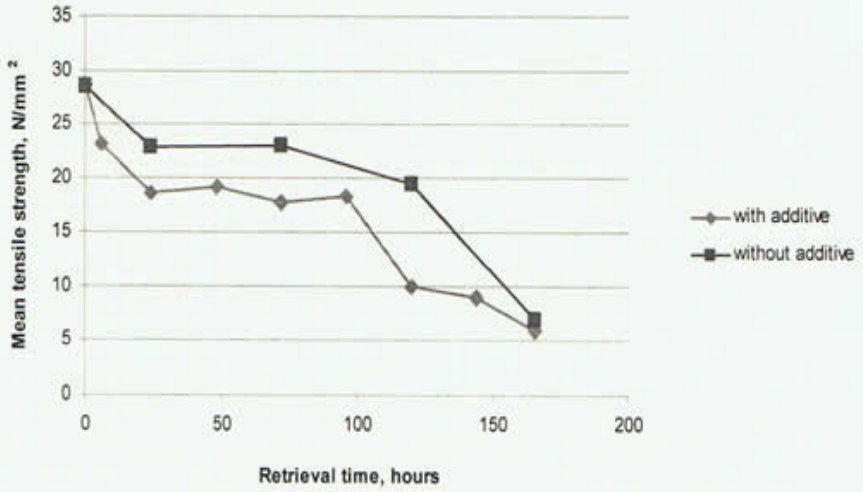

Figure 1. Tensile strength of plastic samples

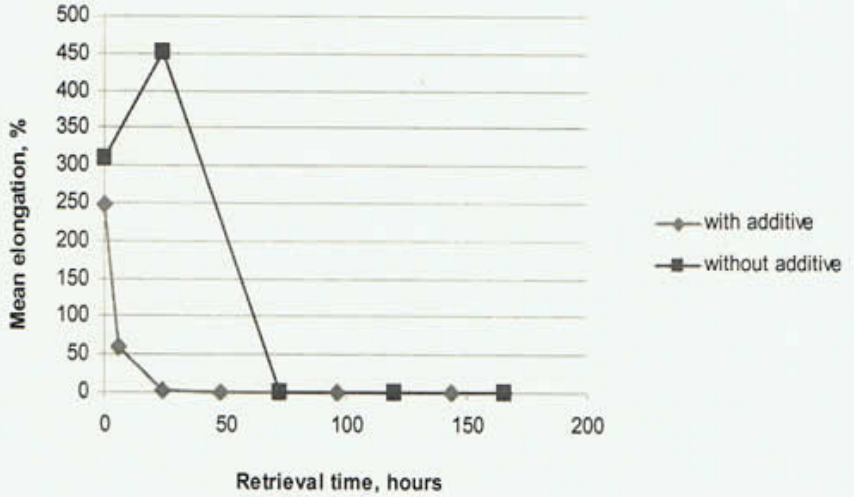

Figure 2. Percentage mean elongation of plastic samples

A decreasing trend was observed for the values of the tensile strength for plastic with additive as the time of UV exposure is increased. For the plastic samples with *MB Biomate BM-205*, tensile strength significantly decreased after 120 hours of UV/condensation exposure. Similarly, the percentage elongation significantly decreased after 24 hours of UV/condensation exposure. Degradation of the films further developed as evidenced by increased degree of brittleness and/or flaking. Hence, the elongation test can no longer be performed at 48 hours and thereafter. The same was observed with the test specimen without the additive, but on a longer time of 72 hours after UV/condensation exposure.

Plastic samples without the additive indicated a relatively higher mean value of tensile strength and mean % elongation after exposure to UV.

The films without *MB Biomate BM-205* have also undergone photo degradation due to UV/Condensation as evidenced by the decreased tensile strength and elongation with longer exposure time, but on a slower rate.

Both samples of SM plastic bags with and without *MB Biomate BM-205* are made of Polyethylene (PE), a thermoplastic material made up of long chain of hydrocarbon polymer molecules. Like other polymers, PE is also subject to oxidation due to UV attack, causing degradation of plastic (photodegradation) but at a very slow rate. For this particular UV exposure test, the degree of degradation of plastic bags with *MB Biomate BM-205* increased significantly with increasing exposure time. The plastic bags with *MB Biomate BM-205* degraded faster than the plastic bags without *MB Biomate BM-205*.

Based on the above test results, the claim of *Licton Industrial Corporation* that the addition of 2% *MB Biomate BM-205* in the formulation for the manufacture of HDPE plastic carry bags accelerates the photodegradation of plastic bags compared to plastic bags without *MB Biomate BM-205*, has been verified.