HEXCYL SYSTEMS

Adjustable Longline Shellfish Farming Technology

Laboratory Testing 2009

Material name withheld

Weathering & Strength of Oyster Baskets

Report Date: 31/07/2009

Test Conducted by: Kerryn Freeman

Report Prepared by: Philip Crosbie

BACKGROUND & TESTING

[redacted] is to be used in the manufacture of Oyster Baskets. There were two areas requiring validation before volume production can commence. These are long term weathering and general strength of the baskets over time.

1.0 Long Term Weathering :

Long term weathering was done in two ways, taking advantage of established data for [redacted] & carbon black pigments. These were :

1.1 Literature search within and outside Marplex for data on carbon black filled [redacted]

1.2 Accelerated Atlas Xenon Arc testing of supplied oyster baskets & laboratory samples.

1.1 Literature Search

The system used is [redacted] (Natural) + 5.0 wt % Superblak PE40/035 RO2 masterbatch (40% carbon black with no additional UV). This effectively gives a 2% carbon black loading.

2.5% is regarded as the saturation point for carbon black additions (no real benefit at higher loadings). 2.0% would be expected to give excellent performance. Blends with only 0.5% have been reported to undergo 10,000 [redacted]herometer with no change to tensile strength. Samples containing 1.5% carbon black have shown excellent results after 48 months outside exposure at the Florida weathering station (ref Table 1 on page 2). Figure 1 shows tensile strength retainment for HDPE blends containing between 0.25% & 1% carbon black. Good dispersion of the carbon black is a key to improved weathering performance, especially at low carbon black additions. This is not so important at levels of over 2.0%. Generally, it would be expected that the combination of injection moulded [redacted] + Superblack PE40/035 would show adequate carbon black dispersion.

Hexcyl Systems Pty Ltd
ABN 70 120 261 994
PO Box 633, Ceduna, SA, 5690
t: +61 (0) 8 8625 3927
f: +61 (0) 8 8625 2822
hexcylsystems@bigpond.com.au
www.hexcylsystems.com.au

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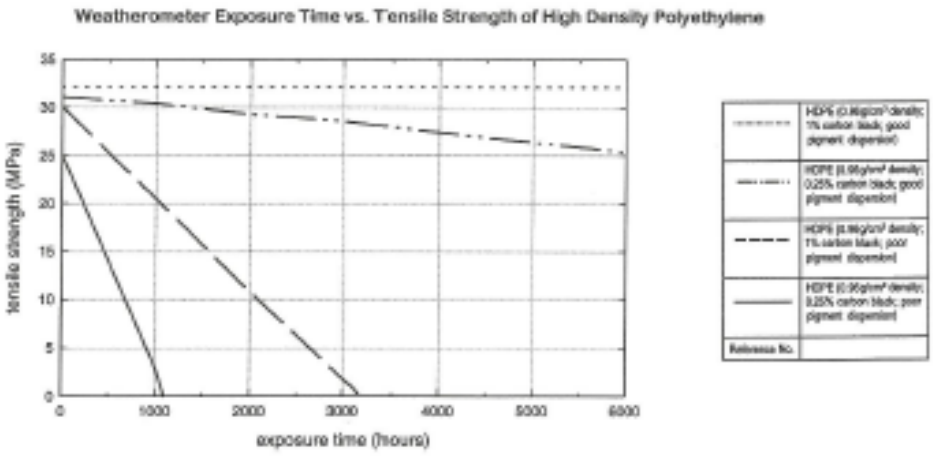
Test Property	As Moulded	12 months Florida	24 months Florida	48 months Florida
Tensile Strength (MPa)	29	29	30	31
Flexural Modulus (GPa)	1.1	1.1	1.1	1.2
Elongation to Fail (%)	450	436	389	312
Durometer Hardness (D)	65	65	67	67
Izod Impact Strength (kJ/m^2)	8.0	7.2	7.5	6.2

(Source: The Effect of UV light & Weather – PDL Handbook Series, 2004)

Table 1: Literature [redacted] Weathering (Containing 1.5% Carbon Black)



(Source: The Effect of UV light & Weather – PDL Handbook Series, 2004)

Figure 1: [redacted] Weathering (Effect of Pigment Loading & Dispersion)

1.2 Accelerated Xenon Arc Weathering

Marplex evaluate the UV colour stability of polymers using an Atlas CI35A Xenon Arc Accelerated Weatherometer. It is possible to vary the weatherometer settings and the filter combination to produce a spectrum that closely replicates natural sunlight over the more damaging UV portion of the spectrum. The program used for polymers intended for external applications is based on an SAE international specification for the Accelerated Exposure of Automotive Exterior Materials, SAE J1960. Atlas Ci35A settings for this program are given in Table 2 on page 3.

Oyster baskets supplied were sectioned and exposed as per Table 2. Laboratory test pieces were also produced and are being tested. All these have been exposed for 200, 500 & 1000 hrs. Visual observation has been carried out & key property testing has been carried out. Taken from the automotive industry, a Grey Scale Rating was used as the colour change assessment tool. These results are shown in Table 4 (refer page 3). No major differences in appearance or properties are visually observed to 1,000 hours weathering.

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PARAMETER	Exterior settings	
	Light Cycle	Dark Cycle
Lamp Filters	Quartz inner, Borosilicate outer	Quartz inner, Borosilicate outer
Cycle	120 min, (40min light, 20min light with water spray, 60 min light)	60 min
Irradiance	0.55 W/m^2	-
Black Panel Temperature	70°C	38°C
Dry Bulb Temperature	47°C	38°C
Wet Bulb Depression	12°C	0
Relative Humidity	50 ± 5 %	95 ± 5 %
Conditioning water	45°C	40°C
Specimen Spray	On	On
Rack Spray	On	On

Table 2: Atlas Weatherometer Settings (SAE J1960 Automotive Exterior Program)

Grey Scale Rating relative to an unexposed control of the same material is shown below in Table 3. This is a comparative visual system used in the automotive and textile sectors. A rating explanation follows :

Rating of 5 : No noticeable change (nnc)
Rating of 4 : Slight change, hard to see by eye
Rating of 3 : Some change, able to be seen by most people
Rating of 2 : Significant change
Rating of 1 : Major change.

Exposure Time (hrs)	Grey Scale Rating	
	Sectioned Oyster Baskets Pieces	[redacted] + 2.0% Carbon Black masterbatch
200	5 nnc	5 nnc
500	5 nnc	5 nnc
1000	5 nnc	5 nnc
1500	5 nnc	5 nnc
2000	4 - 5	4 - 5

Table 3: Colour Shift in Grey Scale Rating Units Following Atlas Exposure

Test Property	As Moulded	500 hours	1,000 hours	2,000 hours
Tensile Strength (MPa)	28.4	28.6	28.9	27.3
Flexural Modulus (MPa)	1,080	1,070	1,030	1,100
Elongation to Fail (%)	414	402	390	345
Durometer Hardness (D)	66	66	67	68
Izod Impact Strength (J/m)	86	76	71	64

Table 4: [redacted] + 2% Carbon Black Masterbatch Weathering (2.0% carbon black)

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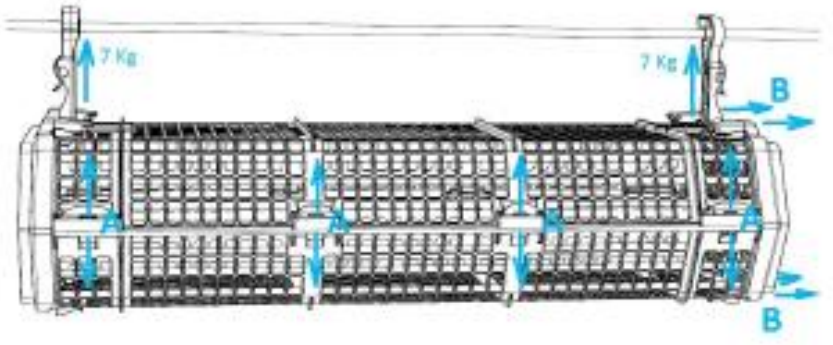
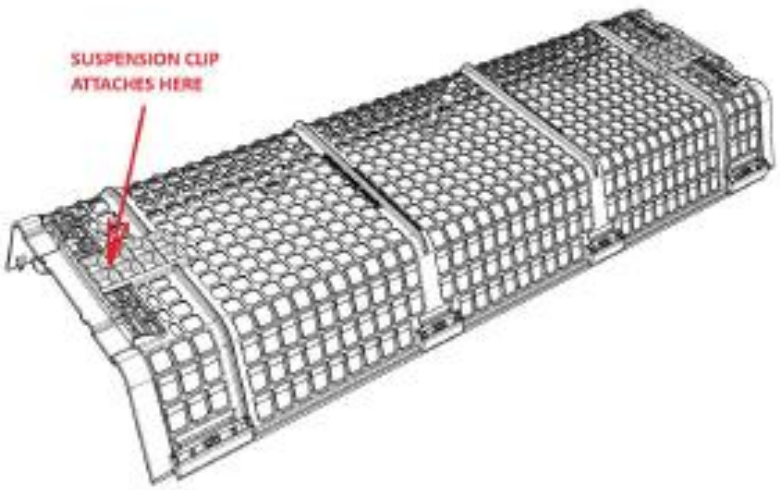
2.0 Strength of Oyster Baskets :

2.1 Background

It was decided to combine product thermocycling with a loaded assembly drop test and falling ball drop impact test to gauge the strength of the oyster baskets. Thermocycling (and testing at 5^{0}C) ensures pre-conditioning of the assembly before testing and ensures difficult field performance conditions are simulated. No customer specifications exist, rough guidelines for loading were provided ex Ian Prendagast in early April (sketches below). The thermocycle conditions chosen were -20^{0}C to +50^{0}C for three cycles.





2.2 Investigation

Fully assembled parts were exposed in the Votsch Environmental Chamber, thermocycling between -20°C and +50°C for a total of 22.5 hours, followed by conditioning at 5°C for 1.5 hrs prior to drop testing. Details of the programme are given in Table 5 (refer page 5) and the test chamber set-up is shown in Photograph 1 (refer page 5). Due to the size of the assembled baskets, parts were required to be exposed individually, placed diagonally in the chamber and supported across the base of the basket using a polypropylene stand.

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Exposure Temperature (°C)	Exposure Time (hrs)
+50	5.0
-20	2.5
+50	5.0
-20	2.5
+50	5.0
-20	2.5
+5	1.5

Table 5: 24hr Thermocycling Programme for Oyster Basket Exposure

Photograph 1: Oyster Basket Positioned in Votsch Chamber and Supported Across Rib with Polypropylene Stand

Photograph 1 : Drop Tube Assembly

Photograph 3: Drop Tube Positioned Over Point of Maximum Load

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On completion of the exposure period, moulded parts were removed from the chamber and immediately dropped from a height of 1 metre onto a concrete floor. Parts were inspected for deformation or damage and then subjected to a falling weight, also from a height of 1 metre (see Photographs 2 and 3 (refer page 5)). Weights of 2.5 kg, 5 kg and 7.5 kg were used with each test site subjected to only one impact from a single weight. The test sites were selected from drawings supplied by Proen Design, illustrating the point of highest applied force being the rectangular area where the suspension clips are attached. Parts were again inspected for damage and results recorded.

2.3 Results

Both assemblies were dropped in full onto the concrete floor immediately on removal from the chamber. Assessment of the assemblies after impact showed no indication of visible deformation or failure of the assembly structure or closures.

Assembly 1 was impacted at one end with 2.5 kg weight and at the other by a 5.0 kg weight. Again, there was no evidence of significant deformation and all closures remained intact.

Assembly 2 was impacted at one end with a 7.5 kg weight, this time resulting in noticeable visible deformation of the assembly, minor disassembly of the body but without fracture of the material. The closures at the impacted end failed to remain locked. The test was repeated on the second end with similar results.

Both assemblies are available for inspection on request.

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