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## APPENDIX A

### SAMPLE CALCULATION

#### 1. Calculation of tensile strength

ASTM D882

Calculation of the tensile strength on the basis of the original cross-sectional area of the test specimen, by the equation

$$\sigma = F/A$$

where

$\sigma$  is the tensile strength, in megapascals (MPa).

F is the force, in newtons (N).

A is the initial cross-sectional area, in square millimetres ( $\text{mm}^2$ ), of the test specimen.

#### 2. Calculation of elongation at break

ASTM D882

Calculation of the percentage elongation at break on the basis of the original gauge length, by the formula

$$(l - l_0) / l_0 \times 100$$

where

l is the distance, in millimetres, between the gauge marks at break.

$l_0$  is the original gauge length, in millimetres.

3. Calculation of intrinsic viscosity

ASTM 1601

## 3.1 Relative viscosity (viscosity ratio)

Calculation of the relative viscosity for each concentration is measured from the average efflux time as follows

$$\eta_r = t/t_0$$

where

$\eta_r$  = relative viscosity (viscosity ratio)

t = average efflux time of solution

$t_0$  = average efflux time of pure solvent

## 3.2 Intrinsic viscosity (logarithmic viscosity number)

Calculation of the inherent viscosity for each concentration is measured as follows

$$\eta_{inh} = (\ln \eta_r) / C$$

where

$\eta_{inh}$  = inherent viscosity at concentration C

$\ln \eta_r$  = natural logarithm of the relative viscosity

C = concentration in grams/ml of solution

## 3.3 Specific viscosity

$$\eta_{sp} = \eta_r - 1$$

where

$\eta_{sp}$  = specific viscosity

### 3.4 Reduced viscosity

$$\eta_{\text{red}} = \eta_{\text{sp}}/C$$

where

$\eta_{\text{red}}$  = reduced viscosity

### 3.5 Intrinsic viscosity

The four logarithmic viscosity numbers are plotted versus their respective concentrations on rectilinear graph paper and then the four reduced viscosity numbers are plotted versus their respective concentrations on the same graph. The slopes of these two lines will not be the same, but they converge to the same value at zero concentration. The intrinsic viscosity,  $[\eta]$ , is the intercept of the line at zero concentration.

Example A.1 Find intrinsic viscosity of original LDPE sample

Viscosity measurement of LDPE for original test sample at 70 c

concentration (g/dl)	$t_1$	$t_2$	$t_3$	$t_{avg}$	$\eta_r$	$\eta_{sp}$	$\eta_{sp}/C$	$\ln \eta_r/C$
solvent	124.44	124.52	124.54	124.50				
0.40	182.55	182.47	182.61	182.54	1.47	0.47	1.17	0.96
0.24	155.11	155.08	154.99	155.06	1.25	0.25	1.02	0.92
0.16	145.12	145.14	144.95	145.07	1.17	0.17	1.03	0.96
0.08	134.63	134.52	134.71	134.62	1.08	0.08	1.02	0.98

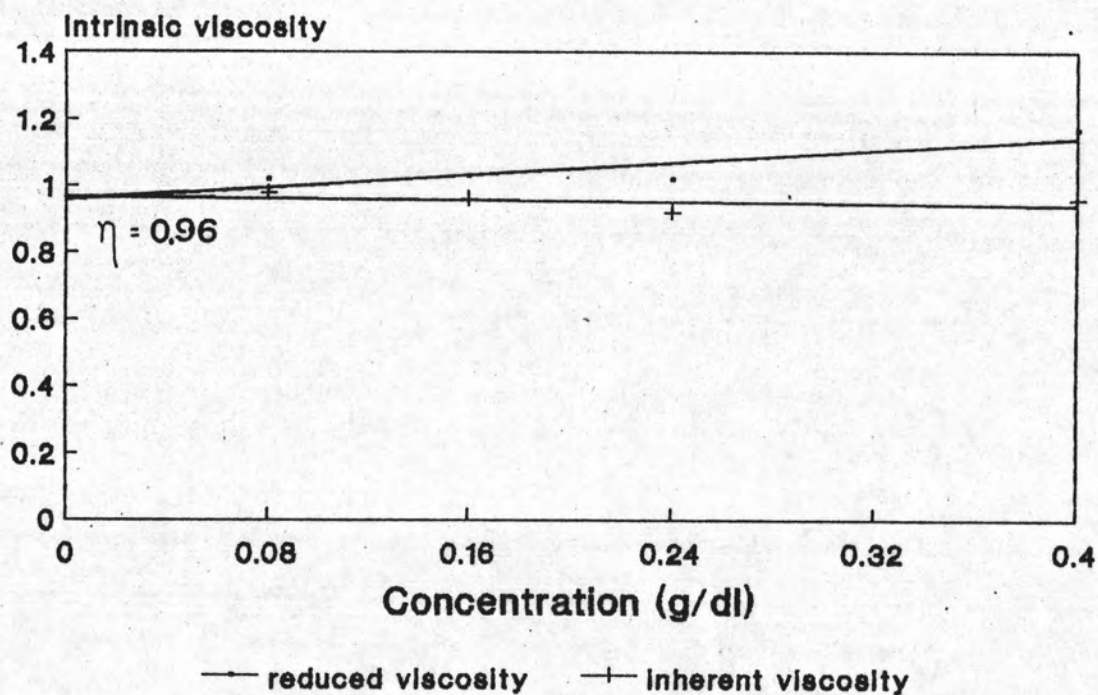


Figure A.1 Intrinsic viscosity of original LDPE sample

Intrinsic viscosity = 0.96

Example A.2 Find intrinsic viscosity of original HDPE sample

Viscosity measurement of HDPE for original test sample at 135 c

concentration (g/dl)	$t_1$	$t_2$	$t_3$	$t_{avg}$	$\eta_r$	$\eta_{sp}$	$\eta_{sp}/C$	$\ln \eta_r/C$
solvent	65.96	65.90	65.99	65.95				
0.40	168.85	168.92	168.77	168.85	2.56	1.56	3.90	2.35
0.24	113.38	113.35	113.32	113.35	1.72	0.72	2.99	2.26
0.16	95.79	95.67	95.62	95.69	1.45	0.45	2.82	2.33
0.08	79.18	79.27	79.38	79.28	1.20	0.20	2.53	2.30

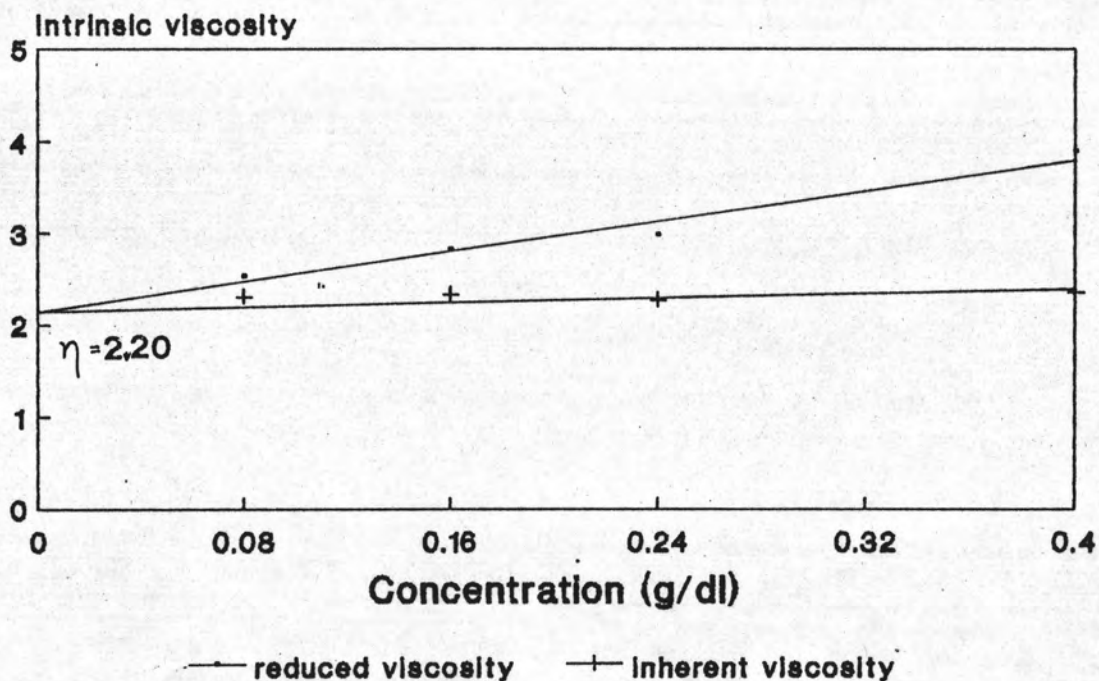


Figure A.2 Intrinsic viscosity of original HDPE sample

Intrinsic viscosity = 2.20

APENDIX B

FTIR DATA

Table B.1 Changes in the relative infrared absorbance peaks of LDPE films

I. Outdoor exposure

(a) Internal standard peak

Sensitizer Exposure time	Absorbance value at 2019 cm <sup>-1</sup>						
	no additive	benzo-phenone	4-methoxy benzo-phenone	thioxan-thone	anthra-quinone	2-methyl anthra-quinone	2-tert-butylanthraquinone
original	0.05	0.05	0.05	0.06	0.07	0.05	0.06
2 weeks	0.04	NA	0.04	0.06	NA	0.05	0.05
1 month	0.06	NA	0.08	0.04	NA	0.04	0.04
3 months	0.05	NA	0.08	0.05	NA	0.05	0.07
6 months	0.08	0.04	0.04	0.06	0.04	0.02	0.02

Note NA = Not available



(b) Carbonyl group ( $1715\text{ cm}^{-1}$ )

Sensitizer Exposure time	Absorbance value at $1715\text{ cm}^{-1}$						
	no additive	benzo- phenone	benzo- phenone	4-methoxy thioxan- thone	anthra- quinone	2-methyl anthra- quinone	2-tert- butylanthra quinone
original	0.00	0.05	0.05	0.06	0.06	0.00	0.04
2 weeks	0.02	NA	0.08	0.16	NA	0.04	0.07
1 month	0.07	NA	0.17	0.11	NA	0.20	0.15
3 months	0.11	NA	0.25	0.16	NA	0.25	0.32
6 months	0.19	0.21	0.28	0.27	0.25	0.21	0.27

(c) Vinyl group ( $909\text{ cm}^{-1}$ )

Sensitizer Exposure time	Absorbance value at $909\text{ cm}^{-1}$						
	no additive	benzo- phenone	benzo- phenone	4-methoxy thioxan- thone	anthra- quinone	2-methyl anthra- quinone	2-tert- butylanthra quinone
original	0.04	0.07	0.07	0.07	0.07	0.04	0.06
2 weeks	0.04	NA	0.07	0.08	NA	0.05	0.06
1 month	0.05	NA	0.07	0.10	NA	0.06	0.07
3 months	0.10	NA	0.12	0.10	NA	0.06	0.08
6 months	0.11	0.08	0.13	0.14	0.10	0.12	0.13

Note NA = Not available

## II. Irradiation using medium pressure mercury lamp

## (a) Internal standard peak

Photosensitizer	$A_{2019}$	
	original	30 hours
No additive	0.05	0.05
Benzophenone	0.05	0.05
4-Methoxybenzophenone	0.05	0.07
Thioxanthone	0.06	0.05
Anthraquinone	0.06	0.05
2-Methylanthraquinone	0.05	0.05
2-tert-Butylanthraquinone	0.06	0.05

(b) Carbonyl group ( $1715\text{ cm}^{-1}$ )

Photosensitizer	$A_{1715}$	
	original	30 hours
No additive	0.00	0.06
Benzophenone	0.05	0.08
4-Methoxybenzophenone	0.05	0.14
Thioxanthone	0.07	0.23
Anthraquinone	0.06	0.18
2-Methylanthraquinone	0.00	0.11
2-tert-Butylanthraquinone	0.04	0.11

(c) Vinyl group ( $909\text{ cm}^{-1}$ )

Photosensitizer	$A_{909}$	
	original	30 hours
No additive	0.04	0.08
Benzophenone	0.07	0.11
4-Methoxybenzophenone	0.07	0.16
Thioxanthone	0.07	0.16
Anthraquinone	0.07	0.12
2-Methylanthraquinone	0.04	0.10
2-tert-Butylanthraquinone	0.06	0.06

Table B.2 Changes in the relative infrared absorbance peaks of HDPE films

I. Outdoor exposure

(a) Internal standard peak

Sensitizer Exposure time	Absorbance value at 2019 $\text{cm}^{-1}$						
	no additive	benzo- phenone	benzo- phenone	4-methoxy thioxan- thone	anthra- quinone	2-methyl anthra- quinone	2-tert- butylanthra quinone
original	0.11	0.10	0.09	0.11	0.09	0.11	0.10
2 weeks	0.10	NA	0.09	0.10	NA	0.10	0.09
1 month	0.13	NA	0.16	0.12	NA	0.17	0.10
2 months	0.12	0.09	0.11	0.10	0.10	0.11	0.10
3 months	0.03	0.03	0.04	0.03	0.03	0.03	0.04

Note NA = Not available

(b) Carbonyl group ( $1715\text{ cm}^{-1}$ )

Sensitizer Exposure time	Absorbance value at $1715\text{ cm}^{-1}$						
	no additive	benzo- phenone	4-methoxy benzo- phenone	thioxan- thone	anthra- quinone	2-methyl anthra- quinone	2-tert- butylanthra quinone
original	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 weeks	0.00	NA	0.09	0.13	NA	0.10	0.11
1 month	0.00	NA	0.17	0.18	NA	0.20	0.14
2 months	0.11	0.11	0.15	0.18	0.13	0.14	0.20
3 months	0.02	0.08	0.08	0.11	0.11	0.09	0.12

(c) Vinyl group ( $909\text{ cm}^{-1}$ )

Sensitizer Exposure time	Absorbance at $909\text{ cm}^{-1}$						
	no additive	benzo- phenone	4-methoxy benzo- phenone	thioxan- thone	anthra- quinone	2-methyl anthra- quinone	2-tert- butylanthra quinone
original	0.02	0.02	0.02	0.03	0.03	0.03	0.03
2 weeks	0.03	NA	0.03	0.03	NA	0.04	0.04
1 month	0.03	NA	0.05	0.05	NA	0.05	0.06
2 months	0.06	0.05	0.07	0.08	0.04	0.06	0.07
3 months	0.10	0.05	0.10	0.08	0.06	0.16	0.08

Note NA = Not available

## II. Irradiation using medium pressure mercury lamp

## (a) Internal standard peak

Photosensitizer	$A_{2019}$	
	original	8 hours
No additive	0.11	0.02
Benzophenone	0.10	0.04
4-Methoxybenzophenone	0.09	0.03
Thioxanthone	0.11	0.03
Anthraquinone	0.09	0.03
2-Methylanthraquinone	0.11	0.05
2-tert-Butylanthraquinone	0.10	0.03

(b) Carbonyl group ( $1715 \text{ cm}^{-1}$ )

Photosensitizer	$A_{1715}$	
	original	8 hours
No additive	0.00	0.01
Benzophenone	0.00	0.06
4-Methoxybenzophenone	0.00	0.05
Thioxanthone	0.00	0.08
Anthraquinone	0.00	0.08
2-Methylanthraquinone	0.00	0.10
2-tert-Butylanthraquinone	0.00	0.09

(c) Vinyl group ( $909\text{ cm}^{-1}$ )

Photosensitizer	$A_{909}$	
	original	8 hours
No additive	0.02	0.03
Benzophenone	0.02	0.05
4-Methoxybenzophenone	0.02	0.03
Thioxanthone	0.03	0.04
Anthraquinone	0.03	0.03
2-Methylanthraquinone	0.03	0.06
2-tert-Butylanthraquinone	0.03	0.04

APPENDIX C

YELLOWNESS INDEX

Table C Yellowness index of polyethylene films

Photosensitizer	Yellowness index	
	LDPE	HDPE
No additive	7.73	7.72
Benzophenone	7.64	9.74
4-Methoxybenzophenone	7.59	8.52
Thioxanthone	9.51	11.66
Anthraquinone	9.32	9.47
2-Methylanthraquinone	9.43	12.35
2-tert-Butylanthraquinone	8.20	9.15

Note The polyethylene films were measured by Double Beam Spectrophotometer



## VITA

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