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APPENDICE

APPENDIX A

1. Viscosity – average molecular weight determination by solution viscosity

Measurement of solution viscosity is usually made by comparing efflux time of polymer solution (t) to flow through a capillary tube with corresponding efflux time of solvent (t_0). Relative viscosity (η_r) is determined by ratio of t and t_0 .

$$\eta_r = t/t_0$$

Specific viscosity (η_{sp}) is determined by relative viscosity minus one.

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

Plot graph between η_{sp} divided by concentration and concentration of polymer solution. Extrapolated to zero concentration, yields the intrinsic viscosity [η], showed in Table A.1 and Figure A.1. Viscosity – average molecular weight (\bar{M}_v) is determined using Mark – Houwink relationship.

$$[\eta] = K\bar{M}_v^a$$

Where^[24] $K = 50.2 \times 10^{-3}$ ml/g

$a = 0.667$

$T = 25$ °C

Solvent as Toluene

From Figure A.1

$$[\eta] = 783.28$$

$$\bar{M}_v = 1,934,981$$

Table A.1 Specific viscosity of natural rubber solution

C (g/ml)	t ₁ (s)	t ₂ (s)	t (s)	η _r	η _{sp}	η _{sp} /C (ml/g)
0	64.25	64.25	64.25	0	0	0
0.0008	106.32	106.47	106.40	1.6560	0.6560	819.94
0.0009	112.14	112.22	112.18	1.7460	0.7460	828.88
0.0011	124.11	123.13	123.62	1.9240	0.9240	840.00
0.0013	135.82	134.17	135.00	2.1011	1.1011	847.00
0.0016	153.44	152.08	152.76	2.3776	1.3776	861.00

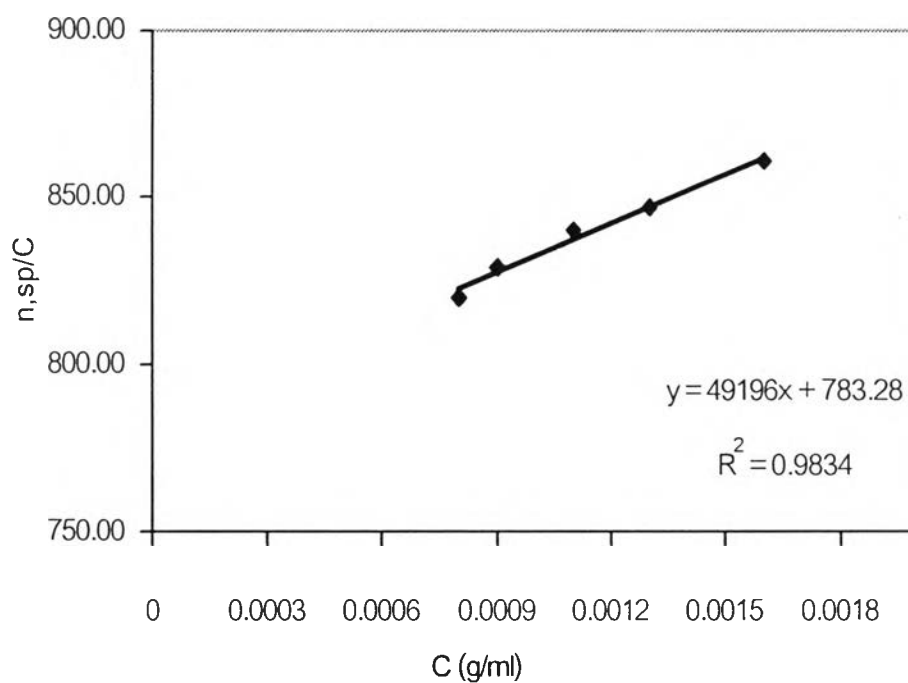


Figure A.1 Intrinsic viscosity of natural rubber solution

Table A.2 Viscosity-average molecular weight of natural rubber after UV exposure under accelerated condition for 15 – 120 min.

Time to UV exposure (min)	\bar{M}_v of NR	\bar{M}_v of NR + 0.05% w/v TiO ₂
15	1,024,964	701,788
30	964,665	621,393
60	780,307	376,309
90	730,328	266,542
120	719,032	150,705

Table A.3 Viscosity-average molecular weight of natural rubber + TiO₂ powder after UV exposure under accelerated condition for 60 min.

% w/v of TiO ₂	\bar{M}_v of NR
0.05	376,309
0.5	365,369
1	345,759
5	304,932

Table A.4 Viscosity-average molecular weight of rubber sheets after UV exposure under accelerated condition for 60 – 150 min.

Time to exposure (min)	\bar{M}_v of NR	\bar{M}_v of NR + 0.5 %w/w TiO ₂ powder	\bar{M}_v of NR + 0.5 %w/w TiO ₂ microparticles
60	1,154,921	1,007,244	1,073,546
120	960,878	821,217	711,560
150	924,616	785,191	658,741

Table A.5 Viscosity-average molecular weight of rubber sheets + TiO₂ powder after UV exposure under accelerated condition for 120 min.

% w/v of TiO ₂ powder	\bar{M}_v of NR
0.1	821,217
0.5	819,451
1	800,569
5	759,365

Table A.6 Viscosity-average molecular weight of rubber sheets + TiO₂ microparticles after UV exposure under accelerated condition for 120 min.

% w/v of TiO ₂ microparticles	\bar{M}_v of NR
0.5	711,560
1	700,478
3	681,265
5	653,178

Table A.7 Viscosity-average molecular weight of rubber sheets after exposed to sunlight for 1 – 4 days

Time to exposure (day)	\bar{M}_v of NR	\bar{M}_v of NR + 0.5 %w/w TiO ₂ powder	\bar{M}_v of NR + 0.5 %w/w TiO ₂ microparticles
1	920,765	416,540	619,542
2	725,300	390,351	292,314
3	400,938	283,561	177,715
4	105,548	89,613	86,594

2. Tensile strength of vulcanized rubbers

Table A.8 Tensile strength of vulcanized rubber after exposed to sunlight
for 15 days

Time to exposed sunlight (days)	1 st Experiment	2 nd Experiment	Tensile strength average (MPa)	Standard derivation
NR				
0	16.0	17.4	16.7	0.10
5	14.0	15.5	14.8	0.11
10	15.8	11.5	13.6	0.31
15	12.1	11.1	11.6	0.07
NR + 1%w/w TiO ₂ powder				
5	12.6	14.4	13.5	0.13
10	13.2	12.0	12.6	0.08
15	11.5	10.4	11.0	0.08
NR + 1%w/w TiO ₂ microparticles				
5	13.5	12.4	13.0	0.08
10	12.9	11.0	12.0	0.13
15	10.0	10.2	10.1	0.01

3. Elongation at break of vulcanized rubbers

Table A.9 Elongation at break of vulcanized rubbers after exposed to sunlight for 15 days

Time to exposed sunlight (days)	1 st Experiment	2 nd Experiment	%Elongation average	Standard derivation
NR				
0	1104	1024	1064	40
5	764	860	812	48
10	436	1048	742	306
15	732	1040	886	154
NR + 1%w/w TiO ₂ powder				
5	936	1056	996	60
10	932	980	956	24
15	412	1000	706	294
NR + 1%w/w TiO ₂ microparticles				
5	1034	996	1015	19
10	1044	876	960	58
15	936	884	910	26

VITA

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