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ศูนย์วิทยทรัพยากร  
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APPENDICES

ศูนย์วิทยทรัพยากร  
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## APPENDIX A

### 1. Conversion of Graft Copolymerization

The grafted samples are characterized according to following equation:

$$\text{Total Conversion (\%)} = \frac{\text{Total weight of polymer formed}}{\text{Weight of monomer charged}} \times 100 \quad (\text{A-1})$$

### 2. Percentage of Grafted Natural Rubber

The products, therefore, contain three components in quantities a, b, and c respectively.

- a. is the weight of free rubber determined by Soxhlet extraction with light petroleum ether (60-80 °C) for 24 h.
- b. is the weight of graft copolymer determined from the residual weight after extraction of free homopolymers.
- c. is the weight of free PMMA determined by Soxhlet extraction with acetone for 24 h.

These quantities combined into a single expression are a measure of the grafted natural rubber.

$$\% \text{ Grafted Natural Rubber} = \frac{b}{a + b + c} \times 100 \quad (\text{A-2})$$

### 3. Percentage of Grafting Efficiency

$$\% \text{ Grafting Efficiency} = \frac{\text{The weight of polymers as grafted copolymer}}{\text{The total weight of polymer formed}} \times 100 \text{ (A-3)}$$



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**Table A-1** Effect of CHPO concentration, reaction temperature, monomer concentration, and reaction time on the percentage conversion, percentage grafted natural rubber, and percentage grafting efficiency.

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
60C <sub>0.50</sub>	50.08	54.91	60.04	82.81	2.0035	0.2571	0.2108	12.83	10.52	76.65	24.84	5.78	19.06	76.74
	50.07	52.24	56.88	79.20	2.0046	0.2532	0.2553	12.63	12.74	74.63	23.76	6.65	17.11	72.00
60C <sub>1.0</sub>	50.08	54.74	60.04	82.24	2.0135	0.2334	0.3034	11.59	15.07	73.34	24.67	8.25	16.42	66.57
	50.08	52.84	56.88	81.18	2.0085	0.2026	0.3193	10.09	15.90	74.02	24.35	8.40	15.95	65.51
60C <sub>1.5</sub>	50.09	56.37	60.04	87.65	2.0064	0.1422	0.3287	7.09	16.38	76.53	26.30	9.23	17.06	64.88
	50.04	54.57	56.88	87.02	2.0038	0.2028	0.3850	10.12	19.21	70.67	26.11	10.48	15.62	59.84
60C <sub>2.0</sub>	50.06	54.78	60.04	82.41	2.0093	0.1955	0.3433	9.73	17.09	73.18	24.72	9.36	15.36	62.14
	50.08	54.64	56.88	87.18	2.0084	0.2094	0.3768	10.43	18.76	70.81	26.15	10.25	15.90	60.81
50C <sub>0.50</sub>	50.04	55.15	60.04	83.69	2.0059	0.1905	0.1418	9.50	7.07	83.43	25.11	3.90	21.21	84.47
	50.10	53.67	56.88	83.91	2.0084	0.1642	0.1485	8.18	7.39	84.43	25.17	3.97	21.20	84.24
50C <sub>1.0</sub>	50.06	55.21	60.04	83.85	2.0135	0.1294	0.3703	6.43	18.39	75.18	25.15	10.15	15.00	59.63
	50.06	53.86	56.88	84.62	2.0057	0.1708	0.3615	8.52	18.02	73.46	25.39	9.71	15.68	61.76
50C <sub>1.5</sub>	50.07	56.61	60.04	88.49	2.0065	0.1218	0.4104	6.07	20.45	73.48	26.55	11.58	14.97	56.39
	50.09	55.12	56.88	88.76	2.0057	0.1715	0.4313	8.55	21.50	69.95	26.63	11.85	14.78	55.49
50C <sub>2.0</sub>	50.08	56.03	60.04	86.54	2.0117	0.1320	0.4396	6.56	21.85	71.59	25.96	12.24	13.72	52.84
	50.06	54.29	56.88	86.05	2.0014	0.1624	0.4289	8.11	21.43	70.46	25.82	11.63	14.18	54.93



Table A-1 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
40C <sub>0.50</sub>	50.04	51.42	60.04	71.25	2.0051	0.2493	0.1863	12.43	9.29	78.28	21.38	4.78	16.60	77.65
	50.12	50.12	56.88	72.04	2.0058	0.2755	0.1711	13.74	8.53	77.73	21.61	4.28	17.34	80.22
40C <sub>1.0</sub>	50.06	57.21	60.04	90.51	2.0100	0.1679	0.3753	8.35	18.67	72.98	27.15	10.68	16.47	60.66
	50.09	55.71	56.88	90.73	2.0044	0.1843	0.3753	9.19	18.72	72.08	27.22	10.43	16.79	61.68
40C <sub>1.5</sub>	50.08	55.33	60.04	84.21	2.0182	0.1717	0.4350	8.51	21.55	69.94	25.26	11.93	13.34	52.79
	50.09	53.78	56.88	84.30	2.0062	0.1233	0.4376	6.15	21.81	72.04	25.29	11.73	13.56	53.61
40C <sub>2.0</sub>	50.06	56.03	60.04	86.58	2.0120	0.1346	0.4871	6.69	24.21	69.10	25.97	13.56	12.41	47.78
	50.03	53.15	56.88	82.31	2.0076	0.1514	0.4583	7.54	22.83	69.63	24.69	12.13	12.56	50.86
30C <sub>0.50</sub>	50.06	44.80	60.04	49.15	2.0040	0.2813	0.1766	14.04	8.81	77.15	14.74	3.95	10.80	73.22
	50.06	43.78	56.88	51.02	2.0074	0.2343	0.1802	11.67	8.98	79.35	15.31	3.93	11.38	74.32
30C <sub>1.0</sub>	50.05	50.20	60.04	67.17	2.0083	0.2834	0.2577	14.11	12.83	73.06	20.15	6.44	13.71	68.03
	50.06	48.18	56.88	65.69	2.0070	0.2352	0.2561	11.72	12.76	75.52	19.71	6.15	13.56	68.80
30C <sub>1.5</sub>	50.02	55.49	60.04	84.86	2.0119	0.1986	0.4688	9.87	23.30	66.83	25.46	12.93	12.53	49.21
	50.02	53.43	56.88	83.26	2.0060	0.1474	0.4468	7.35	22.27	70.38	24.98	11.90	13.08	52.36
30C <sub>2.0</sub>	50.03	57.15	60.04	90.37	2.0078	0.1511	0.5206	7.53	25.93	66.55	27.11	14.82	12.29	45.34
	50.04	56.19	56.88	92.42	2.0029	0.1514	0.5695	7.56	28.43	64.01	27.73	15.98	11.75	42.38

Table A-1 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
M <sub>40</sub>	50.05	37.02	56.88	71.26	2.0048	0.1469	0.1489	7.32	7.42	85.25	8.55	2.75	5.80	67.86
	50.06	38.68	60.48	70.03	2.0070	0.1971	0.1422	9.82	7.08	83.10	8.40	2.74	5.66	67.40
M <sub>60</sub>	50.03	40.88	56.88	69.02	2.0090	0.1649	0.1783	8.21	8.88	82.92	12.42	3.63	8.79	70.79
	50.06	43	60.48	70.69	2.0071	0.1537	0.1797	7.66	8.95	83.39	12.72	3.85	8.87	69.74
M <sub>80</sub>	50.06	46.15	56.88	73.65	2.0063	0.1470	0.2130	7.32	10.62	82.06	17.68	4.90	12.78	72.28
	50.08	47.77	59.99	73.86	2.0049	0.1531	0.2230	7.64	11.12	81.24	17.73	5.31	12.41	70.03
M <sub>100</sub>	50.04	55.15	60.04	83.69	2.0059	0.1905	0.1418	9.50	7.07	83.43	25.11	3.90	21.21	84.47
	50.10	53.67	56.88	83.91	2.0084	0.1642	0.1485	8.18	7.39	84.43	25.17	3.97	21.20	84.24
M <sub>120</sub>	50.07	56.13	59.99	72.48	2.0019	0.2469	0.2661	12.33	13.29	74.38	26.09	7.46	18.63	71.41
	50.04	55.61	60.48	70.41	2.0077	0.2871	0.2889	14.30	14.39	71.31	25.35	8.00	17.34	68.43
t <sub>4</sub>	50.08	31.38	4.46	59.99	2.0063	0.2499	0.0677	12.45	3.37	84.17	1.34	1.06	0.28	20.86
	50.07	31.54	5.01	59.99	2.0049	0.2647	0.0737	13.20	3.68	83.12	1.50	1.16	0.34	22.86
t <sub>6</sub>	50.07	41.48	38.14	59.99	2.0049	0.2072	0.1935	10.33	9.65	80.02	11.44	4.00	7.44	65.02
	50.06	42.34	41.03	59.99	2.0086	0.2135	0.1794	10.63	8.93	80.44	12.31	3.78	8.53	69.29
t <sub>8</sub>	50.04	55.15	83.69	60.04	2.0059	0.1905	0.1418	9.50	7.07	83.43	25.11	3.90	21.21	84.47
	50.10	53.67	83.91	56.88	2.0084	0.1642	0.1485	8.18	7.39	84.43	25.17	3.97	21.20	84.24
t <sub>10</sub>	50.08	50.4	67.86	59.99	2.0065	0.2254	0.2042	11.23	10.17	78.59	20.36	5.13	15.23	74.81
	50.02	51.2	69.83	60.48	2.0014	0.1979	0.2202	9.89	11.00	79.11	20.95	5.63	15.31	73.11

**Table A-2** Effect of TBHP concentration, reaction temperature, monomer concentration, and reaction time on the percentage conversion, percentage grafted natural rubber, and percentage grafting efficiency.

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
60T <sub>0.50</sub>	50.08	55.22	60.04	83.84	2.0072	0.1846	0.2722	9.20	13.56	77.24	25.15	7.49	17.66	70.23
	50.07	52.80	56.88	81.07	2.0064	0.1965	0.3058	9.79	15.24	74.97	24.32	8.05	16.27	66.91
60T <sub>1.0</sub>	50.10	55.64	60.04	85.20	2.0053	0.1881	0.2786	9.38	13.89	76.73	25.56	7.73	17.83	69.76
	50.05	53.48	56.88	83.37	2.0053	0.1144	0.2953	5.70	14.73	79.57	25.01	7.88	17.14	68.51
60T <sub>1.5</sub>	50.01	57.11	60.04	90.28	2.0073	0.1332	0.3188	6.64	15.88	77.48	27.08	9.07	18.01	66.51
	50.01	56.19	56.88	92.48	2.0084	0.1271	0.3345	6.33	16.66	77.02	27.74	9.36	18.39	66.27
60T <sub>2.0</sub>	50.06	56.51	60.04	88.18	2.0085	0.1488	0.3718	7.41	18.51	74.08	26.45	10.46	15.99	60.46
	50.04	54.75	56.88	87.62	2.0045	0.1116	0.3804	5.57	18.98	75.46	26.29	10.39	15.90	60.47
50T <sub>0.50</sub>	50.06	55.18	60.04	83.75	2.0048	0.1518	0.2477	7.57	12.36	80.07	25.42	6.85	18.57	73.04
	50.06	52.87	56.88	81.32	2.0029	0.1479	0.2342	7.38	11.69	80.92	27.01	6.49	20.52	75.98
50T <sub>1.0</sub>	50.04	55.48	60.04	84.79	2.0096	0.1699	0.3531	8.45	17.57	73.97	24.87	9.65	15.22	61.20
	50.04	53.62	56.88	83.86	2.0038	0.1600	0.3699	7.98	18.46	73.56	26.45	10.14	16.31	61.67
50T <sub>1.5</sub>	50.05	54.91	60.04	82.87	2.0111	0.1494	0.4115	7.43	20.46	72.11	26.93	11.66	15.27	56.71
	50.05	53.10	56.88	82.11	2.0037	0.1148	0.4160	5.73	20.76	73.51	28.51	11.83	16.68	58.51
50T <sub>2.0</sub>	50.05	56.98	60.04	89.77	2.0055	0.1235	0.4387	6.16	21.87	71.97	26.93	12.46	14.47	53.72
	50.05	54.19	56.88	85.74	2.0075	0.0905	0.4117	4.51	20.51	74.98	25.72	11.11	14.61	56.79

Table A-2 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
40T <sub>0.50</sub>	50.06	48.69	60.04	62.11	2.0047	0.1912	0.2163	9.54	10.79	79.67	18.63	5.25	13.38	71.81
	50.06	46.52	56.88	60.15	2.0048	0.2393	0.2069	11.94	10.32	77.74	18.05	4.80	13.24	73.40
40T <sub>1.0</sub>	50.03	54.97	60.04	83.11	2.0037	0.1522	0.3910	7.60	19.51	72.89	24.93	9.50	15.43	61.89
	50.03	52.93	56.88	81.58	2.0079	0.1610	0.3845	8.02	19.15	72.83	26.51	10.53	15.99	60.30
40T <sub>1.5</sub>	50.09	57.11	60.04	90.12	2.0049	0.1762	0.4795	8.79	23.92	67.30	24.90	13.15	11.75	47.19
	50.09	56.19	56.88	92.33	2.0033	0.1770	0.4884	8.84	24.38	66.78	28.62	13.92	14.70	51.35
40T <sub>2.0</sub>	50.12	56.51	60.04	88.06	2.0105	0.2447	0.5197	12.17	25.85	61.98	27.02	14.76	12.26	45.36
	50.12	54.31	56.88	86.01	2.0027	0.1965	0.5472	9.81	27.32	62.87	28.00	15.44	12.56	44.86
30T <sub>0.50</sub>	50.06	43.47	60.04	44.71	2.0096	0.2866	0.2672	14.26	13.30	72.44	26.45	7.51	18.94	71.60
	50.06	41.85	56.88	44.59	2.0018	0.2867	0.2886	14.32	14.42	71.26	25.84	7.83	18.01	69.69
30T <sub>1.0</sub>	50.09	48.65	60.04	61.92	2.0081	0.2913	0.3331	14.51	16.59	68.91	18.58	8.07	10.51	56.56
	50.09	46.79	56.88	61.00	2.0073	0.2400	0.3605	11.96	17.96	70.08	18.30	8.40	9.90	54.08
30T <sub>1.5</sub>	50.04	55.98	60.04	86.45	2.0126	0.2237	0.4992	11.11	24.80	64.08	25.94	13.89	12.05	46.46
	50.04	53.92	56.88	84.86	2.0082	0.2654	0.5046	13.22	25.13	61.66	25.46	13.55	11.91	46.78
30T <sub>2.0</sub>	50.06	57.44	60.04	91.28	2.0059	0.2352	0.5729	11.73	28.56	59.71	27.38	16.41	10.98	40.09
	50.06	55.40	56.88	89.75	2.0026	0.2080	0.5576	10.39	27.84	61.77	26.93	15.43	11.50	42.71

Table A-2 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
M <sub>40</sub>	50.05	35.05	56.88	54.85	2.0031	0.1845	0.1565	9.21	7.81	82.98	6.58	2.74	3.84	58.41
	50.06	35.36	56.88	57.38	2.0058	0.1569	0.1628	7.82	8.12	84.06	6.89	2.87	4.02	58.32
M <sub>60</sub>	50.03	41.16	56.88	70.57	2.0039	0.1690	0.2071	8.43	10.33	81.23	12.70	4.25	8.45	66.51
	50.06	41.84	56.88	74.25	2.0071	0.1537	0.2187	7.66	10.90	81.45	13.37	4.56	8.81	65.89
M <sub>80</sub>	50.04	47.24	56.88	78.24	2.0054	0.1657	0.2389	8.26	11.91	79.82	18.78	5.63	13.15	70.03
	50.06	46.83	56.88	76.48	2.0045	0.1579	0.2415	7.88	12.05	80.07	18.36	5.64	12.71	69.26
M <sub>100</sub>	50.06	55.18	60.04	83.75	2.0048	0.1518	0.2477	7.57	12.36	80.07	25.12	6.82	18.31	72.86
	50.06	52.87	56.88	81.32	2.0029	0.1479	0.2342	7.38	11.69	80.92	24.40	6.18	18.21	74.66
M <sub>120</sub>	50.07	55.36	56.88	74.67	2.0046	0.2471	0.3468	12.33	17.30	70.37	26.88	9.58	17.30	64.37
	50.04	54.63	56.88	72.69	2.0066	0.1689	0.3736	8.41	18.62	72.97	26.17	10.17	16.00	61.13
t <sub>4</sub>	50.11	35.77	59.99	19.03	2.0060	0.4446	0.1409	22.16	7.02	70.82	5.71	2.51	3.20	56.01
	50.02	36.36	59.99	21.18	2.0038	0.4582	0.1532	22.86	7.65	69.49	6.35	2.78	3.57	56.24
t <sub>6</sub>	50.07	42.48	59.99	41.48	2.0037	0.2611	0.1680	13.03	8.38	78.59	12.44	3.56	8.88	71.38
	50.06	41.69	59.99	38.86	2.00745	0.26565	0.1680	13.23	8.37	78.40	11.66	3.49	8.17	70.08
t <sub>8</sub>	50.06	55.18	60.04	83.75	2.0039	0.1499	0.2410	7.48	12.02	80.50	25.12	6.64	18.49	73.59
	50.06	52.87	56.88	81.32	2.0029	0.1479	0.2342	7.38	11.69	80.92	24.40	6.18	18.21	74.66
t <sub>10</sub>	50.07	48.57	60.48	60.96	2.0023	0.1501	0.2790	7.50	13.93	78.57	18.29	6.77	11.52	62.99
	50.09	46.75	60.48	54.85	2.0048	0.1514	0.2688	7.55	13.41	79.04	16.46	6.27	10.19	61.92

**Table A-3** Effect of  $K_2S_2O_8$  concentration, reaction temperature, monomer concentration, and reaction time on the percentage conversion, percentage grafted natural rubber, and percentage grafting efficiency.

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
60(10%) $K_{0.50}$	50.07	50.74	60.48	68.19	2.0063	0.2290	0.4844	11.41	24.14	64.44	20.46	12.25	8.21	40.12
	50.07	51.16	60.48	69.59	2.0032	0.2252	0.4824	11.24	24.08	64.68	20.88	12.32	8.56	40.99
60(20%) $K_{1.0}$	50.05	51.20	60.48	69.77	2.0040	0.2207	0.3502	11.01	17.48	71.51	20.93	8.95	11.98	57.25
	50.10	52.68	60.48	74.60	2.0071	0.2316	0.3450	11.54	17.19	71.27	22.38	9.06	13.32	59.54
60(30%) $K_{1.5}$	50.05	44.28	60.48	46.70	2.002	0.2834	0.3436	14.16	17.16	68.68	14.01	7.60	6.41	45.75
	50.09	45.11	60.48	49.39	2.0049	0.2606	0.3501	13.00	17.46	69.54	14.82	7.88	6.94	46.83
60(40%) $K_{2.0}$	50.06	42.76	60.48	41.61	2.0059	0.4880	0.3537	24.33	17.63	58.04	12.48	7.54	4.94	39.60
	50.06	42.61	60.48	41.11	2.0070	0.4737	0.3524	23.60	17.56	58.84	12.33	7.48	4.85	39.34
70 $K_{0.50}$	50.06	54.07	60.48	79.31	2.0034	0.2828	0.5350	14.12	26.70	59.18	23.79	14.44	9.35	39.32
	50.02	53.23	60.48	76.59	2.0046	0.2989	0.5281	14.91	26.34	58.74	22.98	14.02	8.95	38.97
70 $K_{1.0}$	50.09	55.21	60.48	83.05	2.0066	0.2700	0.4768	13.46	23.76	62.78	24.92	13.12	11.80	47.35
	50.04	55.98	60.48	85.72	2.0057	0.2604	0.4828	12.98	24.07	62.95	25.72	13.48	12.24	47.60
70 $K_{1.5}$	50.04	55.77	60.48	85.02	2.0055	0.2671	0.5126	13.32	25.56	61.12	25.51	14.25	11.25	44.11
	50.10	54.98	60.48	82.27	2.0024	0.2522	0.5094	12.59	25.44	61.97	24.68	13.99	10.69	43.33
70 $K_{2.0}$	50.06	55.89	60.48	85.38	2.0047	0.2462	0.5522	12.28	27.55	60.17	25.61	15.40	10.22	39.90
	50.03	55.36	60.48	83.67	2.0064	0.2582	0.5286	12.87	26.35	60.79	25.10	14.58	10.52	41.90

Table A-3 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
60K <sub>0.50</sub>	50.01	52.02	60.48	72.58	2.0082	0.2685	0.4206	13.37	20.94	65.69	21.77	10.90	10.88	49.96
	50.03	53.20	60.48	76.47	2.0039	0.2631	0.4501	13.13	22.46	64.41	22.94	11.95	10.99	47.91
60K <sub>1.0</sub>	50.08	55.40	60.48	83.71	2.0087	0.2270	0.3654	11.30	18.19	70.51	25.11	10.08	15.03	59.87
	50.06	56.21	60.48	86.45	2.0042	0.2303	0.3485	11.49	17.39	71.12	25.93	9.77	16.16	62.31
60K <sub>1.5</sub>	50.06	55.81	60.48	85.11	2.0052	0.2164	0.4485	10.79	22.37	66.84	25.53	12.48	13.05	51.11
	50.13	55.32	60.48	83.34	2.0069	0.2244	0.4190	11.18	20.88	67.94	25.00	11.55	13.45	53.80
60K <sub>2.0</sub>	50.04	55.50	60.48	84.12	2.0044	0.2855	0.4611	14.24	23.00	62.75	25.24	12.77	12.47	49.41
	50.07	54.31	60.48	80.09	2.0054	0.2928	0.4601	14.60	22.94	62.46	24.03	12.46	11.57	48.14
55K <sub>0.50</sub>	50.08	48.78	60.48	61.64	2.0069	0.3350	0.4468	16.69	22.26	61.04	18.49	10.86	7.63	41.27
	50.01	49.86	60.48	65.38	2.0031	0.3453	0.4429	17.24	22.11	60.65	19.61	11.02	8.59	43.79
55TK <sub>1.0</sub>	50.05	51.20	60.48	69.77	2.0040	0.2207	0.3502	11.01	17.48	71.51	20.93	8.95	11.98	57.25
	50.10	52.68	60.48	74.60	2.0071	0.2316	0.3450	11.54	17.19	71.27	22.38	9.06	13.32	59.54
55K <sub>1.5</sub>	50.02	51.63	60.48	72.08	2.0244	0.2917	0.4991	14.41	24.65	60.94	21.38	12.73	8.65	40.46
	50.06	52.30	60.48	74.23	2.0086	0.2771	0.4812	13.80	23.96	62.25	22.02	12.53	9.49	43.11
55K <sub>2.0</sub>	50.12	51.30	60.48	70.78	2.0049	0.3138	0.5152	15.65	25.70	58.65	20.99	13.18	7.80	37.19
	50.05	52.14	60.48	73.72	2.0065	0.3161	0.5256	15.75	26.19	58.05	21.87	13.66	8.21	37.55

Table A-3 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
50K <sub>0.50</sub>	50.06	44.41	60.48	47.11	2.0049	0.2694	0.3811	13.44	19.01	67.55	14.13	8.44	5.69	40.27
	50.08	41.88	59.99	39.46	2.0060	0.2164	0.3471	10.79	17.30	71.91	11.84	7.25	4.59	38.78
50TK <sub>1.0</sub>	50.06	43.46	56.88	49.95	2.0051	0.2598	0.3831	12.96	19.11	67.94	14.99	8.30	6.68	44.59
	50.08	42.87	56.88	47.95	2.0033	0.2613	0.3472	13.04	17.33	69.63	14.38	7.43	6.95	48.35
50K <sub>1.5</sub>	50.01	50.92	60.4	69.05	2.0074	0.2707	0.4558	13.49	22.71	63.81	20.71	11.56	9.15	44.18
	50.13	49.77	60.4	64.97	2.0070	0.2640	0.4577	13.15	22.81	64.04	19.49	11.35	8.14	41.77
50K <sub>2.0</sub>	50.08	51.22	60.48	69.77	2.0078	0.2380	0.4717	11.85	23.49	64.65	20.93	12.03	8.90	42.51
	50.09	52.01	60.48	72.39	2.0024	0.2287	0.4579	11.42	22.87	65.71	21.72	11.89	9.82	45.23
M <sub>40</sub>	50.04	36.37	60.48	50.88	2.0058	0.4107	0.2326	20.48	11.60	67.93	6.11	4.22	1.89	30.92
	50.1	36.98	60.48	55.66	2.0077	0.4617	0.2486	23.00	12.38	64.62	6.68	4.58	2.10	31.45
M <sub>60</sub>	50.07	43.56	60.48	73.76	2.0088	0.2768	0.3474	13.78	17.29	68.93	13.28	7.53	5.74	43.26
	50.1	42.5	60.48	67.78	2.0205	0.3017	0.3328	14.93	16.47	68.60	12.20	7.00	5.20	42.62
M <sub>80</sub>	50.05	48.94	60.48	77.79	2.0160	0.2402	0.4029	11.91	19.99	68.10	18.67	9.78	8.89	47.61
	50.09	49.45	60.48	79.81	2.0046	0.2421	0.4110	12.08	20.50	67.42	19.16	10.14	9.02	47.07
M <sub>100</sub>	50.08	55.40	60.48	83.71	2.0087	0.2270	0.3654	11.30	18.19	70.51	25.11	10.08	15.03	59.87
	50.06	56.21	60.48	86.45	2.0042	0.2303	0.3485	11.49	17.39	71.12	25.93	9.77	16.16	62.31
M <sub>120</sub>	50.09	59.87	60.48	82.15	2.0094	0.2634	0.5028	13.11	25.02	61.87	29.58	14.98	14.59	49.35
	50.07	58.94	60.48	79.60	2.0079	0.2569	0.4808	12.79	23.95	63.26	28.66	14.11	14.54	50.75



Table A-3 (Continued)

Exp.	NRL (g)	Product (g)	%DRC	%Conv.	Sample (g)	Free NR	Free PMMA	%Free NR	%Free PMMA	%Grafted NR	Total PMMA	Total Free PMMA	Total Grafted PMMA	%GE.
t <sub>4</sub>	50.07	51.66	60.48	71.26	2.0044	0.2772	0.4483	13.83	22.37	63.80	21.38	11.55	9.82	45.95
	50.1	51.47	60.48	70.57	2.0055	0.2903	0.4352	14.48	21.70	63.82	21.17	11.17	10.00	47.24
t <sub>6</sub>	50.06	54.06	60.48	79.28	2.0060	0.2803	0.3874	13.97	19.31	66.71	23.78	10.44	13.34	56.10
	50.05	55.55	60.48	84.27	2.0029	0.2346	0.4128	11.71	20.61	67.68	25.28	11.45	13.83	54.71
t <sub>8</sub>	50.08	55.40	60.48	83.71	2.0087	0.2270	0.3654	11.30	18.19	70.51	25.11	10.08	15.03	59.87
	50.06	56.21	60.48	86.45	2.0042	0.2303	0.3485	11.49	17.39	71.12	25.93	9.77	16.16	62.31
t <sub>10</sub>	50.07	55.71	60.48	84.76	2.0033	0.2775	0.4474	13.85	22.33	63.81	25.43	12.44	12.99	51.07
	50.1	55.66	60.48	84.53	2.0030	0.2917	0.4328	14.56	21.61	63.83	25.36	12.03	13.33	52.57

aC<sub>x</sub> :

a = Reaction temperature

a(%b)K<sub>x</sub> : a = Reaction temperature

C = Cumene hydroperoxide

%b = Concentration of VneoD (phr)

x = Initiator concentration (phr)

K = Potassium persulfate

aT<sub>x</sub> :

a = Reaction temperature

x = Initiator concentration (phr)

T = tert-butyl hydroperoxide

My : M = Monomer

x = Initiator concentration (phr)

y = Monomer concentration (phr)

aK<sub>x</sub> :

a = Reaction temperature

Tz : T = Time

K = Potassium persulfate

z = Reaction time (hr)

x = Initiator concentration (phr)

## APPENDIX B

### GEL PERMEATION CHROMATOGRAPHY

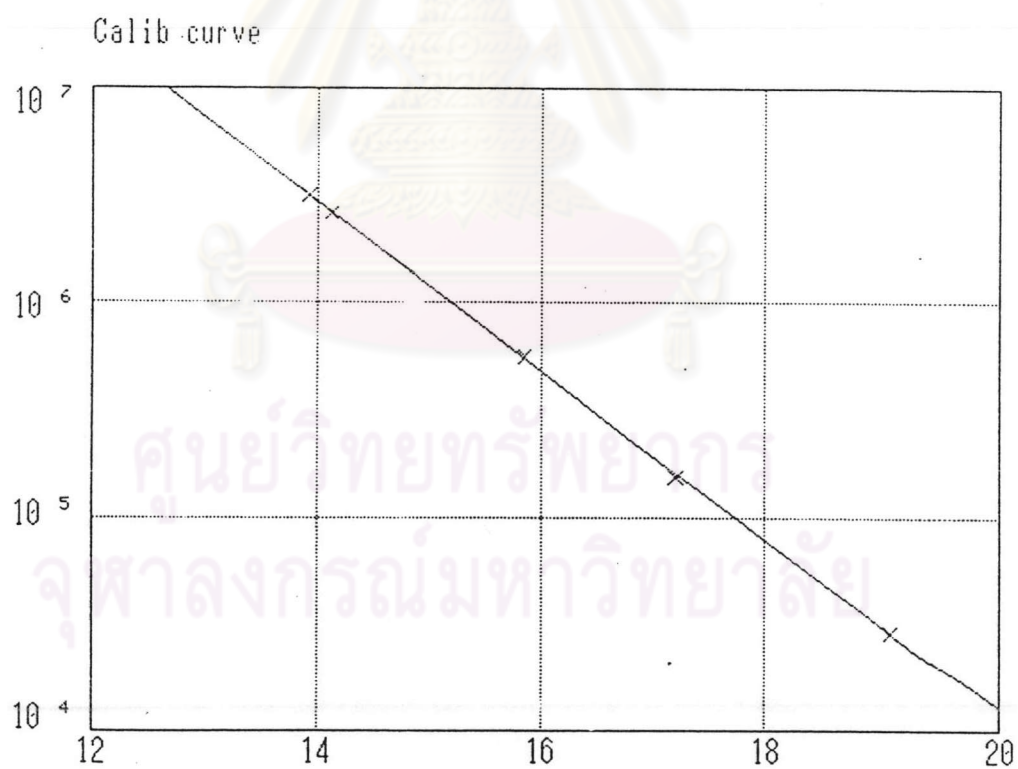
Average molecular weights and along with the molecular weight distribution of the copolymer were measured by gel permeation chromatography. This technique uses a bed of cross-linked polystyrene divinylbenzene gel for the separation of the polymer-taking place in the voids present in the gel particles. The pore volume is available to smaller molecules, and larger molecules are eluted from the column first, because the sorting process takes place on the basis of molecular size, a true size distribution of the polymer species takes place.

Before analysis of the copolymer, the standard curve was set up using standard polystyrene (S-66.0) supplied by Showa denko. The calibration data and calibration curve were shown in Table B-1 and Figure B-1, respectively.

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**Table B-1** The calibration data of Shodex polystyrene standard S-66.0

Average Molecular Weights	Retention Times, (min.)
3,160,000	13.929
2,60,000	14.122
560,000	15.854
156,000	17.211
28,500	19.120

**Figure B-1** The calibration curve of Shodex polystyrene standard S-66.0

## VITA

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