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APPENDICES

APPENDIX A

The Determination of Copolymer Beads Density

The liquid displacement method (ASTM D-792) is the most popular method for measuring the true density of the porous beads. The principle of the method is described below.

Equation of pycnometer:

$$P_d = \frac{W_b - W_a}{(W_b - W_a) - (W_c - W_a)} \times L_d \qquad \text{(A-1)}$$

P_d : True bead density

L_d : Liquid dispersion density

W_a, W_b, W_c, W_d are illustrated clearly as follows:

W_a (g) : Weight of the cell

W_b (g) : Weight of cell and sample

W_c (g) : Total weight of cell, sample and dispersion medium

W_d (g) : Total weight of cell and dispersion medium

Therefore, the true density, P_d, can be calculated from Eq. A-1 shown above.

APPENDIX B

Pore Size Determination by Mercury Porosimetry

Equipment must possess the facility to evacuate the sample, surround it with mercury and generate sufficiently high pressures to cause the mercury to enter the voids or pores whilst monitoring the amount of mercury intruded.

In almost all porosimeters, the amount of mercury intruded is determined by the fall in the level of the interface between the mercury and the compressing fluid. All porosimeters include certain features in their construction (Figure B-1).

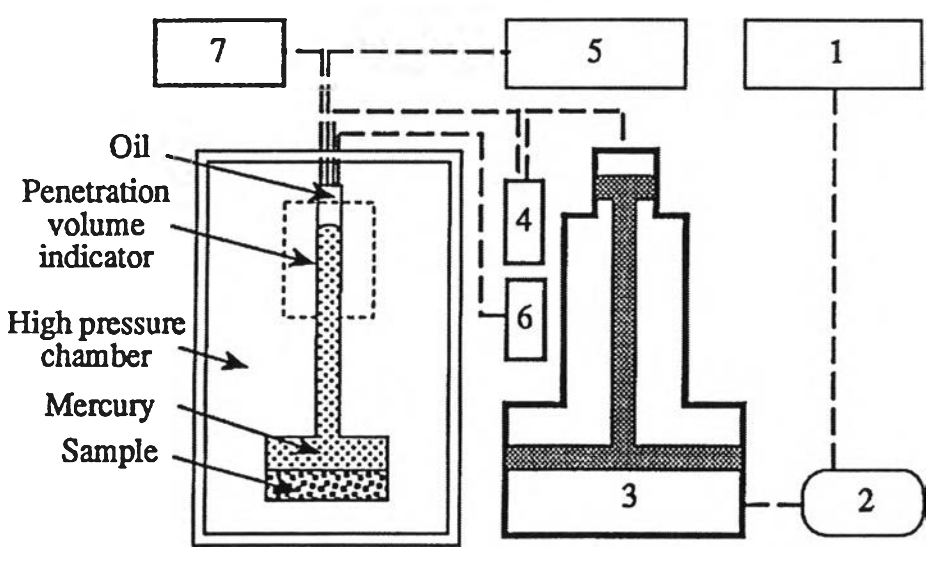


Figure B-1 Conceptual representation of a mercury porosimeter. 1. low pressure oil reservoir; 2. pump; 3. pressure multiplier; 4. pressure transducer; 5. high pressure oil reservoir; 6. mercury reservoir; 7. vacuum pump.

These are:

- sample cell;
- vacuum source (and gauge) for degassing the sample;
- source of clean mercury;
- low pressure source and gauge;
- high pressure generator, fluid reservoir and gauge;
- penetration volume indicator.

The sample is first evacuated and then surrounded with mercury. Air is admitted to the high pressure chamber and the fall in level between the air-mercury interface monitored, to determine the amount of mercury penetrating into the sample, as the air pressure is increased in steps to one atmosphere; the first reading usually being taken at a pressure of 0.5 psia although readings at a pressure of 0.1 psia are possible. This operation is sometimes carried out at a low pressure port. The chamber is then inserted into a high pressure port, the air is evacuated to be replaced by oil, and the pressure is increased to the final pressure of up to 30,000 psia. Commercial instruments work in one of two modes, incremental or continuous. In the former the pressure, or amount of mercury introduced, is increased in steps and the system allowed to stabilize before the next step: in the latter the pressure is increased continuously at a predetermined rate.

APPENDIX C

Data for Calculation of Crosslinking Density of Copolymers

Runs	V_p	V_s	ϕ_p	χ_{12}	$\overline{M}_c$	q
M06	0.1967	1.0514	0.1576	0.3811	11450	7.67
	0.1945	1.0815	0.1524	0.3828	12430	7.07
	0.1948	1.0551	0.1558	0.3817	11770	7.46
	Ave. q = 7.40				Std. Dev. q = 0.30	
M08	0.1923	1.0700	0.1524	0.3828	12540	7.01
	0.1919	1.0270	0.1575	0.3811	11570	7.59
	0.1945	1.0552	0.1556	0.3817	11900	7.38
	Ave. q = 7.33				Std. Dev. q = 0.30	
M10	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
M17	0.1909	1.0412	0.1550	0.3819	12160	7.22
	0.1922	1.0877	0.1501	0.3835	13130	6.69
	0.1912	1.0242	0.1573	0.3812	11720	7.49
	Ave. q = 7.14				Std. Dev. q = 0.41	
R20	0.1895	1.0155	0.1573	0.3812	11740	7.48
	0.1917	1.0248	0.1576	0.3811	11680	7.52
	0.1935	1.0745	0.1526	0.3827	12630	6.95
	Ave. q = 7.32				Std. Dev. q = 0.32	
R27	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
R30	0.1985	1.1985	0.1421	0.3861	14850	5.91
	0.1934	1.1589	0.1430	0.3858	14620	6.01
	0.1961	1.1822	0.1423	0.3860	14800	5.93
	Ave. q = 5.95				Std. Dev. q = 0.05	
T60	0.1943	1.1813	0.1412	0.3864	14960	5.87
	0.1938	1.1849	0.1406	0.3866	15130	5.80
	0.1961	1.1821	0.1423	0.3860	14690	5.98
	Ave. q = 5.88				Std. Dev. q = 0.09	
T70	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
T80	0.1941	1.0015	0.1624	0.3796	10770	8.16
	0.1985	1.0054	0.1649	0.3787	10360	8.48
	0.1938	0.9964	0.1629	0.3794	10680	8.22
	Ave. q = 8.29				Std. Dev. q = 0.17	
t60	0.1972	1.6902	0.1045	0.3981	30040	2.92
	0.1944	1.6133	0.1076	0.3971	28100	3.13
	0.1981	1.6587	0.1067	0.3974	28620	3.07
	Ave. q = 3.04				Std. Dev. q = 0.10	
t08	0.1979	1.3255	0.1299	0.3900	18290	4.80
	0.1997	1.3306	0.1305	0.3898	18100	4.85
	0.1951	1.3247	0.1283	0.3905	18820	4.67
	Ave. q = 4.77				Std. Dev. q = 0.10	

(continued)

Runs	V_p	V_s	ϕ_p	χ_{12}	$\overline{M}_c$	q
t10	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
t15	0.1988	0.9501	0.1730	0.3761	9210	9.54
	0.1958	0.9552	0.1701	0.3771	9600	9.15
	0.1940	0.9021	0.1770	0.3748	8700	10.09
	Ave. q = 9.59				Std. Dev. q = 0.48	
I01	0.1937	1.6622	0.1044	0.3982	30470	2.88
	0.1922	1.6656	0.1035	0.3984	31070	2.83
	0.1942	1.6405	0.1058	0.3977	29510	2.98
	Ave. q = 2.90				Std. Dev. q = 0.08	
I05	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
I10	0.1947	0.9994	0.1630	0.3793	10720	8.19
	0.1983	1.0044	0.1649	0.3787	10440	8.41
	0.1914	1.0133	0.1589	0.3807	11430	7.69
	Ave. q = 8.10				Std. Dev. q = 0.37	
I20	0.1897	0.9266	0.1699	0.3771	9720	9.04
	0.1924	0.9400	0.1699	0.3771	9720	9.04
	0.1904	0.9414	0.1683	0.3777	9960	8.82
	Ave. q = 8.96				Std. Dev. q = 0.13	
P05	0.1928	0.9276	0.1721	0.3764	9320	9.42
	0.1941	0.9254	0.1734	0.3760	9150	9.60
	0.1959	0.9757	0.1672	0.3780	10010	8.78
	Ave. q = 9.27				Std. Dev. q = 0.43	
P10	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
P15	0.1926	1.1316	0.1455	0.3850	14010	6.27
	0.1941	1.1352	0.1460	0.3848	13890	6.32
	0.1924	1.1285	0.1457	0.3849	13960	6.29
	Ave. q = 6.29				Std. Dev. q = 0.03	
P20	0.1967	1.4018	0.1231	0.3922	20730	4.24
	0.1936	1.3661	0.1241	0.3918	20300	4.33
	0.1933	1.3740	0.1234	0.3921	20610	4.26
	Ave. q = 4.27				Std. Dev. q = 0.05	
D03	0.1989	2.2388	0.0816	0.4054	53250	1.65
	0.1917	2.1701	0.0812	0.4055	53890	1.63
	0.1983	2.2254	0.0818	0.4053	52970	1.66
	Ave. q = 1.65				Std. Dev. q = 0.01	
D06	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
D09	0.2006	0.8985	0.1825	0.3730	8040	10.92
	0.1952	0.8641	0.1843	0.3725	7850	11.18
	0.1915	0.8517	0.1836	0.3727	7920	11.09
	Ave. q = 11.06				Std. Dev. q = 0.13	

(continued)

Runs	V_p	V_s	ϕ_p	χ_{12}	$\overline{M}_c$	q
D12	0.1958	0.7469	0.2077	0.3649	5760	15.25
	0.1972	0.7521	0.2078	0.3648	5750	15.27
	0.1954	0.7474	0.2073	0.3650	5790	15.17
	Ave. q = 15.23				Std. Dev. q = 0.05	
D15	0.1962	0.6209	0.2401	0.3542	3930	22.36
	0.1997	0.6321	0.2401	0.3543	3930	22.34
	0.1970	0.6264	0.2392	0.3545	3970	22.13
	Ave. q = 22.28				Std. Dev. q = 0.12	
H00	0.1924	1.0805	0.1512	0.3832	12810	6.86
	0.1918	1.0403	0.1557	0.3817	11920	7.37
	0.1944	1.0659	0.1543	0.3822	12190	7.20
	Ave. q = 7.14				Std. Dev. q = 0.26	
H02	0.1982	1.1191	0.1504	0.3834	12830	6.85
	0.1947	1.0956	0.1509	0.3832	12740	6.90
	0.1951	1.1110	0.1494	0.3837	13050	6.73
	Ave. q = 6.82				Std. Dev. q = 0.09	
H04	0.1971	1.3647	0.1262	0.3912	19350	4.54
	0.1953	1.2347	0.1366	0.3879	16040	5.48
	0.2004	1.2984	0.1337	0.3888	16870	5.20
	Ave. q = 5.07				Std. Dev. q = 0.48	
H06	0.1994	1.0949	0.1541	0.3822	11830	7.42
	0.2007	1.1181	0.1522	0.3828	12190	7.20
	0.2018	1.0910	0.1561	0.3816	11460	7.66
	Ave. q = 7.43				Std. Dev. q = 0.23	
H08	0.2144	0.9858	0.1786	0.3743	7600	11.55
	0.2158	0.9832	0.1800	0.3739	7460	11.77
	0.2145	1.0100	0.1752	0.3754	7990	11.00
	Ave. q = 11.44				Std. Dev. q = 0.40	

APPENDIX D

Data for Calculation of Swelling Ratio of Copolymers

Runs	W_p	W_s	V_p	V_s	Swelling Ratio
M06	0.2038	0.9116	0.1967	1.0514	6.34
	0.2015	0.9377	0.1945	1.0815	6.56
	0.2018	0.9148	0.1948	1.0551	6.42
Average Swelling Ratio = 6.44			Std. Dev. Swelling Ratio = 0.11		
M08	0.2008	0.9277	0.1923	1.0700	6.56
	0.2004	0.8904	0.1919	1.0270	6.35
	0.2031	0.9149	0.1945	1.0552	6.42
Average Swelling Ratio = 6.45			Std. Dev. Swelling Ratio = 0.11		
M10	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
M17	0.2015	0.9027	0.1909	1.0412	6.45
	0.2028	0.9430	0.1922	1.0877	6.66
	0.2018	0.8880	0.1912	1.0242	6.36
Average Swelling Ratio = 6.49			Std. Dev. Swelling Ratio = 0.15		
R20	0.2001	0.8804	0.1895	1.0155	6.36
	0.2024	0.8885	0.1917	1.0248	6.35
	0.2043	0.9316	0.1935	1.0745	6.55
Average Swelling Ratio = 6.42			Std. Dev. Swelling Ratio = 0.12		
R27	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
R30	0.2074	1.0391	0.1985	1.1985	7.04
	0.2021	1.0048	0.1934	1.1589	6.99
	0.2049	1.0250	0.1961	1.1822	7.03
Average Swelling Ratio = 7.02			Std. Dev. Swelling Ratio = 0.02		
T60	0.2015	1.0242	0.1943	1.1813	7.08
	0.2010	1.0273	0.1938	1.1849	7.11
	0.2034	1.0249	0.1961	1.1821	7.03
Average Swelling Ratio = 7.07			Std. Dev. Swelling Ratio = 0.04		
T70	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
T80	0.2033	0.8683	0.1941	1.0015	6.16
	0.2079	0.8717	0.1985	1.0054	6.06
	0.2030	0.8639	0.1938	0.9964	6.14
Average Swelling Ratio = 6.12			Std. Dev. Swelling Ratio = 0.05		
t06	0.2029	1.4654	0.1972	1.6902	9.57
	0.2001	1.3987	0.1944	1.6133	9.30
	0.2039	1.4381	0.1981	1.6587	9.37
Average Swelling Ratio = 9.41			Std. Dev. Swelling Ratio = 0.14		
t08	0.2058	1.1492	0.1979	1.3255	7.70
	0.2076	1.1536	0.1997	1.3306	7.66
	0.2028	1.1485	0.1951	1.3247	7.79
Average Swelling Ratio = 7.72			Std. Dev. Swelling Ratio = 0.07		

(continued)

Runs	W_p	W_s	V_p	V_s	Swelling Ratio
t10	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
t15	0.2085	0.8237	0.1988	0.9501	5.78
	0.2054	0.8282	0.1958	0.9552	5.88
	0.2035	0.7821	0.1940	0.9021	5.65
Average Swelling Ratio = 5.77			Std. Dev. Swelling Ratio = 0.11		
I01	0.2017	1.4411	0.1937	1.6622	9.58
	0.2002	1.4441	0.1922	1.6656	9.66
	0.2022	1.4223	0.1942	1.6405	9.45
Average Swelling Ratio = 9.57			Std. Dev. Swelling Ratio = 0.11		
I05	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
I10	0.2054	0.8665	0.1947	0.9994	6.13
	0.2091	0.8708	0.1983	1.0044	6.06
	0.2019	0.8785	0.1914	1.0133	6.29
Average Swelling Ratio = 6.16			Std. Dev. Swelling Ratio = 0.12		
I20	0.2007	0.8034	0.1897	0.9266	5.89
	0.2036	0.8150	0.1924	0.9400	5.89
	0.2015	0.8162	0.1904	0.9414	5.94
Average Swelling Ratio = 5.90			Std. Dev. Swelling Ratio = 0.03		
P05	0.2018	0.8042	0.1928	0.9276	5.81
	0.2032	0.8023	0.1941	0.9254	5.77
	0.2051	0.8459	0.1959	0.9757	5.98
Average Swelling Ratio = 5.85			Std. Dev. Swelling Ratio = 0.11		
P10	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
P15	0.2010	0.9811	0.1926	1.1316	6.87
	0.2025	0.9842	0.1941	1.1352	6.85
	0.2008	0.9784	0.1924	1.1285	6.86
Average Swelling Ratio = 6.86			Std. Dev. Swelling Ratio = 0.01		
P20	0.2040	1.2154	0.1967	1.4018	8.13
	0.2008	1.1844	0.1936	1.3661	8.06
	0.2005	1.1913	0.1933	1.3740	8.11
Average Swelling Ratio = 8.10			Std. Dev. Swelling Ratio = 0.04		
D03	0.2088	1.9410	0.1989	2.2388	12.25
	0.2012	1.8815	0.1917	2.1701	12.32
	0.2081	1.9294	0.1983	2.2254	12.22
Average Swelling Ratio = 12.27			Std. Dev. Swelling Ratio = 0.05		
D06	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	1.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
D09	0.2099	0.7790	0.2006	0.8985	5.48
	0.2042	0.7492	0.1952	0.8641	5.43
	0.2004	0.7384	0.1915	0.8517	5.45
Average Swelling Ratio = 5.45			Std. Dev. Swelling Ratio = 0.03		

(continued)

Runs	W_p	W_s	V_p	V_s	Swelling Ratio
D12	0.2036	0.6476	0.1958	0.7469	4.82
	0.2051	0.6521	0.1972	0.7521	4.81
	0.2032	0.6480	0.1954	0.7474	4.82
Average Swelling Ratio = 4.82			Std. Dev. Swelling Ratio = 0.01		
D15	0.2032	0.5383	0.1962	0.6209	4.16
	0.2068	0.5480	0.1997	0.6321	4.17
	0.2040	0.5431	0.1970	0.6264	4.18
Average Swelling Ratio = 4.17			Std. Dev. Swelling Ratio = 0.01		
H00	0.2013	0.9368	0.1924	1.0805	6.62
	0.2007	0.9019	0.1918	1.0403	6.42
	0.2034	0.9241	0.1944	1.0659	6.48
Average Swelling Ratio = 6.51			Std. Dev. Swelling Ratio = 0.10		
H02	0.2054	0.9703	0.1982	1.1191	6.64
	0.2018	0.9499	0.1947	1.0956	6.63
	0.2022	0.9632	0.1951	1.1110	6.69
Average Swelling Ratio = 6.66			Std. Dev. Swelling Ratio = 0.03		
H04	0.2023	1.1832	0.1971	1.3647	7.92
	0.2005	1.0705	0.1953	1.2347	7.32
	0.2057	1.1257	0.2004	1.2984	7.45
Average Swelling Ratio = 7.58			Std. Dev. Swelling Ratio = 0.31		
H06	0.2020	0.9493	0.1994	1.0949	6.49
	0.2033	0.9694	0.2007	1.1181	6.57
	0.2044	0.9459	0.2018	1.0910	6.41
Average Swelling Ratio = 6.49			Std. Dev. Swelling Ratio = 0.08		
H08	0.2010	0.8547	0.2144	0.9858	5.60
	0.2023	0.8524	0.2158	0.9832	5.56
	0.2011	0.8757	0.2145	1.0100	5.71
Average Swelling Ratio = 5.62			Std. Dev. Swelling Ratio = 0.08		

APPENDIX E

FT-IR Spectra of Copolymers

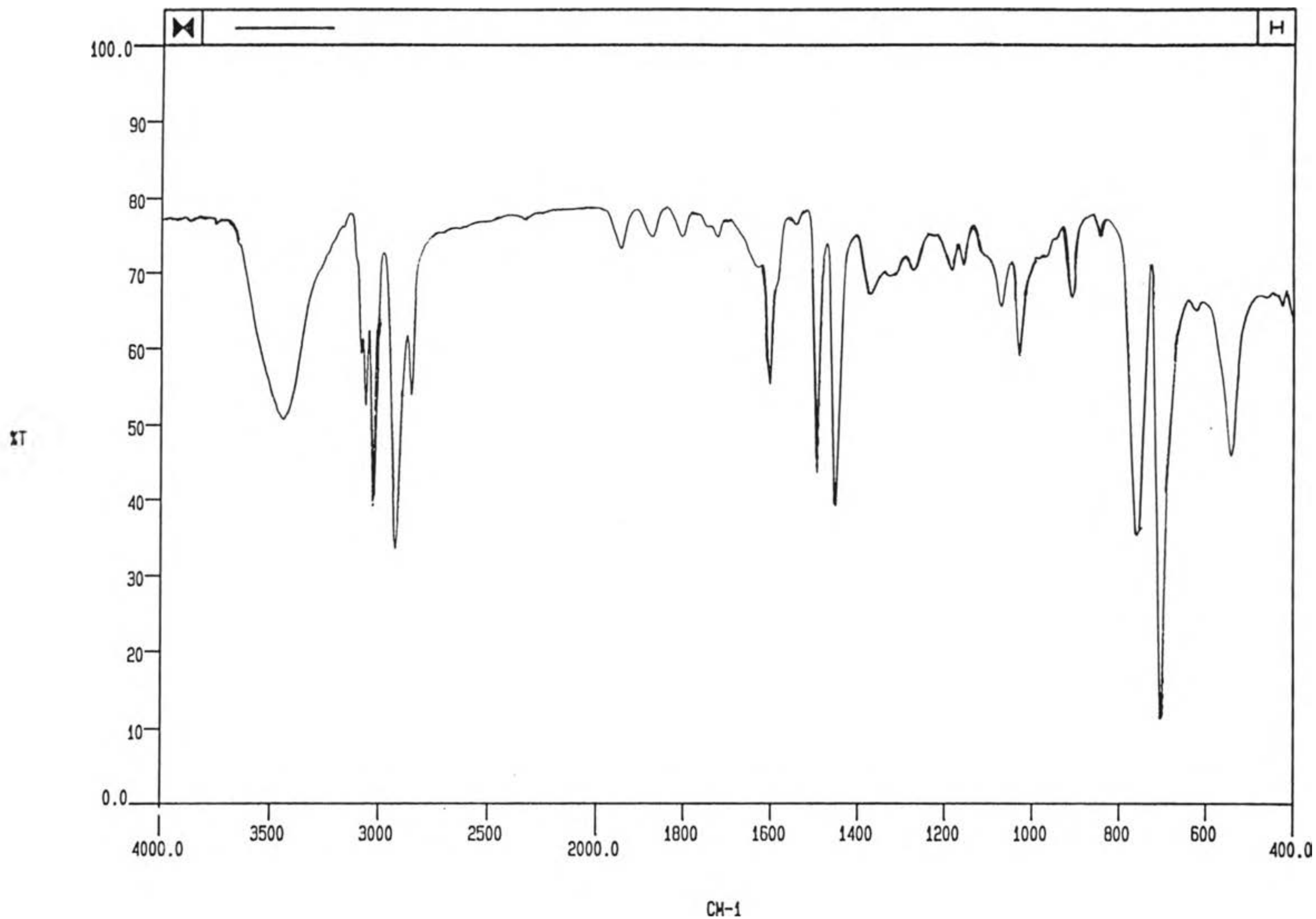


Figure E-1 FT-IR spectrum of the polystyrene

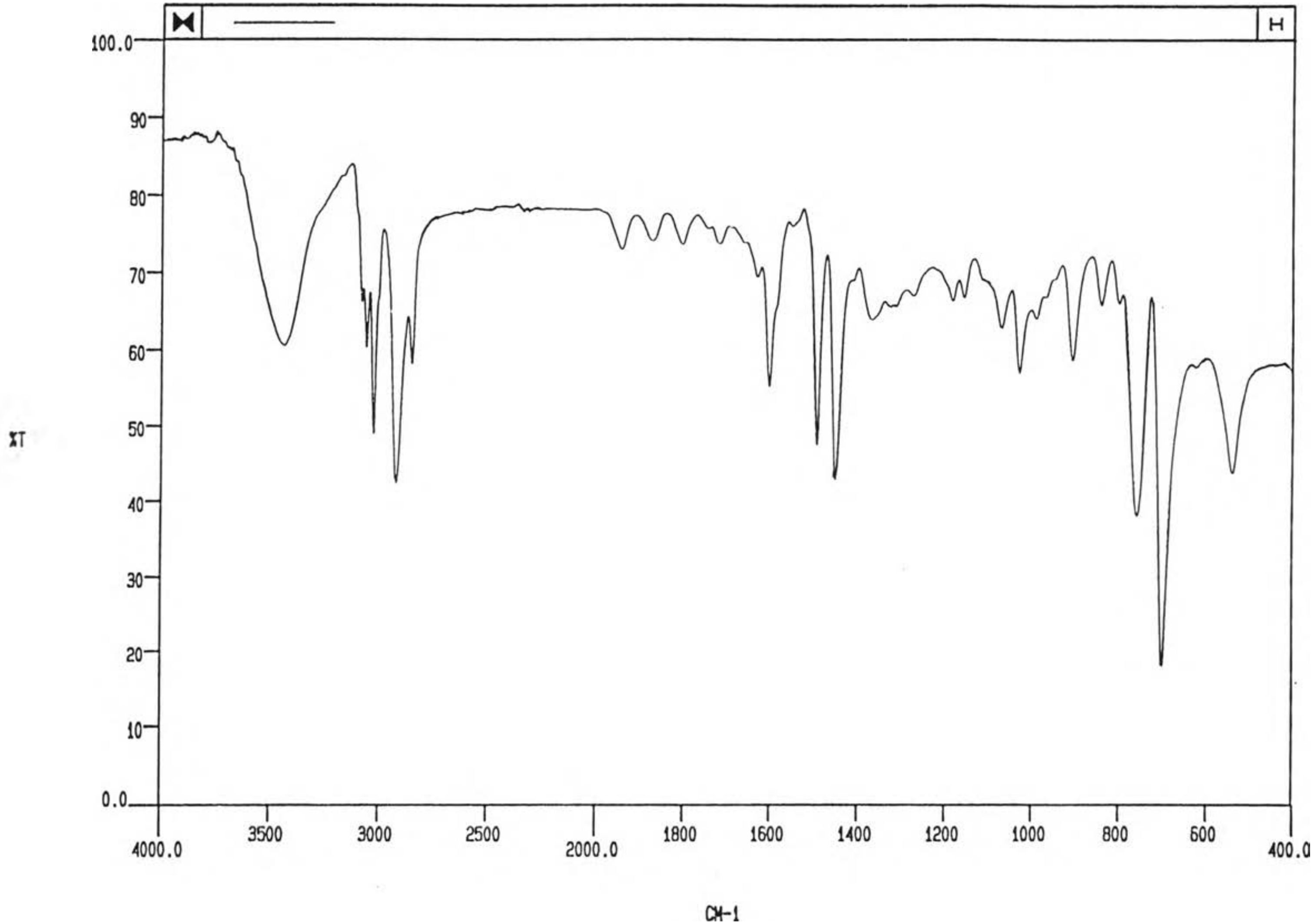


Figure E-2 FT-IR spectrum of styrene-divinylbenzene copolymer of Run H04

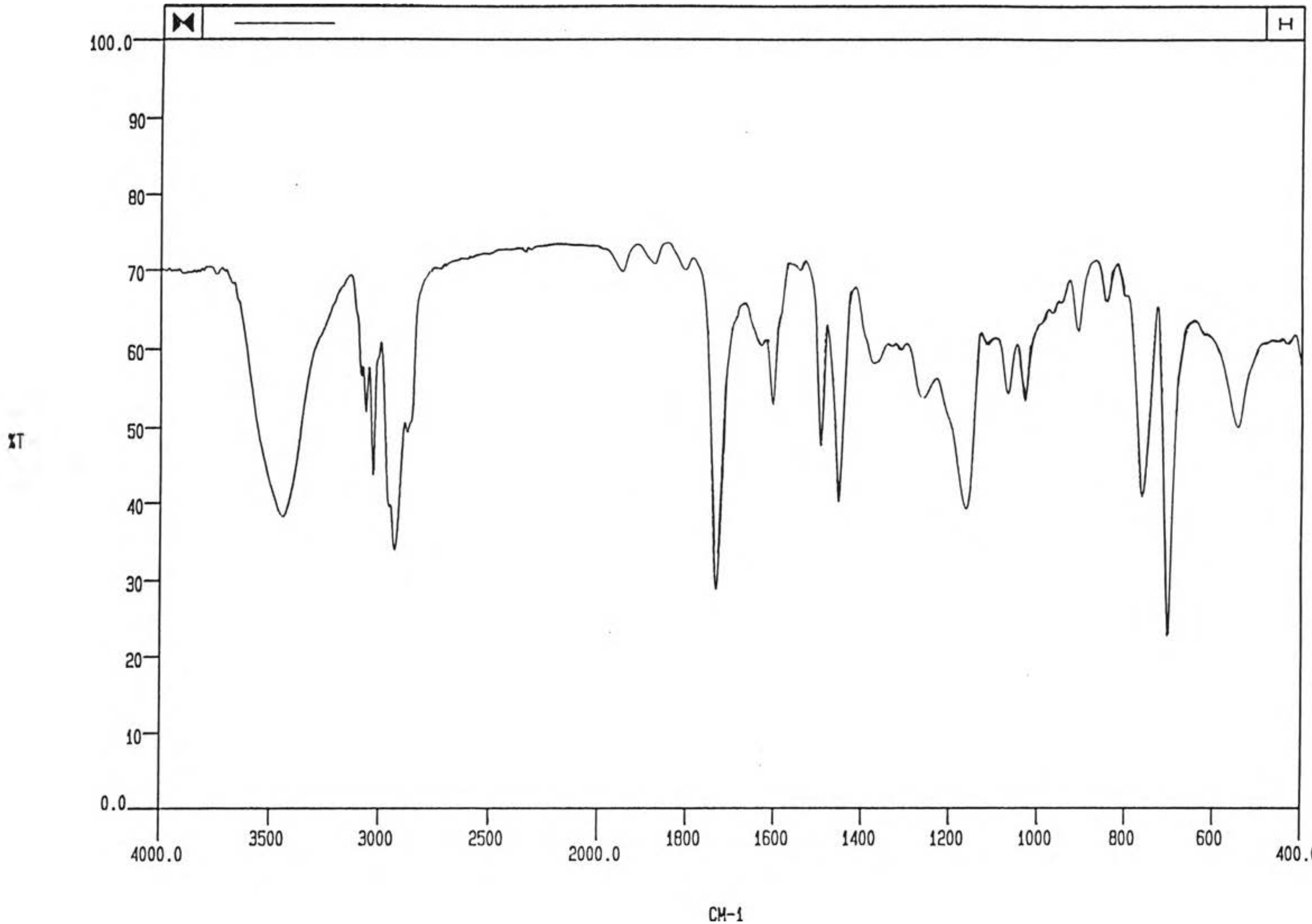


Figure E-3 FT-IR spectrum of styrene-divinylbenzene-24% *n*-butyl acrylate terpolymer of Run B24

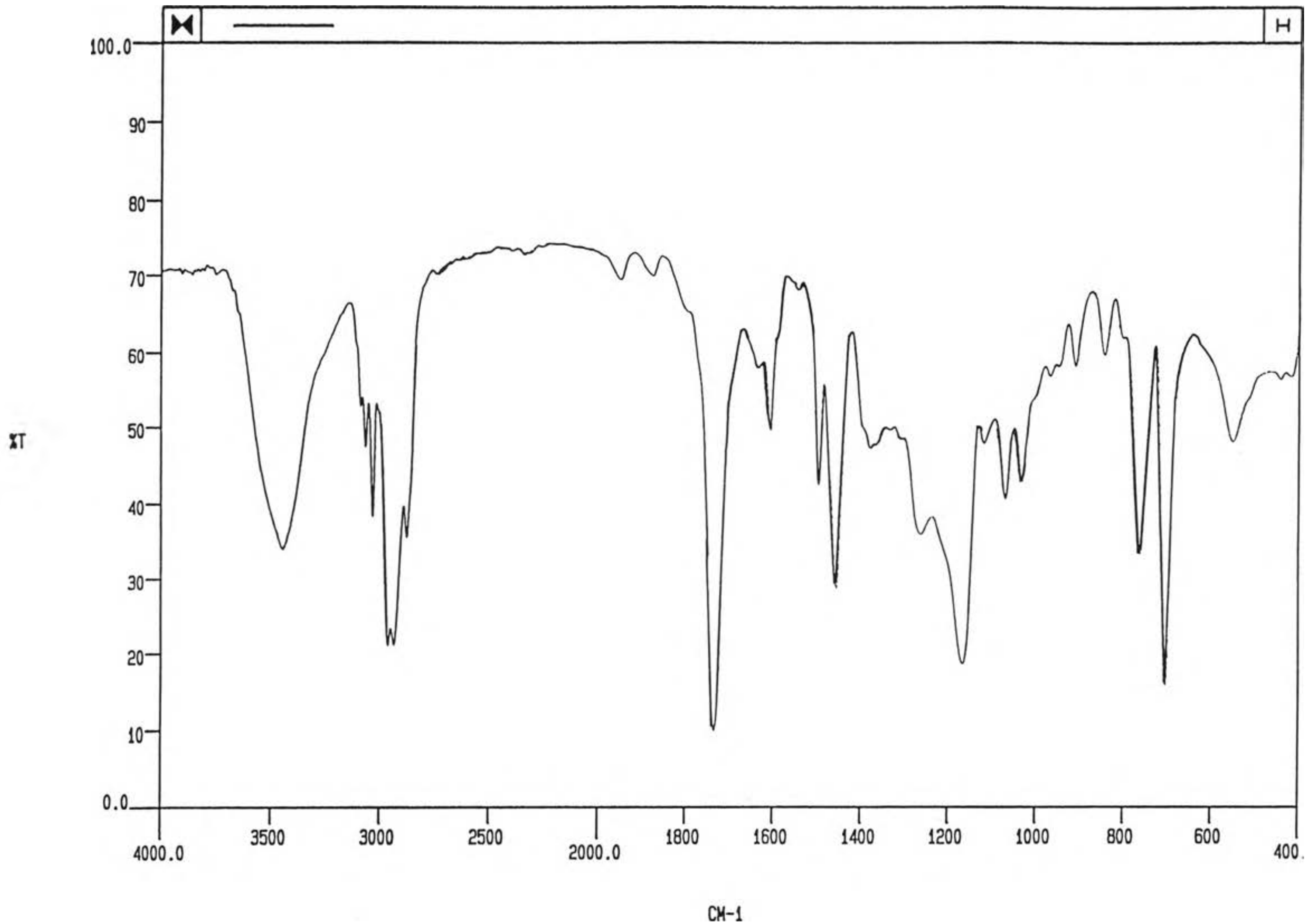


Figure E-4 FT-IR spectrum of styrene-divinylbenzene-47% *n*-butyl acrylate terpolymer of Run B47

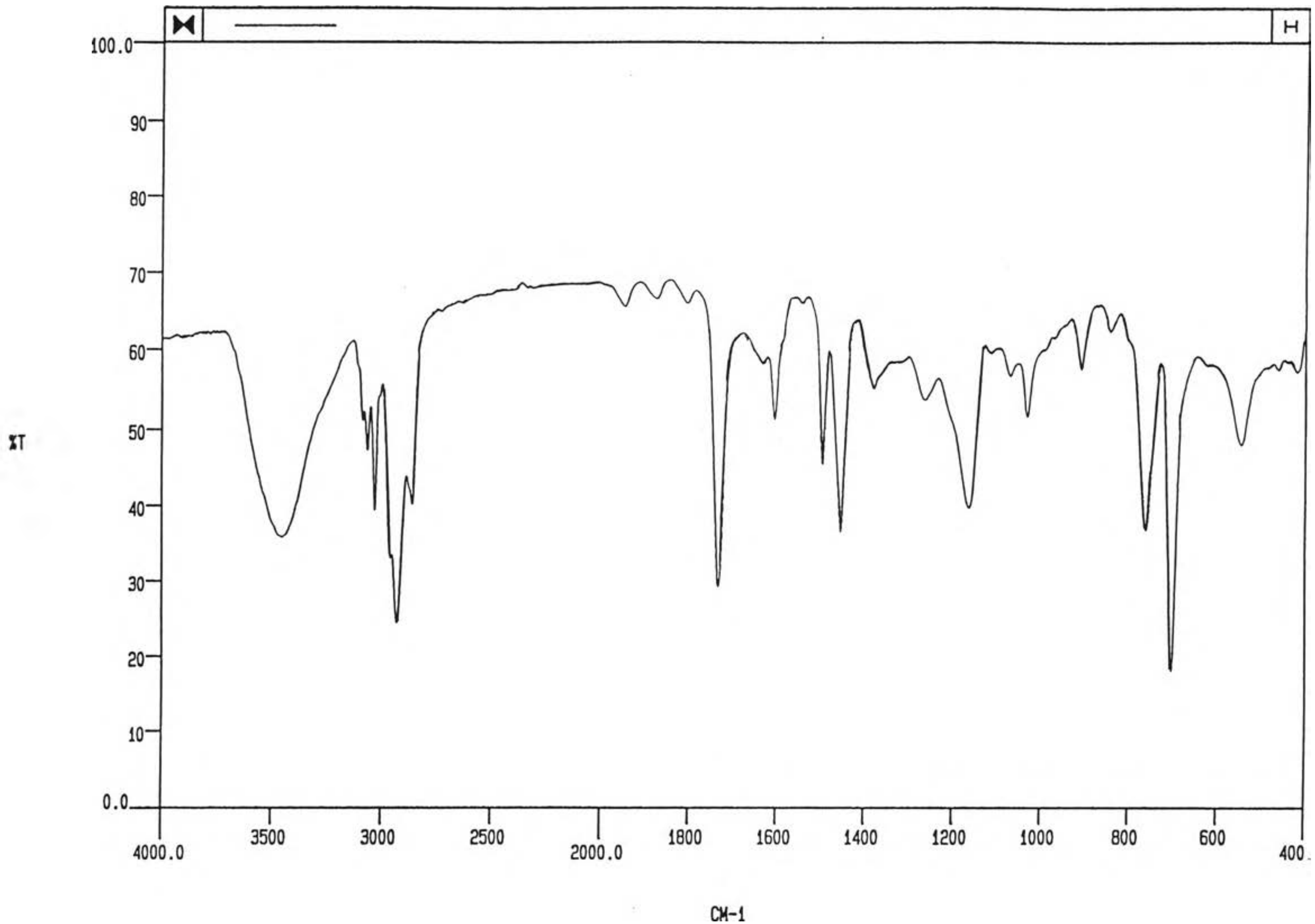


Figure E-5 FT-IR spectrum of styrene-divinylbenzene-24% 2-ethyl hexyl acrylate terpolymer of Run E24

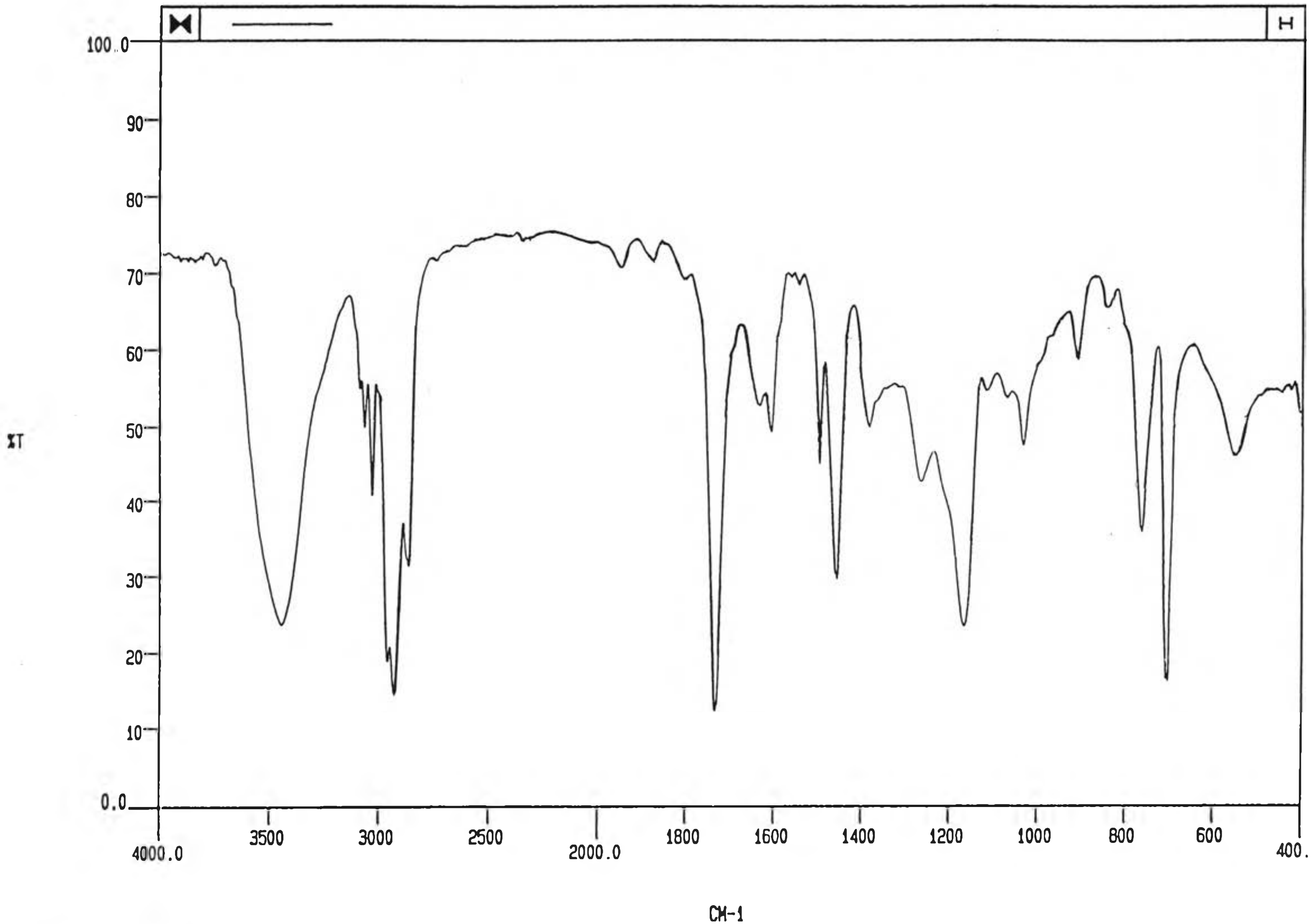


Figure E-6 FT-IR spectrum of styrene-divinylbenzene-47% 2-ethyl hexyl acrylate terpolymer of Run E47

APPENDIX F

Data for calculation of Swelling Ratio of Copolymers in Different Solvents

Table F-1 Swelling Ratio of the Copolymer Beads (Run PS) in Different Solvents

Solvent	W_p	W_s	V_p	V_s	Swelling Ratio
Hexane	0.2031	0.2577	0.1978	0.3911	1.98
	0.2013	0.2500	0.1961	0.3793	1.93
	0.2061	0.2584	0.2008	0.3921	1.95
Average Swelling Ratio = 1.95			Std. Dev. Swelling Ratio = 0.02		
Heptane	0.2033	0.2562	0.1980	0.3745	1.89
	0.2009	0.2688	0.1957	0.3930	2.01
	0.2034	0.2661	0.1981	0.3890	1.96
Average Swelling Ratio = 1.95			Std. Dev. Swelling Ratio = 0.06		
Cyclohexane	0.2016	0.3992	0.1964	0.5157	2.63
	0.2023	0.3882	0.1971	0.5016	2.55
	0.2034	0.3962	0.1981	0.5118	2.58
Average Swelling Ratio = 2.58			Std. Dev. Swelling Ratio = 0.04		
Trichloroethane	0.2015	2.1564	0.1963	1.6140	8.22
	0.2013	2.1374	0.1961	1.5998	8.16
	0.2019	2.1277	0.1967	1.5926	8.10
Average Swelling Ratio = 8.16			Std. Dev. Swelling Ratio = 0.06		
Carbon tetrachloride	0.2021	2.6502	0.1969	1.6626	8.45
	0.2044	2.6244	0.1991	1.6464	8.27
	0.2045	2.6444	0.1992	1.6590	8.33
Average Swelling Ratio = 8.35			Std. Dev. Swelling Ratio = 0.09		
Xylene	0.2051	1.4895	0.1998	1.7239	8.63
	0.2036	1.4736	0.1983	1.7056	8.60
	0.2035	1.4969	0.1982	1.7325	8.74
Average Swelling Ratio = 8.66			Std. Dev. Swelling Ratio = 0.07		
Toluene	0.2041	1.5903	0.1988	1.8343	9.23
	0.2033	1.5889	0.1980	1.8326	9.25
	0.2034	1.6027	0.1981	1.8486	9.33
Average Swelling Ratio = 9.27			Std. Dev. Swelling Ratio = 0.05		
Benzene	0.2038	1.6659	0.1985	1.8952	9.55
	0.2069	1.7067	0.2015	1.9417	9.63
	0.2025	1.6572	0.1973	0.18854	9.56
Average Swelling Ratio = 9.58			Std. Dev. Swelling Ratio = 0.05		
Chloroform	0.2046	2.8370	0.1993	1.9156	9.61
	0.2018	2.8219	0.1966	1.9054	9.69
	0.2014	2.8118	0.1962	1.8986	9.68
Average Swelling Ratio = 9.66			Std. Dev. Swelling Ratio = 0.04		
Chlorobenzene	0.2049	2.0845	0.1996	1.8850	9.44
	0.2060	2.1588	0.2007	1.9519	9.73
	0.2033	2.0869	0.1980	1.8869	9.53
Average Swelling Ratio = 9.57			Std. Dev. Swelling Ratio = 0.15		
Methylene Chloride	0.2025	2.2263	0.1973	1.6802	8.52
	0.2068	2.3208	0.2014	1.7515	8.70
	0.2014	2.2244	0.1962	1.6788	8.56
Average Swelling Ratio = 8.59			Std. Dev. Swelling Ratio = 0.09		
Ethylene Chloride	0.2044	2.0039	0.1991	1.5993	8.03
	0.2012	1.9441	0.1960	1.5515	7.92
	0.2007	1.9239	0.1955	1.5354	7.85
Average Swelling Ratio = 7.93			Std. Dev. Swelling Ratio = 0.09		

Table F-2 Swelling Ratio of the Copolymer Beads (Run B24) in Different Solvents

Solvent	W_p	W_s	V_p	V_s	Swelling Ratio
Hexane	0.2076	0.2826	0.2026	0.4289	2.12
	0.2019	0.2911	0.1971	0.4417	2.24
	0.2063	0.2858	0.2014	0.4337	2.15
Average Swelling Ratio = 2.17			Std. Dev. Swelling Ratio = 0.06		
Heptane	0.2014	0.2824	0.1966	0.4128	2.10
	0.2027	0.2913	0.1979	0.4259	2.15
	0.2058	0.3092	0.2009	0.4521	2.25
Average Swelling Ratio = 2.17			Std. Dev. Swelling Ratio = 0.08		
Cyclohexane	0.2061	0.6025	0.2012	0.7785	3.87
	0.2065	0.6183	0.2016	0.7988	3.96
	0.2058	0.5998	0.2009	0.7749	3.86
Average Swelling Ratio = 3.90			Std. Dev. Swelling Ratio = 0.06		
Trichloroethane	0.2020	2.0014	0.1972	1.4981	7.60
	0.2038	1.9898	0.1989	1.4894	7.49
	0.2037	1.9928	0.1988	1.4916	7.50
Average Swelling Ratio = 7.53			Std. Dev. Swelling Ratio = 0.06		
Carbon tetrachloride	0.2040	2.4776	0.1991	1.5544	7.81
	0.2028	2.4037	0.1980	1.5080	7.62
	0.2034	2.4541	0.1985	1.5396	7.75
Average Swelling Ratio = 7.73			Std. Dev. Swelling Ratio = 0.10		
Xylene	0.2055	1.4063	0.2006	1.6277	8.1146
	0.2013	1.3330	0.1965	1.5428	7.8522
	0.2033	0.3655	0.1984	1.5804	7.9642
Average Swelling Ratio = 7.98			Std. Dev. Swelling Ratio = 0.13		
Toluene	0.2004	1.3721	0.1956	1.5826	8.09
	0.2051	1.3979	0.2002	1.6123	8.05
	0.2049	1.4375	0.2000	1.6465	8.23
Average Swelling Ratio = 8.13			Std. Dev. Swelling Ratio = 0.09		
Benzene	0.2011	1.5085	0.1963	1.7162	8.74
	0.2043	1.4954	0.1994	1.7013	8.53
	0.2034	015071	0.1985	1.7145	8.64
Average Swelling Ratio = 8.64			Std. Dev. Swelling Ratio = 0.11		
Chloroform	0.2038	2.4866	0.1989	1.6790	8.44
	0.2027	2.4692	0.1979	1.6672	8.43
	0.2051	2.5727	0.2002	1.7371	8.68
Average Swelling Ratio = 8.51			Std. Dev. Swelling Ratio = 0.14		
Chlorobenzene	0.2011	1.7838	0.1963	1.6129	8.22
	0.2035	1.8230	0.1986	1.6483	8.30
	0.2022	1.8162	0.1974	1.6421	8.32
Average Swelling Ratio = 8.28			Std. Dev. Swelling Ratio = 0.05		
Methylene Chloride	0.2016	2.1218	0.1968	1.6014	8.14
	0.2017	2.0982	0.1969	1.5835	8.04
	0.2044	2.0855	0.1995	1.5740	7.89
Average Swelling Ratio = 8.02			Std. Dev. Swelling Ratio = 0.13		
Ethylene Chloride	0.2046	1.8188	0.1997	1.4516	7.27
	0.2010	1.8047	0.1962	1.4403	7.34
	0.2044	1.8161	0.1995	1.4494	7.26
Average Swelling Ratio = 7.29			Std. Dev. Swelling Ratio = 0.04		

Table F-3 Swelling Ratio of the Copolymer Beads (Run B47) in Different Solvents

Solvent	W_p	W_s	V_p	V_s	Swelling Ratio
Hexane	0.2061	0.3153	0.2014	0.4785	2.38
	0.2006	0.3197	0.1961	0.4851	2.47
	0.2050	0.3059	0.2004	0.4643	2.32
Average Swelling Ratio = 2.39			Std. Dev. Swelling Ratio = 0.08		
Heptane	0.2046	0.3368	0.2000	0.4924	2.46
	0.2003	0.3145	0.1958	0.4597	2.35
	0.2075	0.3267	0.2028	0.4776	2.36
Average Swelling Ratio = 2.39			Std. Dev. Swelling Ratio = 0.06		
Cyclohexane	0.2026	0.6213	0.1980	0.8027	4.05
	0.2032	0.6410	0.1986	0.8282	4.17
	0.2033	0.6306	0.1987	0.8147	4.10
Average Swelling Ratio = 4.11			Std. Dev. Swelling Ratio = 0.06		
Trichloroethane	0.2014	1.7749	0.1968	1.3285	6.75
	0.2009	1.7793	0.1963	1.3318	6.78
	0.2021	1.7555	0.1975	1.3140	6.65
Average Swelling Ratio = 6.73			Std. Dev. Swelling Ratio = 0.07		
Carbon tetrachloride	0.2041	2.3340	0.1995	1.4643	7.34
	0.2046	2.3599	0.2000	1.4805	7.40
	0.2020	2.3007	0.1974	1.4434	7.31
Average Swelling Ratio = 7.35			Std. Dev. Swelling Ratio = 0.05		
Xylene	0.2011	1.2611	0.1965	1.4596	7.43
	0.2022	1.2865	0.1976	1.4890	7.53
	0.2034	1.2678	0.1988	1.4674	7.38
Average Swelling Ratio = 7.45			Std. Dev. Swelling Ratio = 0.08		
Toluene	0.2049	1.3557	0.2003	1.5636	7.81
	0.2038	1.3711	0.1992	1.5814	7.94
	0.2074	1.3997	0.2027	1.6144	7.96
Average Swelling Ratio = 7.90			Std. Dev. Swelling Ratio = 0.08		
Benzene	0.2007	1.4200	0.1961	1.6155	8.24
	0.2044	1.4774	0.1998	1.6807	8.41
	0.2025	1.4516	0.1979	1.6514	8.34
Average Swelling Ratio = 8.33			Std. Dev. Swelling Ratio = 0.09		
Chloroform	0.2035	2.3329	0.1989	1.5752	7.92
	0.2013	2.3336	0.1967	1.5757	8.01
	0.2023	2.3061	0.1977	1.5571	7.88
Average Swelling Ratio = 7.94			Std. Dev. Swelling Ratio = 0.07		
Chlorobenzene	0.2018	1.6865	0.1972	1.5249	7.73
	0.2027	1.7204	0.1981	1.5556	7.85
	0.2035	1.7333	0.1989	1.5672	7.88
Average Swelling Ratio = 7.82			Std. Dev. Swelling Ratio = 0.08		
Methylene Chloride	0.2018	1.9691	0.1972	1.4861	7.54
	0.2012	1.9857	0.1966	1.4987	7.62
	0.2043	2.0315	0.1997	1.5332	7.68
Average Swelling Ratio = 7.61			Std. Dev. Swelling Ratio = 0.07		
Ethylene Chloride	0.2043	1.7611	0.1997	1.4055	7.04
	0.2014	1.7014	0.1968	1.3579	6.90
	0.2035	1.7162	0.1989	1.3697	6.89
Average Swelling Ratio = 6.94			Std. Dev. Swelling Ratio = 0.08		

Table F-4 Swelling Ratio of the Copolymer Beads (Run E24) in Different Solvents

Solvent	W_p	W_s	V_p	V_s	Swelling Ratio
Hexane	0.2015	0.3477	0.1976	0.5276	2.67
	0.2028	0.3454	0.1988	0.5241	2.64
	0.2018	0.3471	0.1979	0.5267	2.66
Average Swelling Ratio = 2.66			Std. Dev. Swelling Ratio = 0.02		
Heptane	0.2013	0.3592	0.1974	0.5252	2.66
	0.2007	0.3558	0.1968	0.5202	0.64
	0.2034	0.3632	0.1994	0.5310	0.66
Average Swelling Ratio = 2.66			Std. Dev. Swelling Ratio = 0.01		
Cyclohexane	0.2008	0.7869	0.1969	1.0167	5.16
	0.2004	0.7618	0.1965	0.9843	5.01
	0.2031	0.7930	0.1991	1.0245	5.14
Average Swelling Ratio = 5.11			Std. Dev. Swelling Ratio = 0.08		
Trichloroethane	0.2038	1.8819	0.1998	1.4086	7.05
	0.2015	1.9015	0.1976	1.4233	7.20
	0.2018	1.8991	0.1979	1.4215	7.18
Average Swelling Ratio = 7.15			Std. Dev. Swelling Ratio = 0.08		
Carbon tetrachloride	0.2001	2.2279	0.1962	1.3977	7.12
	0.2013	2.3136	0.1974	1.4515	7.35
	0.2074	2.3510	0.2034	1.4749	7.25
Average Swelling Ratio = 7.24			Std. Dev. Swelling Ratio = 0.12		
Xylene	0.2024	1.3069	0.1985	1.5126	7.62
	0.2007	1.3159	0.1968	1.5230	7.74
	0.2021	1.3099	0.1982	1.5160	7.65
Average Swelling Ratio = 7.67			Std. Dev. Swelling Ratio = 0.06		
Toluene	0.2043	1.4528	0.2003	1.6756	8.36
	0.2034	1.3986	0.1994	1.6132	8.09
	0.2049	1.4016	0.2009	1.6166	8.05
Average Swelling Ratio = 8.17			Std. Dev. Swelling Ratio = 0.17		
Benzene	0.2018	1.4227	0.1979	1.6186	8.18
	0.2022	1.3789	0.1983	1.5687	7.91
	0.2019	1.4262	0.1980	1.6225	8.20
Average Swelling Ratio = 8.10			Std. Dev. Swelling Ratio = 0.16		
Chloroform	0.2091	2.3525	0.2050	1.5884	7.75
	0.2036	2.3520	0.1996	1.5881	7.96
	0.2007	2.3077	0.1968	1.5582	7.92
Average Swelling Ratio = 7.87			Std. Dev. Swelling Ratio = 0.11		
Chlorobenzene	0.2054	1.7269	0.2014	1.5614	7.75
	0.2013	1.6892	0.1974	1.5273	7.74
	0.2009	1.6546	0.1970	1.4961	7.60
Average Swelling Ratio = 7.70			Std. Dev. Swelling Ratio = 0.09		
Methylene Chloride	0.2043	1.9473	0.2003	1.4697	7.34
	0.2011	1.9519	0.1972	1.4731	7.47
	0.2068	1.9179	0.2028	1.4475	7.14
Average Swelling Ratio = 7.32			Std. Dev. Swelling Ratio = 0.17		
Ethylene Chloride	0.2035	1.6832	0.1995	1.3433	6.73
	0.2017	1.6294	0.1978	1.3004	6.58
	0.2051	1.6934	0.2011	0.3515	6.72
Average Swelling Ratio = 6.68			Std. Dev. Swelling Ratio = 0.09		

Table F-5 Swelling Ratio of the Copolymer Beads (Run E47) in Different Solvents

Solvent	W_p	W_s	V_p	V_s	Swelling Ratio
Hexane	0.2002	0.4122	0.1967	0.6255	3.18
	0.2018	0.4133	0.1983	0.6272	3.16
	0.2013	0.4175	0.1978	0.6335	3.20
Average Swelling Ratio = 3.18			Std. Dev. Swelling Ratio = 0.02		
Heptane	0.2028	0.4354	0.1992	0.6365	3.19
	0.2047	0.4437	0.2011	0.6487	3.23
	0.2007	0.4249	0.1972	0.6211	3.15
Average Swelling Ratio = 3.19			Std. Dev. Swelling Ratio = 0.04		
Cyclohexane	0.2021	0.9069	0.1985	1.1717	5.90
	0.2036	0.9255	0.2000	1.1957	5.98
	0.2031	0.9137	0.1995	1.1805	5.92
Average Swelling Ratio = 5.93			Std. Dev. Swelling Ratio = 0.04		
Trichloroethane	0.2050	1.6399	0.2014	1.2275	6.09
	0.2006	1.6564	0.1971	1.2398	6.29
	0.2061	1.6865	0.2025	1.2623	6.23
Average Swelling Ratio = 6.21			Std. Dev. Swelling Ratio = 0.10		
Carbon tetrachloride	0.2041	2.1467	0.2005	1.3467	6.72
	0.2004	2.1287	0.1969	1.3354	6.78
	0.2037	2.1583	0.2001	1.3540	6.77
Average Swelling Ratio = 6.76			Std. Dev. Swelling Ratio = 0.03		
Xylene	0.2046	1.2253	0.2010	1.4182	7.06
	0.2054	1.2780	0.2018	1.4792	7.33
	0.2017	1.2006	0.1982	1.3896	7.01
Average Swelling Ratio = 7.13			Std. Dev. Swelling Ratio = 0.17		
Toluene	0.2033	1.2154	0.1968	1.4018	7.12
	0.2057	1.3066	0.2021	1.5070	7.46
	0.2023	1.2618	0.1987	1.4554	7.32
Average Swelling Ratio = 7.30			Std. Dev. Swelling Ratio = 0.17		
Benzene	0.2023	1.2445	0.1987	1.4158	7.12
	0.2003	1.2680	0.1968	1.4425	7.33
	0.2010	0.2186	0.1975	1.3864	7.02
Average Swelling Ratio = 7.16			Std. Dev. Swelling Ratio = 0.16		
Chloroform	0.2008	2.0098	0.1973	1.3570	6.88
	0.2033	2.1139	0.1997	1.4273	7.15
	0.2018	2.1018	0.1983	1.4192	7.16
Average Swelling Ratio = 7.06			Std. Dev. Swelling Ratio = 0.16		
Chlorobenzene	0.2007	1.4310	0.1972	1.2939	6.56
	0.2020	1.4748	0.1984	1.3335	6.72
	0.2057	1.4989	0.2021	1.3552	6.71
Average Swelling Ratio = 6.66			Std. Dev. Swelling Ratio = 0.09		
Methylene Chloride	0.2003	1.6450	0.1968	1.2415	6.31
	0.2039	1.7188	0.2003	1.2972	6.48
	0.2045	1.6805	0.2009	1.2683	6.31
Average Swelling Ratio = 6.37			Std. Dev. Swelling Ratio = 0.10		
Ethylene Chloride	0.2004	1.4532	0.1969	1.1598	5.89
	0.2014	0.4747	0.1979	1.1769	5.95
	0.2049	1.5175	0.2013	1.2111	6.02
Average Swelling Ratio = 5.95			Std. Dev. Swelling Ratio = 0.06		

APPENDIX G

Data of Absorption and Desorption in Toluene-Heptane Solution of the Copolymer Beads [the Toluene Volume Fraction (z) = 0.5

Table G-1 Absorption and desorption of copolymer bead (Run. PS: 1st)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.6714	0.1585	-	1.1072	0.7106	-
2	0.8357	0.3056	0.0736	0.9027	0.3851	-0.1628
5	0.9429	0.4389	0.0444	0.7357	0.2058	-0.0589
10	1.0357	0.5817	0.0286	0.6714	0.1585	-0.0100
15	1.0786	0.6570	0.0151	0.6714	0.1585	0.0000
20	1.0987	0.6944	0.0075	0.6714	0.1585	0.0000
25	1.1072	0.7106	0.0032	0.6714	0.1585	0.0000
30	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
35	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
40	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
45	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
50	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
55	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000
60	1.1072	0.7106	0.0000	0.6714	0.1585	0.0000

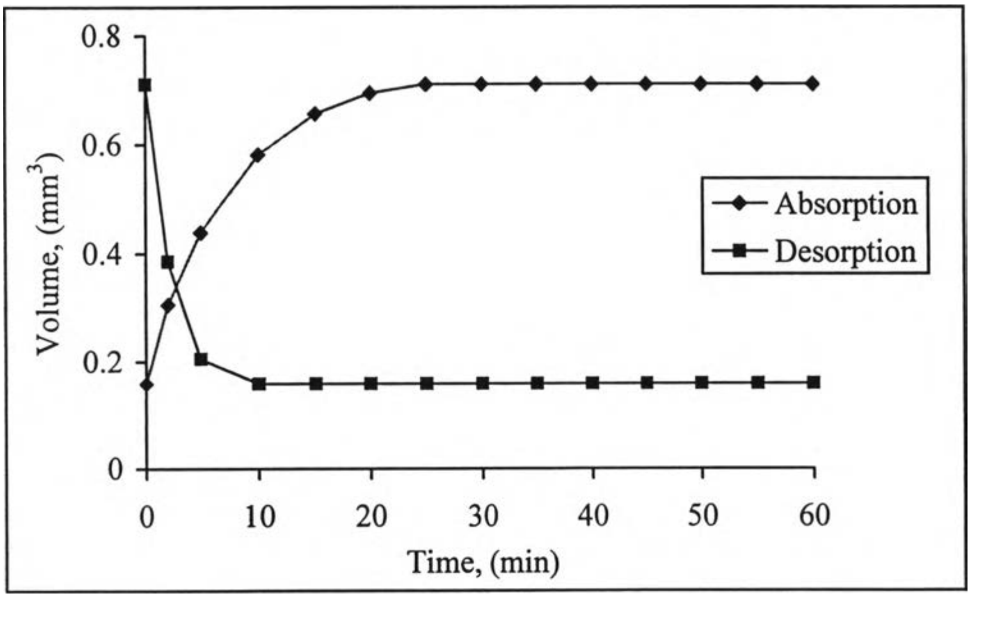


Figure G-1 Variation of copolymer bead volume with time (Run. PS: 1st).

Table G-2 Absorption and desorption of copolymer bead (Run. PS: 2nd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.6710	0.1582	-	1.1046	0.7056	-
2	0.8311	0.3006	0.0712	0.8868	0.3651	-0.1703
5	0.9500	0.4489	0.0494	0.7114	0.1885	-0.0589
10	1.0327	0.5767	0.0256	0.6710	0.1582	-0.0061
15	1.0675	0.6370	0.0121	0.6710	0.1582	0.0000
20	1.0944	0.6864	0.0099	0.6710	0.1582	0.0000
25	1.1019	0.7006	0.0028	0.6710	0.1582	0.0000
30	1.1046	0.7056	0.0010	0.6710	0.1582	0.0000
35	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000
40	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000
45	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000
50	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000
55	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000
60	1.0946	0.7056	0.0000	0.6710	0.1582	0.0000

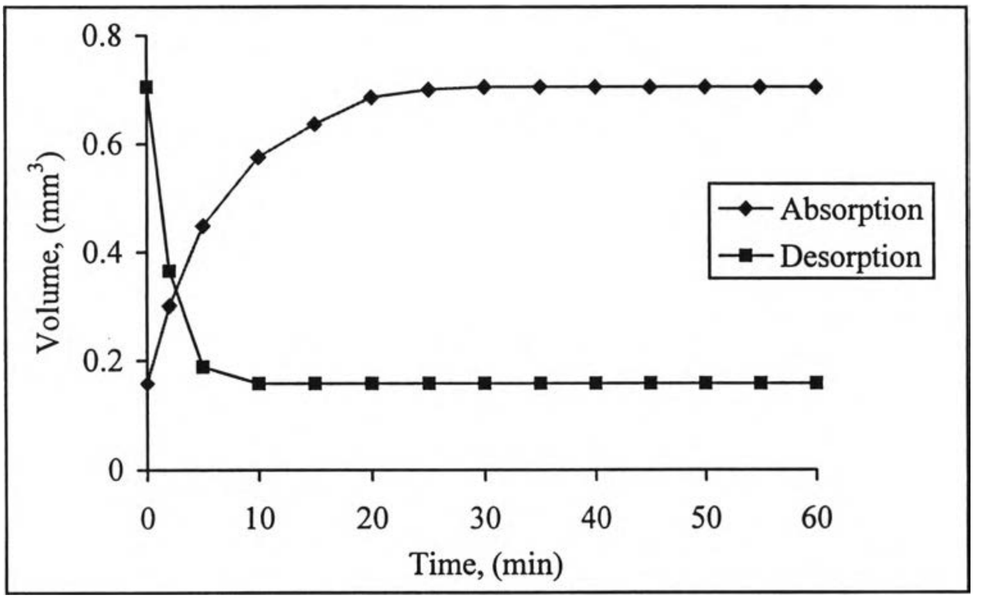


Figure G-2 Variation of copolymer bead volume with time (Run. PS: 2nd).

Table G-3 Absorption and desorption of copolymer bead (Run. PS: 3rd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.6693	0.1570	-	1.1040	0.7046	-
2	0.8265	0.2956	0.0693	0.8540	0.3261	-0.1893
5	0.9378	0.4319	0.0454	0.7114	0.1885	-0.0459
10	1.0297	0.5717	0.0280	0.6693	0.1570	-0.0063
15	1.0653	0.6330	0.0123	0.6693	0.1570	0.0000
20	1.0907	0.6794	0.0093	0.6693	0.1570	0.0000
25	1.0983	0.6936	0.0028	0.6693	0.1570	0.0000
30	1.1066	0.7096	0.0032	0.6693	0.1570	0.0000
35	1.1064	0.7091	-0.0001	0.6693	0.1570	0.0000
40	1.1040	0.7046	-0.0009	0.6693	0.1570	0.0000
45	1.1040	0.7046	0.0000	0.6693	0.1570	0.0000
50	1.1040	0.7046	0.0000	0.6693	0.1570	0.0000
55	1.1040	0.7046	0.0000	0.6693	0.1570	0.0000
60	1.1040	0.7046	0.0000	0.6693	0.1570	0.0000

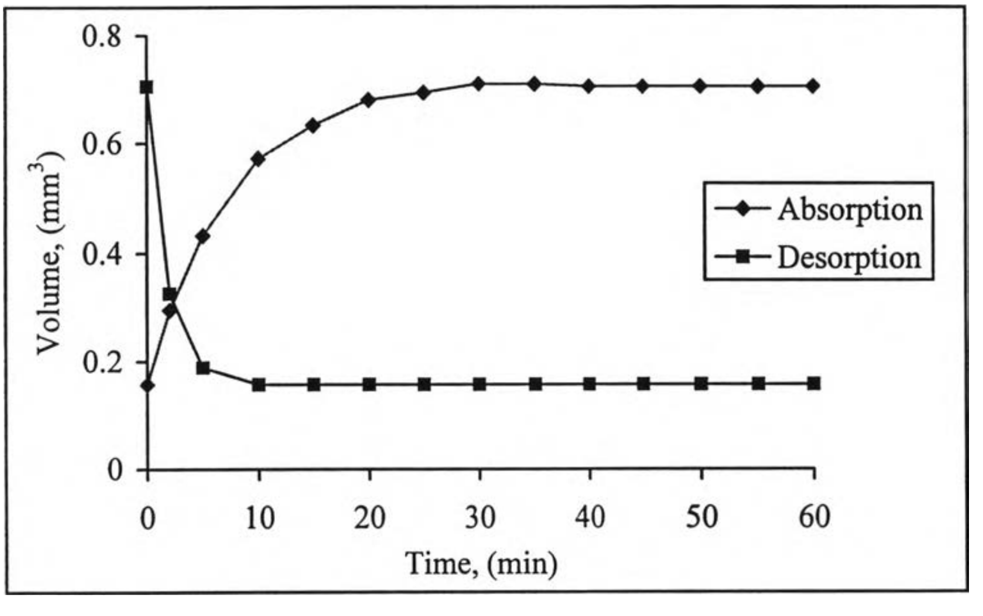


Figure G-3 Variation of copolymer bead volume with time (Run. PS: 3rd).

Table G-4 Absorption and desorption of copolymer bead (Run. B24: 1st)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.8000	0.2681	-	1.3286	1.2280	-
2	1.0429	0.5939	0.1629	1.0714	0.6440	-0.2920
5	1.1571	0.8112	0.0724	0.9500	0.4489	-0.0650
10	1.2571	1.0402	0.0458	0.8929	0.3727	-0.0152
15	1.2929	1.1316	0.0183	0.8786	0.3551	-0.0035
20	1.3143	1.1887	0.0114	0.8380	0.3081	-0.0094
25	1.3214	1.2081	0.0039	0.8098	0.2781	-0.0060
30	1.3286	1.2280	0.0040	0.8000	0.2681	-0.0020
35	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000
40	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000
45	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000
50	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000
55	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000
60	1.3286	1.2280	0.0000	0.8000	0.2681	0.0000

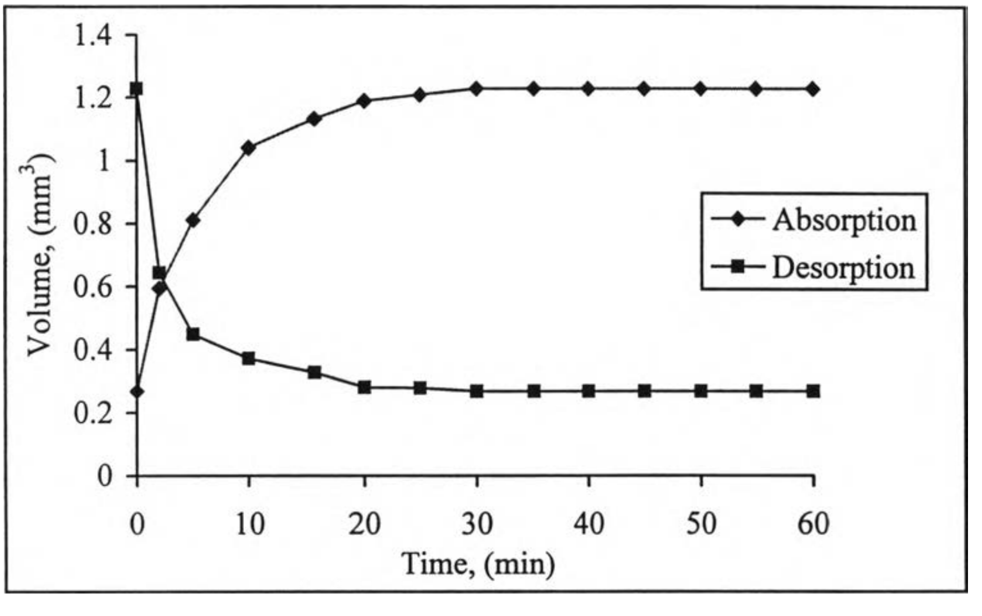


Figure G-4 Variation of copolymer bead volume with time (Run. B24: 1st).

Table G-5 Absorption and desorption of copolymer bead (Run. B24: 2nd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.7997	0.2678	-	1.3250	1.2180	-
2	1.0516	0.6089	0.1706	1.1131	0.7221	-0.2480
5	1.1619	0.8212	0.0708	0.9230	0.4117	-0.1035
10	1.2449	1.0102	0.0378	0.8806	0.3575	-0.0108
15	1.2852	1.1116	0.0203	0.8490	0.3204	-0.0074
20	1.3113	1.1807	0.0138	0.8098	0.2781	-0.0085
25	1.3177	1.1981	0.0035	0.8101	0.2784	0.0001
30	1.3250	1.2180	0.0040	0.7997	0.2678	-0.0021
35	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000
40	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000
45	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000
50	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000
55	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000
60	1.3250	1.2180	0.0000	0.7997	0.2678	0.0000

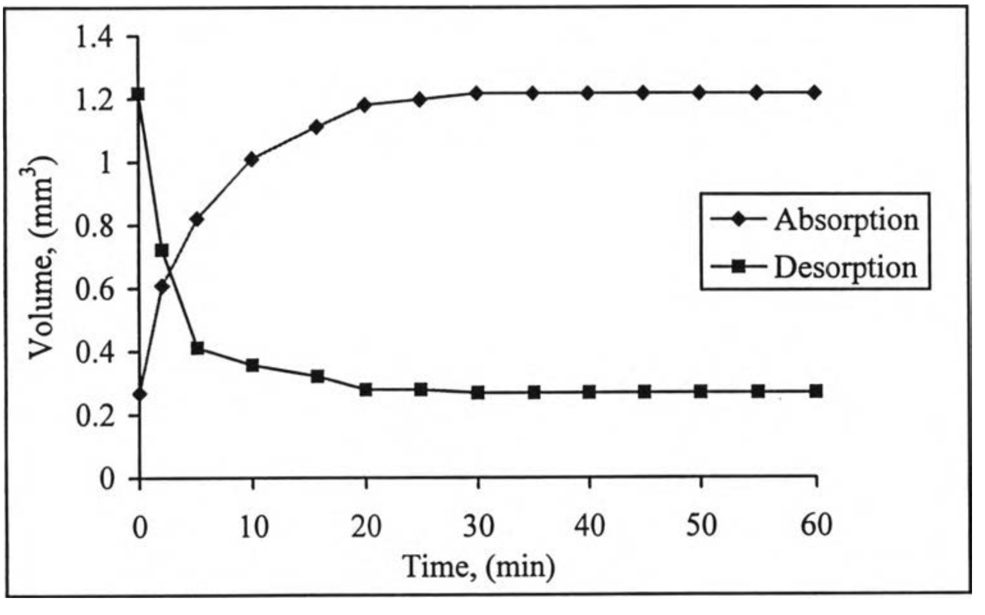


Figure G-5 Variation of copolymer bead volume with time (Run. B24: 2nd).

Table G-6 Absorption and desorption of copolymer bead (Run. B24: 3rd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.7985	0.2666	-	1.3232	1.2130	-
2	1.0128	0.5439	0.1387	1.0469	0.6007	-0.3062
5	1.1392	0.7742	0.0768	0.9025	0.3849	-0.0719
10	1.2366	0.9902	0.0432	0.8682	0.3427	-0.0084
15	1.2837	1.1076	0.0235	0.8270	0.2961	-0.0093
20	1.3087	1.1737	0.0132	0.8194	0.2881	-0.0016
25	1.3152	1.1911	0.0035	0.8113	0.2796	-0.0017
30	1.3225	1.2110	0.0040	0.7985	0.2666	-0.0026
35	1.3232	1.2130	0.0004	0.7985	0.2666	0.0000
40	1.3232	1.2130	0.0000	0.7985	0.2666	0.0000
45	1.3232	1.2130	0.0000	0.7985	0.2666	0.0000
50	1.3232	1.2130	0.0000	0.7985	0.2666	0.0000
55	1.3232	1.2130	0.0000	0.7985	0.2666	0.0000
60	1.3232	1.2130	0.0000	0.7985	0.2666	0.0000

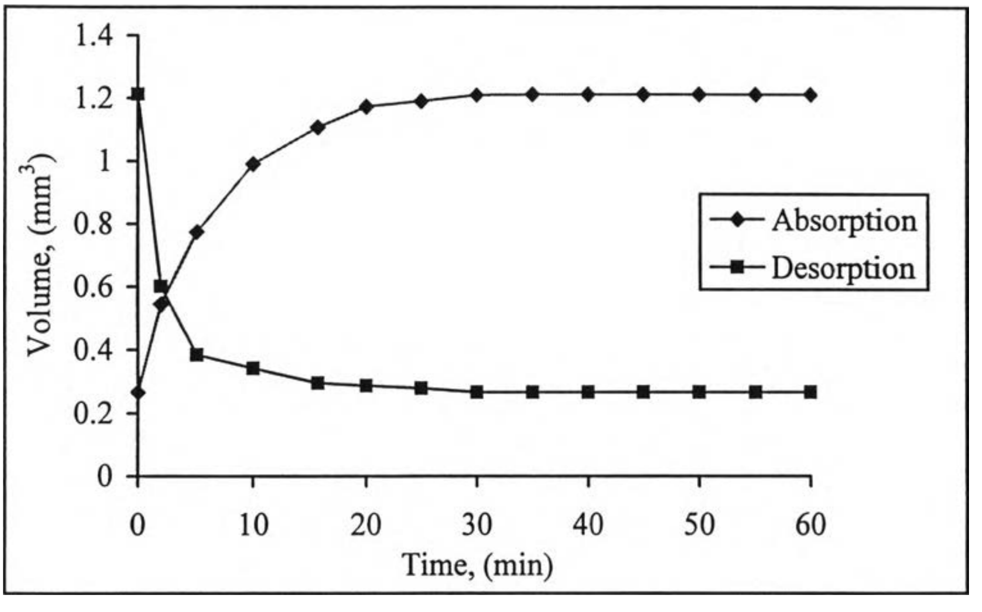


Figure G-6 Variation of copolymer bead volume with time (Run. B24: 3rd).

Table G-7 Absorption and desorption of copolymer bead (Run. B47: 1st)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5857	0.1052	-	0.9786	0.4907	-
2	0.8500	0.3216	0.1082	0.7320	0.2054	-0.1427
5	0.9429	0.4389	0.0391	0.6657	0.1545	-0.0170
10	0.9714	0.4799	0.0082	0.6121	0.1201	-0.0069
15	0.9786	0.4907	0.0022	0.5956	0.1106	-0.0019
20	0.9786	0.4907	0.0000	0.5857	0.1052	-0.0011
25	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
30	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
35	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
40	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
45	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
50	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
55	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000
60	0.9786	0.4907	0.0000	0.5857	0.1052	0.0000

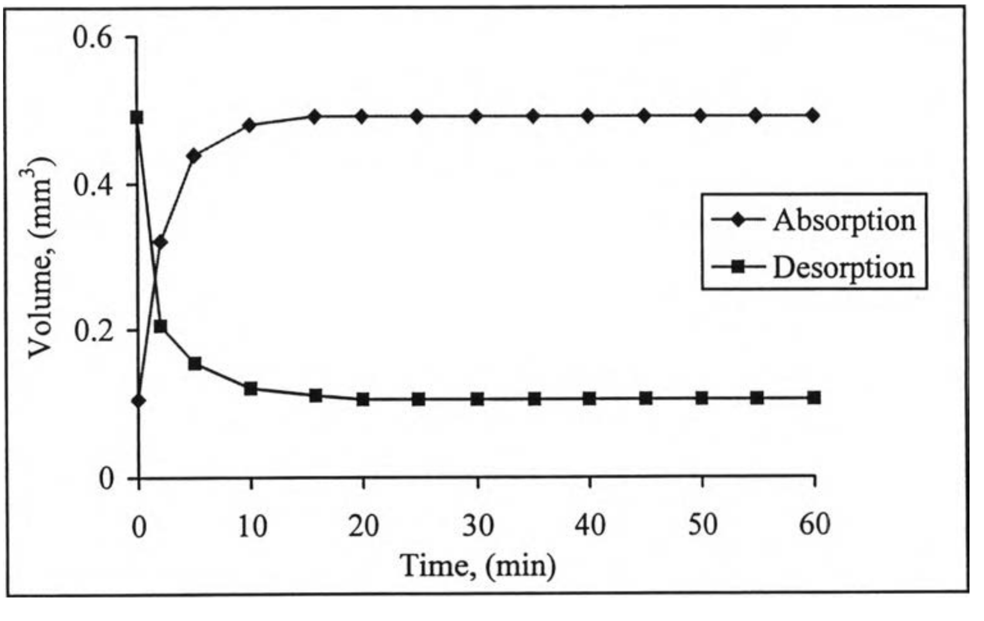


Figure G-7 Variation of copolymer bead volume with time (Run. B47: 3rd).

Table G-8 Absorption and desorption of copolymer bead (Run. B47: 2nd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)
0	0.5851	0.1049	-	0.9739	0.4837	-
2	0.8320	0.3016	0.0984	0.6945	0.1754	-0.1542
5	0.9422	0.4379	0.0454	0.6511	0.1445	-0.0103
10	0.9611	0.4649	0.0054	0.6116	0.1198	-0.0049
15	0.9695	0.4772	0.0025	0.5950	0.1103	-0.0019
20	0.9733	0.4827	0.0011	0.5851	0.1049	-0.0011
25	0.9739	0.4837	0.0002	0.5851	0.1049	0.0000
30	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
35	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
40	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
45	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
50	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
55	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000
60	0.9739	0.4837	0.0000	0.5851	0.1049	0.0000

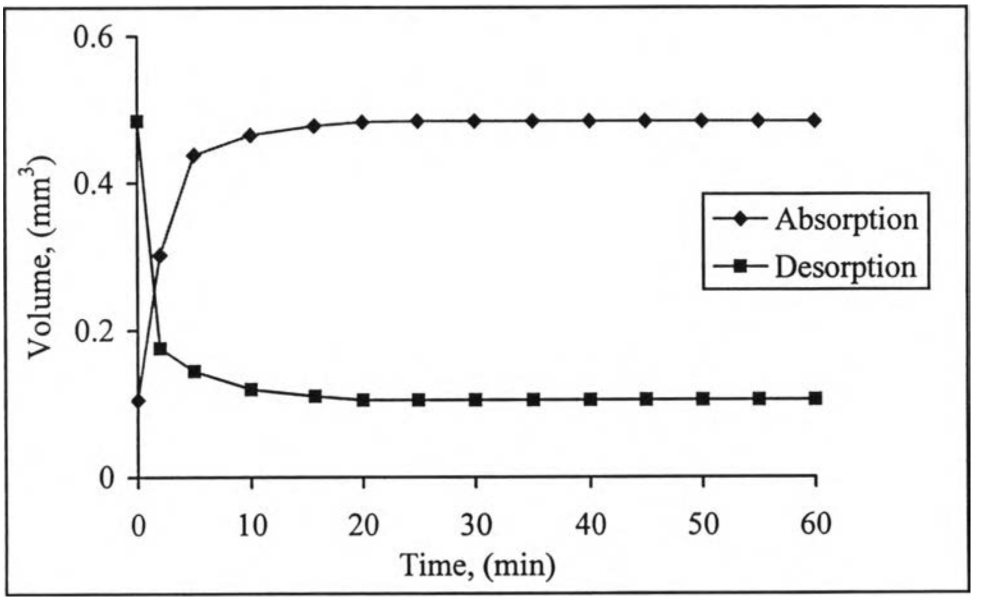


Figure G-8 Variation of copolymer bead volume with time (Run. B47: 2nd).

Table G-9 Absorption and desorption of copolymer bead (Run. B47: 3rd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5829	0.1037	-	0.9736	0.4832	-
2	0.8035	0.2716	0.0840	0.7494	0.2204	-0.1314
5	0.9283	0.4189	0.0491	0.6435	0.1395	-0.0270
10	0.9577	0.4599	0.0082	0.6096	0.1186	-0.0042
15	0.9651	0.4707	0.0022	0.5928	0.1091	-0.0019
20	0.9699	0.4777	0.0014	0.5829	0.1037	-0.0011
25	0.9739	0.4837	0.0012	0.5829	0.1037	0.0000
30	0.9736	0.4832	-0.0001	0.5829	0.1037	0.0000
35	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000
40	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000
45	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000
50	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000
55	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000
60	0.9736	0.4832	0.0000	0.5829	0.1037	0.0000

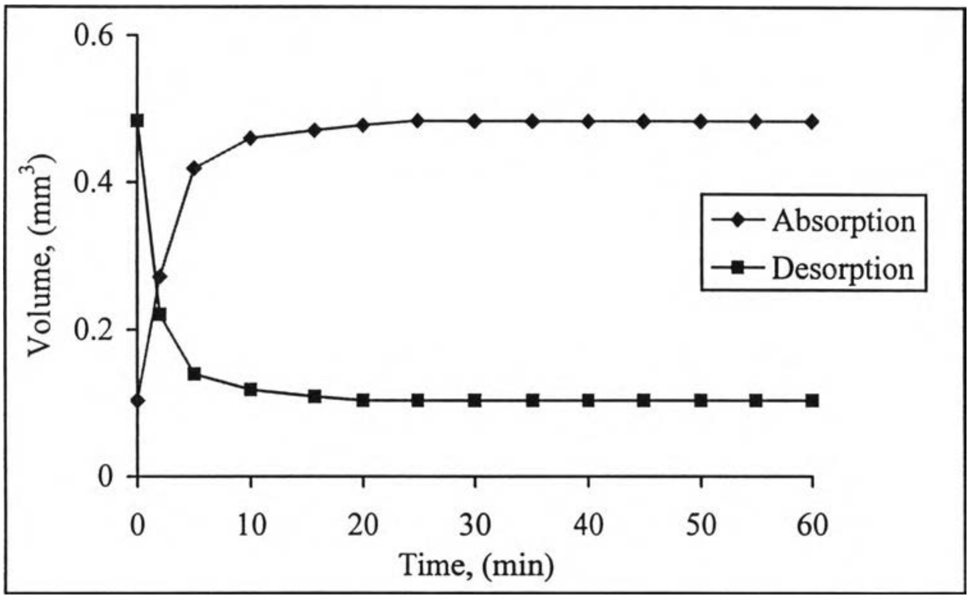


Figure G-9 Variation of copolymer bead volume with time (Run. B47: 3rd).

Table G-10 Absorption and desorption of copolymer bead (Run. E24: 1st)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5357	0.0805	-	0.9857	0.5015	-
2	0.8286	0.2979	0.1087	0.7118	0.1888	-0.1564
5	0.9357	0.4290	0.0434	0.6319	0.1321	-0.0189
10	0.9714	0.4799	0.0102	0.5857	0.1052	-0.0054
15	0.9786	0.4907	0.0022	0.5570	0.0905	-0.0029
20	0.9857	0.5015	0.0022	0.5357	0.0805	-0.0020
25	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
30	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
35	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
40	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
45	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
50	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
55	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000
60	0.9857	0.5015	0.0000	0.5357	0.0805	0.0000

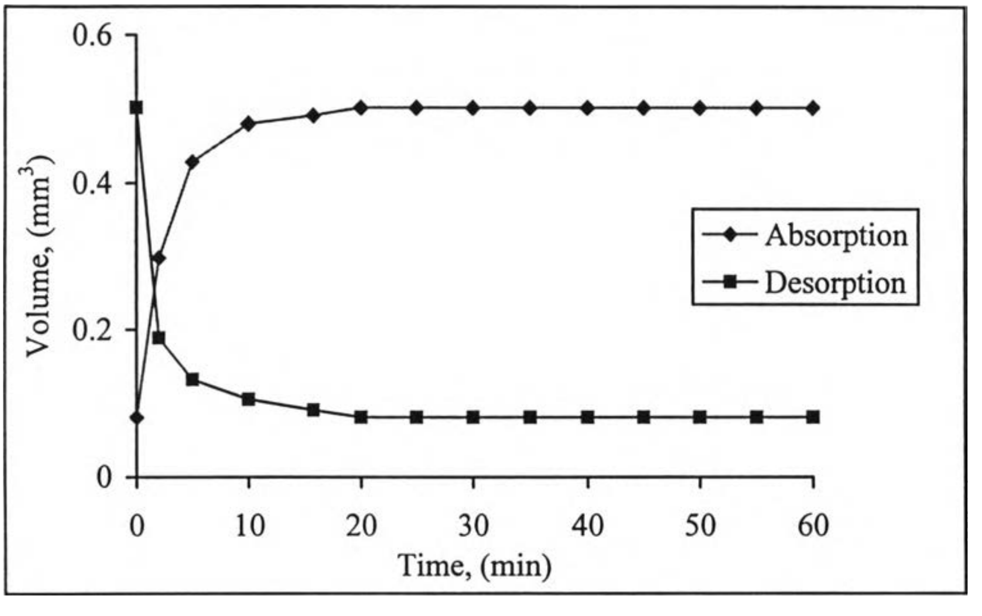


Figure G-10 Variation of copolymer bead volume with time (Run. E24: 1st).

Table G-11 Absorption and desorption of copolymer bead (Run. E24: 2nd)

Time (min)	Asorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)
0	0.5346	0.0800	-	0.9811	0.4945	-
2	0.8145	0.2829	0.1015	0.6734	0.1599	-0.1673
5	0.9284	0.4190	0.0454	0.6056	0.1163	-0.0145
10	0.9646	0.4699	0.0102	0.5734	0.0987	-0.0035
15	0.9719	0.4807	0.0022	0.5466	0.0855	-0.0026
20	0.9805	0.4935	0.0026	0.5346	0.0800	-0.0011
25	0.9811	0.4945	0.0002	0.5346	0.0800	0.0000
30	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
35	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
40	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
45	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
50	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
55	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000
60	0.9811	0.4945	0.0000	0.5346	0.0800	0.0000

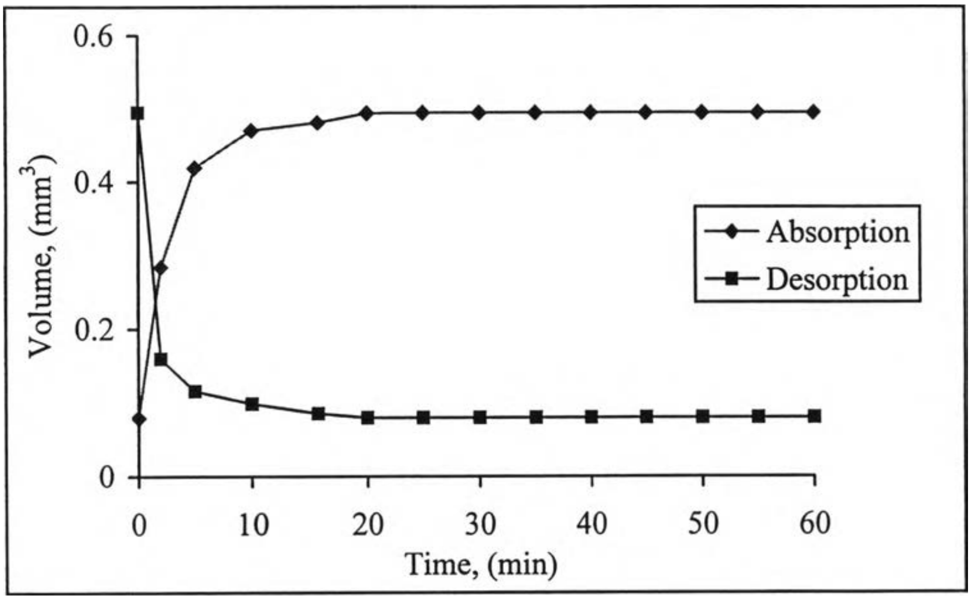


Figure G-11 Variation of copolymer bead volume with time (Run. E24: 2nd).

Table G-12 Absorption and desorption of copolymer bead (Run. E24: 3rd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5324	0.0790	-	0.9808	0.4940	-
2	0.7794	0.2479	0.0845	0.6891	0.1713	-0.1614
5	0.9210	0.4090	0.0537	0.5870	0.1059	-0.0218
10	0.9577	0.4599	0.0102	0.5527	0.0884	-0.0035
15	0.9651	0.4707	0.0022	0.5357	0.0805	-0.0016
20	0.9771	0.4885	0.0036	0.5301	0.0780	-0.0005
25	0.9808	0.4940	0.0011	0.5301	0.0780	0.0000
30	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
35	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
40	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
45	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
50	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
55	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000
60	0.9808	0.4940	0.0000	0.5301	0.0780	0.0000

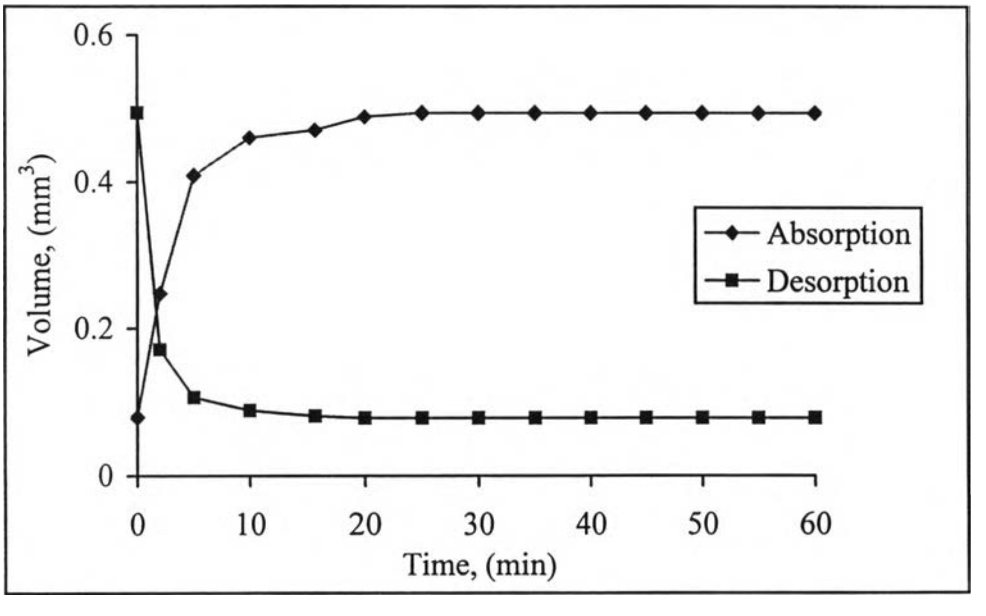


Figure G-12 Variation of copolymer bead volume with time (Run. E24: 3rd).

Table G-13 Absorption and desorption of copolymer bead (Run. E47: 1st)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5857	0.1052	-	1.1071	0.7105	-
2	0.9500	0.4489	0.1719	0.7865	0.2547	-0.2279
5	1.0714	0.6440	0.0650	0.6572	0.1486	-0.0354
10	1.1000	0.6969	0.0106	0.5857	0.1052	-0.0087
15	1.1071	0.7105	0.0027	0.5857	0.1052	0.0000
20	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
25	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
30	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
35	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
40	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
45	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
50	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
55	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000
60	1.1071	0.7105	0.0000	0.5857	0.1052	0.0000

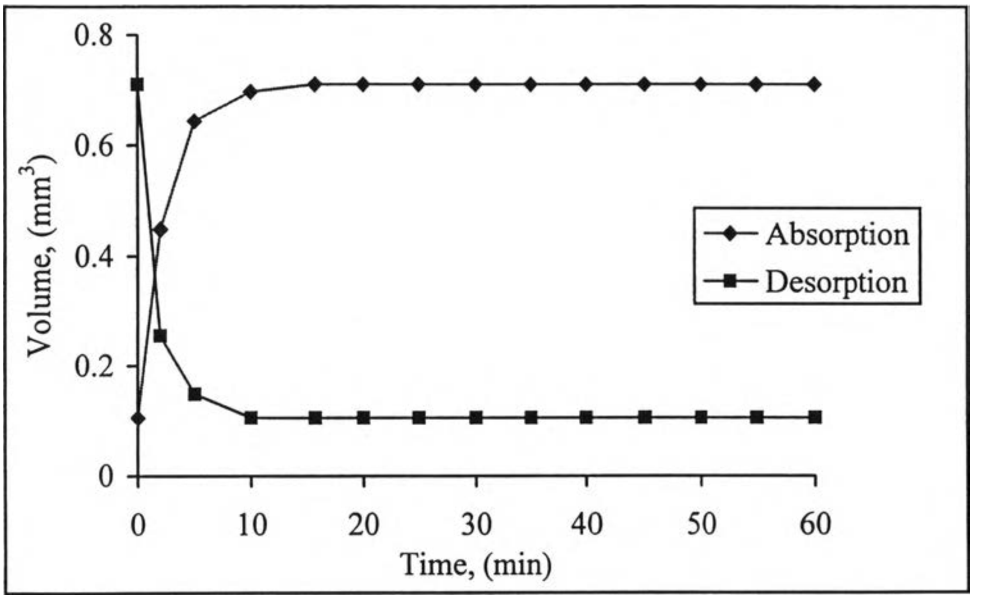


Figure G-13 Variation of copolymer bead volume with time (Run. E47: 1st).

Table G-14 Absorption and desorption of copolymer bead (Run. E47: 2nd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	ΔV/ΔT (mm^3/min)
0	0.5801	0.1022	-	1.1035	0.7035	-
2	0.9133	0.3989	0.1484	0.7648	0.2342	-0.2347
5	1.0703	0.6420	0.0810	0.6448	0.1404	-0.0313
10	1.0920	0.6819	0.0080	0.5801	0.1022	-0.0076
15	1.1000	0.6970	0.0030	0.5801	0.1022	0.0000
20	1.1029	0.7025	0.0011	0.5801	0.1022	0.0000
25	1.1035	0.7035	0.0002	0.5801	0.1022	0.0000
30	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
35	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
40	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
45	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
50	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
55	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000
60	1.1035	0.7035	0.0000	0.5801	0.1022	0.0000

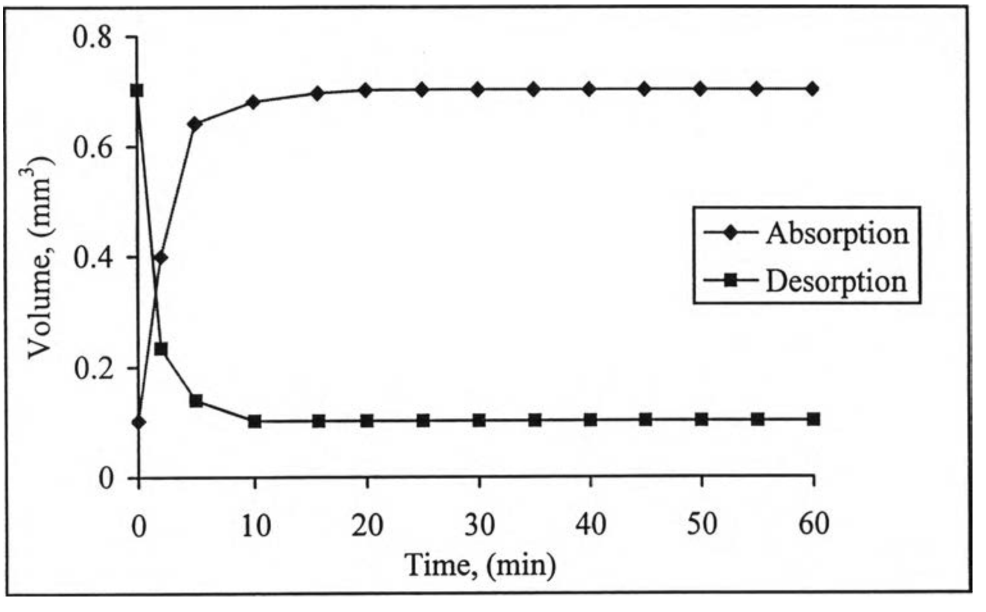


Figure G-14 Variation of copolymer bead volume with time (Run. E47: 2nd).

Table G-15 Absorption and desorption of copolymer bead (Run. E47: 3rd)

Time (min)	Absorption			Desorption		
	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)	Bead Dia. (min)	Bead Vol. (mm^3)	$\Delta V/\Delta T$ (mm^3/min)
0	0.5665	0.0952	-	1.1032	0.7030	-
2	0.9133	0.3989	0.1519	0.8155	0.2840	-0.2095
5	0.10602	0.6240	0.0750	0.6325	0.1325	-0.0505
10	1.0894	0.6769	0.0106	0.5665	0.0952	-0.0075
15	0.0966	0.6905	0.0027	0.5665	0.0952	0.0000
20	1.1003	0.6975	0.0014	0.5665	0.0952	0.0000
25	1.1035	0.7035	0.0012	0.5665	0.0952	0.0000
30	1.1032	0.7030	-0.0001	0.5665	0.0952	0.0000
35	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000
40	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000
45	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000
50	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000
55	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000
60	1.1032	0.7030	0.0000	0.5665	0.0952	0.0000

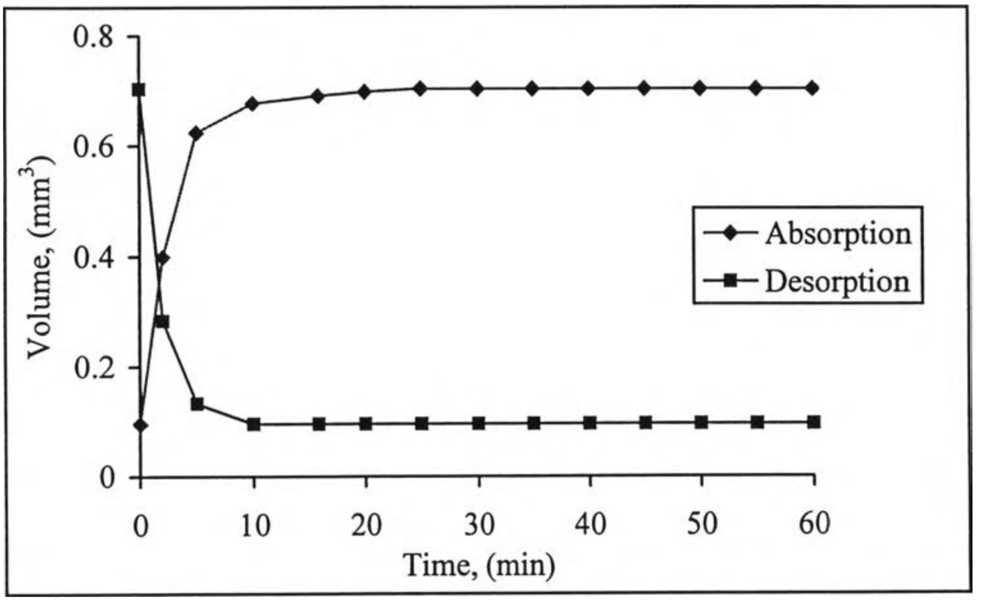


Figure G-15 Variation of copolymer bead volume with time (Run. E47: 3rd).

APPENDIX H

The Calculation of the Diffusion Coefficient of the Copolymer Beads

The diffusion coefficient of the copolymer beads can be calculated from Eq. (H-1)

$$\tau = \frac{a^2}{D} \tag{H-1}$$

where τ is a characteristic swelling time.

a is the final radius of the swollen gel at equilibrium.

D is the diffusion coefficient of the gel in the liquid.

From Eq. (H-2), the characteristic swelling time τ can be obtained from the slope of the $\ln(\Delta a_t/\Delta a_o)$ – time plot.

$$\ln\left(\frac{\Delta a_t}{\Delta a_o}\right) = \text{const.} - t/\tau \tag{H-2}$$

where Δa_t is the difference between the size at time t and that at saturation swelling.

Δa_o is the total change in radius throughout the entire swelling process.

From the experiments, sample code E47, the slope of the $\ln(\Delta a_t/\Delta a_o)$ – time plot is -0.2986. Thus,

$\tau = 3.35$ min

Since $a = 0.5536$ mm, thus, $D = 0.0915$ mm^2/min

$= 1.53 \times 10^{-5}$ cm^2/sec

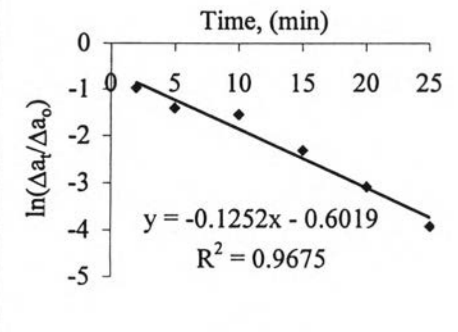
Table H-1 Data for the calculation of the diffusion coefficient of the copolymers beads

Runs	Time (min)	Bead radius (a, mm)	Δa_t (mm)	$\ln(\Delta a_t/\Delta a_o)$
PS	0	0.3357	-	-
(1st)	2	0.4179	0.0822	-0.9749
	5	0.4714	0.0535	-1.4044
	10	0.5178	0.0464	-1.5467
	15	0.5393	0.0215	-2.3160
	20	0.5493	0.0100	-3.0815
	25	0.5536	0.0043	-3.9254
B24	0	0.4000	-	-
(1st)	2	0.5214	0.1214	-0.7643
	5	0.5786	0.0572	-1.5168
	10	0.6286	0.0500	-1.6513
	15	0.6464	0.0178	-2.6842
	20	0.6571	0.0107	-3.1931
	25	0.6607	0.0036	-4.2824
B47	0	0.2928	-	-
(1st)	2	0.4250	0.1322	-0.3963
	5	0.4714	0.0464	-1.4434
	10	0.4857	0.0143	-2.6204
	15	0.4893	0.0036	-3.9997
E24	0	0.2679	-	-
(1st)	2	0.4143	0.1464	-0.4298
	5	0.4679	0.0536	-1.4346
	10	0.4857	0.0178	-2.5369
	15	0.4893	0.0036	-4.1352
E47	0	0.2928	-	-
(1st)	2	0.4750	0.1822	-0.3586
	5	0.5357	0.0607	-1.4578
	10	0.5500	0.0143	-2.9035
	15	0.5536	0.0036	-4.2828
PS	0	0.3355	-	-
(2nd)	2	0.4156	0.0801	-0.9957
	5	0.4750	0.0594	-1.2947
	10	0.5164	0.0414	-1.6557
	15	0.5338	0.0174	-2.5225
	20	0.5472	0.0134	-2.7837
	25	0.5510	0.0038	-4.0440
B24	0	0.3999	-	-
(2nd)	2	0.5258	0.1259	-0.7213
	5	0.5809	0.0551	-1.5477
	10	0.6225	0.0416	-1.8287
	15	0.6426	0.0201	-2.5561
	20	0.6557	0.0131	-2.9842
	25	0.6589	0.0032	-4.3937

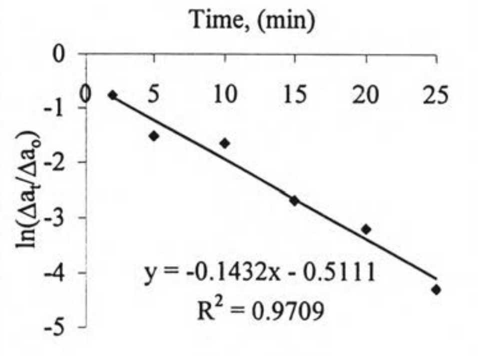
Table H-1 (continued)

Runs	Time (min)	Bead radius (a, mm)	Δa_t (mm)	$\ln(\Delta a_t/\Delta a_o)$
B47	0	0.2926	-	-
(2nd)	2	0.4160	0.1234	-0.4545
	5	0.4711	0.0551	-1.2608
	10	0.4806	0.0095	-3.0186
	15	0.4848	0.0042	-3.8348
E24	0	0.2673	-	-
(2nd)	2	0.4072	0.1399	-0.4676
	5	0.4642	0.0570	-1.3655
	10	0.4823	0.0181	-2.5126
	15	0.4860	0.0037	-4.1002
E47	0	0.2900	-	-
(2nd)	2	0.4567	0.1667	-0.4510
	5	0.5352	0.0785	-1.2041
	10	0.5460	0.0108	-3.1877
	15	0.5500	0.0040	-4.1809
PS	0	0.3347	-	-
(3rd)	2	0.4132	0.0785	-1.0182
	5	0.4689	0.0557	-1.3613
	10	0.5149	0.0460	-1.5526
	15	0.5326	0.0177	-2.5077
	20	0.5454	0.0128	-2.8318
	25	0.5491	0.0037	-4.0729
B24	0	0.3993	-	-
(3rd)	2	0.5064	0.1071	-0.8957
	5	0.5696	0.0632	-1.4232
	10	0.6183	0.0487	-1.6838
	15	0.6418	0.0235	-2.4125
	20	0.6544	0.0126	-3.0358
	25	0.6576	0.0032	-4.4063
B47	0	0.2914	-	-
(3rd)	2	0.4017	0.1103	-0.5718
	5	0.4642	0.0625	-1.1399
	10	0.4788	0.0146	-2.5940
	15	0.4826	0.0038	-3.9400
E24	0	0.2662	-	-
(3rd)	2	0.3897	0.1235	-0.5963
	5	0.4605	0.0708	-1.1527
	10	0.4788	0.0183	-2.5056
	15	0.4826	0.0038	-4.0775
E47	0	0.2833	-	-
(3rd)	2	0.4567	0.1734	-0.4365
	5	0.5301	0.0734	-1.2962
	10	0.5447	0.0146	-2.9111
	15	0.5483	0.0036	-4.3112

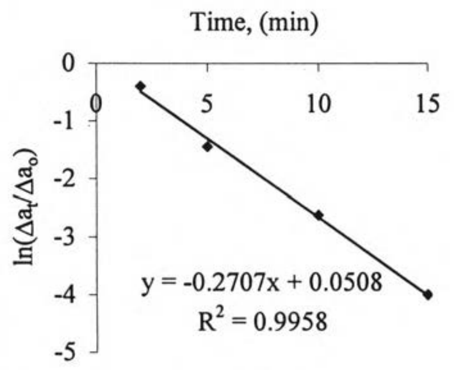
Variation of $\ln(\Delta a_t/\Delta a_o)$ with swelling time.



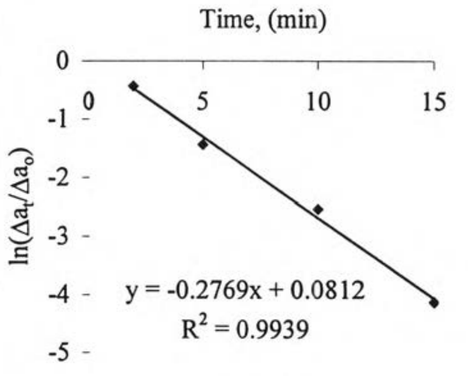
Run. PS: 1st



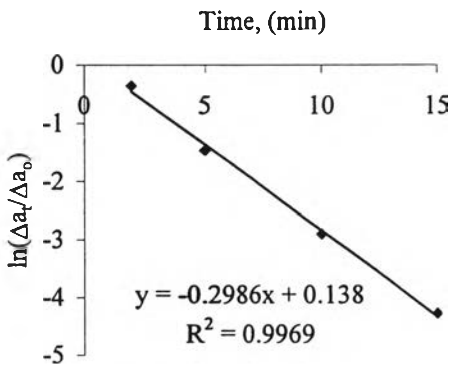
Run. B25: 1st



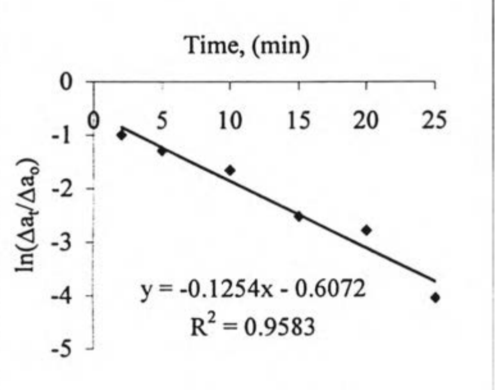
Run. B50: 1st



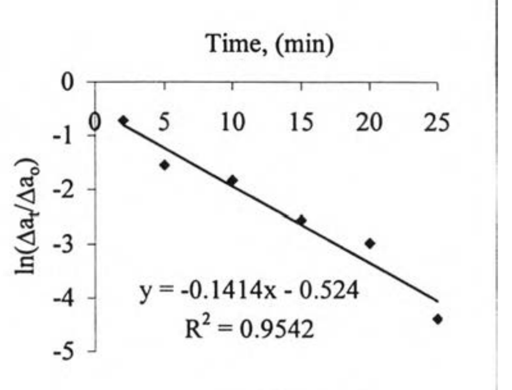
Run. E25: 1st



Run. E50: 1st



Run. PS: 2nd



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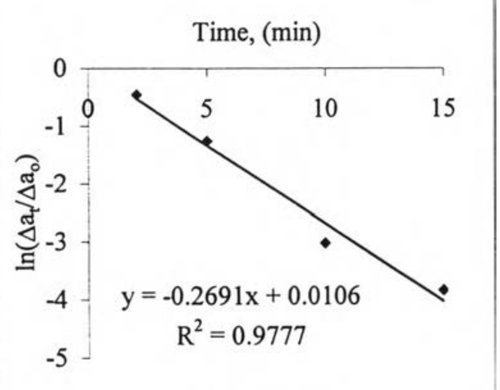
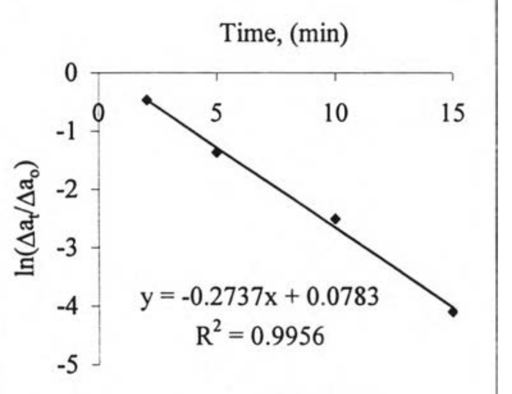
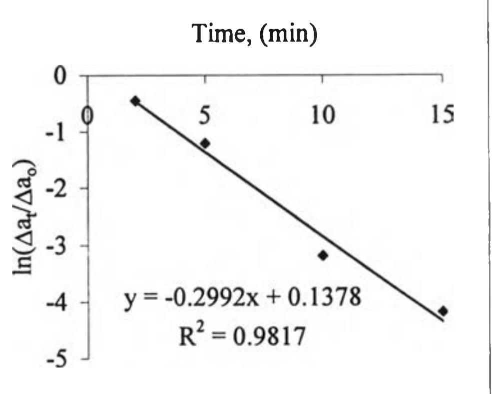


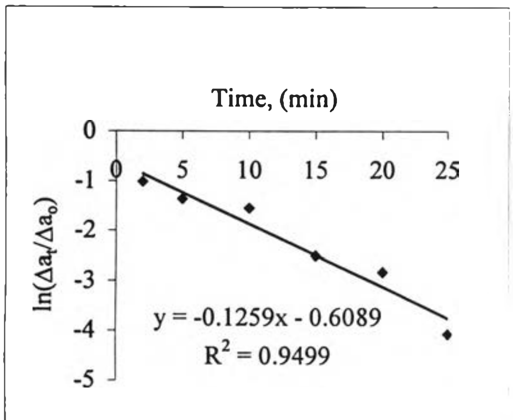
Run. B50: 2nd



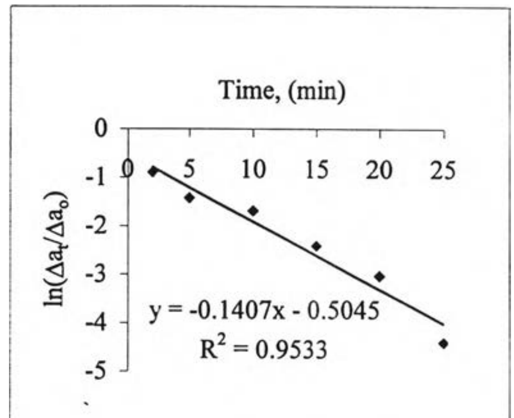
Run. E25: 2nd



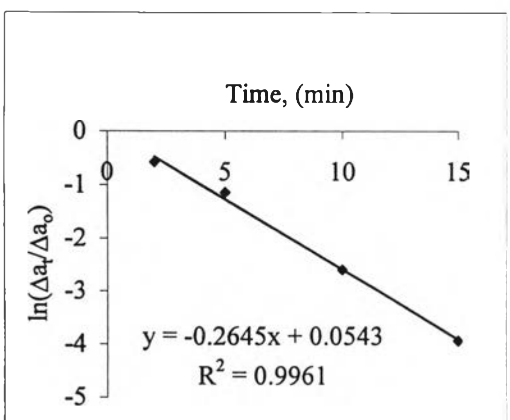
Run. E50: 2nd



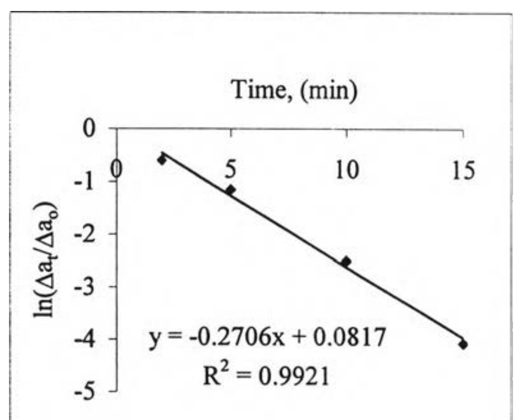
Run. PS: 3rd



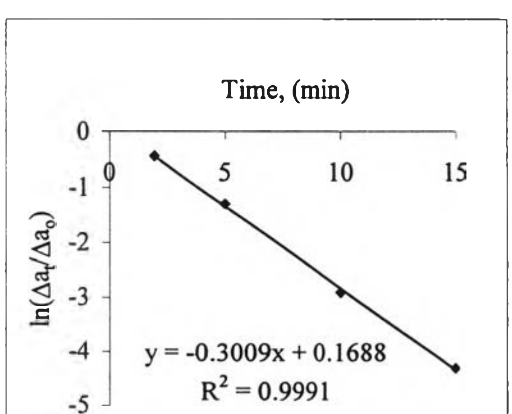
Run. B25: 3rd



Run. B50: 3rd



Run. E25: 3rd



Run. E50: 3rd

VATA

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