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The Reactivity Ratios of Acrylonitrile Copolymerization

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ABSTRACT

The reactivity ratios of acrylonitrile copolymerization published from 1971 to 1982 are tabulated.

A comprehensive listing of copolymerization reactivity ratios is available in Ref. 1 which covers the copolymerization of acrylonitrile up to 1971. Since then much activity of acrylonitrile copolymerization has appeared in the literature. Table 1 compiles acrylonitrile reactivity ratios available from 1971 to 1982. The copolymerization conditions are included wherever available. It is hoped that this tabulation will be useful to those who are interested in the copolymerization of acrylonitrile.

TABLE 1. Reactivity Ratios of Acrylonitrile (M_1) in Copolymerization^a

M_2	r_1	r_2	Conditions	Refs.
Acetic acid, monochloro-, vinyl ester	4.05 ± 0.1 (4.187)	0.001 ± 0.001 -0.007)	60°C, AIBN, DMF	2
	$r_1 = 3.85 \pm 0.1$ $r_1' = 5.55 \pm 0.5$	$r_2 = 0$ $r_2' = 0$	" "	3
Acetic acid, dichloro-, vinyl ester	7.0 ± 0.25 (7.481)	0.05 ± 0.015 0.044)	" "	2
	$r_1 = 7.5 \pm 0.5$ $r_1' = 3.2 \pm 0.5$	$r_2 = 0$ $r_2' = 0$	" "	3
Acetic acid, trichloro-, vinyl ester	7.13 ± 0.25	0.06 ± 0.015	" "	2
	$r_1 = 7.5 \pm 0.5$	$r_2 = 0$	" "	2
Acrolein diethyl acetal	$r_1' = 2.5 \pm 0.3$	$r_2' = 0$	" "	4
	11.19 ± 0.50	0.02 ± 0.00	? " bulk	5
Acrolein oxime	0.1	1.0	60°C, thermal, "	5
	0.1	1.0	0°C, BuLi, "	5
Acrylamide	0.10	0.50	20°C, γ -radiation, acetonitrile	6
	0.08	0.44	" " dioxane	6
	0.08	0.44	" " acetone	6
	0.50	0.47	" " acetic acid	6

1.91	0.55	"	"	water	6
1.13	0.33	"	"	methanol	6
1.9	0.21	"	"	DMF	6
0.06	2.22	80°C,	"	toluene	6
2.34 ± 0.35	0.65 ± 0.04	Homogeneous polymerization in water			7
3.58 ± 0.26	0.41 = 0.06	Heterogeneous			7
1.45 ± 0.41	0.027 ± 0.003	Homogeneous in the presence of polyamide			7
1.37 ± 0.42	0.021 ± 0.004	Homogeneous polymerization in water in the presence of 80:20 M ₁ :M ₂ co- polymerization			7
Acrylamide, N-tert-butyl-	1.14 ± 0.02	60°C,	AIBN,	DMSO	8
Acrylamide, N,N-diethyl-	0.22 ± 0.05	?	?	PhMe	9
	0.27 ± 0.03	?	?	AcOEt	9
Acrylamide, N-methylol-	0.22	?	?	emulsion	10
Acrylic acid	0.72 ± 0.02	60°C,	K ₂ S ₂ O ₈ /Na ₂ S ₂ O ₅ ,	water	11
Acrylic acid, 1-bromo-	0.53 ± 0.01	?	?	?	12
Acrylic acid, 2,3-dibromo- propyl ester	0.96	50°C,	Bz ₂ O ₂ ,	DMF	13
Acrylic acid, 1-chloro-	0.18 ± 0.01	?	?	?	12
Acrylic acid, butyl ester	0.708	70°C,	(NH ₄) ₂ S ₂ O ₈ /Na ₂ S ₂ O ₅ ,	emulsion	14

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Acrylic acid, 2-chloroethyl ester	1.03	0.87	50°C, AIBN, acetone	15
Acrylic acid, 3,4-epoxyhexahydrobenzyl ester	0.30	0.41	60/70°C, Bz_2O_2 , ?	16
Acrylic acid, methyl ester	4.8 ± 0.1	0.1 ± 0.05	25°C, $RuH_2(PPh_3)_4$, toluene	17
	0.69 ± 0.07	1.04 ± 0.09	50°C, $K_2S_2O_8/Na_2S_2O_5$, emulsion	18
	1.95 ± 0.13	1.35 ± 0.14	-50°C, BuLi, ?	19
	2.40 ± 0.10	0.20 ± 0.08	-70°C, " "	19
	0.65 ± 0.02	0.46 ± 0.03	50°C, Lr_2O_2 , toluene/acetone azeotrope, 10^5 Pa	20
	0.76 ± 0.02	0.43 ± 0.03	" " " "	20
	1.0	0.83	3×10^8 Pa	
Acrylic acid, phenyl ester	0.46 ± 0.02	0.36 ± 0.04	60°C, AIBN(?), DMF	21
	(0.432)	0.326)	" AIBN, "	22
Acrylic acid, p-bromo-phenyl ester	0.82 ± 0.03	1.02 ± 0.03	" " "	3
Acrylic acid, m-chloro-phenyl ester	1.26 ± 0.05	0.86 ± 0.05	" " "	22
Acrylic acid, o-chloro-phenyl ester	1.12 ± 0.05	1.16 ± 0.05	" " "	22

Acrylic acid, p-chloro-phenyl ester	0.33 ± 0.03	0.94 ± 0.02	"	"	"	"	22
Acrylic acid, p-cresyl ester	0.73 ± 0.02	0.80 ± 0.02	"	"	"	"	22
Acrylonitrile, 1-chloro-	0.31	3.25	"	"	"	, bulk	23
Benzene, allyl-	5.10	0	"	"	"		24
	3.28	0	"	"	"		24
	2.50	0	"	"	"		24
	1.98	0	"	"	"		24
	2.05	0	"	"	"		24
	2.00	0	"	"	"		24
	2.17	0	"	"	"		24
	5.10 ± 0.3	0	"	"	"		25
	(5.351	0.026	"	"	"		3
M ₂ = acrylonitrile · ZnCl ₂ complex	K ₁₁ /k ₁₂ = 0.13,	k ₁₁ /k ₁₃ = 5.1	"	"	"		24
M ₃ = benzene, allyl-	k ₁₂ /k ₁₃ = 39.4,	k ₂₂ /k ₂₁ = 1.05	"	"	"		
	K ₂₂ /k ₂₃ = 0.85,	k ₂₁ /k ₂₃ = 0.81	"	"	"		

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Benzene, allyl-	4.84-2.87	0	60°C, AIBN, DMF	26
	$\chi_{AN} = 0.2-0.9$			
Benzene, methallyl-	1.88-1.14	0	" "	26
	$\chi_{AN} = 0.4-0.9$			
Bicyclo(2,2,1)hept-5-ene-2,3-dicarboxylic acid, bis(2-((1-oxo-2-propenyl)oxy)ethyl) ester (Diacryloylbis(ethylene glycol) endicate)	0.64	1.12	? DMSO	27
1,3-Butadiene	0.02	0.28	5°C, ?, emulsion	28
	0.09	0.35	85-90°C, H ₂ O ₂ , cyclohexanone	29
3-Butyrolactone, 1-methyl-ene-	0.09	1.1	60°C, AIBN, bulk	30
1,4-Butyrolactone, 3-vinyl-	4.6	0.058	70°C, Bz ₂ O ₂ , "	31
	4.7	0.078	" " "	31
1,4-Butyrolactone, 4-vinyl-	4.4	0.004	50°C, AIBN, "	32
Chromium, carbonyl-	0.79	0.07	70°C, " , ethyl acetate	33

Cinnamic acid, amide, 1-cyano-	8 ± 0.8	0	60°C, AIBN, DMF	34
Cinnamic acid, azide	3.5 ± 0.5	0 ± 0.5	" " bulk	35
Citric acid, tripropenyl ester	8.7 (1.774)	0.01 -0.074)	" " DMF	36
	$r_1 = 11$	$r_2 = 0.01$	" " "	3
	$r_1' = 5$	$r_2' = 0.01$	" " "	36
Cobalt(III), tris(3-(2- pyrrolyl methylenimino)- 1-propenato-	0.86	8.6	70°C, " THF	37, 38
Crotonic acid, 1-acetyl-, methyl ester	8.68	0	60°C, " bulk	39
Crotonic acid, 1-chloro-, ethyl ester	9.53	0	" " "	39
Crotonic acid, 1-cyano-, ethyl ester	11.4	0.06 ± 0.06	" " "	39
Crotonic acid, 1-cyano-, methyl ester	5.34-5.7	-0.1-0	70°C, " "	40
Crotonic acid, ethyl ester	25.2	0	60°C, " "	39
Crotonic acid, 1-methoxy-, methyl ester	1.00	0	" " "	39
Crotonic acid, 2-methyl-, methyl ester	2.97	0	" " "	39

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Cycloheptatriene-maleic anhydride adduct	0.27	11.00	? , ? , ?	41
Dimethacrylamide, N-propyl-	0.77	0.31	30°C, AVN, bulk	42
1,3-Dioxane, 2-vinyl-	5.2	0.01	65°C, Bz_2O_2 , DMF	43
1,3-Dioxane, 2-vinyl-, 5,5-bis(hydroxymethyl)-	3.7	0.01	" " "	43
1,3-Dioxane, 2-vinyl-, 5,5-dimethyl-	3.9	0.01	" " "	43
Ether, butyl vinyl-maleic anhydride complex	0.009	83	60°C, AIBN, CH_3Cl	44
Ethylene, bromo-	2.25 (2.79)	0.055 0.06)	" " bulk	45
	0.94 ± 0.02	0.007 ± 0.003	0°C, $FeSO_4 \cdot H_2O_2$ -ascorbic acid, emulsion	3 45
Ethylene, chloro-	2.9	0.085	20°C, radiation, bulk	46
	$r_1 = 4.0$	$r_2 = 0.03$	60°C, AIBN, DMF	47
	$r_1' = 2.5$	$r_2' = 3.0$		
	3.14 ± 0.25	0.08 ± 0.02	15°C, photo, bulk	48

Ethylene, 1,1-dichloro-	0.8	0.6	60°C, AIBN(?), DMF	21
	0.8	0.54	50°C, AIBN, DMSO	49
	0.75	0.53	60°C, " DMF	50
Ethylene, 2-chloro-, 1-sulfonic acid Na salt	11.0 ± 1.0	-0.9 ± 0.5	" " "	51
	26.0 ± 1.0	-0.05 ± 0.1	" " 25.8% ZnCl ₂ in H ₂ O	51
	26.0 ± 3.0	-0.4 ± 0.2	" " 44.9% ZnCl ₂ in H ₂ O	51
Ethylene glycol mono- acrylate	0.8 ± 0.1	1.2 ± 0.1	80°C, " NaSCN	52
Ethylene glycol mono- methacrylate	0.19 ± 0.05	1.5 ± 0.1	" " "	52
Fumaric acid, ethyl ester	5.50 ± 0.2	0.15 ± 0.05	50°C, Lr ₂ O ₂ , toluene/acetone 10 ⁵ Pa	20
	9.20 ± 0.20	0.10 ± 0.02	" " " 3 × 10 ⁵ Pa	20
1-Hexene-2-methyl(3,5-) dion(methacryloyl acetone)	0.015 (0.010)	3.6 3.740)	? , ? , ?	53
Hydroquinone, vinyl	0.46 (0.561)	0.02 0.041)	35°C, tri-n-butylborane, cyclo- hexanone	54
Indene	0.25 ± 0.01	0.03 ± 0.01	50°C, Bz ₂ O ₂ , heptane, 10 ⁵ Pa	55
	(0.28	0.092	" " "	3
	0.40 ± 0.02	0.03 ± 0.01	" " " 3 × 10 ⁸ Pa	55
	(0.29	0.069)	" " "	3

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Indene	0.33 ± 0.01	0.07 ± 0.01	50°C , Bz_2O_2 , dioxane, 10^5 Pa	55
	0.49 ± 0.01	0.06 ± 0.01	" " " " 3×10^8 Pa	55
	0.15 ± 0.01	0.09 ± 0.01	40°C , " " 10^5 Pa	55
	0.42 ± 0.01	0.06 ± 0.01	" " " " 3×10^8 Pa	55
Isoprene	0.05 ± 0.10	0.36 ± 0.02	45°C , photo, bulk	48
Itaconic acid, mono- methyl ester	0.21 ± 0.02	0.05 ± 0.02	70°C , AIBN, "	56
	0.41 ± 0.03	0.14 ± 0.05	" " " " $M_2:\text{ZnCl}_2$ (2:1)	56
Itaconic anhydride	0.13 ± 0.02	4.8 ± 0.2	70°C , ? , benzene	57
	(0.034)	4.852)		3
Ketone, vinyl, chloro- methyl	0.06	0.83	60°C , AIBN, bulk	58
	(0.064)	0.878)		3
Maleic anhydride	2.23	0.02	50°C , Lr_2O_2 , chloroform, 10^5 Pa	59
	2.14	0.07	" " " " 3×10^8 Pa	59
Malonic acid, ethylidene-, diethyl ester	18.7	0	60°C , AIBN, bulk	39
Methacrylamide, N-phenyl-	0.35	0.60	" " " DMF	60
	(0.382)	0.712)		

Methacrylamide, N-phenyl- p-chloro-	0.40	0.62	60°C, AIBN, DMF	60
Methacrylamide, N-phenyl- p-methoxy-	0.34	0.57	" "	60
Methacrylamide, N-phenyl- p-methyl-	0.36	0.57	" "	60
Methacrylamide, N-phenyl- p-nitro-	0.45	2.70	" "	60
Methacrylic acid, 2-bromo- ethoxyphenoxyphosphoryl ester	0.27	2.20	40°C " bulk	61
Methacrylic acid, 2-(N,N- dimethylcarbamoyloxy)- alkyl ester	0.38 ± 0.15	1.89 ± 0.5	60°C " DMF	62
Methacrylic acid, p- cresoxy-, methyl ester	2.57	0.22	80°C " "	63
			$\frac{\text{ZnCl}_2 \text{ mol}}{\overline{M_1 + M_2}, \text{ mol}}$	
Methacrylic acid, ethyl ester	0.15 ± 0.008	0.95 ± 0.12	65°C " bulk	64
	0.25 ± 0.007	0.31 ± 0.06	" " "	64
	0.25 ± 0.001	0.36 ± 0.01	" " "	64
	0.16 ± 0.007	0.22 ± 0.03	" " "	64
	0.19 ± 0.005	0.95 ± 0.09	60°C " DMF	64
	0.29 ± 0.018	0.26 ± 0.10	" " "	64

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Methacrylic acid, ethyl ester	0.28	1.35	54°C, AIBN, DMSO	65
Methacrylic acid, ethyl, hydroxyester	0.18	2.9	70°C, Bz_2O_2 , bulk/DMF	66
	0.22-0.25	0.97-1.05	60°C, AIBN, DMF/DMSO	67
			" , $K_2S_2O_8$, isoprOH	67
Methacrylic acid, ethyl, 2-hydroxyester	0.027	0.632	" , AIBN, DMF	68
	0.03	1.584	" , " , DMSO	68
Methacrylic acid, ferrocenylmethyl ester	0.11	0.30	80°C, " , benzene	69
	(0.151)	0.826)		3
Methacrylic acid, 3,4-methylenedioxybenzyl ester	0.16	0.78	30°C, tributylborane, cyclohexanone	70
Methacrylic acid, phenoxy-, methyl ester	0.76	0.31	80°C, AIBN, DMF	63
Methacrylic acid, propyl-, 2-hydroxyester	0.036	1.209	60°C, " "	68
	0.053	1.497	" " DMSO	68
Methacrylic acid, triphenylmethyl ester	0.62	0.46	" " DMF	71

Methyl methacrylate	0.29	1.53	54°C, AIBN, DMF	65
	0.10 ± 0.04	1.23 ± 0.15	45°C, photo, bulk	48
	0.11 ± 0.01	2.4 ± 0.02	? , Bz ₂ O ₂ , emulsion (?)	72
	r ₁ = 0.27	r ₂ = 1.06	60°C, AIBN, THF	71
	r ₁ ' = 0.18	r ₂ ' = 1.50		
	r ₁ = 0.35	r ₂ = 1.05	" " DMF	71
	r ₁ ' = 0.23	r ₂ ' = 1.35		
Muconic acid	0.2	4.0	50°C, " DMSO	73
Muconic acid, ethyl ester	0.3	3.2	" " benzene	73
	(0.29)	2.79)		3
p-Oxathiene-maleic anhydride complex	0.0176	55.8	60°C " "	74
2,4-Pentadienoic acid, trans-4-ethoxy-, ethyl ester	0.01 ± 0.01	5.4 ± 1.3	" " "	75
Pentene-1, 2-methyl-	1.51-1.17	0	" " DMF	26
	x _{AN} = 0.4-0.9			
Phosphonic acid, bis(2-chloroethyl) vinyl ester	7.3	0.13	50°C, ? , "	76

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Phosphonic acid, diethyl vinyl ester	6.6	0.049	60°C, Bz ₂ O ₂ , DMF	77
Phthalic acid, dimethylacryloylbis(triethylene glycol) ester	0.35	0	? , AIBN, DMSO	27
4-Piperidinol, 1,2,5-trimethyl-4-(vinylethynyl)-	0.08 ± 0.05	0.38 ± 0.1	60°C, " , ?	78
1-Propanol, 2-acrylamido-2-methyl-	0.37	0.68	" , (Me ₂ CCN) ₂ N ₂ , DMF	79
1-Propene, 2-methyl-	1.00-1.23-0.69	0	" , AIBN, "	26
	$x_{AN} = 0.3-0.4-0.9$			
1-Propene, 1-nitro-	0.135 ± 0.004	7.25 ± 0.2	-55°C, MeONa, DMF	80
	0.031 ± 0.004	8.1 ± 0.4	0°C, " "	80
1-Propene, 3-(2-pyrrolylmethylenimino)-	2.30	0.40	70°C, AIBN, "	37, 38
Propionaldehyde, 2-allyloxy-	5.2	0.01	15°C, photo, "	81
Pyridazinone, 6-methyl-, 3(2-phenyl)-	11	0	60°C, AIBN, "	82

Pyridazinone, 6-methyl-, 3-(2-p-chlorophenyl)-	12	0	"	"	"	82
Pyridazinone, 6-methyl-, 3-(2-p-methyl-phenyl)-	10	0	"	"	"	82
3(2H)-Pyridazinone, 6- hydroxy-2-phenyl-	14	0	"	"	DMSO	83
3(2H)-Pyridazinone, 6- hydroxy-2-(p-chloro- phenyl)-	15	0	"	"	"	83
3(2H)-Pyridazinone, 6- hydroxy-2-(p-tolyl)-	12	0	"	"	"	83
Pyridazinone, 3-(2-vinyl)- 6-methyl-	0.30 (0.32)	0.22 0.19)	"	"	DMF	84 3
Pyridazinone, 3-(2-vinyl)- 6-methyl-4,5-dihydro-	0.72 (0.74)	0.02 0.02)	"	"	"	84 3
Pyridine, 2-vinyl-	0.10	0.02	15°C, photo,	"	"	84
	0.083	4.00	Basic, ?			85
	0.050	1.9	Acidic, ?			85
Pyridine, 4-vinyl-	0.093	0.32	60°C, AIBN, chloroform			86
Pyrrrole, 2-allyl-	0.05 ± 0.01	1.18 ± 0.01	70°C, " , benzene			87
Pyrrrolidinone, N-acryloyl-	1.56	0.43	50°C, ? , DMF			88
Pyrrrolidinone, vinyl-	3.1	0.23	56°C, AIBN, "			89

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Sebacic acid, castor oil-prepolymer	0.35 ± 0.02	1.53 ± 0.02	75°C , Bz_2O_2 , DMF	90
Silane, diacetoxy-, vinyl-methyl-	2.26 ± 0.25	0	50°C , AIBN, bulk	91
Silane, trimethyl-, ((2-methacryloyloxy)ethoxy)-	0.361 ± 0.04	0.810 ± 0.09	" " , DMF	92
	0.229 ± 0.02	1.018 ± 0.10	60°C , " "	92
	0.124 ± 0.01	1.332 ± 0.12	70°C , " "	92
	0.193 ± 0.01	0.463 ± 0.01	60°C , " , DMSO	92
Silane, trimethyl-, ((2-methacryloyloxy)-propoxy)-	0.485 ± 0.02	1.157 ± 0.03	" " , DMF	92
	0.216 ± 0.01	0.394 ± 0.01	" " , DMSO	92
Silane, linaloxytrimethyl-, 2,6-dimethyl-2,7-octadiene-6-trimethylsilyl-ether	5.3 ± 0.2	0	" , Bz_2O_2 , bulk	93
Styrene	0.039	0.71	75°C , Bz_2O_2 , "	94
	0.418 ± 0.011	0.342 ± 0.007	90°C , t-butyl-5-ethylperhexanoate, isooctane in the presence of ethylene-propylene copolymers	95
	0.035 ± 0.118	0.318 ± 0.028	60°C , ? , ethylenechloride	96
	0.037 ± 0.104	0.340 ± 0.026	" , ? , nitrobenzene	96

0.063 ± 0.068	0.314 ± 0.017	" , ? , acetanhydride	96
0.090 ± 0.016	0.365 ± 0.023	" , ? , butanone	96
0.131	0.303	" , ? , HMPT	96
0.130	0.312	" , ? , DMSO	96
0.122	0.318	" , ? , DMF	96
0.123	0.311	70°C, ? , toluene	97
0.12	0.32	60°C, AIBN, DMF	98
0.06	0.386	80-100°C, Bz ₂ O ₂ , toluene	99
0.03	0.3	18-60°C, radiation, bulk	100
0.10	0.27	20°C, radiation, DMF	101
0.13	0.36	60°C, AIBN, DMF	102
0.13	0.40	" " , toluene	102
0.13	0.25	" " " M ₁ +M ₂ = 2 mol%	103
0.16	0.30	" " DMF M ₁ +M ₂ = 2 mol%	103
0.20	0.41	" " " M ₁ +M ₂ = 0.6 mol%	103
0.06 ± 0.01	0.43 ± 0.03	45°C, photo, bulk	48
0.062	0.276	70°C, (NH ₄) ₂ S ₂ O ₈ /Na ₂ S ₂ O ₅ , emulsion	14
0.1 ± 0.02	0.44 ± 0.04	50°C, K ₂ S ₂ O ₈ /Na ₂ S ₂ O ₅ , emulsion	18

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Styrene	0.11	2.8	60°C, $Bz_2O_2/ZnCl_2$, ?	104
	0.17	0.30	" , AIBN, DMSO	105
	0.17	0.33	80°C, " "	105
	0.15	0.33	60°C, " CH_3CN	105
	0.17	0.36	80°C, " "	105
	0.07	0.46	60°C, " EtOH	105
	0.06	0.41	80°C, " "	105
	0.03	0.43	60°C, " benzene	105
	0.06	0.55	80°C, " "	105
	0.02 ± 0.01	0.65 ± 0.03	50°C, Lr_2O_2 , toluene/acetone 10 ⁵ Pa, azeotrope	20
	0.05 ± 0.01	0.53 ± 0.02	50°C, Lr_2O_2 , toluene/acetone 3 × 10 ⁸ Pa, azeotrope	20
	0.02	0.65	50°C, Lr_2O_2 , chloroform 10 ⁵ Pa	59
	0.05	0.53	" " " 3 × 10 ⁸ Pa	59
	$r_1 = 0.039$	$r_2 = 0.229$	60°C, Bz_2O_2 , bulk	106
	$r_1' = 0.091$	$r_2' = 0.634$	" " "	106
	0.053	0.331	" " "	106

Styrene, p-acetoxy-	0.08	0.42	" , AIBN, "	107
Styrene, α -methyl-	0.05 \pm 0.01	0.15 \pm 0.02	50°C, Lr.O ₂ , toluene/acetone 10 ⁵ Pa	20
	0.04 \pm 0.01	0.10 \pm 0.01	" " " 3 \times 10 ⁸ Pa	20
	0.03	0.4	Room temp, plasma, bulk	108
	0.072	0.065	80°C, AIBN, ethylene carbonate	109
	0.045	0.140	" " ethylene carbonate:H ₂ O (9:1)	109
Styryl isocyanate	9 \pm 0.5	0 \pm 0.5	60°C, " , bulk	35
Sulfonic acid, propenyl ester, Na/NH ₄ salts	Varies with monomer ratio	~0	50°C, " , DMF	110
Sulfoxide, ethyl vinyl	3.0	0.2	60°C, " , bulk	111
	(1.646	-0.088)		3
Tetrazole, 2-methyl-5-(4'-vinyl)-phenyl-	0.42	1.1	" " , benzene	112
Tetrazole, 2-(4'-vinyl)-phenyl-5-phenyl-	0.32	1.4	" " " "	112
Thiazole, mercaptobenzo-, vinyl	0.2	0.2	" " , bulk	113
Thiazole, 4-methyl-2-vinyl-	0.08	2.50	? , " , benzene	114

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Tin, tributyl-, acrylate	1.008	0.243	70°C, AIBN, toluene	115
Tin, tributyl-, methacrylate	0.467	0.465	" " "	115, 116
Triethylene glycol di-methacrylate	0.2 ± 0.02	6.5 ± 0.5	? , ? , DMSO	117
Tungsten, (η^5 -vinylcyclopentadienyl)-tricar-bonylmethyl-	0.006	0.007	60°C, AIBN, benzene	118
Vinyl acetate	3.10 ± 0.10	0.1 ± 0.02	50°C, Li_2O_2 , toluene/acetone, 10^5 Pa	20
	3.50 ± 0.10	0.05 ± 0.01	" " "	3×10^5 Pa
	0.5 ± 0.01	0.02 ± 0.03	? , ZnCl_2 , ?	119
	4.0	0.008	60°C, AIBN(?), DMF	21
	4.20 ± 0.20	0.08 ± 0.02	45°C, photo, bulk	48
	12.411	0.064	80°C, AIBN, ethylene carbonate	109
	6.300	0.007	" " ethylene carbonate: H_2O (9:1)	109
	1.10	0.30	? , Bz_2O_2 : $(\text{HOCH}_2\text{CH}_2)_3\text{N}$ (1:1)	120
	0.76	0.52	" , Bz_2O_2 : $(\text{HOCH}_2\text{CH}_2)_3\text{NEt}$ (1:1)	120
Vinyl acetate, 2,2-dichloro-	5.6	0.12	65°C, AIBN, DMF	121

Vinyl ether, n-butyl	$r_1 = 0.15$	$r_2 = r_2' = r_2'' = 0$	50°C,	"	, acetone	122
	$r_1' = 0.65$					
	$r_1'' = 2.50$					
	$r_1 = 0.65$	$r_2 = r_2' = 0$	60°C,	"	"	123
	$r_1' = 2.50$					
Vinyl ether, 2-chloroethyl	$r_1 = 0.65$	$r_2 = r_2' = 0$	70°C,	"	"	123
	$r_1' = 2.50$					
	$r_1 = 1.00$	$r_2 = r_2' = 0$	50°C,	"	, DMF	123
	$r_1' = 3.40$					
	$r_1 = 1.09$	$r_2 = r_2' = 0$	70°C,	?	, DMF	124
Vinyl ether, isobutyl	$r_1' = 2.56$					
	$r_1 = 0.68$	$r_2 = r_2' = 0$	40°C,	AIBN,	acetone	123
	$r_1' = 2.56$					
	$r_1 = 0.68$	$r_2 = r_2' = 0$	50°C,	"	"	123
	$r_1' = 2.56$					

(continued)

TABLE 1 (continued)

M_2	r_1	r_2	Conditions	Refs.
Vinyl ether, isobutyl	$r_1 = 0.68$	$r_2 = r_2' = 0$	70°C, AIBN, acetone	123
	$r_1' = 2.63$			
	$r_1 = 0.96$	$r_2 = r_2' = 0$	50°C, " DMF	123
	$r_1' = 3.23$			
	$r_1 = 0.95$	$r_2 = r_2' = 0$	70°C, " "	123
	$r_1' = 3.03$			
Vinyl sulfide, ethyl	0.065	0.055	60°C, thermal, bulk	125
Vinyl sulfide, isobutyl	0.068	0.05	" , AIBN, "	125
	(0.08)	(0.03)		3
Vinyl sulfide, phenyl	0.11	0.07	" " "	125
	(0.11)	(0.03)		3
Vinylbenzyl bromide	0.20 ± 0.02	0.16 ± 0.02	? , Bz_2O_2 , ?	126
1-Vinylimidazolium, 3-methyl-, methylsulfate	1.65	0.67	? , AIBN, $MeOH:H_2O$ (2:8)	127
	2.2	0.1	60°C, " , CH_3CN	128
Vinyl, methylphenyl-, sulfonium tetrafluoroborate				

3-(4-Vinylphenoxy)- phthalide	$r_1 = 0.08$ $r_1' = 0.11$	$r_2 = 0.23$ $r_2' = 0.41$	45°C, " , DMF	129
$M_1 = (\text{Acrylonitrile})_2\text{ZnCl}_2$ styrene $M_2 = (\text{AN})_2\text{ZnCl}_2$				
1,3-cycloheptadiene $M_2 = (\text{AN})_2\text{ZnCl}_2$	1.80	0.78	40°C, ZnCl_2 , ?	130
1,3-cyclohexadiene $M_2 = (\text{AN})_2\text{ZnCl}_2$	0.32	1.78	" " "	130
1,3-cyclooctadiene $M_2 = (\text{AN})_2\text{ZnCl}_2$	12.0	0.15	" " "	130
indene	5.1	0.23	" " "	131

^aValues in parentheses are from Ref. 3, recalculated by the Kelen and Tüdd's equations.

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