Kazan State University
Butlerov Institute of Chemistry
Lab. of High Pressure Chemistry
Phys. Chemistry Department

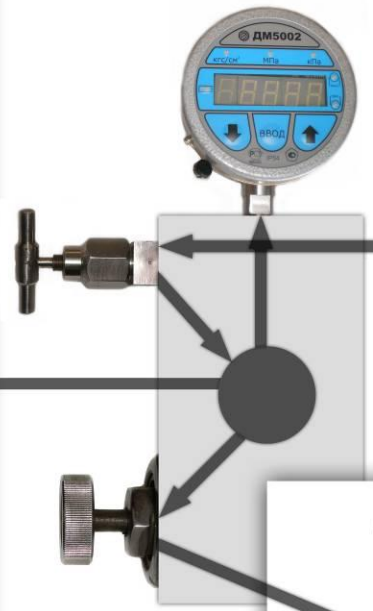
COMPRESSIBILITY OF LIQUIDS
RULE OF NONCROSSING P-V CURVATURES

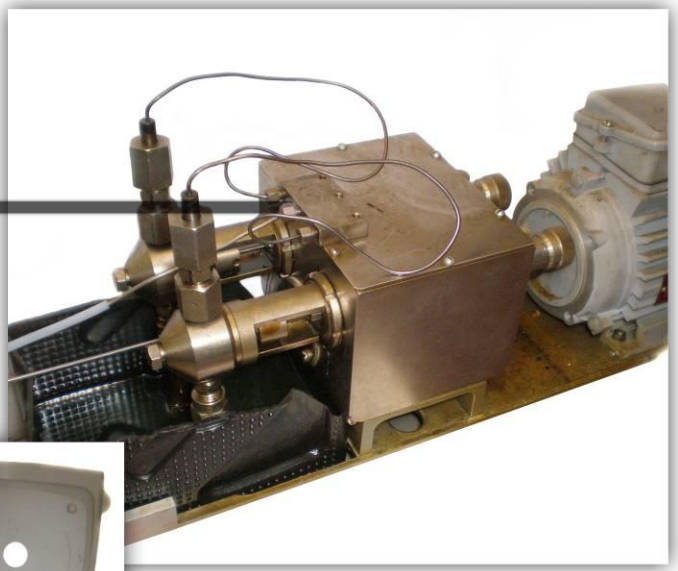
$$\beta_T = - 1/V(\partial V/\partial P)_T$$

Marcus Y. The compressibility of liquids at ambient temperature and pressure. *J. Mol. Liquids,* 1997, V. 73, 74, P. 61-74

$$\beta_T = (0.246\pm0.105) + (0.0298\pm0.0030)V_0 - (0.0356\pm0.0038)V_w + (0.462\pm0.089)\alpha_p + (0.0049\pm0.0008)p$$

New method of determination of the isothermal compressibility under pressure up to 1000 bar





$$m_{hf\text{-}hf}/d_P = \Sigma\Delta v_{hf\text{-}hf} = \Delta v_1 + \Delta v_2 + \Delta v_3 + \Delta v_4 + \Delta v_{cap.} + \Delta v_{def}$$

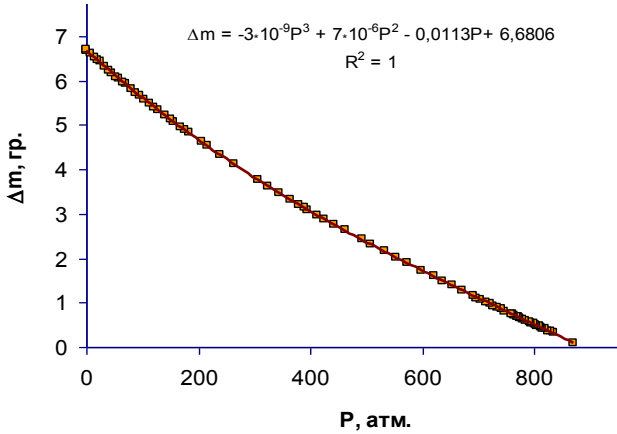
$$m_{hf\text{-}water}/d_P = \Sigma\Delta v_{hf\text{-}water} = \Delta v_1 + \Delta v_2 + \Delta v_3 + \Delta v_4 + \Delta v_{cap.} + \Delta v_{def.}$$

$$(m_{hf\text{-}hf} - m_{hf\text{-}water})/d_P = \Delta v_{(3+4)\,hf} - \Delta v_{(3+4)water}$$

$$\Delta m/d_{p,hf} = \Delta v_{(3+4)\,hf} - \Delta v_{(3+4)water} = V_0 \times (d_p - d_0)/d_p - (V_0 - V_p^{water})$$

$$\Delta m + M_{0,hf} = V_p^{water} \times d_{p,hf}$$

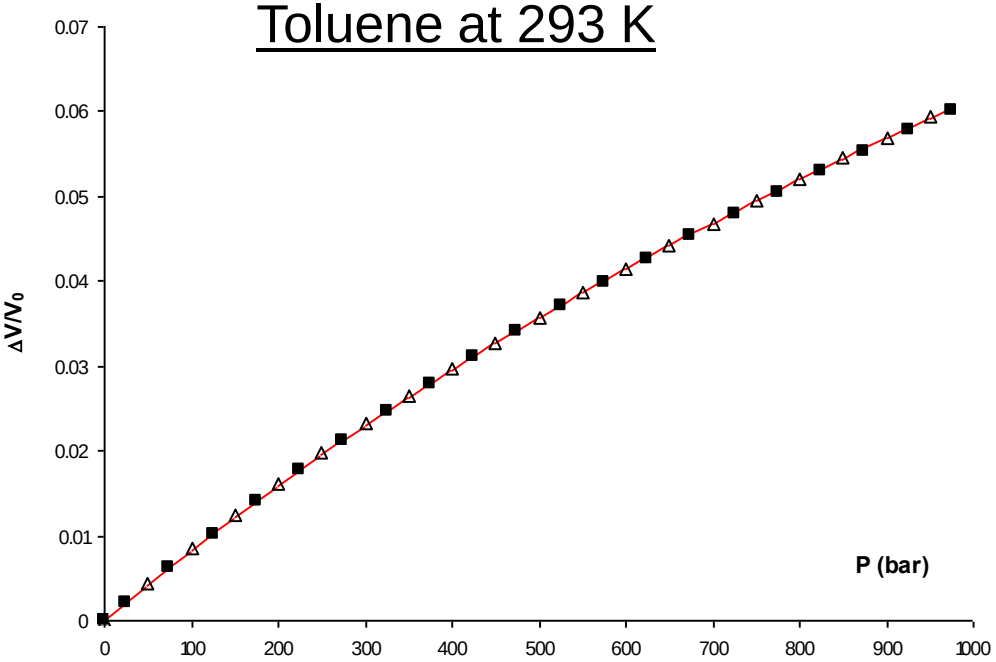
$$(m_{hf\text{-}hf} - m_{hf\text{-}S})/d_P = \Delta v_{p,(3+4),hf} - \Delta v_{p,(3+4),S}$$

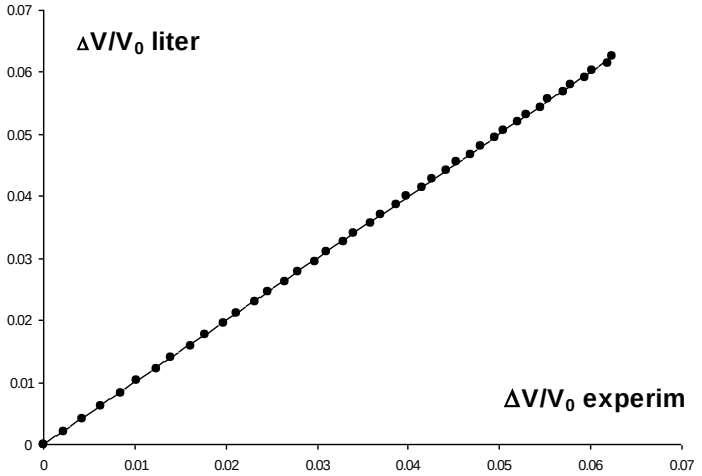


Dependence of the weight of compressed liquid with the pressure decrease

Compressibility of toluene at temperature 293 K and pressures from 1 to 1000 bar

Toluene at 293 K





$\Delta V/V_0^{liter} = 1.001051 \times \Delta V/V_0^{experim}$

r = 0.99998

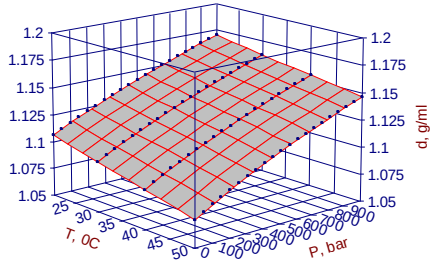
Δ toluene (20⁰C) the first series of measurements

■ toluene (20⁰C) the second series of measurements

I. Cibulka, T. Takagi , *J. Chem. Eng. Data*, 1999, **44**, 411 – 429

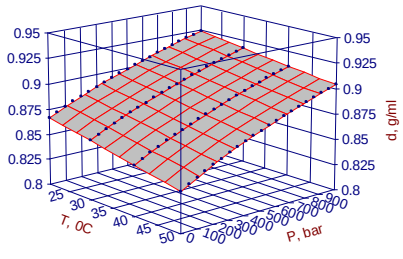
	T_{min}/K	T_{max}/K	P_{min}/bar	P_{max}/bar	N_p
Toluene	179.02	583.18	1.3	3792	873

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0939	± 0.0006
	B	1279	± 10.4
30	C	0.0942	± 0.0007
	B	1208	± 11
40	C	0.0922	± 0.0004
	B	1103	± 6.23
50	C	0.0950	± 0.0005
	B	1078	± 7.2



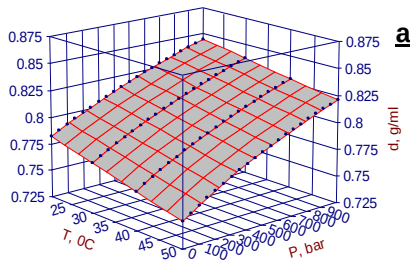
chlorobenzene

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0911	± 0.0003
	B	1029	± 3.8
30	C	0.0903	± 0.0003
	B	947	± 3.5
40	C	0.0887	± 0.0002
	B	872	± 3
50	C	0.0902	± 0.0003
	B	821	± 4



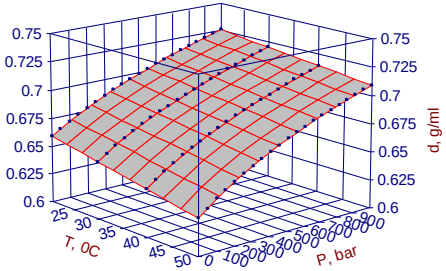
toluene

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.1018	± 0.0004
	B	934	± 4.8
30	C	0.1028	± 0.0004
	B	875	± 4
40	C	0.1020	± 0.0006
	B	807	± 6
50	C	0.1032	± 0.0004
	B	751	± 4.5



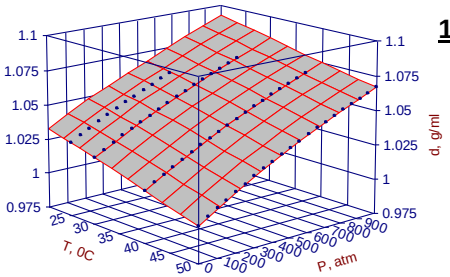
acetonitrile

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0881	± 0.0003
	B	548	± 2.4
30	C	0.0883	± 0.0003
	B	501	± 2.5
40	C	0.0874	± 0.0003
	B	451	± 2.4
50	C	0.0888	± 0.0004
	B	415	± 2.4



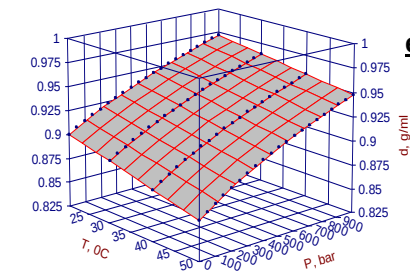
n-hexane

T, ^{0}C	coef. of Tait eq.	Values	st. error
25	C	0.0907	± 0.0001
	B	1217	± 20
30	C	0.0872	± 0.0002
	B	1117	± 3
40	C	0.0887	± 0.0002
	B	1070	± 4
50	C	0.0906	± 0.0003
	B	1016	± 3.6



1,4-dioxane

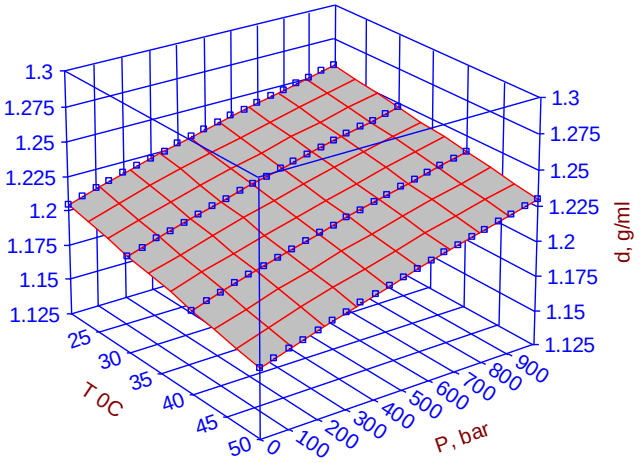
T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0887	± 0.0003
	B	786	± 3.5
30	C	0.0905	± 0.0003
	B	743	± 2.8
40	C	0.0879	± 0.0002
	B	652	± 2.3
50	C	0.0894	± 0.0003
	B	604	± 3

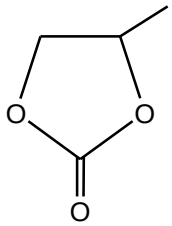


ethyl acetate

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0911	± 0.0002
	B	1798	± 5.1
30	C	0.0937	± 0.0001
	B	1762	± 2.3
40	C	0.0908	± 0.0003
	B	1611	± 7.0
50	C	0.0917	± 0.0002
	B	1547	± 3.6

Propylene carbonate



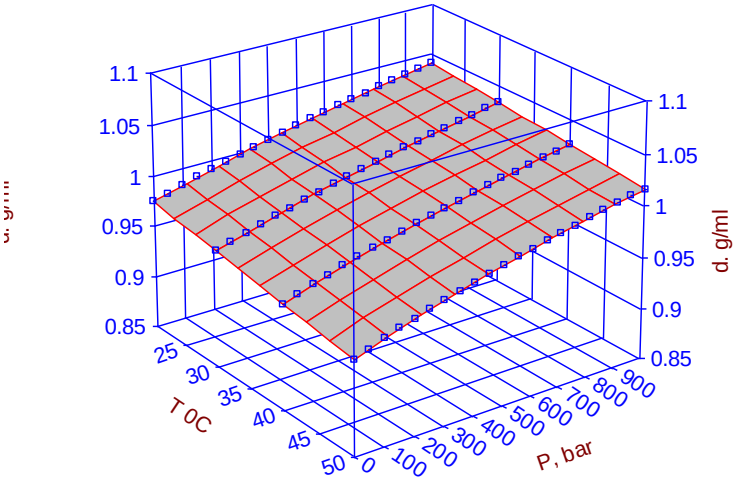


$$\varepsilon^{20} = 66.6$$

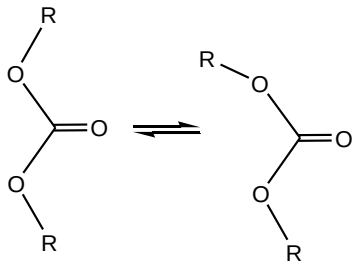
$$\beta_T^{20} = 50.6 \times 10^{-6} bar^{-1}$$

T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0885	± 0.0003
	B	947	± 4.0
30	C	0.0876	± 0.0004
	B	868	± 5.8
40	C	0.0894	± 0.0003
	B	825	± 4.0
50	C	0.0864	± 0.0004
	B	762	±4.2

Diethyl carbonate



D. Saar et.al. Ultrasonic and microwave dielectric relaxation of liquid dialkyl carbonates, *J. Phys. Chem.*, 1978, 82, 2531 – 2535

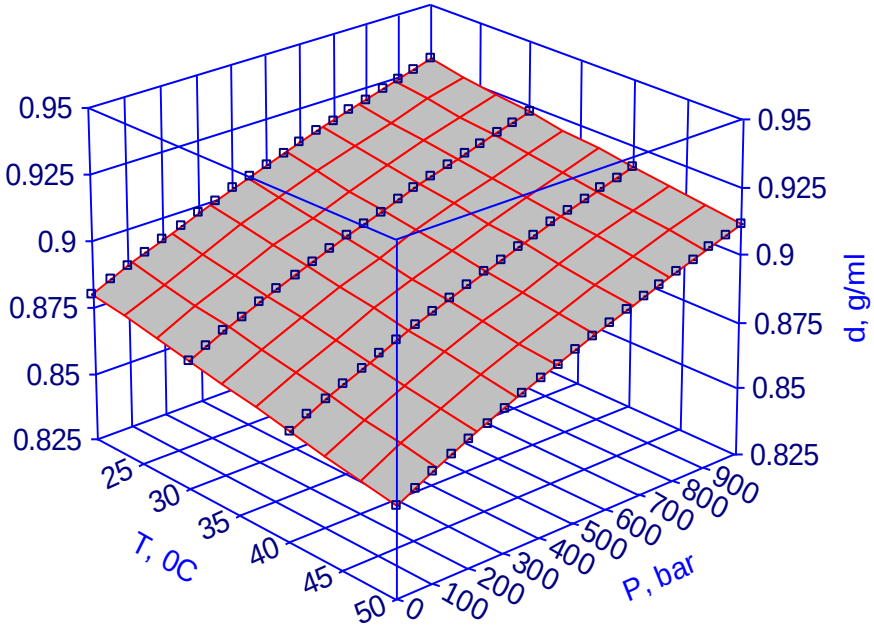


$$\varepsilon^{20} = 2.82$$

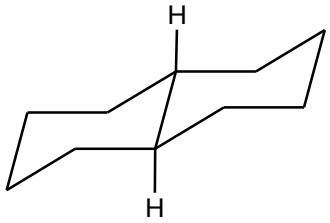
$$\beta_T^{20} = 93.5 \times 10^{-6} bar^{-1}$$

V.D. Kiselev, A.V. Bolotov «P-V-T parameters of decahydronaphthalene and propylene carbonate at pressure up to 1000 bar in temperature range 20-50C» // Russ. J. Phys. Chem., 2009, in press

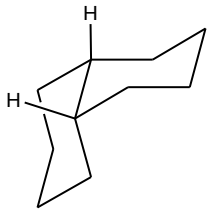
Cis, trans – decahydronaphthalene (40 / 60)



T, ^{0}C	coef. of Tait eq.	Values	st. error
20	C	0.0806	± 0.0006
	B	1111	± 9.7
30	C	0.0844	± 0.0002
	B	1124	± 2.9
40	C	0.0843	± 0.0002
	B	1056	± 4.0
50	C	0.0847	± 0.0002
	B	1003	± 3.6

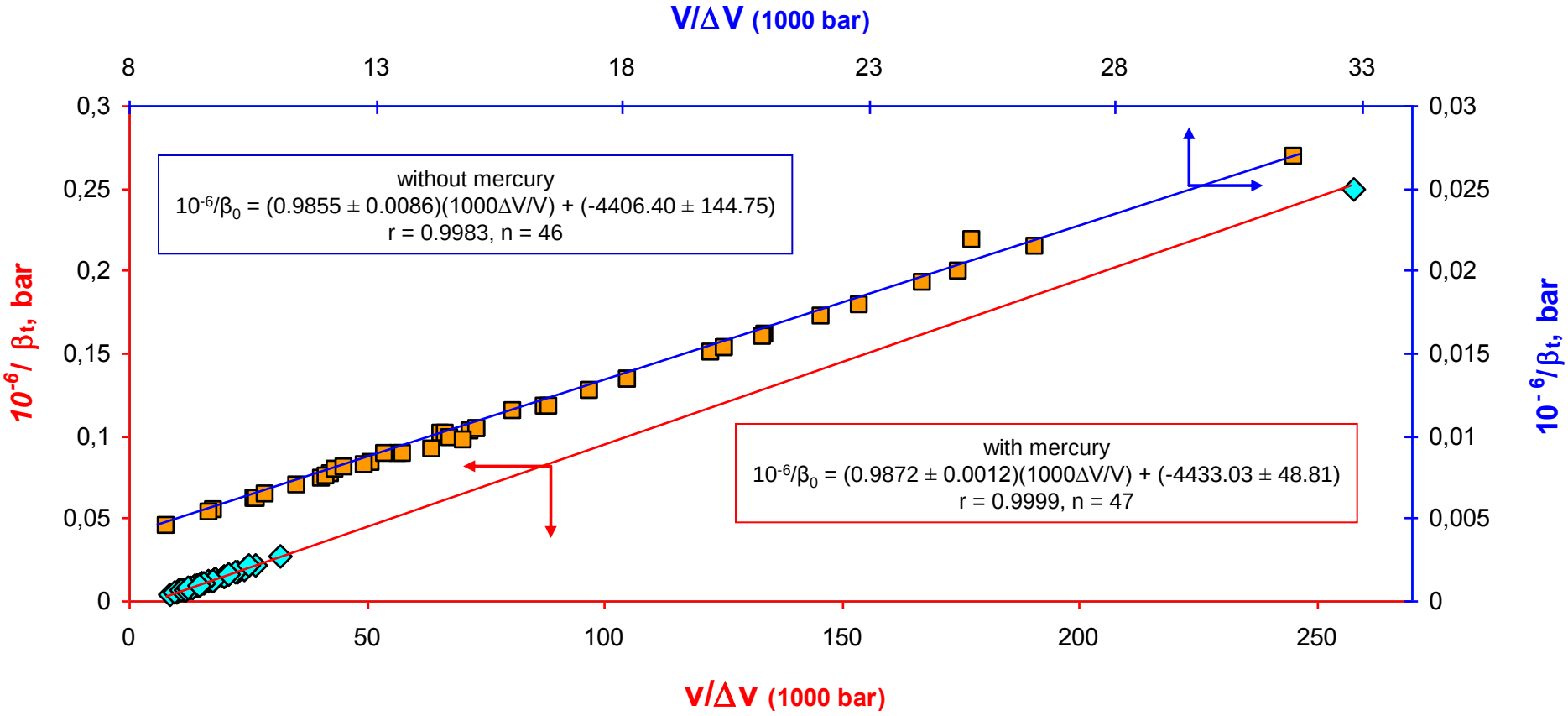


Trans- decahydronaphthalene



Cis - decahydronaphthalene

V.D. Kiselev, A.V. Bolotov, E.A. Kashaeva, A.I. Konovalov
«Determination of isothermic compressibility of solvent from changes in the absorbance of a dye solution under pressure» // Russ. Chem. Bull., Inter. Ed., 2006,V.55, №12, 2129 - 2132



N^0	Liquid	Experimental data				Ref.	Predict	error
		C	B, bar	$10^{-6}/\beta_0$, bar	$V/\Delta V_{1kbar}$		$V/\Delta V_{1kbar}$	%
1	diethyl ether	0.0951	489	0.005145	9.4483	9	9.7668	3.26
2	di-*n*-propyl ether	0.0860	488	0.005679	10.4349	9	10.3140	-1.17
3	diisopropyl ether	0.0888	485	0.005458	10.0574	9	10.0876	0.30
4	di-*n*-butyl ether	0.0906	750	0.008271	13.0170	9	12.9701	-0.36
5	methyl *tert*-butyl ether	0.0916	527	0.005750	10.2561	9	10.3868	1.26
6	ethyl *tert*-butyl ether	0.0865	485	0.005605	10.3289	9	10.2382	-0.89
7	methyl *tert*-pentyl ether	0.0872	641	0.007353	12.1996	9	12.0294	-1.41
8	ethylene glycol dimethyl ether	0.0926	837	0.009034	13.7330	9	13.7520	0.14
9	diethylene glycol dimethyl ether	0.0897	1098	0.012244	17.2230	9	17.0414	-1.07
10	tetraethylene glycol dimethyl ether	0.0862	1372	0.015918	21.1927	9	20.8062	-1.86
11	anisole	0.0959	1460	0.015228	19.9907	9	20.0991	0.54
12	tetrahydrofuran	0.0930	921	0.009906	14.6314	9	14.6456	0.10
13	1,4-dioxane (25)	0.0893	1192	0.013349	18.3827	our	18.1737	-1.15
14	1,4-dioxane (30)	0.0893	1153	0.012916	17.9367	our	17.7300	-1.17
15	1,4-dioxane (40)	0.0893	1080	0.012093	17.0846	our	16.8866	-1.17
16	1,4-dioxane (50)	0.0893	996	0.011152	16.1075	our	15.9224	-1.16
17	furan	0.0945	950	0.010053	14.7178	9	14.7962	0.53
18	2-propanone	0.0992	767	0.007732	12.0782	9	12.4178	2.73
19	2-butanone	0.0950	818	0.008614	13.1839	9	13.3216	1.03
20	2-pentanone	0.0874	858	0.009812	14.8025	9	14.5492	-1.74
21	3-pentanone	0.0946	908	0.009596	14.2328	9	14.3279	0.66
22	2-hexanone	0.0852	1017	0.011932	17.1327	9	16.7216	-2.46
23	4-methyl-2-pentanone	0.0991	1000	0.010089	14.5568	9	14.8331	1.86
24	4-heptanone	0.1024	1222	0.011933	16.3329	9	16.7227	2.33
25	cyclopentanone	0.0985	957	0.009721	14.1985	9	14.4560	1.78
26	cyclohexanone	0.0916	1388	0.015154	20.1239	9	20.0233	-0.50
27	butanal	0.0918	1041	0.011343	16.1843	9	16.1181	-0.41
28	3-methylbutanal	0.0941	832	0.008845	13.4668	9	13.5583	0.68
29	heptanal	0.1022	1130	0.011052	15.4293	9	15.8199	2.47
30	octanal	0.1027	1216	0.011838	16.2208	9	16.6253	2.43
31	benzaldehyde	0.0940	1541	0.016382	21.2577	9	21.2817	0.11
32	formic acid	0.0963	1494	0.015510	20.2593	9	20.3881	0.63
33	acetic acid	0.0924	1005	0.010879	15.6719	9	15.6426	-0.19
34	propionic acid	0.0913	987	0.010812	15.6545	9	15.5740	-0.52
35	isobutyric acid	0.0874	870	0.009961	14.9612	9	14.7019	-1.76
36	capric acid (80)	0.0939	959	0.010216	14.9120	9	14.9636	0.34
37	methyl acetate	0.0879	757	0.008615	13.5170	9	13.3226	-1.46
38	ethyl acetate	0.0894	743	0.008305	13.1120	9	13.0050	-0.82
39	ethyl acetate (20)	0.0891	792	0.008881	13.7357	our	13.5952	-1.03
40	ethyl acetate (30)	0.0891	726	0.008149	12.9590	our	12.8451	-0.89
41	ethyl acetate (40)	0.0891	666	0.007472	12.2369	our	12.1514	-0.70
42	ethyl acetate (50)	0.0891	601	0.006744	11.4527	our	11.4054	-0.41

43	triacetin	0.0988	1983	0.020064	24.7791	9	25.0547	1.10
44	isopentyl propionate	0.0854	900	0.010544	15.6778	9	15.2993	-2.47
45	methyl caproate	0.0914	694	0.007595	12.2628	9	12.2774	0.12
46	*n*-nonyl caproate	0.0939	813	0.008661	13.2819	9	13.3698	0.66
47	tricaproin	0.0956	1470	0.015379	20.1597	9	20.2539	0.46
48	2-ethylhexyl benzoate	0.0978	1382	0.014125	18.7735	9	18.9689	1.03
49	methyl methacrylate	0.0943	998	0.010582	15.2765	9	15.3383	0.40
50	*n*-nonyl methacrylate	0.0935	1200	0.012842	17.6533	9	17.6541	0.00
51	methyl oleate	0.0968	1492	0.015411	20.1370	9	20.2867	0.74
52	diethyl dibenzylmalonate	0.1038	2028	0.019537	24.0332	9	24.5147	1.96
53	di-*n*-butyl phthalate	0.0917	1585	0.017281	22.2908	9	22.2029	-0.40
54	propylene carbonate	0.0930	1816	0.019532	24.5183	9	24.5095	-0.04
55	methanol	0.0979	806	0.008231	12.6598	7	12.9291	2.08
56	ethanol	0.0950	849	0.008930	13.5159	7	13.6454	0.95
57	1-propanol	0.0921	943	0.010239	15.0209	7	14.9868	-0.23
58	1-butanol	0.0910	1005	0.011045	15.9127	7	15.8127	-0.63
59	1-pentanol	0.0952	1099	0.011545	16.2345	7	16.3251	0.55
60	1-heptanol	0.0989	2043	0.020659	25.3808	7	25.6644	1.11
61	1-octanol	0.0940	1264	0.013452	18.2591	7	18.2792	0.11
62	1-undecanol (40)	0.1002	1153	0.011517	15.9938	10	16.2969	1.86
63	1-dodecanol	0.0908	1294	0.014250	19.2325	10	19.0970	-0.71
64	1-tetradecanol (60)	0.0955	1155	0.012096	16.7900	10	16.8894	0.59
65	1-hexadecanol (75)	0.0908	1027	0.011318	16.2065	10	16.0925	-0.71
66	2-propanol	0.0890	792	0.008904	13.7656	10	13.6188	-1.08
67	2-butanol	0.0890	930	0.010448	15.3866	10	15.2010	-1.22
68	2-methyl-1-propanol	0.0866	853	0.009858	14.8954	10	14.5964	-2.05
69	2-methyl-2-propanol (60)	0.0834	498	0.005977	10.8962	10	10.6195	-2.61
70	2-pentanol	0.0995	1015	0.010199	14.6531	10	14.9458	1.96
71	3-pentanol	0.0952	1013	0.010644	15.3003	10	15.4018	0.66
72	4-methyl-2-pentanol	0.0827	858	0.010379	15.6559	10	15.1303	-3.47
73	2-octanol	0.0905	1084	0.011982	16.9110	10	16.7729	-0.82
74	3-octanol	0.0937	1155	0.012329	17.1141	10	17.1285	0.08
75	3-methyl-1-heptanol	0.0945	1244	0.013167	17.9409	10	17.9872	0.26
76	2-methyl-3-heptanol	0.0960	1154	0.012026	16.6966	10	16.8180	0.72
77	6-methyl-3-heptanol	0.0924	1083	0.011717	16.5415	10	16.5013	-0.24
78	3-methyl-4-heptanol	0.0907	1100	0.012127	17.0477	10	16.9215	-0.75
79	2,7-dimethyl-2-octanol	0.0832	1233	0.014823	20.2410	10	19.6841	-2.83
80	cyclopentanol	0.0862	1330	0.015434	20.6964	10	20.3102	-1.90
81	ethylene glycol	0.0950	2585	0.027206	32.1823	10	32.3733	0.59
82	1,2-propanediol	0.0984	2337	0.023766	28.5489	10	28.8482	1.04
83	1,3-propanediol	0.0964	2427	0.025184	30.0753	10	30.3013	0.75
84	glycerine	0.1143	4946	0.043286	47.5281	10	48.8508	2.71
85	2-methoxyethanol	0.0952	1338	0.014063	18.8313	10	18.9053	0.39

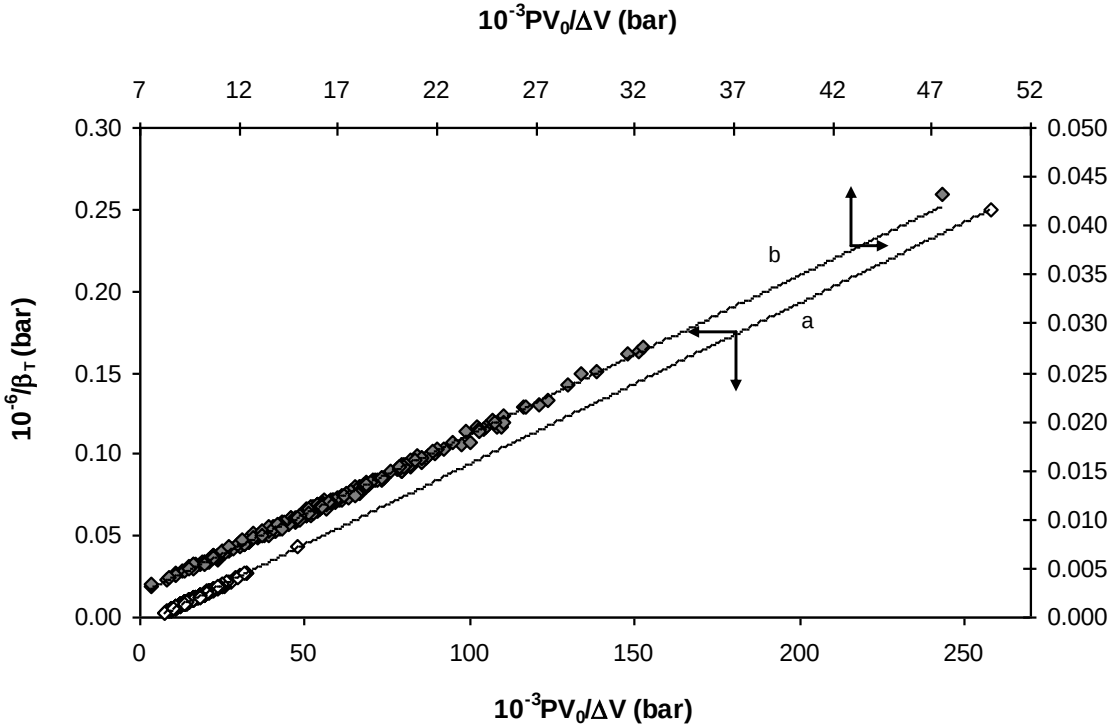
86	2-butoxyethanol	0.0913	1185	0.012981	17.9031	10	17.7966	-0.60
87	diethylene glicol	0.1008	2791	0.027703	32.4124	10	32.8826	1.43
88	eugenol	0.0856	1856	0.021689	27.1147	10	26.7199	-1.48
89	benzene (40)	0.0937	861	0.010368	15.0822	11	15.1190	0.24
90	hexadeuteriobenzene (40)	0.0930	878	0.009191	13.8504	11	13.9128	0.45
91	toluene	0.0937	1042	0.009443	14.1436	11	14.1713	0.20
92	toluene (20)	0.0901	1013	0.011247	16.1674	our	16.0197	-0.92
93	toluene (30)	0.0901	944	0.010477	15.3649	our	15.2307	-0.88
94	toluene (40)	0.0901	891	0.009896	14.7569	our	14.6353	-0.83
95	toluene (50)	0.0901	819	0.009096	13.9169	our	13.8155	-0.73
96	ethenyl-benzene	0.0928	1226	0.013208	18.0616	11	18.0292	-0.18
97	ethylbenzene	0.0884	1011	0.011436	16.4506	11	16.2134	-1.46
98	p-xylene	0.0845	946	0.011185	16.3938	11	15.9562	-2.74
99	cumene	0.0936	1112	0.011882	16.6558	11	16.6704	0.09
100	pseudocumene	0.0829	1011	0.012205	17.5535	11	17.0014	-3.25
101	mesitylene	0.0884	1125	0.012722	17.7804	11	17.5312	-1.42
102	naphthalene (120)	0.0911	594	0.006519	11.1177	11	11.1748	0.51
103	tetralin	0.0900	1518	0.016854	21.9403	11	21.7653	-0.80
104	*sec*-butylbenzene (50)	0.0922	931	0.010100	14.8717	11	14.8447	-0.18
105	1-methylnaphthalene	0.0920	1778	0.019329	24.3620	11	24.3015	-0.25
106	hexylbenzene	0.0835	1065	0.012766	18.1009	11	17.5763	-2.98
107	1,1-diphenylethane (50)	0.0891	1452	0.016294	21.4167	11	21.1912	-1.06
108	nonylbenzene	0.0844	1175	0.013916	19.2354	11	18.7547	-2.56
109	DHCH[a] (50)	0.0852	1886	0.022139	27.5935	11	27.1814	-1.52
110	1,1-diphenylheptane (50)	0.0868	1299	0.014967	20.1821	11	19.8317	-1.77
111	1-phenyl-3-(2-phenylethyl)undecane (50)	0.0936	1524	0.016287	21.1824	11	21.1840	0.01
112	1-pentadecylnaphthalene (70)	0.0888	1463	0.016466	21.6080	11	21.3674	-1.13
113	(3-octylundecyl)benzene (50)	0.0908	1268	0.013966	18.9428	11	18.8062	-0.73
114	1,1-diphenyltetradecane (50)	0.0863	1220	0.014142	19.3607	11	18.9859	-1.97
115	hexane	0.0943	587	0.006222	10.6586	8	10.8705	1.95
116	n-hexane (0)	0.0943	723	0.007670	12.2143	24	12.3543	1.13
117	n-hexane (40)	0.0943	515	0.005464	9.8310	24	10.0937	2.60
118	n-hexane (60)	0.0943	430	0.004561	8.8256	24	9.1684	3.74
119	n-hexane (20)	0.0882	549	0.006222	10.9305	our	10.8705	-0.55
120	n-hexane (30)	0.0882	500	0.005668	10.3210	our	10.3028	-0.18
121	n-hexane (40)	0.0882	458	0.005191	9.7914	our	9.8140	0.23
122	n-hexane (50)	0.0882	410	0.004648	9.1808	our	9.2576	0.83
123	heptane	0.0943	662	0.007017	11.5162	8	11.6851	1.45
124	n-heptane (0)	0.0943	799	0.008473	13.0651	24	13.1771	0.85
125	n-heptane (40)	0.0943	591	0.006263	10.7030	24	10.9125	1.92
126	n-heptane (60)	0.0943	505	0.005359	9.7150	24	9.9861	2.72
127	octane	0.0943	787	0.008343	12.9275	8	13.0439	0.89
128	n-octane (0)	0.0943	944	0.010007	14.6757	24	14.7491	0.50
129	n-octane (40)	0.0943	706	0.007486	12.0185	24	12.1657	1.21
130	n-octane (60)	0.0943	607	0.006437	10.8915	24	11.0908	1.80

131	pentane	0.0888	419	0.004711	9.2217	8	9.3221	1.08
132	hexane	0.0924	561	0.006078	10.5833	8	10.7229	1.30
133	heptane	0.0916	641	0.006997	11.6123	8	11.6646	0.45
134	octane	0.0928	739	0.007966	12.5940	8	12.6576	0.50
135	nonane	0.0943	848	0.008988	13.6073	8	13.7049	0.71
136	decane	0.0880	813	0.009244	14.1754	8	13.9672	-1.49
137	undecane	0.0903	837	0.009270	14.0882	8	13.9938	-0.67
138	dodecane	0.0905	907	0.010016	14.8604	8	14.7583	-0.69
139	tridecane (40)	0.0880	840	0.009552	14.5002	8	14.2832	-1.52
140	tetradecane	0.0901	981	0.010888	15.7910	8	15.6518	-0.89
141	pentadecane (40)	0.0885	968	0.010936	15.9230	8	15.7012	-1.41
142	hexadecane	0.0905	1044	0.011540	16.4499	8	16.3200	-0.80
143	isopentane	0.0880	376	0.004270	8.7552	12	8.8702	1.30
144	neopentane	0.0865	274	0.003165	7.5191	12	7.7379	2.83
145	2-methylpentane	0.0895	499	0.005575	10.1554	12	10.2075	0.51
146	3-methylpentane	0.0879	513	0.005830	10.5113	12	10.4688	-0.41
147	2,2-dimethylbutane	0.0890	452	0.005080	9.6318	12	9.7002	0.71
148	2,3-dimethyl-butane	0.0874	489	0.005590	10.2686	12	10.2228	-0.45
149	3-ethylpentane	0.0919	680	0.007400	12.0336	12	12.0776	0.36
150	2,2,3-trimethylbutane	0.0902	608	0.006747	11.4075	12	11.4085	0.01
151	isooctane	0.0878	572	0.006512	11.2641	12	11.1676	-0.86
152	heptadecane	0.0877	1035	0.011794	16.8563	12	16.5802	-1.67
153	octadecane (80)	0.0878	800	0.009110	14.0433	12	13.8299	-1.54
154	7-hexyltridecane (50)	0.0888	929	0.010454	15.4035	12	15.2075	-1.29
155	eicosane (120)	0.0867	599	0.006910	11.7463	12	11.5757	-1.47
156	9-octyl-heptadecane (50)	0.0922	1117	0.012112	16.9606	12	16.9059	-0.32
157	triacontane (120)	0.0862	718	0.008335	13.3042	12	13.0361	-2.06
158	squalane	0.0902	1222	0.013549	18.5426	12	18.3786	-0.89
159	11-decylheneicosane (40)	0.0886	1143	0.012903	17.9618	12	17.7171	-1.38
160	13-dodecylhexacosane (40)	0.0895	1207	0.013490	18.5192	12	18.3185	-1.10
161	tetracontane (160)	0.0868	625	0.007208	12.0677	12	11.8808	-1.57
162	isoprene	0.0991	809	0.008162	12.5378	12	12.8584	2.49
163	amilene	0.0961	519	0.005406	9.6971	12	10.0343	3.36
164	1,5-hexadiene	0.0841	509	0.006054	10.9438	12	10.6983	-2.29
165	1-hexene	0.0854	512	0.005997	10.8149	12	10.6399	-1.64
166	1-octene	0.0895	677	0.007560	12.3114	12	12.2416	-0.57
167	squalene	0.0912	1395	0.015284	20.2722	12	20.1565	-0.57
168	cyclopentane	0.0886	677	0.007642	12.4459	12	12.3256	-0.98
169	methylcyclopentane	0.0880	671	0.007623	12.4519	12	12.3061	-1.18
170	cyclohexane	0.0852	750	0.008808	13.8597	12	13.5204	-2.51
171	methylcyclohexane	0.0870	773	0.008883	13.8443	12	13.5973	-1.82
172	cycloheptane	0.0909	1006	0.011067	15.9376	12	15.8353	-0.65
173	cyclooctane (50)	0.0866	926	0.010692	15.7667	12	15.4508	-2.04
174	*trans*-decalin	0.0921	1253	0.013595	18.4941	12	18.4258	-0.37
175	butylcyclohexane	0.1008	1133	0.011246	15.6872	12	16.0187	2.07
176	perhydrochrysene (40)	0.0847	1657	0.019567	25.0091	12	24.5456	-1.89

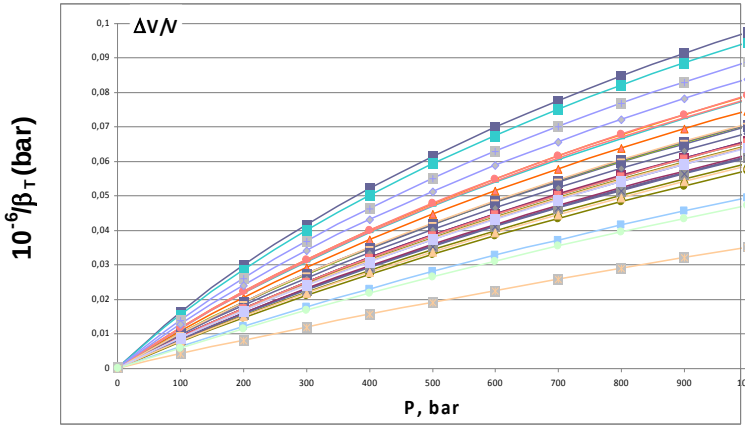
177	DPPH[b] (40)	0.0905	1466	0.016202	21.2521	12	21.0975	-0.73
178	1-(1-decahydronaphthyl)pentadecane (80)	0.0871	1114	0.013073	18.2145	12	17.8910	-1.81
179	CPPD[c] (40)	0.0927	1402	0.015124	20.0378	12	19.9929	-0.22
180	CHHU[d] (40)	0.0922	1447	0.015686	20.6356	12	20.5688	-0.32
181	9-(2-cyclohexylethyl)heptadecane (40)	0.0898	1274	0.014185	19.2183	12	19.0299	-0.99
182	9-(3-cyclopentylpropyl)heptadecane (40)	0.0921	1246	0.013526	18.4249	12	18.3552	-0.38
183	DHNU[e] (40)	0.0820	1451	0.017691	23.2588	12	22.6231	-2.81
184	1,4-cyclohexadiene	0.0884	974	0.011018	16.0122	12	15.7850	-1.44
185	dichloromethane	0.0976	946	0.009693	14.2038	13	14.4273	1.55
186	chloroform	0.0957	923	0.009640	14.2303	13	14.3730	0.99
187	tetrachloromethane	0.0933	827	0.008861	13.5174	13	13.5747	0.42
188	bromomethane	0.0976	662	0.006789	11.1386	13	11.4515	2.73
189	bromoform (50)	0.1035	1165	0.011254	15.5892	13	16.0267	2.73
190	iodomethane	0.0955	908	0.009511	14.1055	13	14.2408	0.95
191	1,1-dichloroethane	0.0980	856	0.008740	13.1910	13	13.4507	1.93
192	1,2-dichloroethane	0.0960	1199	0.012486	17.1691	13	17.2893	0.70
193	1,1,1-trichloroethane	0.0987	916	0.009276	13.7230	13	14.0000	1.98
194	1,1,2-trichloroethane	0.0992	1374	0.013857	18.4412	13	18.6942	1.35
195	1,1,2,2-tetrachloroethane	0.1000	1643	0.016423	21.0270	13	21.3237	1.39
196	trichloroethene	0.1010	1160	0.011487	15.9285	13	16.2656	2.07
197	tetrachloroethene	0.1017	1366	0.013429	17.8965	13	18.2557	1.97
198	bromoethane	0.0943	702	0.007442	11.9689	13	12.1206	1.25
199	1-bromopropane	0.0889	782	0.008796	13.6580	13	13.5081	-1.11
200	2-bromopropane	0.0902	678	0.007520	12.2395	13	12.2006	-0.32
201	1-iodopropane	0.1010	1117	0.011058	15.4826	13	15.8260	2.17
202	1-chlorobutane	0.0964	811	0.008411	12.9122	13	13.1136	1.54
203	1-bromobutane	0.0977	934	0.009559	14.0628	13	14.2900	1.59
204	1-iodobutane	0.1006	1163	0.011565	16.0258	13	16.3456	1.96
205	1-chloropentane	0.0966	874	0.009049	13.5742	13	13.7674	1.40
206	1-bromopentane	0.0899	953	0.010610	15.5146	13	15.3670	-0.96
207	1-iodopentane	0.1005	1152	0.011459	15.9184	13	16.2370	1.96
208	fluorobenzene	0.0854	851	0.009966	15.0710	13	14.7070	-2.47
209	hexafluorobenzene	0.0850	714	0.008407	13.4427	13	13.1095	-2.54
210	chlorobenzene	0.0957	1275	0.013325	18.0476	13	18.1491	0.56
211	chlorobenzene (45)	0.0937	1098	0.011710	16.4721	25	16.4942	0.13
212	chlorobenzene (65)	0.0937	961	0.010250	14.9547	25	14.9981	0.29
213	chlorobenzene (85)	0.0937	835	0.008907	13.5477	25	13.6219	0.54
214	chlorobenzene (20)	0.0938	1278	0.013617	18.4359	our	18.4483	0.07
215	chlorobenzene (30)	0.0938	1202	0.012807	17.6013	our	17.6183	0.10
216	chlorobenzene (40)	0.0938	1129	0.012037	16.8069	our	16.8292	0.13
217	chlorobenzene (50)	0.0938	1060	0.011296	16.0390	our	16.0699	0.19
218	1,2-dichlorobenzene	0.0934	1525	0.016324	21.2298	13	21.2222	-0.04
219	chlorocyclohexane	0.0937	1110	0.011857	16.6286	13	16.6448	0.10
220	2,4-dichlorotoluene	0.0794	1550	0.019509	25.2833	13	24.4860	-3.26

227	aniline	0.0937	2007	0.021404	26.3794	14	26.4278	0.18
228	aniline (45)	0.0937	1798	0.019182	24.1242	25	24.1509	0.11
229	aniline (65)	0.0937	1606	0.017127	22.0317	25	22.0451	0.06
230	aniline (85)	0.0937	1429	0.015247	20.1116	25	20.1186	0.03
231	*o*-toluidine (50)	0.0849	1688	0.019872	25.3048	14	24.8579	-1.80
232	acetonitrile (20)	0.1025	942	0.009199	13.4957	our	13.9211	3.06
233	acetonitrile (30)	0.1025	871	0.008499	12.7635	our	13.2038	3.33
234	acetonitrile (40)	0.1025	812	0.007928	12.1622	our	12.6187	3.62
235	acetonitrile (50)	0.1025	743	0.007251	11.4465	our	11.9249	4.01
236	propanenitrile	0.0950	863	0.009083	13.6766	14	13.8022	0.91
237	butanenitrile	0.0922	934	0.010133	14.9051	14	14.8782	-0.18
238	2-methylpropanenitrile	0.0989	867	0.008772	13.1884	14	13.4835	2.19
239	benzonitrile	0.0989	1586	0.016040	20.6858	14	20.9312	1.17
240	pyridine (40)	0.0947	1282	0.013528	18.3014	14	18.3572	0.30
241	quinoline	0.0919	1972	0.021453	26.5225	14	26.4780	-0.17
242	nitromethane	0.0943	1300	0.013789	18.5900	14	18.6246	0.19
243	nitroethane	0.0965	1225	0.012689	17.3575	14	17.4974	0.80
244	1-nitropropane	0.0925	1149	0.012413	17.2561	14	17.2145	-0.24
245	2-nitropropane	0.0892	1005	0.011264	16.2270	14	16.0371	-1.18
246	2-methyl-2-nitropropane (40)	0.1032	991	0.009602	13.8876	14	14.3342	3.12
247	nitrobenzene	0.0932	1852	0.019876	24.8562	14	24.8621	0.02
248	nitrobenzene (45)	0.0937	1679	0.017908	22.8274	25	22.8454	0.08
249	nitrobenzene (65)	0.0937	1505	0.016049	20.9309	25	20.9404	0.05
250	nitrobenzene (85)	0.0937	1342	0.014311	19.1518	25	19.1595	0.04
251	formamide	0.1053	2614	0.024816	29.3076	14	29.9242	2.06
252	N-methylformamide	0.0937	1581	0.016862	21.7625	14	21.7735	0.05
253	N,N-dimethylformamide	0.0982	1535	0.015622	20.2882	14	20.5029	1.05
254	N,N-dimethylacetamide	0.0921	1428	0.015505	20.4573	14	20.3830	-0.36
255	triethanolamine	0.1014	2736	0.026974	31.6484	14	32.1355	1.52
256	1-methylpyrrolidin-2-one	0.0911	1735	0.019048	24.1231	14	24.0136	-0.46
257	3-cyanopropanal	0.0906	1390	0.015339	20.3610	14	20.2129	-0.73
258	2-fluoroethanol	0.0974	1496	0.015358	20.0559	14	20.2323	0.87
259	2,2-difluoroethanol	0.0948	1294	0.013650	18.4248	14	18.4821	0.31
260	2,2,2-trifluoroethanol	0.0929	749	0.008064	12.6939	14	12.7580	0.50
261	2,2,3,3-tetrafluoropropanol	0.0837	1063	0.012702	18.0198	14	17.5107	-2.91
262	bis(disfluoromethyl) ether	0.0869	333	0.003832	8.2973	14	8.4214	1.47
263	HFE245mf[f]	0.0903	450	0.004982	9.4639	14	9.5998	1.42
264	HFE245mc[g]	0.0891	365	0.004098	8.5103	14	8.6940	2.11
265	pentafluorobenzonitrile	0.0847	1062	0.012547	17.8039	14	17.3519	-2.61
266	tetramethylstannane	0.0937	580	0.006186	10.6437	14	10.8336	1.75
267	tetramethylsilane	0.0904	305	0.003372	7.6056	14	7.9500	4.33
268	tetraethylsilane	0.0855	777	0.009093	14.1443	14	13.8125	-2.40
269	tetraethoxysilane	0.0880	728	0.008272	13.1439	14	12.9712	-1.33
270	octamethylcyclotetrasiloxane (50)	0.0859	472	0.005494	10.2343	14	10.1241	-1.09
271	dimethyl sulfoxide	0.1057	2010	0.019019	23.4327	14	23.9839	2.30
272	Hg	0.0640	16003	0.250000	257.732	26	260.6756	1.13

V.D. Kiselev, A.V. Bolotov, A.P. Satonin, I.I. Shakirova, E.A. Kashaeva, A.I. Konovalov. Compressibility of Liquids. Rule of Noncrossing V-P Curvatures. Journal Physical Chemistry B, 2008, V.112, pp. 6674-6682.



Rule of noncrossing V-P curvatures



- **a) with mercury**

$$10^{-6}/\beta_t = (9.865\times10^{-4} \pm 9.9\times10^{-7})\times V/\Delta V_{1kbar} - (4.559\times10^{-3} \pm 2.3\times10^{-5})$$

$$r = 0.9999 \quad n = 272$$

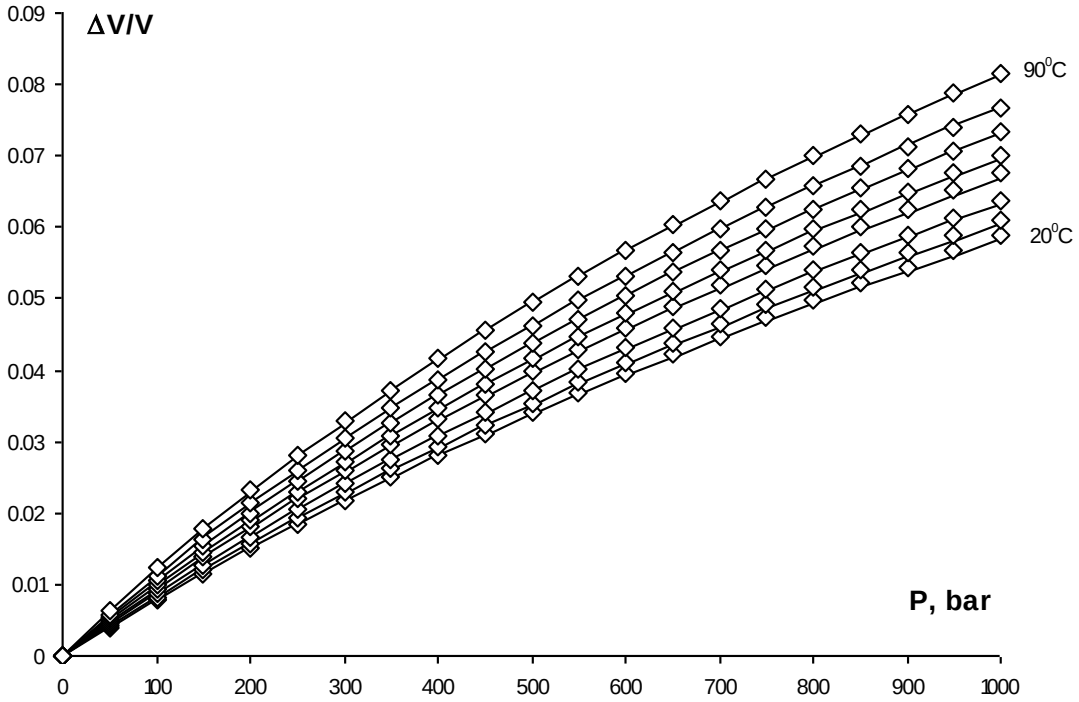
- **b) without mercury**

$$10^{-6}/\beta_t = (9.759\times10^{-4} \pm 3.0\times10^{-6})\times V/\Delta V_{1kbar} - (4.386\times10^{-3} \pm 5.1\times10^{-5})$$

$$r = 0.9993 \quad n = 271$$

Predict of PVT properties of DMIPEC at temperatures from 293 to 363 K and pressures from 1 to 1000 bar

V.N. Belonenko, Y.E. Belyaev, J. Chem. Eng. Data, 2001, 46, 626 – 630



Liquid	$(CH_3)_2C(OH)C{\equiv}CC(CH_3){=}CH_2$
T range, K	293 - 363
P range, bar	1 - 3500
Method	Micro-PVT system

Predicted coef. of Tait eq.

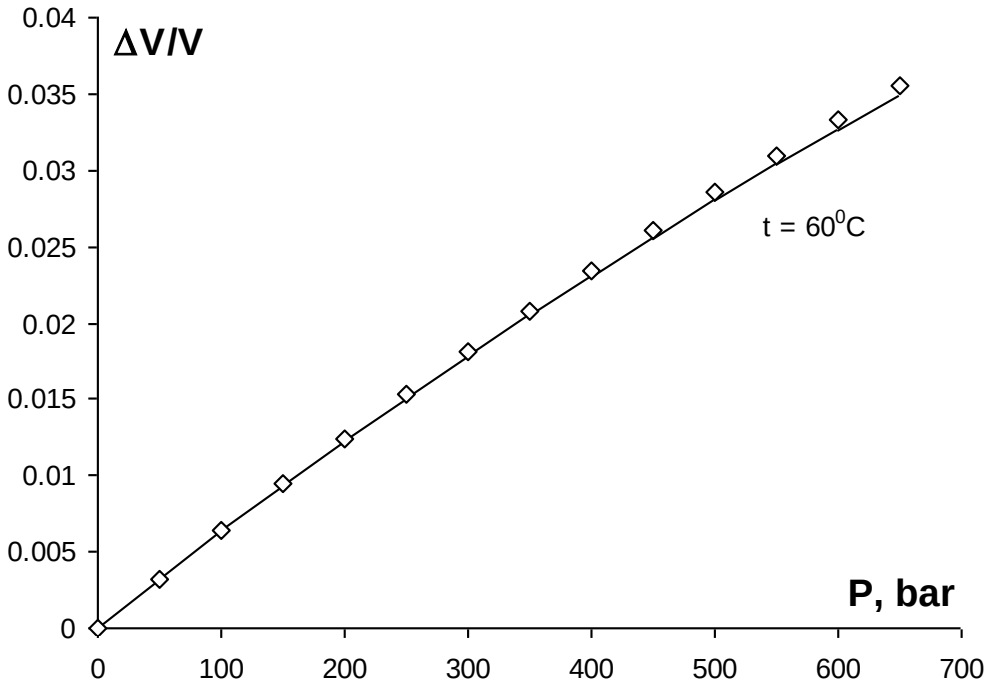
T, K	C	B, bar
293	0.0934	1136
303	0.0932	1082
313	0.0931	1017
323	0.0927	933
333	0.0925	882
343	0.0921	821
353	0.0917	764
363	0.0911	692

Experimental and predicted data of thermal coefficients α and β of DMIPEC at 90°C

P, bar	$\beta\cdot10^6$bar^{-1} exp	$\beta\cdot10^6$bar^{-1} pred	K, bar exp	K, bar pred	$\alpha\times10^3$ K^{-1} exp	$\alpha\times10^3$ K^{-1} pred
0	131,3	131,4	7611,1	7604,3	1,21	1,19
50	122,6	122,7	7878,7	7870,1	1,14	1,14
100	114,8	115,0	8145,8	8135,4	1,10	1,10
150	107,9	108,2	8407,5	8395,3	1,06	1,06
200	101,9	102,1	8664,2	8650,3	0,99	1,02
300	91,6	91,8	9164,1	9147,1	0,94	0,96
400	83,1	83,4	9648,4	9628,3	0,87	0,91
600	70,2	70,5	10578,0	10552,1	0,82	0,83
800	60,8	61,0	11464,9	11433,7	0,77	0,77
1000	53,6	53,8	12317,5	12281,3	0,72	0,73

Predict of PVT properties of ionic liquids at temperatures from 298 to 333 K and pressures from 1 to 650 bar

J.M.S.S. Esperanca, H.J.R. Guedes, J. Chem. Eng. Data, 2006, 51, 237 – 242.



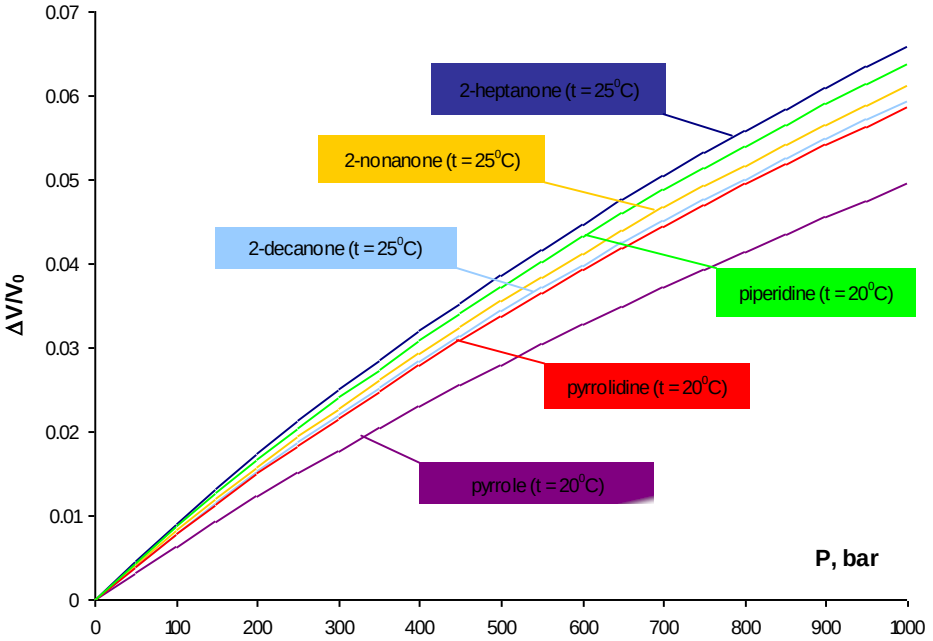
Compressibility of trihexyltetradecylphosphonium chloride at pressure range up to 650 bar at temperature 60^{0}C

Liquid	$[(C_6H_{13})_3P(C_{14}H_{29})][Cl]$
T range, K	298 - 333
P range, bar	1 - 650
Method	Vibrating tube densimeter

Experimental and predicted data of value ΔV/V at 60^{0}C

P, bar	ΔV/V predict	ΔV/V
0	0	0
50	0.003274055	0.003234
100	0.006437443	0.006354
150	0.009497401	0.009367
200	0.012460479	0.01228
250	0.015332623	0.0151
300	0.01811925	0.017833
350	0.020825305	0.020483
400	0.023455317	0.023056
450	0.026013442	0.025555
500	0.028503506	0.027986
550	0.030929038	0.030351
600	0.033293297	0.032655

N⁰	Liquid	Exp. data	Predict data		
		$10^{-6}/\beta_0$, bar	$V/\Delta V_{1kbar}$	C	B, bar
1	2-heptanone	0.010449	15.2023	0.0929	971
2	2-nonanone	0.011561	16.3412	0.0932	1078
3	2-decanone	0.012048	16.8407	0.0933	1125
4	1,1,2-trichloro-1,2,2-trifluoroethane	0.005637	10.2710	0.0885	499
5	carbon disulfide	0.010526	15.2812	0.0929	978
6	hexamethyl phosphoric triamide	0.012658	17.4658	0.0934	1183
7	2-methyl-1-pentanol	0.011534	16.3138	0.0932	1075
8	3-methyl-2-pentanol	0.011416	16.1924	0.0932	1064
9	3-methyl-3-pentanol	0.010718	15.4777	0.0930	997
10	2-ethylhexanol (20)	0.01087	15.6329	0.0930	1011
11	propyl formate (20)	0.009434	14.1618	0.0924	872
12	*n*-propyl acetate(30)	0.008703	13.4130	0.0920	800
13	*n*-butyl acetate (30)	0.009542	14.2725	0.0925	882
14	*n*-pentyl acetate (30)	0.010438	15.1911	0.0929	970
15	*i*-pentyl acetate (30)	0.009452	14.1801	0.0924	874
16	ethyl propanoate (20)	0.009434	14.1618	0.0924	872
17	methyl butanoate (30)	0.00817	12.8666	0.0916	748
18	ethyl butanoate (30)	0.007974	12.6663	0.0914	729
19	1-chlorohexane	0.00993	14.6706	0.0927	920
20	pentanonitrile	0.010526	15.2812	0.0929	978
21	hexanonitrile	0.010799	15.5608	0.0930	1004
22	octanonitrile	0.011628	16.4100	0.0932	1084
23	2-propylamine (20)	0.005945	10.5869	0.0890	529
24	2-butylamine (20)	0.007962	12.6533	0.0914	728
25	diethylamine (20)	0.006605	11.2630	0.0900	594
26	*di-n*-propylamine (20)	0.00811	12.8055	0.0915	742
27	*di-n*-butylamine (20)	0.00939	14.1165	0.0924	868
28	triethylamine	0.007252	11.9256	0.0907	658
29	*m*-toluidine (20)	0.019608	24.5873	0.0931	1826
30	pyrrole (20)	0.015337	20.2113	0.0936	1435
31	pyrrolidine (20)	0.012285	17.0834	0.0934	1147
32	piperidine (20)	0.010905	15.6694	0.0930	1015
33	2-aminoethanol (20)	0.023474	28.5492	0.0923	2167
34	morpholine (20)	0.01626	21.1568	0.0935	1521



$$\beta_T = (C_p + T_0 \times \alpha^2 \times v^2)/v^2 \times \rho \times C_p$$

$$\beta_T = \beta_S + T_0 \times \alpha^2/\rho \times C_p$$

Method of measuring of sound velocity

Conclusion

1.We have proposed a simple and precise method for the determination of the compressibility of liquids in a range of temperatures by measuring the differences in the weights of hydraulic oil injected into the high-pressure device.

2. The detected clear relation between the tangent and secant bulk moduli for various liquids at different temperatures ("noncrossing rule") has reveald the means of calculation of the Tait equation coefficients from the values of compressibility at ambient pressure.

3. We have predicted unknown coefficients *C* and *B* for 34 liquids and obtained *P*-*V* curves in this pressure interval.

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