Table II. Viscosity of Isobutane

Pressure, P.S.I.A.	100° F.		160° F.		220° F.		280° F.		340° F.		400° F.		460° F.	
	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises	Density, g./cc.	Viscosity, micropoises
14.7	0.0023	79	0.0021	86	0.0011	93	0.0017	101	0.0016	108	0.0015	115	0.0014	122
100	0.5378	1343(1358.4)	0.0159	91 (959.9)	0.0139	96	0.0155	106 (106.1)	0.0114	113(115.3)	0.0105	117	0.0097	123
165	...	...	0.4880	971 (959.9)	...	...	...	...	...	...	...	...	...	...
200	0.5397	1362(1368.3)	0.4887	974 (967.0)	0.0314	100	0.0271	107 (106.7)	0.0242	116(118.4)	0.0220	119	0.0201	126
300	0.5416	1379	0.4918	994	0.0570	108	0.0450	111	0.0387	117	0.0345	123	0.0312	129
310	...	...	...	...	0.4218	661 (680.6)	...	...	...	...	...	...	...	...
400	0.5435	1402(1401.7)	0.4950	1014(1002.2)	0.4276	681 (681.4)	0.0692	120 (119.6)	0.0557	123(124.7)	0.0483	127	0.0431	132
500	0.5448	1414	0.4976	1031	0.4346	709	0.1122	139	0.0766	130	0.0638	132	0.0559	136
600	0.5464	1433(1449.3)	0.5003	1048	0.4404	733 (731.9)	0.3117	365 (397.4)	0.1037	142(145.2)	0.0812	138	0.0698	141
800	0.5496	1469(1478.4)	0.5054	1081(1069.5)	0.4506	777 (781.6)	0.3730	509 (508.7)	0.1920	202(210.6)	0.1241	159	0.1009	154
1000	0.5528	1509(1514.1)	0.5099	1116(1106.3)	0.4588	818 (817.6)	0.3927	566 (562.3)	0.2847	322(329.0)	0.1780	197	0.1361	173
1250	0.5565	1549	0.5152	1154	0.4667	857	0.4105	627	0.3279	405	0.2444	268	0.1833	209
1500	0.5598	1594(1629.4)	0.5201	1194	0.4745	902 (901.7)	0.4243	675	0.3582	475(489.2)	0.2882	335	0.2271	254
1750	0.5629	1634	0.5248	1231	0.4811	937	0.4340	716	0.3783	530	0.3204	395	0.2630	302
2000	0.5653	1669(1670.6)	0.5287	1266(1259.0)	0.4884	973 (973.0)	0.4431	755 (755.0)	0.3940	578(586.0)	0.3412	442	0.2909	348
2500	0.5705	1750	0.5366	1341	0.4981	1041	0.4577	819	0.4160	653	0.3724	521	0.3299	423
3000	0.5754	1829(1860.5)	0.5432	1401	0.5068	1107(1107.0)	0.4700	883	0.4322	716(721.6)	0.3945	586	0.3582	490
3500	0.5804	1919	0.5489	1466	0.5149	1161	0.4806	941	0.4450	768	0.4105	641	0.3791	547
4000	0.5852	1999(1983.1)	0.5542	1533(1518.4)	0.5222	1217	0.4905	1001(1008.0)	0.4575	826	0.4251	695	0.3955	597
4500	0.5889	2074	0.5595	1598	0.5293	1274	0.4989	1055	0.4681	879	0.4381	747	0.4092	642
5000	0.5926	2142(2125.8)	0.5639	1660	0.5350	1333(1344.8)	0.5065	1111(1117.0)	0.4777	931(936.9)	0.4498	798	0.4220	690
6000	0.5985	2275(2282.5)	0.5720	1784(1774.4)	0.5470	1453	0.5208	1215	0.4944	1034	0.4682	886	0.4430	776
7000	0.6063	2424	0.5795	1910	0.5560	1560	0.5318	1310	0.5057	1108	0.4845	977	0.4616	860
8000	0.6126	2550(2550.4)	0.5860	2030(2021.5)	0.5648	1670	0.5410	1400	0.5192	1208	0.4990	1069	0.4775	946

RECOMMENDED VALUES

Recommended values for viscosity of isobutane for temperatures from 100° to 460° F. and pressures from atmospheric to 8000 p.s.i.a. are presented in Table II, which also shows experimental data in parentheses. The recommended values are believed to be within ±2% of the true isobutane viscosity values over the entire ranges of temperature and pressure reported. These values were determined from smoothed large-scale viscosity-temperature, and residual viscosity–density plots based on the authors' experimental data.

The density values presented in Table II are those of Sage and Lacey for pressures up to 5000 p.s.i.a. The densities for higher pressures were read from large-scale density-pressure plots in which smooth isotherms connecting Sage and Lacey's data and the experimental values at 8000 p.s.i.a. were drawn. The 400° and 460° F. isotherms were extended to 8000 p.s.i.a. with large-scale cross-plots of density-temperature . The resulting densities were checked further by comparing viscosities obtained from the residual plot with those values giving smooth curves in the viscosity-pressure and viscosity-temperature plots. The densities obtained are believed to be within ±5% of true isobutane density values.

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LITERATURE CITED

(1) Brebach, W.J., Thodos, G., *Ind. Eng. Chem.* **50**, 1095–1100 (1958).
(2) Dolan, J.P., Starling, K.E., Lee, A.L., Eakin, B.E., Ellington, R.T., J. CHEM. ENG. DATA **8**, 396–9 (1963).
(3) Evans, E.B., *J. Inst. Petroleum Technol.* **24**, 321–23 (1938).
(4) Feldkirchner, H.L., Lee, A.L., Johnson, J.L., Eakin, B.E., "Novel Laboratory Equipment for Physical Property and Reaction Kinetic Studies," presented at A.I.Ch.E. Meeting, Memphis, Tenn., February 1964.
(5) Gonzalez, M.H., unpublished Master's thesis, Institute of Gas Technology, Chicago, 1966.
(6) Ishida, Y., *Phys. Rev.* **21**, 550–63 (1923).
(7) Lambert, J.D., Cotton, K.J., Pailthorpe, M.W., Robinson, A.M., Scrivins, J., Vale, W.R.F., Young, R.M., *Proc. Roy. Soc. (London)* **A 231**, 380–90 (1955).
(8) Lee, A.L., "Viscosity of Light Hydrocarbons," American Petroleum Institute, New York, 1965.
(9) Lee, A.L., Starling, K.E., Dolan, J.P., Ellington, R.T., *A.I.Ch.E. J.* **10**, 694–97 (1964).
(10) Lipkin, M.R., Davidson, J.A., Kurtz, S.S., *Ind. Eng. Chem.* **34**, 976–8 (1942).
(11) Sage, B.H., Lacey, W.N., "Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen," American Petroleum Institute, New York, 1950.
(12) Sage, B.H., Yale, W.D., Lacey, W.N., *Ind. Eng Chem.* **31**, 223–6 (1939).
(13) Svehla, R.A., *NASA*. **TR R-132**, 119, 1962.
(14) Thermophysical Properties Research Center, "Data Book, Vol. **II**," Table 2057, Purdue University, Lafayette, Ind., 1963.
(15) Titani, T., *Bull. Chem. Soc. Japan* **5**, 98–108 (1930).

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