Physical Properties of Four Spiro Hydrocarbons

PAUL A. NARO[1]
Whitmore Laboratory, College of Chemistry and Physics, The Pennsylvania State University, University Park, Pa.

The viscosities and densities at five temperatures, refractive indices at three temperatures, and boiling points at five pressures are reported for spiro(4.5)decane, 7-*n*-hexadecylspiro(4.5)decane, spiro(5.5)undecane, and spiro(5.6)dodecane.

FOUR SPIRO hydrocarbons have been prepared and studied as part of a continuing investigation of hydrocarbon structure and physical properties (*2*, *4*, *7*). The syntheses, purification, and infrared spectra of these compounds were described previously (*3*).

Unfortunately, a critical lack of data on spiro hydrocarbons makes a discussion of structure-property relationships impossible. The data presented here will serve as a focus for an understanding of such relationships among spiranes.

Table I. Physical Properties of the Spiro Hydrocarbons

Hydrocarbon	Viscosity, Cp., at ° C. 0.0°	20.0°	37.8°	60.0°	98.9°	KVI[a]	Density, Grams/Ml., at ° C. 0.0°	20.0°	37.8°	60.0°	98.9°
Spiro(4.5)decane	3.332	2.208	1.619	1.165	[b]	216	0.8934	0.8782	0.8646	0.8475	[b]
7-*n*-Hexadecylspiro(4.5)decane	[c]	29.45	15.15	7.923	3.456	146	[c]	0.8596	0.8482	0.8341	0.8096
Spiro(5.5)undecane	5.079	3.144	2.212	1.534	0.9186	217	0.9031	0.8887	0.8763	0.8606	0.8328
Spiro(5.6)dodecane	8.001	4.507	3.009	1.992	1.138	198	0.9170	0.9031	0.8909	0.8757	0.8489

Hydrocarbon	Boiling Point, ° C., at Mm. of Hg 20 Mm.	30 Mm.	40 Mm.	60 Mm.	100 Mm.	ΔH_v^d, Cal. per Gram	Refractive Index, n_D, at ° C. 20°	30°	40°	Molar Refraction[e] Exptl.	Theor.
Spiro(4.5)decane	74.8	84.5	91.5	101.9	116.1	76	1.4710	1.4666	1.4624	44.0	44.0
7-*n*-Hexadecylspiro(4.5)decane	189.4 at 0.50mm.	204.4 at 1.00mm.	220.3 at 2.00mm.	242.8 at 5.00mm.	260.9 at 10.0mm.	57	1.4724	1.4687	1.4651	118.2	117.9
Spiro(5.5)undecane	96.1	105.9	113.2	124.1	138.7	75	1.4781	1.4740	1.4699	48.5	48.6
Spiro(5.6)dodecane	116.8	127.4	135.1	146.6	162.2	72	1.4873	1.4833	1.4794	53.0	53.2

[a] Kinematic viscosity index calculated by the method used by Hardiman and Nissan (*6*). [b] Vapor pressure too high. [c] Solid at this temperature. [d] Calculated from the boiling points at the greatest pressure difference measured, using the Clausius-Clapeyron equation. [e] Calculated molar refraction using 2.420 for carbon and 1.100 for hydrogen.

The physical properties of the hydrocarbons are listed in Table I. The viscosities and densities at five temperatures, refractive indices at three temperatures, and boiling points at five pressures are reported for spiro(4.5)decane, 7-*n*-hexadecylspiro(4.5)decane, spiro(5.5)undecane, and spiro(5.6)dodecane.

The pycnometers were calibrated with triple-distilled water and checked with pure methylcyclohexane. All densities were corrected for air buoyancy and are believed accurate to ±0.0002 gram per cc. Refractive indices were determined with a Valentine-Abbe type five-place refractometer calibrated with certified N.B.S. hydrocarbon standards. The indices were determined with a precision of ±0.00003 units and are reported to 0.0001 units. Boiling points were measured in a modified Cottrell apparatus described by Fenske (*5*), and they were determined with a precision of ±0.5° C. and an accuracy of ±2° C. The viscometers, Ostwald type, as modified by Cannon and Fenske (*1*), were calibrated with oil standards. The viscosities reported are referred to the new standard for water at 20° C., 1.0038 cs. Determinations were made with calibrated stop watches with a precision of ±0.2%.

[1] Present address: Socony Mobil Oil Company, Inc., Research Department, Central Research Division, Princeton, N. J.

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