U. S. Department of Commerce
National Bureau of Standards

Research Paper RP2085
Volume 44, April 1950

Part of the Journal of Research of the National Bureau of Standards

Refractive Index as a Function of Wavelength for Sixty API–NBS Hydrocarbons[1]

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Measurements of the refractive index at 20°, 25°, and 30° C and at seven wavelengths, from 6678.1 to 4358.3 Angstrom units, were made on 60 purified hydrocarbons of the API–NBS series. The apparatus consisted of a precision Abbe-type refractometer, calibrated by means of NBS Standard Samples of hydrocarbons certified with respect to refractive index at the three temperatures and seven wavelengths used. The light sources used were a mercury arc, a sodium vapor lamp, and hydrogen and helium discharge tubes, with suitable filters. A constant temperature bath maintained the temperature of the refractometer prisms constant within ±0.02° C.

The experimental data on the hydrocarbons were adjusted by means of a four constant Hartmann equation, $n_\lambda = n_\infty + C/(\lambda - \lambda^*)^{1.6}$, and a two constant modified Cauchy equation, $\Delta n_\lambda = a + b/\lambda^2$. ($\Delta n_\lambda$, the change in the refractive index at the wavelength, λ, when the temperature is changed from 20° to 25° C or 25° to 30° C, is used instead of n_λ of the Cauchy equation).

The computed refractive index at 20°, 25°, and 30° C, together with the values of the specific dispersions, and the constants of the Hartmann and modified Cauchy equations, applicable over the range of measurement, are reported for 60 API–NBS hydrocarbons, comprising 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes.

I. Introduction

This investigation is part of the systematic program on the physical properties of highly purified hydrocarbons being prepared in the cooperative program of the American Petroleum Institute and the National Bureau of Standards.

Precision measurements of the refractive index were made on 60 hydrocarbons of the API-NBS series at 20°, 25°, and 30° C and at the seven wavelengths, helium 6678.1 and 5015.7 A, hydrogen 6562.8 and 4861.3 A, sodium (intensity-weighted mean) 5892.6 A, and mercury 5460.7 and 4358.3 A.

This paper gives the results of the adjustment of the data by means of the Hartmann and the modified Cauchy equations, together with the calculated specific dispersions, for 17 paraffin, 14 alkylcyclopentane, 8 alkylcyclohexane, and 21 alkylbenzene hydrocarbons.

[1] This investigation was performed at the National Bureau of Standards as part of the work of the American Petroleum Institute Research Project 6 on the "Analysis, Purification, and Properties of Hydrocarbons".

[2] Research Associate on the American Petroleum Institute Research Project 6 at the National Bureau of Standards.

II. Apparatus and Procedure

A precision Abbe-type Bausch and Lomb refractometer was used to measure the refractive index. In order to maintain the temperature of the refracting prism constant within the required limit of ±0.02° C, it was found necessary to remove the thermometer furnished with the instrument and to adapt a small cylinder to the water exit-tube. The top of this cylinder was threaded to accommodate a short platinum resistance thermometer (25 ohms) made specially for this purpose.[3] This cylinder permitted the water at constant temperature to flow freely through the exit-tube and provided for complete immersion of the thermometer in the water.[4]

A constant-temperature bath was assembled and connected to the refractometer, as shown in figure 1. The temperature of the water as it left the prism cell was measured by means of the

[3] Manufactured by Cyril H. Meyers, Arlington, Va.

[4] The bulb of the mercury-in-glass thermometer originally in the water exit-tube of the instrument throttled the flow of water to such an extent that it was impossible to attain adequate temperature control.

platinum resistance thermometer and a Mueller-type resistance bridge. The maximum drift observed over a period of 6 hr was ± 0.02 deg C, whereas the temperature of the water in the bath itself varied only ± 0.005 deg C. To obtain satisfactory control of temperature, it is very important that the connections from the constant-temperature bath to the refractometer be well insulated and as short as possible. Furthermore, the temperature of the water leaving the prism assembly should be measured before and after each group of measurements on each hydrocarbon and a suitable correction applied if necessary.

A diagram of the controls for the constant-temperature bath is shown in figure 2, with details given in the legend.

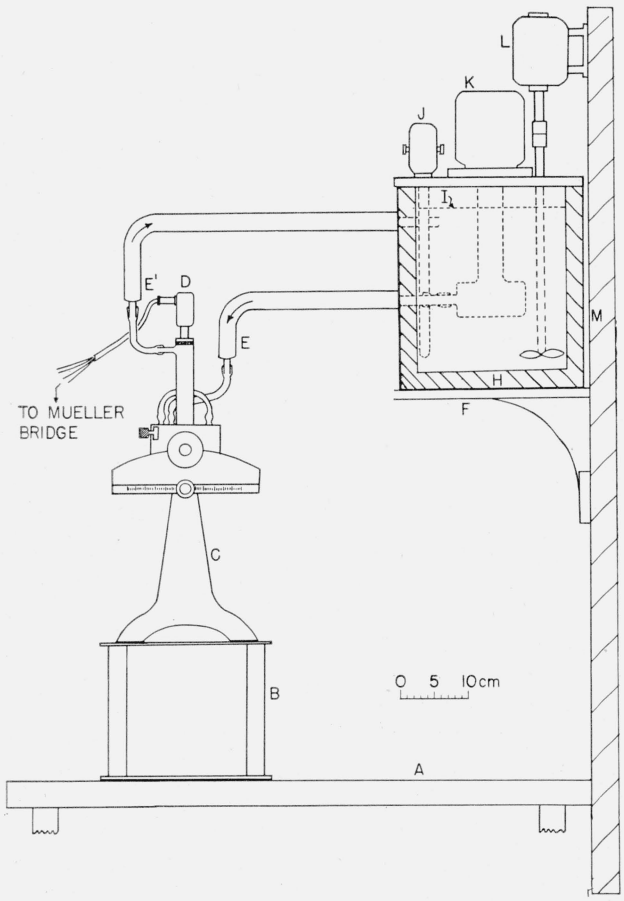

FIGURE 1. *Assembly of precision refractometer*

The letters have the following significance: A, table; B, metal supporting-stand for refractometer; C, refractometer (Bausch and Lomb Precision): *D*, platinum resistance thermometer; E, water inlet to prism assembly; E′, water outlet from prism assembly; F, support for constant-temperature water bath; H, thermal insulation on water-bath; I, water level; J, mercury-type thermoregulator; K, water pump; L, motor with stirrer; M, wall of room.

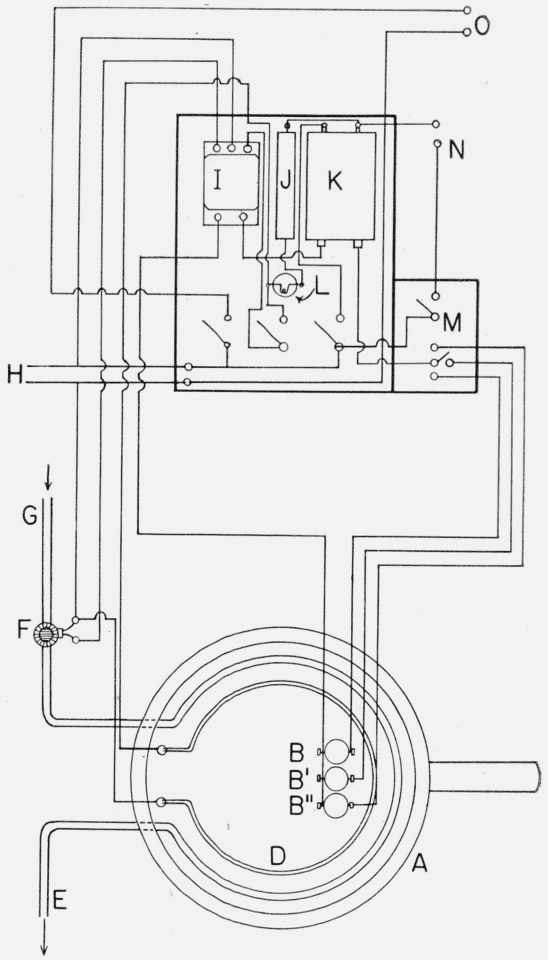

FIGURE 2. *Diagram of controls for precision refractometer*

The letters have the following significance: A, water bath; B, B′, and B″, mercury-type thermoregulators set at 20° C (±0.01° C), 25° C (±0.01° C), and 30° C (±0.01° C), respectively; D, heater; E, water discharge; F, solenoid valve; G, inlet for cooling water; H, power line, 110 volts, alternating current; I, relay; J, resistance, 1,000 ohms; K, rectifier and transformer; L, miniature lamp, 14 volts; M, switch assembly; N, to stirrer motor; O, to pump motor.

The sources of light used were as follows:

For the mercury lines, a mercury arc (General Electric type H4) was used. For isolating the line at 4358.3 A, a combination of Corning filter No. 5850 (melt 647, thickness of 3.98 mm) and Corning filter No. 3389 (melt 622, thickness of 3.05 mm) was used. For the line at 5460.7 A, a Wratten filter No. 62 was used.

For the hydrogen lines, a low-pressure discharge tube of the Texas Co. design [1] [5] filled with hydrogen was used. A Wratten filter No. 45 was used for the line at 4861.3 A. A Corning filter No.

[5] Figures in brackets indicate the literature references at the end of this paper.

2404 (thickness of 3.35 mm) was used for the line at 6562.8 A in order to improve the contrast of the light and dark portions of the field.

For the helium lines, a low-pressure discharge tube of the same type as for hydrogen, but filled with helium, was used. A Wratten filter No. 45 was used for the line at 5015.7 A. For the line at 6678.1 A, the same filter was used as for the hydrogen line at 6562.8 A.

For the sodium line, intensity-weighted mean at 5892.6 A, the standard sodium vapor lamp supplied with the refractometer was used.

The mercury arc and sodium vapor lamp were equipped with shields bearing a vertical slit, 1x25 mm in size.

At the beginning of each series of measurements, the refractometer was calibrated by means of the NBS Standard Samples of 2,2,4-trimethylpentane, methylcyclohexane, and toluene, each of which is certified with respect to refractive index at 20°, 25°, and 30° C, at each of the seven wavelengths given above. During the series of measurements, the refractometer was periodically checked with the standard used on that day. The complete calibration was repeated after a prolonged series and the change, if any, was prorated over the time interval. A table of corrections for each wavelength at 20°, 25°, and 30° C was prepared for each one of the three standards. These corrections were then applied to the observations in accordance with the standard liquid used. The calibrating values of the three standards used, as obtained by the NBS Optical Instruments Section, are given in table 1.

TABLE 1. *Certified values of refractive index for three NBS Standard Samples of Hydrocarbons*

Wavelength in Angstrom units	Designation of line	Index of refraction [a]								
		2,2,4-Trimethylpentane No. 217			Methylcyclohexane No. 218			Toluene No. 211a		
		20° C	25° C	30° C	20° C	25° C	30 C	20° C	25° C	30° C
6678.1	Helium	1.38916	1.38670	1.38424	1.42064	1.41812	1.41560	1.49180	1.48903	1.48619
6562.8	Hydrogen, C	1.38945	1.38698	1.38452	1.42094	1.41842	1.41591	1.49243	1.48966	1.48682
5892.6 [b]	Sodium, D_1, D_2	1.39145	1.38898	1.38650	1.42312	1.42058	1.41806	1.49693	1.49413	1.49126
5460.7	Mercury, e	1.39316	1.39068	1.38820	1.42497	1.42243	1.41989	1.50086	1.49803	1.49514
5015.7	Helium	1,39544	1.39294	1.39044	1.42744	1.42488	1.42233	1.50620	1.50334	1,50041
4861.3	Hydrogen, F	1,39639	1.39389	1.39138	1.42847	1.42590	1.42334	1.50847	1.50559	1.50265
4358.3	Mercury, g	1.40029	1.39776	1.39523	1.43269	1.43010	1.42752	1.51800	1.51506	1.51206

[a] These measurements were made by the NBS Section on Optical Instruments.
[b] Intensity-weighted mean of doublet, D_1, D_2.

III. Source and Purity of Compounds

The compounds whose refractive indices were measured in the present investigation were samples from the API-NBS series of highly purified hydrocarbons, which are being prepared through a cooperative undertaking of the American Petroleum Institute and the National Bureau of Standards. The description of the compounds is given in a preceding report [2]. The purification and determination of purity and freezing points of these compounds are described in references [3, 4, 5, 6, 7]. It is believed that in each case the impurity was of such nature and present in such small amount that the properties measured were not affected beyond the indicated limits of uncertainty.

IV. Adjustment of the Data

1. Method of Adjustment

The Hartmann dispersion formula, in its simple form,

$$n_\lambda = n_\infty + C/(\lambda - \lambda^*), \qquad (1)$$

where n_λ is the refractive index of the substance for light of wavelength λ, and n_∞, C, and λ^* are constants, is not sufficiently accurate for the representation of refractive indices to five decimal places. It is well known that some exponent other than unity is desirable for $(\lambda - \lambda^*)$ in accurate work over an extended range in wavelengths. Tilton and Gurewitz [8] found that the refractive indices of three standard hydrocarbons

could be accurately represented to within a few units of the sixth decimal when 1.6 was used as the exponent.

The data obtained in the present investigation have been adjusted by means of the Hartmann equation as used by Tilton and Gurewitz:

$$n_\lambda = n_\infty + C/(\lambda - \lambda^*)^{1.6}. \quad (2)$$

The results show that the equation is entirely adequate to represent the refractive indices of a wide variety of liquid hydrocarbons over the range of wavelength from 0.66781 to 0.43583 μ (or 6678 to 4358 A).

The constants in eq 2 were adjusted by means of a modification [6] of an interpolation precedure recommended by Tilton and Gurewitz [8]. The following abbreviations are used:

$$\beta = 1/(\lambda - \lambda^*)^{1.6}, \quad (3)$$

$$\gamma = (\beta_{0.43583} - \beta_{0.65628})/(\beta_{0.43583} - \beta_{0.54607}). \quad (4)\ [7]$$

To facilitate the calculations, values of β and γ were calculated over certain ranges. Table 2 gives the values of β for each of the seven wavelengths, for values of λ^* from 0.0700 to 0.1500 μ. Table 3 gives values of γ for values of λ^* from 0.07 to 0.15.

TABLE 2. *Values of $\beta = 1/(\lambda - \lambda^*)^{1.6}$, for each of seven wavelengths, λ, for the range $\lambda^* = 0.0700$ to 0.1500*

λ^*	Wavelength, λ in microns						
	0.6678149	0.6562793	0.5892620	0.5460740	0.5015675	0.4861327	0.4358342
	$\beta = 1/(\lambda - \lambda^*)^{1.6}$						
	β_{He-red}	β_C	β_{D_1, D_2}	β_e	$\beta_{He-blue}$	β_F	β_g
0.070	2.277683	2.349809	2.85352	3.278846	3.836384	4.066578	4.997411
	6109	6427	881	11050	14266	15684	21934
.071	2.283792	2.356236	2.86233	3.289896	3.850650	4.082262	5.019345
	6136	6456	886	11110	14353	15782	22092
072	2.289928	2.362692	2.87119	3.301006	3.865003	4.098044	5.041437
	6163	6485	891	11171	14439	15882	22249
.073	2.296091	2.369177	2.88010	3.312177	3.879442	4.113926	5.063686
	6190	6513	895	11233	14528	15982	22410
.074	2.302281	2.375690	2.88905	3.323410	3.893970	4.129908	5.086096
	6217	6543	899	11295	14616	16083	22572
.075	2.308498	2.382233	2.89804	3.334705	3.908586	4.145991	5.108668
	6244	6572	904	11358	14705	16187	22734
.076	2.314742	2.388805	2.90708	3.346063	3.923291	4.162178	5.131402
	6272	6601	909	11420	14795	16290	22900
.077	2.321014	2.395406	2.91617	3.357483	3.938086	4.178468	5.154302
	6299	6631	913	11484	14887	16393	23066

[6] Harold Hurwitz, Scientific Aid on the API Research Project 6 at this Bureau, developed this modification and computed tables 2 and 3.

[7] Any three wavelengths may be used to define γ. Table 3 must then be recomputed for the selected wavelengths.

TABLE 2. *Values of $\beta = 1/(\lambda - \lambda^*)^{1.6}$, for each of seven wavelengths, λ, for the range $\lambda^* = 0.700$ to 0.1500*—Con.

λ^*	Wavelength, λ in microns						
	0.6678149	0.6562793	0.5892620	0.5460740	0.5015675	0.4861327	0.4358342
	$\beta = 1/(\lambda - \lambda^*)^{1.6}$						
	β_{He-red}	β_C	β_{D_1, D_2}	β_e	$\beta_{He-blue}$	β_F	β_g
0.078	2.327313	2.402037	2.92530	3.368967	3.952973	4.194861	5.177368
	6327	6661	917	11548	14978	16499	23234
.079	2.333640	2.408698	2.93447	3.380515	3.967951	4.211360	5.200602
	6355	6691	923	11613	15070	16603	23404
.080	2.339995	2.415389	2.94370	3.392128	3.983021	4.227963	5.224006
	6383	6721	927	11677	15164	16707	23576
.081	2.346378	2.422110	2.95297	3.403805	3.998185	4.244670	5.247582
	6412	6752	932	11743	15258	16814	23749
.082	2.352790	2.428862	2.96229	3.415548	4.013443	4.261484	5.271331
	6441	6782	937	11809	15353	16923	23924
.083	2.359231	2.435644	2.97166	3.427357	4.028796	4.278407	5.295255
	6469	6814	942	11876	15448	17033	24102
.084	2.365700	2.442458	2.98108	3.439233	4.044244	4.295440	5.319357
	6498	6844	946	11942	15545	17144	24280
.085	2.372198	2.449302	2.99054	3.451175	4.059789	4.312584	5.343637
	6527	6876	951	12010	15642	17260	24460
.086	2.378725	2.456178	3.00005	3.463185	4.075431	4.329844	5.368097
	6556	6907	957	12078	15740	17372	24643
.087	2.385281	2.463085	3.00962	3.475263	4.091171	4.347216	5.392740
	6586	6938	961	12147	15839	17487	24827
.088	2.391867	2.470023	3.01923	3.487410	4.107010	4.364703	5.417567
	6615	6971	967	12216	15939	17602	25013
.089	2.398482	2.476994	3.02890	3.499626	4.122949	4.382305	5.442580
	6645	7002	971	12285	16040	17717	25202
.090	2.405127	2.483996	3.03861	3.511911	4.138989	4.400022	5.467782
	6675	7034	976	12355	16142	17831	25392
.091	2.411802	2.491030	3.04837	3.524266	4.155131	4.417853	5.493174
	6705	7067	982	12427	16244	17948	25584
.092	2.418507	2.498097	3.05819	3.536693	4.171375	4.435801	5.518758
	6735	7099	986	12497	16347	18067	25779
.093	2.425242	2.505196	3.06805	3.549190	4.187722	4.453868	5.544537
	6766	7133	992	12570	16453	18187	25975
.094	2.432008	2.512329	3.07797	3.561760	4.204175	4.472055	5.570512
	6797	7165	997	12642	16557	18307	26174
.095	2.438805	2.519494	3.08794	3.574402	4.220732	4.490362	5.596686
	6828	7199	1002	12716	16663	18430	26373
.096	2.445633	2.526693	3.09796	3.587118	4.237395	4.508792	5.623059
	6858	7232	1008	12789	16771	18553	26576
.097	2.452491	2.533925	3.10804	3.599907	4.254166	4.527345	5.649635
	6890	7267	1013	12864	16878	18677	26781
.098	2.459381	2.541192	3.11817	3.612771	4.271044	4.546022	5.676416
	6922	7300	1018	12938	16988	18803	26988
.099	2.466303	2.548492	3.12835	3.625709	4.288032	4.564825	5.703404
	6953	7334	1023	13014	17098	18930	27197
.100	2.473256	2.555826	3.13858	3.638723	4.305130	4.583755	5.730601
	6985	7369	1028	13090	17209	19058	27408
.101	2.480241	2.563195	3.14886	3.651813	4.322339	4.602813	5.758009
	7017	7403	1034	13166	17320	19186	27621
.102	2.487258	2.570598	3.15920	3.664979	4.339659	4.621999	5.785630
	7050	7438	1039	13243	17434	19318	27838
.103	2.494308	2.578036	3.16959	3.678222	4.357093	4.641317	5.813468
	7082	7473	1045	13322	17549	19448	28056
.104	2.501390	2.585509	3.18004	3.691544	4.374642	4.660765	5.841524
	7115	7508	1051	13400	17663	19582	28277
.105	2.508505	2.593017	3.19055	3.704944	4.392305	4.680347	5.869801
	7058	7544	1058	13479	17780	19715	28500
.106	2.515653	2.600561	3.20113	3.718423	4.410085	4.700062	5.898301
	7271	7579	1063	13560	17897	19851	28725

TABLE 2. *Values of* $\beta=1/(\lambda-\lambda^*)^{1.6}$, *for each of seven wavelengths,* λ, *for the range* $\lambda^*=0.700$ *to* 0.1500—Con.

	Wavelength, λ in microns						
λ^*	0.6678149	0.6562793	0.5892620	0.5460740	0.5015675	0.4861327	0.4358342
	$\beta=1/(\lambda-\lambda^*)^{1.6}$						
	β_{He-red}	β_C	$\beta_{D_1\cdot D_2}$	β_e	$\beta_{H4-blue}$	β_F	β_g
0.107	2.522834	2.608140	3.21176	3.731983	4.427982	4.719913	5.927026
	7214	7615	1070	13640	18016	19987	28953
.108	2.530048	2.615755	3.22246	3.745623	4.445998	4.739900	5.955979
	7248	7652	1075	13721	18135	20125	29185
.109	2.537296	2.623407	3.23321	3.759344	4.464133	4.760025	5.985164
	7282	7688	1081	13803	18255	20264	29417
.110	2.544578	2.631095	3.24402	3.773147	4.482388	4.780289	6.014581
	7316	7725	1086	13885	18376	20405	29652
.111	2.551894	2.638820	3.25488	3.787032	4.500764	4.800694	6.044233
	7350	7761	1092	13969	18499	20546	29891
.112	2.559244	2.646581	3.26580	3.801001	4.519263	4.821240	6.074124
	7385	7799	1098	14052	18624	20690	30131
.113	2.566629	2.654380	3.27678	3.815053	4.537887	4.841930	6.104255
	7419	7836	1103	14137	18748	20835	30376
.114	2.574048	2.662216	3.28781	3.829190	4.556635	4.862765	6.134631
	7454	7874	1110	14223	18874	20981	30622
.115	2.581502	2.670090	3.29891	3.843413	4.575509	4.883746	6.165253
	7489	7912	1116	14309	19002	21129	30871
.116	2.588991	2.678002	3.31007	3.857722	4.594511	4.904875	6.196124
	7525	7949	1122	14395	19130	21277	31122
.117	2.596516	2.685951	3.32129	3.872117	4.613641	4.926152	6.227246
	7560	7988	1129	14483	19261	21428	31378
.118	2.604076	2.693939	3.33258	3.886600	4.632902	4.947580	6.258624
	7596	8027	1134	14572	19391	21580	31636
.119	2.611672	2.701966	3.34392	3.901172	4.652293	4.969160	6.290260
	7632	8066	1141	14660	19524	21734	31897
.120	2.619304	2.710032	3.35533	3.915832	4.671817	4.990894	6.322157
	7668	8105	1147	14750	19657	21888	32160
.121	2.626972	2.718137	3.36680	3.930582	4.691474	5.012782	6.354317
	7705	8144	1154	14840	19792	22044	32426
.122	2.634677	2.726281	3.37834	3.945422	4.711266	5.034826	6.386743
	7742	8184	1160	14932	19928	22203	32697
.123	2.642419	2.734465	3.38994	3.960354	4.731194	5.057029	6.419440
	7779	8225	1166	15024	20065	22362	32969
.124	2.650198	2.742690	3.40160	3.975378	4.751259	5.079391	6.452409
	7816	8264	1173	15116	20204	22523	33246
.125	2.658014	2.750954	3.41333	3.990494	4.771463	5.101914	6.485655
	7853	8305	1180	15209	20344	22685	33524
.126	2.665867	2.759259	3.42513	4.005703	4.791807	5.124599	6.519179
	7891	8346	1186	15304	20484	22850	33807
.127	2.673758	2.767605	3.43699	4.021007	4.812291	5.147449	6.552986
	7930	8387	1193	15399	20628	23016	34093
.128	2.681688	2.775992	3.44892	4.036406	4.832919	5.170465	6.587079
	7967	8428	1200	15496	20772	23184	34382
.129	2.689655	2.784420	3.46092	4.051902	4.853691	5.193649	6.621461
	8006	8470	1207	15592	20917	23353	34675
.130	2.697661	2.792890	3.47299	4.067494	4.874608	5.217002	6.656136
	8045	8512	1213	15690	21064	23524	34971
.131	2.705706	2.801402	3.48512	4.083184	4.895672	5.240526	6.691107
	8084	8554	1220	15790	21212	23698	35270
.132	2.713790	2.809956	3.49732	4.098974	4.916884	5.264224	6.726377
	8124	8597	1228	15888	21362	23872	35574
.133	2.721914	2.818553	3.50960	4.114862	4.938246	5.288096	6.761951
	8163	8640	1234	15990	21513	24049	35881
.134	2.730077	2.827193	3.52194	4.130852	4.959759	5.312145	6.797832
	8203	8683	1241	16090	21666	24227	36192
.135	2.738280	2.835876	3.53435	4.146942	4.981425	5.336372	6.834024
	8243	8726	1248	16192	21820	24406	36504

TABLE 2. *Values of* $\beta=1/(\lambda-\lambda^*)^{1.6}$, *for each of seven wavelengths,* λ, *for the range* $\lambda^*=0.700$ *to* 0.1500—Con.

	Wavelength, λ in microns						
λ^*	0.6678149	0.6562793	0.5892620	0.5460740	0.5015675	0.4861327	0.4358342
	$\beta=1/(\lambda-\lambda^*)^{1.6}$						
	β_{He-red}	β_C	$\beta_{D_1\cdot D_2}$	β_e	$\beta_{He-blue}$	β_F	β_g
0.136	2.746523	2.844602	3.54683	4.163134	5.003245	5.360778	6.870528
	8283	8770	1256	16296	21977	24588	36823
.137	2.754806	2.853372	3.55939	4.179430	5.025222	5.385366	6.907351
	8324	8814	1263	16399	22133	24772	37144
.138	2.763130	2.862186	3.57202	4.195829	5.047355	5.410138	6.944495
	8365	8858	1270	16504	22293	24958	37471
.139	2.771495	2.871044	3.58472	4.212333	5.069648	5.435096	6.981966
	8406	8903	1278	16609	22453	25145	37800
.140	2.779901	2.879947	3.59750	4.228942	5.092101	5.460241	7.019766
	8448	8948	1285	16714	22614	25335	38133
.141	2.788349	2.888895	3.61035	4.245656	5.114715	5.485576	7.057899
	8489	8993	1292	16822	22779	25527	38470
.142	2.796838	2.897888	3.62327	4.262478	5.137494	5.511103	7.096369
	8531	9039	1300	16931	22943	25720	38813
.143	2.805369	2.906927	3.63627	4.279409	5.160437	5.536823	7.135182
	8574	9084	1308	17040	23111	25916	39160
.144	2.813943	2.916011	3.64935	4.296449	5.183548	5.562739	7.174342
	8617	9131	1315	17152	23279	26114	39510
.145	2.822560	2.925142	3.66250	4.313601	5.206827	5.588853	7.213852
	8660	9177	1323	17265	23450	26313	39864
.146	2.831220	2.934319	3.67573	4.330866	5.230277	5.615166	7.253716
	8703	9224	1331	17378	23621	26514	40223
.147	2.839923	2.943543	3.68904	4.348244	5.253898	5.641680	7.293939
	8747	9271	1338	17493	23796	26719	40588
.148	2.848670	2.952814	3.70242	4.365737	5.277694	5.668399	7.334527
	8790	9319	1347	17606	23972	26926	40956
.149	2.857460	2.962133	3.71589	4.383343	5.301666	5.695325	7.375483
	8835	9367	1354	17723	24149	27134	41329
.150	2.866295	2.971500	3.72943	4.401066	5.325815	5.722459	7.416812

The value of γ was determined from the relation

$$\gamma=(n_{0.43583}-n_{0.65628})/(n_{0.43583}-n_{0.54607}). \quad (5)$$

Using table 3, the corresponding value of λ^* was interpolated. Further interpolation in table 2 yielded values for β for each of the seven wavelengths used. The constant C was then readily computed from the equation

$$C=(n_{0.43583}-n_{0.65628})/(\beta_{0.43583}-\beta_{0.65628}). \quad (6)$$

The Hartmann equation was written as

$$n_\lambda=n_\infty+C\beta_\lambda. \quad (7)$$

The remaining unknown constant, n_∞, was easily computed by inserting the observed values of the refractive index at $\lambda=0.65628$, 0.54607, and 0.43583μ, the numerical value of C, and appropriate values of β_λ, successively into the above

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equation and solving three times for n_∞. If no errors were made, the three computed values of n_∞ agreed within ± 0.00001. The same equation was used to compute the refractive index at $\lambda = 0.66781$, 0.58926, 0.50157, and 0.48613μ, by inserting the average value of n_∞, and the values of C and β_λ. Since it was found that this procedure reproduces good data to about ± 0.00001 units in the refractive index, it is obvious that attempts to better these constants of the Hartmann equation by least squares or any other method of adjustment would be of no practical value in this work where only fifth decimal data is to be considered.

TABLE 3. *Values of* $\gamma = (\beta_{0.43583} - \beta_{0.65628})/(\beta_{0.43583} - \beta_{0.54607})$, *for values of* λ^* *from 0.07 to 0.15*

Intervals of λ^*	λ^*							
	0.07000	0.08000	0.09000	0.10000	0.11000	0.12000	0.13000	0.14000
	$\gamma = (\beta_{0.43583} - \beta_{0.65628})/(\beta_{0.43583} - \beta_{0.54607})$							
0.000	1.540589	1.533190	1.525554	1.517667	1.509518	1.501096	1.492383	1.483368
	729	753	778	802	830	858	888	920
.001	1.539860	1.532437	1.524776	1.516865	1.508688	1.500238	1.491495	1.482448
	733	755	779	806	832	860	890	923
.002	1.539127	1.531682	1.523997	1.516059	1.507856	1.499378	1.490605	1.481525
	734	757	783	809	835	864	894	926
.003	1.538393	1.530925	1.523214	1.515250	1.507021	1.498514	1.489711	1.480599
	736	761	785	810	838	867	896	929
.004	1.537657	1.530164	1.522429	1.514440	1.506183	1.497647	1.488815	1.479670
	739	762	787	814	841	869	901	932
.005	1.536918	1.529402	1.521642	1.513626	1.505342	1.496778	1.487914	1.478738
	741	765	789	817	844	874	903	935
.006	1.536177	1.528637	1.520853	1.512809	1.504498	1.495904	1.487011	1.477803
	744	767	793	818	846	875	905	937
.007	1.535433	1.527870	1.520060	1.511991	1.503652	1.495029	1.486106	1.476866
	745	769	795	821	849	879	910	940
.008	1.534688	1.527101	1.519265	1.511170	1.502803	1.494150	1.485196	1.475926
	748	773	798	825	852	882	912	945
.009	1.533940	1.526328	1.518467	1.510345	1.501951	1.493268	1.484284	1.474981
	750	774	800	827	855	885	916	947

Instead of applying the above procedure separately to the data obtained at 20°, 25°, and 30° C, it was decided that the 21 measurements on each hydrocarbon would be better correlated if the change in refractive index in going from 20° to 25° C and from 25° to 30° C were first adjusted by means of the method of least squares and the Cauchy formula

$$\Delta n_\lambda = a + b/\lambda^2, \qquad (8)$$

using Δn_λ instead of n_λ.

The computed values of Δn, for each wavelength, were then added to the 30° C refractive indices and subtracted from the 20° C indices to give two values at 25° C. These were averaged with the experimentally determined indices of refraction at 25° C, and the average fitted to the Hartmann equation by the interpolation method described above. By adding and subtracting the computed values of Δn from the refractive indices calculated by means of the constants of the Hartmann equation, the values of refractive index for 20° and 30° C were obtained. This procedure automatically "smoothed" the values for 20° and 30° C. In the case of the paraffins and cycloparaffins, the values of Δn for the range 20° to 25° C were so nearly equal to those for the range 25° to 30° C that average values of Δn were used.

2. Results of the Adjustment

Table 4 gives the values of the constants of the modified Cauchy equation for each of the 60 compounds. The last column of the table gives the root-mean-square value, $\rho \times 10^5$, of the deviations of the observed from the calculated refractive indices.

Table 5 gives the values of the constants of the Hartmann equation for each of the 60 compounds. As before, the last column of the table gives the root-mean-square value, $\rho \times 10^5$, of the deviations

of the observed from the calculated refractive indices.

Table 6 gives the calculated values of refractive index at 20°, 25°, and 30° C, at each of seven wavelengths, for each of the 60 compounds.

Table 7 gives values of the specific dispersion, $10^4(n_F-n_C)/d$ and $10^4(n_g-n_D)/d$, for each of the 60 compounds, from the values of refractive index given in this report and the values of density given in an earlier report [2].

TABLE 4. *Values of the constants of the modified Cauchy equation for 60 API–NBS hydrocarbons*

Compound	Formula	Constants in the equation $\Delta n = a \times b/\lambda^2$					
		$a \times 10^3$		$b \times 10^3$		$\rho \times 10^5$	
		20° to 25°C	25° to 30°C	20° to 25°C	25° to 30°C	20° to 25°C	25° to 30°C
PARAFFINS							
n-Heptane	C_7H_{16}	2.455	2.455	0.0273	0.0273	4.79	3.71
2-Methylhexane	C_7H_{16}	2.532	2.532	.0179	.0179	6.69	6.15
3-Methylhexane	C_7H_{16}	2.466	2.466	.0296	.0296	6.68	6.73
3-Ethylpentane	C_7H_{16}	2,491	2,491	.0215	.0215	3.28	3.39
2,2-Dimethylpentane	C_7H_{16}	2.528	2.528	.0253	.0253	5.29	3.92
2,3-Dimethylpentane	C_7H_{16}	2.430	2.430	.0283	.0283	3.52	4.92
2,4-Dimethylpentane	C_7H_{16}	2.554	2.554	.0268	.0268	3.93	4.68
3,3-Dimethylpentane	C_7H_{16}	2.407	2.407	.0313	.0313	4.38	4.70
2,2,3-Trimethylbutane	C_7H_{16}	2.422	2.422	.0351	.0351	4.98	1.95
n-Nonane	C_9H_{20}	2.230	2.230	.0293	.0293	4.69	3.82
2,2,5-Trimethylhexane	C_9H_{20}	2.392	2.392	.0157	.0157	4.83	2.65
2,4,4-Trimethylhexane	C_9H_{20}	2.234	2.234	.0227	.0227	3.06	2.11
3,3-Diethylpentane	C_9H_{20}	2.060	2.060	.0276	.0276	4.80	4.01
2,2,3,3-Tetramethylpentane	C_9H_{20}	2.132	2.132	.0250	.0250	2.18	1.52
2,2,3,4-Tetramethylpentane	C_9H_{20}	2.200	2.200	.0196	.0196	5.97	4.65
2,2,4,4-Tetramethylpentane	C_9H_{20}	2.322	2.322	.0106	.0106	4.68	4.10
2,3,3,4-Tetramethylpentane	C_9H_{20}	2.128	2.128	.0211	.0211	3.37	2.45
ALKYLCYCLOPENTANES							
Ethylcyclopentane	C_7H_{14}	2.438	2.438	0.0243	0.0243	3.45	3.47
1,1-Dimethylcyclopentane	C_7H_{14}	2.570	2.570	.0284	.0284	4.64	2.03
1,*cis*-2-Dimethylcyclopentane	C_7H_{14}	2.408	2.408	.0470	.0470	5.31	5.33
1,*trans*-2-Dimethylcyclopentane	C_7H_{14}	2.514	2.514	.0252	.0252	3.34	2.54
1,*cis*-3-Dimethylcyclopentane	C_7H_{14}	2.518	2.518	.0313	.0313	2.61	2.18
1,*trans*-3-Dimethylcyclopentane	C_7H_{14}	2.535	2.535	.0250	.0250	4.09	3.80
n-Propylcyclopentane	C_8H_{16}	2.272	2.272	.0337	.0337	3.58	3.20
Isopropylcyclopentane	C_8H_{16}	2.247	2.247	.0265	.0265	2.57	1.68
1-Methyl-1-ethylcyclopentane	C_8H_{16}	2.319	2.319	.0342	.0342	2.81	2.19
1-Methyl-*cis*-2-ethylcyclopentane	C_8H_{16}	2.360	2.360	.0071	.0071	3.90	2.41
1,1,2-Trimethylcyclopentane	C_8H_{16}	2,391	2,391	.0263	.0263	4.80	4.86
1,1,3-Trimethylcyclopentane	C_8H_{16}	2.371	2.371	.0412	.0412	6.41	4.91
1,*cis*-2,*trans*-4-Trimethylcyclopentane	C_8H_{16}	2.343	2.343	.0304	.0304	4.10	3.12
1,*trans*-2,*cis*-4-Trimethylcyclopentane	C_8H_{16}	2.413	2.413	.0216	.0216	4.87	4.00
ALKYLCYCLOHEXANES							
1,1-Dimethylcyclohexane	C_8H_{16}	2.296	2.296	0.0294	0.0294	5.23	4.99
n-Propylcyclohexane	C_9H_{18}	2.211	2.211	.0215	.0215	4.03	3.81
Isopropylcyclohexane	C_9H_{18}	2.192	2.192	.0226	.0226	4.50	3.10
1,1,3-Trimethylcyclohexane	C_9H_{18}	2.248	2.248	.0172	.0172	2.58	2.46
n-Butylcyclohexane	$C_{10}H_{20}$	2.156	2.156	.0170	.0170	3.06	1.32
Isobutylcyclohexane	$C_{10}H_{20}$	2.202	2.202	.0165	.0165	3.12	1.64
sec-Butylcyclohexane	$C_{10}H_{20}$	2.142	2.142	.0169	.0169	2.74	2.28
tert-Butylcyclohexane	$H_{10}C_{20}$	2.174	2.174	.0110	.0110	3.30	3.12

TABLE 4. *Values of the constants of the modified Cauchy equation for 60 API–NBS hydrocarbons*—Continued

Compound	Formula	Constants in the equation $\Delta n = a + b/\lambda^2$					
		$a \times 10^3$		$b \times 10^3$		$\rho \times 10^5$	
		20° to 25°C	25° to 30°C	20° to 25°C	25° to 30°C	20° to 25°C	25° to 30°C
ALKYLBENZENES							
Benzene	C_6H_6	2.988	3.020	0.0753	0.0424	0.94	1.97
Methylbenzene	C_7H_8	2.658	2.704	.0459	.0620	2.89	1.28
Ethylbenzene	C_8H_{10}	2,541	2.617	.0501	.0290	7.70	0.80
1,2-Dimethylbenzene	C_8H_{10}	2.331	2.503	.0590	.0432	1.55	1.49
1,3-Dimethylbenzene	C_8H_{10}	2.383	2.585	.0669	.0255	1.90	1.57
1,4-Dimethylbenzene	C_8H_{10}	2.394	2.616	.0595	.0325	2.62	1.02
n-Propylbenzene	C_9H_{12}	2.372	2.382	.0494	.0368	1.39	1.54
Isopropylbenzene	C_9H_{12}	2.428	2.328	.0419	.0398	3.21	1.34
1-Methyl-2-ethylbenzene	C_9H_{12}	2.340	2.396	.0478	.0193	3.86	2.12
1-Methyl-3-ethylbenzene	C_9H_{12}	2.390	2.439	.0535	.0271	1.54	3.22
1-Methyl-4-ethylbenzene	C_9H_{12}	2.428	2.348	.0443	.0356	1.20	1.94
1,2,3-Trimethylbenzene	C_9H_{12}	2.320	2.341	.0467	.0184	1.91	1.75
1,2,4-Trimethylbenzene	C_9H_{12}	2.337	2.337	.0457	.0457	2.81	1.93
1,3,5-Trimethylbenzene	C_9H_{12}	2.445	2.341	.0303	.0431	1.52	1.95
n-Butylbenzene	$C_{10}H_{14}$	2.246	2.376	.0421	.0075	2.78	2.61
Isobutylbenzene	$C_{10}H_{14}$	2.347	2.348	.0407	.0294	2.41	1.80
sec-Butylbenzene	$C_{10}H_{14}$	2.280	2.354	.0443	.0220	1.84	1.59
tert-Butylbenzene	$C_{10}H_{14}$	2.306	2.348	.0395	.0443	3.24	3.06
1,2-Diethylbenzene	$C_{10}H_{14}$	2.249	2.370	.0527	.0147	1.98	1.91
1,3-Diethylbenzene	$C_{10}H_{14}$	2.282	2.334	.0469	.0348	0.91	2.03
1,4-Diethylbenzene	$C_{10}H_{14}$	2.223	2.353	.0537	.0234	1.30	1.05

TABLE 5. *Values of the constants of the Hartmann equation for the 60 API–NBS hydrocarbons*

Compound	Formula	Constants in the equation $n_\lambda = n_\infty + C/(\lambda - \lambda^*)^{1.6}$ at 25°C			
		n_∞	C	λ^*	ρ
PARAFFINS					
n-Heptane	C_7H_{16}	1.37475	0.003341	0.09641	1.49
2-Methylhexane	C_7H_{16}	1.37195	.003307	.09832	1.34
3-Methylhexane	C_7H_{16}	1.37570	.003348	.09649	1.02
3-Ethylpentane	C_7H_{16}	1.38046	.003357	.09544	1.15
2,2-Dimethylpentane	C_7H_{16}	1.36927	.003274	.10022	0.87
2,3-Dimethylpentane	C_7H_{16}	1.37920	.003254	.10122	1.46
2,4-Dimethylpentane	C_7H_{16}	1.36860	.003266	.09907	1.12
3,3-Dimethylpentane	C_7H_{16}	1.37781	.003494	.08991	1.30
2,2,3-Trimethylbutane	C_7H_{16}	1.37620	.003536	.08921	1.22
n-Nonane	C_9H_{20}	1.39243	.003381	.10202	1.68
2,2,5-Trimethylhexane	C_9H_{20}	1.38657	.003389	.10208	0.93
2,4,4-Trimethylhexane	C_9H_{20}	1.39411	.003560	.09624	.37
3,3-Diethylpentane	C_9H_{20}	1.40733	.003560	.09624	1.07
2,2,3,3-Tetramethylpentane	C_9H_{20}	1.41030	.003503	.10282	0.93
2,2,3,4-Tetramethylpentane	C_9H_{20}	1.40146	.003494	.10082	.84
2,2,4,4-Tetramethylpentane	C_9H_{20}	1.39343	.003543	.10116	2.32
2,3,3,4-Tetramethylpentane	C_9H_{20}	1.40880	.003617	.09667	1.28

TABLE 5. *Values of the constants of the Hartmann equation for the 60 API–NBS hydrocarbons*—Continued

Compound	Formula	Constants in the equation $n_\lambda = n_\infty + C/(\lambda - \lambda^*)^{1.6}$ at 25°C			
		n_∞	C	λ^*	ρ
ALKYLCYCLOPENTANES					
Ethylcyclopentane	C_7H_{14}	1.40579	0.003778	0.09084	0.62
1,1-Dimethylcyclopentane	C_7H_{14}	1.39941	.003750	.09273	1.15
1,*cis*-2-Dimethylcyclopentane	C_7H_{14}	1.40729	.004306	.07150	3.31
1,*trans*-2-Dimethylcyclopentane	C_7H_{14}	1.39830	.003559	.09830	1.78
1,*cis*-3-Dimethylcyclopentane	C_7H_{14}	1.39687	.003669	.09299	1.10
1, *trans*-3-Dimethylcyclopentane	C_7H_{14}	1.39522	.003559	.09830	2.42
n-Propylcyclopentane	C_8H_{16}	1.41247	.003640	.09991	1.03
Isopropylcyclopentane	C_8H_{16}	1.41210	.003624	.10076	1.22
1-Methyl-1-ethylcyclopentane	C_8H_{16}	1.41300	.003850	.09160	0.80
Ethylcyclopentane	C_8H_{16}	1.41529	.003799	.09320	.84
1,1,2-Trimethylcyclopentane	C_8H_{16}	1.40888	.003755	.09589	.54
1,1,3-Trimethylcyclopentane	C_8H_{16}	1.39691	.003956	.08384	1.45
1, *cis*-2, *trans*-4-Trimethylcyclopentane	C_8H_{16}	1.40481	.003641	.09694	0.68
1, *trans*-2, *cis*-4-Trimethylcyclopentane	C_8H_{16}	1.39683	.003668	.09405	1.17
ALKYLCYCLOHEXANES					
1,1-Dimethylcyclohexane	C_8H_{16}	1.41434	0.004109	0.08469	0.87
n-Propylcyclohexane	C_9H_{18}	1.42266	.003954	.09262	1.92
Isopropylcyclohexane	C_9H_{18}	1.42653	.003919	.09432	0.78
1,1,3-Trimethylcyclohexane	C_9H_{18}	1.41535	.003803	.09917	.84
n-Butylcyclohexane	$C_{10}H_{20}$	1.42646	.003911	.09522	.69
Isobutylcyclohexane	$C_{10}H_{20}$	1.42431	.003877	.09689	1.31
sec-Butylcyclohexane	$C_{10}H_{20}$	1.43238	.003942	.09460	1.54
tert-Butylcyclohexane	$C_{10}H_{20}$	1.43248	.003959	.09563	0.89
ALKYLBENZENES					
Benzene	C_6H_6	1.47421	0.006825	0.13003	0.60
Methylbenzene	C_7H_8	1.47132	.006556	.13046	.20
Ethylbenzene	C_8H_{10}	1.47152	.006276	.12843	3.08
1,2-Dimethylbenzene	C_8H_{10}	1.48037	.006500	.13012	1.48
1,3-Dimethylbenzene	C_8H_{10}	1.47249	.006349	.13126	0.87
1,4-Dimethylbenzene	C_8H_{10}	1.47098	.006393	.13089	1.79
n-Propylbenzene	C_9H_{12}	1.46895	.005968	.12771	1.98
Isopropylbenzene	C_9H_{12}	1.46850	.005898	.12886	2.51
1-Methyl-2-ethylbenzene	C_9H_{12}	1.48026	.006355	.12666	1.73
1-Methyl-3-ethylbenzene	C_9H_{12}	1.47258	.006239	.12745	1.97
1-Methyl-4-ethylbenzene	C_9H_{12}	1.47114	.006126	.13028	1.09
1,2,3-Trimethylbenzene	C_9H_{12}	1.48915	.006406	.13118	1.07
1,2,4-Trimethylbenzene	C_9H_{12}	1.48024	.006337	.13160	1.10
1,3,5-Trimethylbenzene	C_9H_{12}	1.47501	.006249	.13173	0.78
n-Butylbenzene	$C_{10}H_{14}$	1.46761	.005805	.12487	2.92
Isobutylbenzene	$C_{10}H_{14}$	1.46418	.005817	.12448	1.37
sec-Butylbenzene	$C_{10}H_{14}$	1.46803	.005784	.12527	0.84
tert-Butylbenzene	$C_{10}H_{14}$	1.47032	.005838	.12485	2.66
1,2-Diethylbenzene	$C_{10}H_{14}$	1.48014	.006059	.12832	1.18
1,3-Diethylbenzene	$C_{10}H_{14}$	1.47241	.006013	.12731	2.55
1,4-Diethylbenzene	$C_{10}H_{14}$	1.47172	.006001	.12838	1.71

TABLE 6. *Refractive indices at seven wavelengths and three temperatures for 60 API–NBS hydrocarbons*

Wavelength in Angstrom units	Spectral line	Index of refraction														
		20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C
		n-Heptane C_7H_{16}			2-Methylhexane C_7H_{16}			3-Methylhexane C_7H_{16}			3-Ethylpentane C_7H_{16}			2,2-Dimethylpentane C_7H_{16}		
6678.1	He_{red}	1.38545	1.38293	1.38041	1.38266	1.38009	1.37752	1.38643	1.38390	1.38137	1.39120	1.38866	1.38612	1.37995	1.37737	1.37479
6562.8	H_c	1.38572	1.38320	1.38068	1.38293	1.38036	1.37779	1.38671	1.38417	1.38163	1.39147	1.38893	1.38639	1.38023	1.37764	1.37505
5892.6	Na_D	1.38764	1.38511	1.38258	1.38485	1.38227	1.37969	1.38864	1.38609	1.38354	1.39339	1.39084	1.38829	1.38215	1.37955	1.37695
5460.7	Hg_e	1.38930	1.38675	1.38420	1.38650	1.38391	1.38132	1.39029	1.38773	1.38517	1.39504	1.39248	1.38992	1.38380	1.38119	1.37858
5015.7	He_{blue}	1.39149	1.38893	1.38637	1.38869	1.38609	1.38349	1.39249	1.38991	1.38733	1.39723	1.39465	1.39207	1.38601	1.38338	1.38075
4861.3	H_F	1.39241	1.38984	1.38727	1.38961	1.38700	1.38439	1.39342	1.39083	1.38824	1.39814	1.39556	1.39298	1.38699	1.38435	1.38171
4358.3	Hg_g	1.39617	1.39357	1.39097	1.39338	1.39075	1.38812	1.39719	1.39457	1.39195	1.40189	1.39929	1.39669	1.39071	1.38805	1.38539
		2,3-Dimethylpentane C_7H_{16}			2,4-Dimethylpentane C_7H_{16}			3,3-Dimethylpentane C_7H_{16}			2,2,3-Trimethylbutane C_7H_{16}			*n*-Nonane C_9H_{20}		
6678.1	He_{red}	1.38977	1.38728	1.38479	1.37927	1.37666	1.37405	1.38869	1.38621	1.38373	1.38719	1.38469	1.38219	1.40314	1.40084	1.39854
6562.8	H_c	1.39005	1.38755	1.38505	1.37954	1.37692	1.37430	1.38897	1.38649	1.38401	1.38746	1.38496	1.38246	1.40342	1.40112	1.39882
5892.6	Na_D	1.39196	1.38945	1.38694	1.38145	1.37882	1.37619	1.39092	1.38842	1.38592	1.38944	1.38692	1.38440	1.40542	1.40311	1.40080
5460.7	Hg_e	1.39362	1.39110	1.38858	1.38308	1.38044	1.37780	1.39259	1.39008	1.38757	1.39112	1.38858	1.38604	1.40715	1.40482	1.40249
5015.7	He_{blue}	1.39582	1.39328	1.39074	1.38527	1.38261	1.37995	1.39480	1.39227	1.38974	1.39335	1.39079	1.38823	1.40954	1.40710	1.40475
4861.3	H_F	1.39674	1.39419	1.39164	1.38618	1.38351	1.38084	1.39572	1.39318	1,39064	1.39428	1.39171	1.38914	1.41041	1.40806	1.40571
4358.3	Hg_g	1.40054	1.39796	1.39538	1.38993	1.38723	1.38453	1.39948	1.39691	1.39434	1.39807	1.39546	1.39285	1.41437	1.41199	1.40961
		2,2,5-Trimethylhexane C_9H_{20}			2,4,4-Trimethylhexane C_9H_{20}			3,3-Diethylpentane C_9H_{20}			2,2,3,3-Tetramethylpentane C_9H_{20}			2,2,3,4-Tetramethylpentane C_9H_{20}		
6678.1	He_{red}	1.39743	1.39500	1.39257	1.40510	1.40282	1.40054	1.41816	1.41604	1.41392	1.42122	1.41903	1.41684	1.41236	1.41012	1.40788
6562.8	H_c	1.39771	1.39528	1.39285	1.40540	1.40311	1.40082	1.41845	1.41633	1.41421	1.42152	1.41933	1.41714	1.41266	1.41041	1.40816
5892.6	Na_D	1.39972	1.39728	1.39484	1.40745	1.40515	1.40285	1.42051	1.41837	1.41623	1.42360	1.42140	1.41920	1.41472	1.41246	1.41020
5460.7	Hg_e	1.40143	1.39899	1.39655	1.40920	1.40689	1.40458	1.42226	1.42011	1.41796	1.42540	1.42318	1.42096	1.41648	1.41421	1.41194
5015.7	He_{blue}	1.40373	1.40128	1.39883	1.41153	1.40921	1.40689	1.42460	1.42243	1.42026	1.42778	1.42555	1.42332	1.41883	1.41655	1.41427
4861.3	H_F	1.40470	1.40224	1.39978	1.41251	1.41018	1.40785	1.42558	1.42340	1.42122	1.42879	1.42655	1.42431	1.41981	1.41753	1.41525
4358.3	Hg_g	1.40866	1.40618	1.40370	1.41650	1.41415	1.41180	1.42957	1.42737	1.42517	1.43291	1.43065	1.42839	1.42386	1.42156	1.41926
		2,2,4,4-Tetramethylpentane C_9H_{20}			2,3,3,4-Tetramethylpentane C_9H_{20}			Ethylcyclopentane C_7H_{14}			1,1-Dimethylcyclopentane C_7H_{14}			1,*cis*-2-Dimethylcyclopentane C_7H_{14}		
6678.1	He_{red}	1.40457	1.40222	1.39987	1.41984	1.41766	1.41548	1.41739	1.41490	1.41241	1.41113	1.40850	1.40587	1.41965	1.41714	1.41463
6562.8	H_c	1.40487	1.40252	1.40017	1.42016	1.41798	1.41580	1.41769	1.41520	1.41271	1.41144	1.40880	1.40616	1.41997	1.41745	1.41493
5892.6	Na_D	1.40694	1.40459	1.40224	1.42222	1.42003	1.41784	1.41981	1.41730	1.41479	1.41356	1.41091	1.40826	1.42217	1.41963	1.41709
5460.7	Hg_e	1.40874	1.40638	1.40402	1.42402	1.42182	1.41962	1.42162	1.41910	1.41658	1.41538	1.41271	1.41004	1.42405	1.42148	1.41891
5015.7	He_{blue}	1.41111	1.40875	1.40639	1.42638	1.42417	1.42196	1.42401	1.42148	1.41895	1.41778	1.41510	1.41242	1.42649	1.42390	1.42131
4861.3	H_F	1.41212	1.40975	1.40738	1.42737	1.42515	1.42293	1.42501	1.42247	1.41993	1.41878	1.41609	1.41340	1.42751	1.42490	1.42229
4358.3	Hg_g	1.41623	1.41385	1.41147	1.43144	1.42920	1.42696	1.42910	1.42653	1.42396	1.42260	1.42018	1.41746	1.43161	1.42895	1.42629
		1,*trans*-2-Dimethylcyclopentane C_7H_{14}			1,*cis*-3-Dimethylcyclopentane C_7H_{14}			1,*trans*-3-Dimethylcyclopentane C_7H_{14}			*n*-Propylcyclopentane C_8H_{16}			Isopropylcyclopentane C_8H_{16}		
6678.1	He_{red}	1.40963	1.40706	1.40449	1.40836	1.40577	1.40318	1.40657	1.40398	1.40139	1.42382	1.42147	1.41912	1.42339	1.42108	1.41877
6562.8	H_c	1.40992	1.40735	1.40478	1.40865	1.40606	1.40347	1.40686	1.40427	1.40168	1.42412	1.42177	1.41942	1.42369	1.42138	1.41907
5892.6	Na_D	1.41200	1.40941	1.40682	1.41074	1.40813	1.40552	1.40894	1.40633	1.40372	1.42626	1.42389	1.42152	1.42582	1.42350	1.42118
5460.7	Hg_e	1.41377	1.41117	1.40857	1.41250	1.40988	1.40726	1.41071	1.40809	1.40547	1.42809	1.42571	1.42333	1.42716	1.42532	1.42298
5015.7	He_{blue}	1.41612	1.41351	1.41090	1.41487	1.41223	1.40959	1.41307	1.41044	1.40781	1.43055	1.42814	1.42573	1.43010	1.42775	1.42540
4861.3	H_F	1.41717	1.41455	1.41193	1.41586	1.41321	1.41056	1.41411	1.41147	1.40883	1.43156	1.42915	1.42674	1.43112	1.42876	1.42640
4358.3	Hg_g	1.42118	1.41853	1.41588	1.41989	1.41721	1.41453	1.41812	1.41545	1.41278	1.43577	1.43332	1.43087	1.43533	1.43294	1.43055
		1-Methyl-1-ethylcyclopentane C_8H_{16}			1-Methyl-*cis*-2-ethylcyclopentane C_8H_{16}			1,1,2-Trimethylcyclopentane C_8H_{16}			1,1,3-Trimethylcyclopentane C_8H_{16}			1,*cis*-2, *trans*-4-Trimethylcyclopentane C_8H_{16}		
6678.1	He_{red}	1.42473	1.42233	1.41993	1.42689	1.42451	1.42213	1.42051	1.41806	1.41561	1.40872	1.40626	1.40380	1.41615	1.41374	1.41133
6562.8	H_c	1.42501	1.42261	1.42021	1.42719	1.42481	1.42243	1.42081	1.41836	1.41591	1.40904	1.40657	1.40410	1.41644	1.41403	1.41162
5892.6	Na_D	1.42718	1.42476	1.42234	1.42933	1.42695	1.42457	1.42298	1.42051	1.41804	1.41119	1.40870	1.40621	1.41855	1.41612	1.41369
5460.7	Hg_e	1.42903	1.42660	1.42417	1.43116	1.42878	1.42640	1.42482	1.42234	1.41986	1.41302	1.41051	1.40799	1.42035	1.41791	1.41547
5015.7	He_{blue}	1.43148	1.42903	1.42657	1.43360	1.43121	1.42882	1.42728	1.42478	1.42228	1.41543	1.41290	1.41037	1.42276	1.42030	1.41784
4861.3	H_F	1.43251	1.43005	1.42759	1.43461	1.43222	1.42983	1.42830	1.42580	1.42330	1.41644	1.41389	1.41134	1.42376	1.42129	1.41882
4358.3	Hg_g	1.43671	1.43421	1.43171	1.43877	1.43637	1.43397	1.43251	1.42998	1.42745	1.42053	1.41794	1.41535	1.42787	1.42537	1.42287

TABLE 6.—*Refractive indices at seven wavelengths and three temperatures for 60 API–NBS hydrocarbons*—Continued

Wavelength in Angstrom units	Spectral line	Index of refraction														
		20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C	20° C	25° C	30° C
		1, *trans*-2, *cis*-4-Trimethylcyclopentane C_8H_{16}			1,1-Dimethylcyclohexane C_8H_{16}			*n*-Propylcyclohexane C_9H_{18}			Isopropylcyclohexane C_9H_{18}			1,1,3-Trimethylcyclohexane C_9H_{18}		
6678.1	He_{red}	1.40821	1.40575	1.40329	1.42644	1.42408	1.42172	1.43450	1.43224	1.42998	1.43831	1.43607	1.43383	1.42702	1.42473	1.42244
6562.8	H_e	1.40851	1.40305	1.40359	1.42676	1.42440	1.42204	1.43481	1.43255	1.43029	1.43862	1.43638	1.43414	1.42734	1.42505	1.42276
5892.6	Na_D	1.41060	1.40812	1.40564	1.42900	1.42662	1.42424	1.43705	1.43478	1.43251	1.44087	1.43861	1.43635	1.42955	1.42725	1.42495
5460.7	Hg_e	1.41239	1.40990	1.40741	1.43090	1.42851	1.42612	1.43895	1.43667	1.43439	1.44277	1.44050	1.43823	1.43146	1.42915	1.42684
5015.7	He_{blue}	1.41475	1.41225	1.40975	1.43341	1.43100	1.42859	1.44149	1.43919	1.43689	1.44524	1.44296	1.44068	1.43399	1.43167	1.42935
4861.3	H_F	1.41574	1.41324	1.41074	1.43446	1.43204	1.42962	1.44254	1.44024	1.43794	1.44637	1.44408	1.44179	1.43504	1.43272	1.43040
4358.3	Hg_g	1.41980	1.41727	1.41474	1.43872	1.43627	1.43382	1.44686	1.44454	1.44222	1.45070	1.44839	1.44608	1.43940	1.43706	1.43472
		n-Butylcyclohexane $C_{10}H_{20}$			Isobutylcyclohexane $C_{10}H_{20}$			*sec*-Butylcyclohexane $C_{10}H_{20}$			*tert*-Butylcyclohexane $C_{10}H_{20}$			Benzene C_6H_6		
6678.1	He_{red}	1.43819	1.43600	1.43381	1.43606	1.43382	1.43158	1.44416	1.44198	1.43980	1.44435	1.44215	1.43995	1.49578	1.49262	1.48950
6562.8	H_e	1.43852	1.43632	1.43412	1.43637	1.43413	1.43189	1.44446	1.44228	1.44010	1.44467	1.44247	1.44027	1.49643	1.49327	1.49015
5892.6	Na_D	1.44075	1.43855	1.43635	1.43861	1.43636	1.43411	1.44673	1.44454	1.44235	1.44694	1.44473	1.44252	1.50112	1.49792	1.49478
5460.7	Hg_e	1.44266	1.44045	1.43824	1.44052	1.43826	1.43600	1.44864	1.44644	1.44424	1.44887	1.44666	1.44445	1.50521	1.50197	1.49881
5015.7	He_{blue}	1.44520	1.44298	1.44076	1.44307	1.44080	1.43853	1.45120	1.44899	1.44678	1.45145	1.44923	1.44701	1.51077	1.50748	1.50429
4861.3	H_F	1.44627	1.44404	1.44181	1.44412	1.44185	1.43958	1.45219	1.44998	1.44777	1.45252	1.45030	1.44808	1.51313	1.50982	1.50662
4358.3	Hg_g	1.45061	1.44837	1.44613	1.44849	1.44620	1.44391	1.45664	1.45441	1.45218	1.45693	1.45470	1.45247	1.52302	1.51964	1.51640
		Methylbenzene C_7H_8			Ethylbenzene C_8H_{10}			1,2-Dimethylbenzene C_8H_{10}			1,3-Dimethylbenzene C_8H_{10}			1,4-Dimethylbenzene C_8H_{10}		
6678.1	He_{red}	1.49180	1.48903	1.48619	1.49102	1.44837	1.48569	1.50037	1.49791	1.49531	1.49221	1.48968	1.48704	1.49079	1.48827	1.48558
6562.8	H_e	1.49243	1.48966	1.48682	1.49162	1.48896	1.48628	1.50100	1.49853	1.49593	1.49283	1.49029	1.48765	1.49141	1.48888	1.48619
5892.6	Na_D	1.49693	1.49413	1.49126	1.49588	1.49320	1.49050	1.50545	1.50295	1.50032	1.49722	1.49464	1.49198	1.49582	1.49325	1.49054
5460.7	Hg_e	1.50086	1.49803	1.49514	1.49960	1.49689	1.49418	1.50935	1.50682	1.50417	1.50105	1.49844	1.49577	1.49966	1.49707	1.49434
5015.7	He_{blue}	1.50620	1.50334	1.50041	1.50465	1.50191	1.49918	1.51463	1.51207	1.50940	1.50626	1.50361	1.50092	1.50489	1.50226	1.49951
4861.3	H_F	1.50847	1.50559	1.50265	1.50678	1.50403	1.50129	1.51688	1.51430	1.51161	1.50847	1.50580	1.50311	1.50712	1.50447	1.50172
4358.3	Hg_g	1.51800	1.51506	1.51206	1.51575	1.51295	1.51018	1.52630	1.52366	1.52093	1.51777	1.51503	1.51231	1.51644	1.51373	1.51094
		n-Propylbenzene C_9H_{12}			Isopropylbenzene C_9H_{12}			1-Methyl-2-ethylbenzene C_9H_{12}			1-Methyl-3-ethylbenzene C_9H_{12}			1-Methyl-4-ethylbenzene C_9H_{12}		
6678.1	He_{red}	1.48742	1.48494	1.48248	1.48688	1.48436	1.48194	1.49968	1.49723	1.49479	1.49179	1.48928	1.48678	1.49021	1.48768	1.48525
6562.8	H_e	1.48799	1.48550	1.48303	1.48744	1.48492	1.48250	1.50028	1.49783	1.49539	1.49238	1.48987	1.48737	1.49079	1.48826	1.48583
5892.6	Na_D	1.49202	1.48951	1.48702	1.49145	1.48890	1.48646	1.50456	1.50208	1.49963	1.49660	1.49406	1.49154	1.49500	1.49244	1.48999
5460.7	Hg_e	1.49555	1.49301	1.49051	1.49498	1.49239	1.48993	1.50828	1.50578	1.50332	1.50028	1.49771	1.49518	1.49866	1.49608	1.49361
5015.7	He_{blue}	1.50033	1.49776	1.49523	1.49970	1.49711	1.49462	1.51333	1.51080	1.50833	1.50526	1.50266	1.50011	1.50364	1.50104	1.49855
4861.3	H_F	1.50235	1.49977	1.49723	1.50171	1.49911	1.49661	1.51546	1.51292	1.51044	1.50738	1.50476	1.50221	1.50576	1.50314	1.50064
4358.3	Hg_g	1.51033	1.50820	1.50562	1.51018	1.50753	1.50499	1.52442	1.52183	1.51933	1.51623	1.51356	1.51098	1.51463	1.51197	1.50943
		1,2,3-Trimethylbenzene C_9H_{12}			1,2,4-Trimethylbenzene C_9H_{12}			1,3,5-Trimethylbenzene C_9H_{12}			*n*-Butylbenzene $C_{10}H_{14}$			Isobutylbenzene $C_{10}H_{14}$		
6678.1	He_{red}	1.50891	1.50650	1.50412	1.49986	1.49742	1.49498	1.49446	1.49195	1.48951	1.48537	1.48303	1.48064	1.48205	1.47962	1.47721
6562.8	H_e	1.50952	1.50711	1.50473	1.50047	1.49803	1.49559	1.49507	1.49255	1.49011	1.48591	1.48357	1.48118	1.48260	1.48016	1.47774
5892.6	Na_D	1.51393	1.51150	1.50911	1.50484	1.50237	1.49990	1.49937	1.49684	1.49437	1.48979	1.48742	1.48502	1.48646	1.48400	1.48157
5460.7	Hg_e	1.51778	1.51533	1.51293	1.50867	1.50618	1.50369	1.50314	1.50059	1.49810	1.49315	1.49076	1.48836	1.48983	1.48735	1.48490
5015.7	He_{blue}	1.52303	1.52055	1.51814	1.51386	1.51134	1.50892	1.50826	1.50569	1.50318	1.49770	1.49529	1.49288	1.49438	1.49187	1.48941
4861.3	H_F	1.52524	1.52276	1.52034	1.51607	1.51354	1.51101	1.51043	1.50786	1.50534	1.49963	1.49721	1.49480	1.49631	1.49379	1.49132
4358.3	Hg_g	1.53459	1.53205	1.52962	1.52536	1.52278	1.52020	1.51957	1.51697	1.51440	1.50770	1.50523	1.50281	1.50437	1.50181	1.49931
		sec-Butylbenzene $C_{10}H_{14}$			*tert*-Butylbenzene $C_{10}H_{14}$			1,2-Diethylbenzene $C_{10}H_{14}$			1,3-Diethylbenzene $C_{10}H_{14}$			1,4-Diethylbenzene $C_{10}H_{14}$		
6678.1	He_{red}	1.48580	1.48342	1.48102	1.48822	1.48583	1.48338	1.49877	1.49640	1.49400	1.49089	1.48850	1.48609	1.49017	1.48783	1.48542
6562.8	H_e	1.48633	1.48395	1.48154	1.48877	1.48637	1.48392	1.49935	1.49698	1.49458	1.49146	1.48907	1.48666	1.49075	1.48840	1.48599
5892.6	Na_D	1.49026	1.48779	1.48537	1.49266	1.49024	1.48776	1.50346	1.50106	1.49865	1.49552	1.49310	1.49067	1.49483	1.49245	1.49003
5460.7	Hg_e	1.49356	1.49113	1.48870	1.49604	1.49360	1.49110	1.50706	1.50463	1.50221	1.49906	1.49662	1.49417	1.49838	1.49598	1.49355
5015.7	He_{blue}	1.49812	1.49566	1.49322	1.50062	1.49816	1.49564	1.51192	1.50946	1.50703	1.50385	1.50138	1.49891	1.50321	1.50077	1.49832
4861.3	H_F	1.50004	1.49757	1.49512	1.50256	1.50009	1.49755	1.51398	1.51151	1.50908	1.50588	1.50340	1.50092	1.50525	1.50280	1.50035
4358.3	Hg_g	1.50810	1.50559	1.50312	1.51066	1.50815	1.50557	1.52265	1.52012	1.51767	1.51441	1.51188	1.50936	1.51384	1.51133	1.50885

TABLE 7. *Calculated values of the specific dispersion for 60 API–NBS hydrocarbons*

Temperature	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$
°C	*n*-Heptane		2-Methylhexane		3-Methylhexane		3-Ethylpentane		2,2-Dimethylpentane	
20	97.8	124.8	98.4	125.7	97.7	124.4	95.5	121.7	100.3	127.0
25	97.7	124.5	98.5	125.7	97.5	124.2	95.5	121.8	100.2	127.0
30	97.6	124.2	98.5	125.8	97.4	123.9	95.6	121.8	100.1	126.9
	2,3-Dimethylpentane		2,4-Dimethylpentane		3,3-Dimethylpentane		2,2,3-Trimethylbutane		*n*-Nonane	
20	96.2	123.4	98.7	126.0	97.4	123.5	98.8	125.0	97.4	124.7
25	96.1	123.2	98.6	125.8	97.1	123.2	98.4	124.5	97.2	124.4
30	96.0	122.9	98.5	125.6	96.8	123.0	98.0	124.0	97.0	124.1
	2,2,5-Trimethylhexane		2,4,4-Trimethylhexane		3,3-Diethylpentane		2,2,3,3-Tetramethylpentane		2,2,3,4-Tetramethylpentane	
20	98.8	126.4	98.2	125.0	94.6	120.2	96.1	123.0	96.8	123.7
25	99.0	126.6	98.2	125.0	94.3	120.0	95.9	122.8	96.8	123.8
30	99.1	126.7	98.2	125.0	93.9	119.8	95.7	122.6	96.9	123.9
	2,2,4,4-Tetramethylpentane		2,3,3,4-Tetramethylpentane		Ethylcyclopentane		1,1-Dimethylcyclopentane		1,*cis*-2-Dimethylcyclopentane	
20	100.8	129.1	95.5	122.2	95.5	121.2	97.3	123.8	97.6	122.2
25	101.0	129.4	95.4	122.1	95.4	121.1	97.2	123.6	97.0	121.3
30	101.3	129.7	95.4	122.0	95.3	121.0	97.1	123.4	96.4	120.4
	1,*trans*-2-Dimethylcyclopentane		1,*cis*-3-Dimethylcyclopentane		1,*trans*-3-Dimethylcyclopentane		*n*-Propylcyclopentane		Isopropylcyclopentane	
20	96.5	122.2	96.3	122.2	97.3	123.2	95.8	122.5	95.7	122.5
25	96.4	122.1	96.0	122.0	97.3	123.2	95.6	122.1	95.5	122.2
30	96.3	122.0	95.8	121.8	97.2	123.1	95.3	121.7	95.4	121.9
	1-Methyl-1-ethylcyclopentane		1-Methyl-*cis*-2-ethylcyclopentane		1,1,2-Trimethylcyclopentane		1,1,3-Trimethylcyclopentane		1,*cis*-2,*trans*-4-Trimethylcyclopentane	
20	96.0	122.0	94.5	120.2	97.0	123.4	98.9	124.8	95.9	122.1
25	95.8	121.7	94.9	120.6	96.9	123.3	98.4	124.2	95.6	121.8
30	95.5	121.3	95.2	121.0	96.7	123.2	97.9	123.6	95.4	121.6
	1,*trans*-2,*cis*-4-Trimethylcyclopentane		1,1-Dimethylcyclohexane		*n*-Propylcyclohexane		Isopropylcyclohexane		1,1,3-Trimethylcyclohexane	
20	96.8	123.1	98.6	124.5	97.4	123.6	96.6	122.5	98.9	126.5
25	96.8	123.1	98.4	124.2	97.4	123.6	96.5	122.5	99.0	126.6
30	96.8	123.2	98.1	124.0	97.4	123.6	96.3	122.5	99.1	126.7
	n-Butylcyclohexane		Isobutylcyclohexane		*sec*-Butylcyclohexane		*tert*-Butylcyclohexane		Benzene	
20	97.0	123.4	97.4	124.2	95.1	121.9	96.6	122.9	190.0	249.1
25	97.0	123.4	97.5	124.3	95.1	121.9	96.8	123.2	189.4	248.6
30	97.1	123.5	97.6	124.4	95.2	122.0	97.0	123.6	189.6	248.9
	Methylbenzene		Ethylbenzene		1,2-Dimethylbenzene		1,3-Dimethylbenzene		1,4-Dimethylbenzene	
20	185.0	243.0	174.9	229.2	180.4	236.9	181.0	237.8	182.4	239.5
25	184.7	242.7	174.7	228.9	180.0	236.4	180.4	237.1	182.0	239.0
30	184.6	242.5	174.9	229.3	179.8	236.3	180.7	237.6	182.2	239.3

TABLE 7. *Calculated values of the specific dispersion for 60 API–NBS hydrocarbons*—Continued

Temperature	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$	$10^4(n_F-n_C)/d$	$10^4(n_g-n_D)/d$
°C	*n*-Propylbenzene		Isopropylbenzene		1-Methyl-2-ethylbenzene		1-Methyl-3-ethylbenzene		1-Methyl-4-ethylbenzene	
20	166.6	218.2	165.6	217.3	172.4	225.5	173.5	227.1	173.8	227.9
25	166.4	217.9	165.5	217.2	172.1	225.3	173.0	226.6	173.6	227.9
30	166.3	217.9	165.3	217.1	172.5	225.8	173.3	227.0	173.6	227.9
	1,2,3-Trimethylbenzene		1,2,4-Trimethylbenzene		1,3,5-Trimethylbenzene		*n*-Butylbenzene		Isobutylbenzene	
20	175.8	231.0	178.1	234.3	177.5	233.5	159.5	208.2	160.7	209.9
25	175.8	230.9	177.9	234.1	177.8	233.8	159.3	208.0	160.5	210.0
30	176.1	231.4	177.7	233.9	177.7	233.7	159.8	208.8	160.7	209.9
	sec-Butylbenzene		tert-Butylbenzene		1,2-Diethylbenzene		1,3-Diethylbenzene		1,4-Diethylbenzene	
20	159.0	207.6	159.1	207.7	166.2	218.1	166.9	218.6	168.2	220.5
25	158.7	207.5	159.1	207.7	165.9	217.6	166.6	218.4	167.8	220.1
30	159.0	207.8	158.8	207.5	166.3	218.1	166.6	218.4	168.1	220.4

V. Discussion

Figure 3 gives, for the several normal alkylbenzenes measured, plots of the values of the constants n_∞ and C in relation to the number of carbon atoms in the normal alkyl radical. It appears that these relations are such that, when one sufficiently higher member of the series, such as *n*-decylbenzene, is evaluated, it will be possible to set up the complete equation for the intermediate members of the series as well as for some members higher than *n*-decylbenzene, with a knowledge only of the refractive index at one wavelength, as n_D.

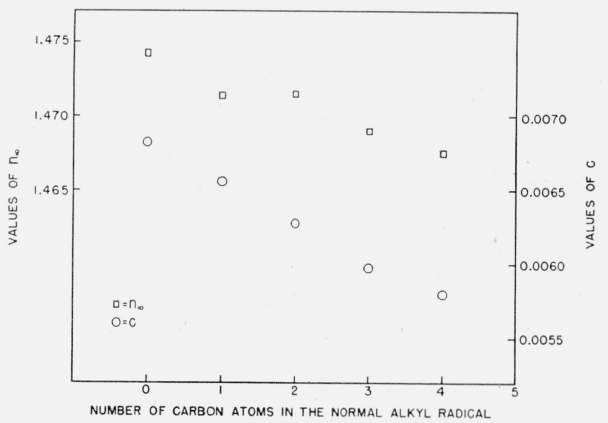

FIGURE 3. *Values of the constants ,n_∞ and C, of the Hartman equation, as a function of the number of carbon atoms in the normal alkyl radical of five alkylbenzenes.*

It is planned to do this for the series of normal alkylbenzenes, normal monoolefins (1-alkenes), normal paraffins, normal alkylcyclopentanes, and normal alkylcyclohexanes.

Grateful acknowledgement is made to Frederick D. Rossini for his many suggestions in the course of the investigation and in the preparation of this report.

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WASHINGTON, November 4, 1949.

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