Physical Properties of Hydrocarbons

PART 35–Miscellaneous Amines

From charts you can get these properties for amines:

- Vapor Pressure
- Heat of Vaporization
- Heat Capacity
- Density
- Viscosity
- Surface Tension
- Thermal Conductivity

Robert W. Gallant
The Dow Chemical Co., Plaquemine, La.

THIS PART covers the remaining commercially important amines. Isopropylamine, diisopropylamine, butylamine and dibutylamine—all find use in producing specialty products. As a group, their usage is about 10 million pounds per year.

Vapor Pressure and Critical Properties. The critical temperatures are reported in the literature.[1] The critical pressures were calculated by the technique proposed by Riedel.[2] Vowles' method was used to estimate the critical [illegible].[2]

The vapor pressures up to the boiling point have been measured for all four compounds.[1] Above the boiling point, the values were estimated by the method used in previous articles.

Fig. 35-2 presents the vapor pressures of aqueous solutions of isopropylamine.[3]

Heat of Vaporization. Only the heats of vaporization at the boiling points have been reported in the literature.[1,3] These data were extended from −40° C to the critical temperature by the Kharbanda nomograph of the Watson equation.[4]

Heat Capacity. The vapor heat capacities were estimated since there are no data available.[5]

Hough and co-workers[6] have measured the liquid heat capacity of isopropylamine from 30° to 70° C. The heat capacities at 20° C for the other three compounds were estimated by the technique of Johnson and Haung,[7] with a probable error of 5 percent. These data were extended over the −40° to +160° C range by the method used in previous articles.

Density. The densities have been measured from 0° to 80° C.[1,6] Lyderson's method was used to estimate the densities from −40° C to the critical point.[2] When compared to seven experimental values, the error averaged 1.1 percent.

Viscosity. The vapor viscosities were estimated by the technique developed by Bromley and Wilkes.[7]

Mason and coworkers[8] have determined the effect of pressure on the liquid viscosity of isopropylamine from 0° to 180° C. These data are plotted in Fig. 35-9.

Data are available on butylamine from 20° to 75° C;[1,3,9] on diisopropylamine at 25° C;[1] and on dibutylamine from 25° to 60° C.[1,3] The constant in the Thomas equation[2] was calculated from the experimental data and used to estimate the viscosities from −40° to +160° C. Comparison with eight experimental values showed an average error of 6 percent.

Surface Tension. Surface tension data are available for isopropylamine from −72° to +25° C;[9] from −21° to +71° C for butylamine;[1,9] and at 20° C for diisopropylamine and dibutylamine.[1] Sugden's equation, which relates surface tension to the density, parachor and molecular weight, was used to calculate the surface tension at other temperatures.

Thermal Conductivity. The vapor and liquid thermal conductivities were estimated by methods described in previous articles.[10,11]

LITERATURE CITED

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7 Bromley, L. A. and Wilkes, C. R. *Industrial and Engineering Chemistry* 43 (7), pp. 1641-8 (1951).
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10 Owens, E. J. and Thodos, G. *AIChE Journal* 6 (4), pp. 676-81 (1960).
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TABLE 35-1—Physical Properties of Miscellaneous Amines

Compound	Abbreviation	Boiling Point, °C	Freezing Point, °C	Molecular Weight	Critical Properties		
					T_c, °C	P_c,* psia	d_c,* g/ml
Isopropylamine	IPA	33.0	−95.2	59.11	209	612	0.251
Butylamine	BA	77.7	−50.5	73.14	251	556	0.251
Diisopropylamine	DIPA	84.0	−96.3	101.2	249	434	0.240
Dibutylamine	DBA	159.0	−61.9	129.25	325	356	0.249

* Estimated

Charts on following pages

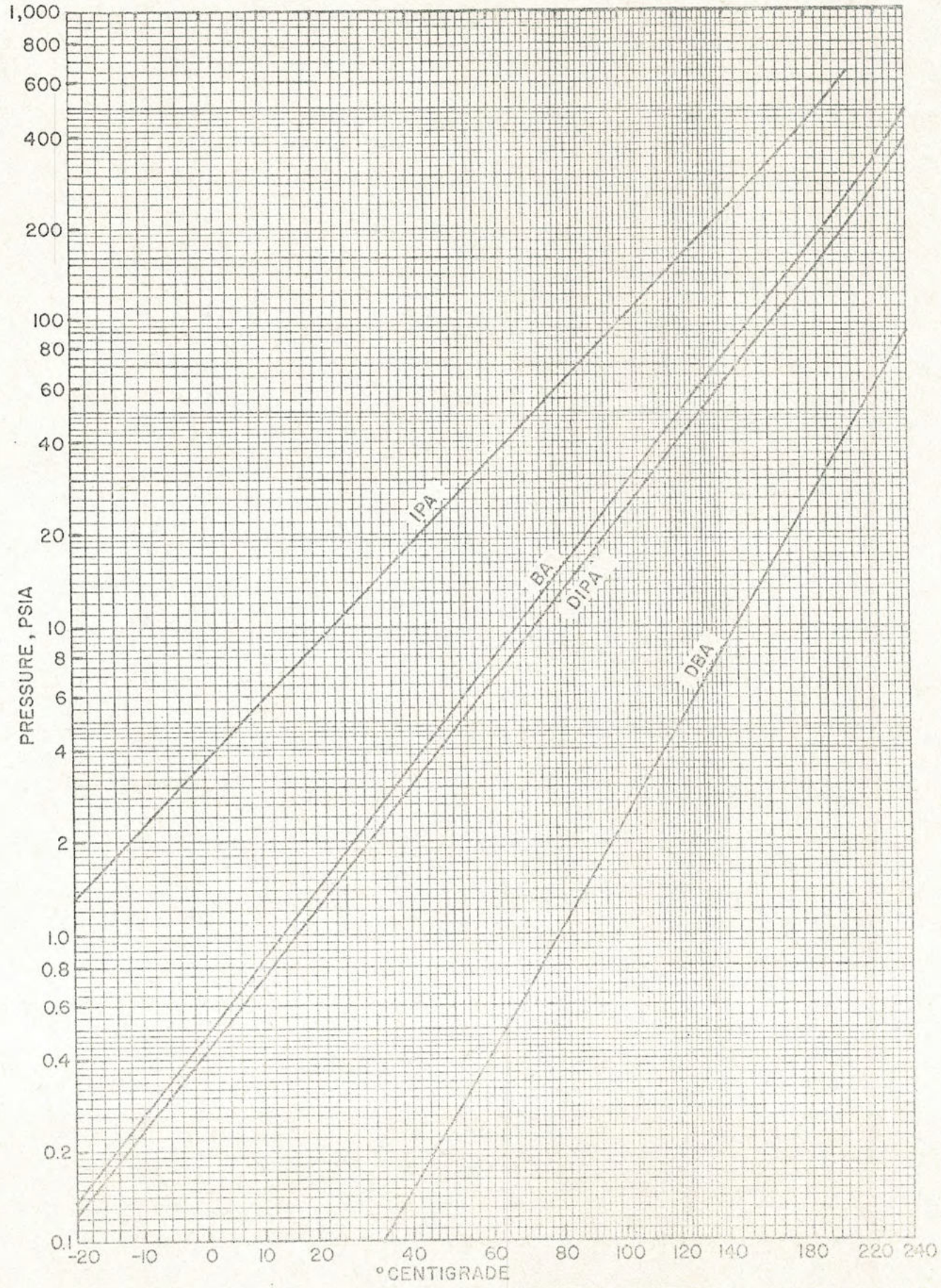

Fig. 35-1—Vapor pressure of amines from —20° C to +240° C.

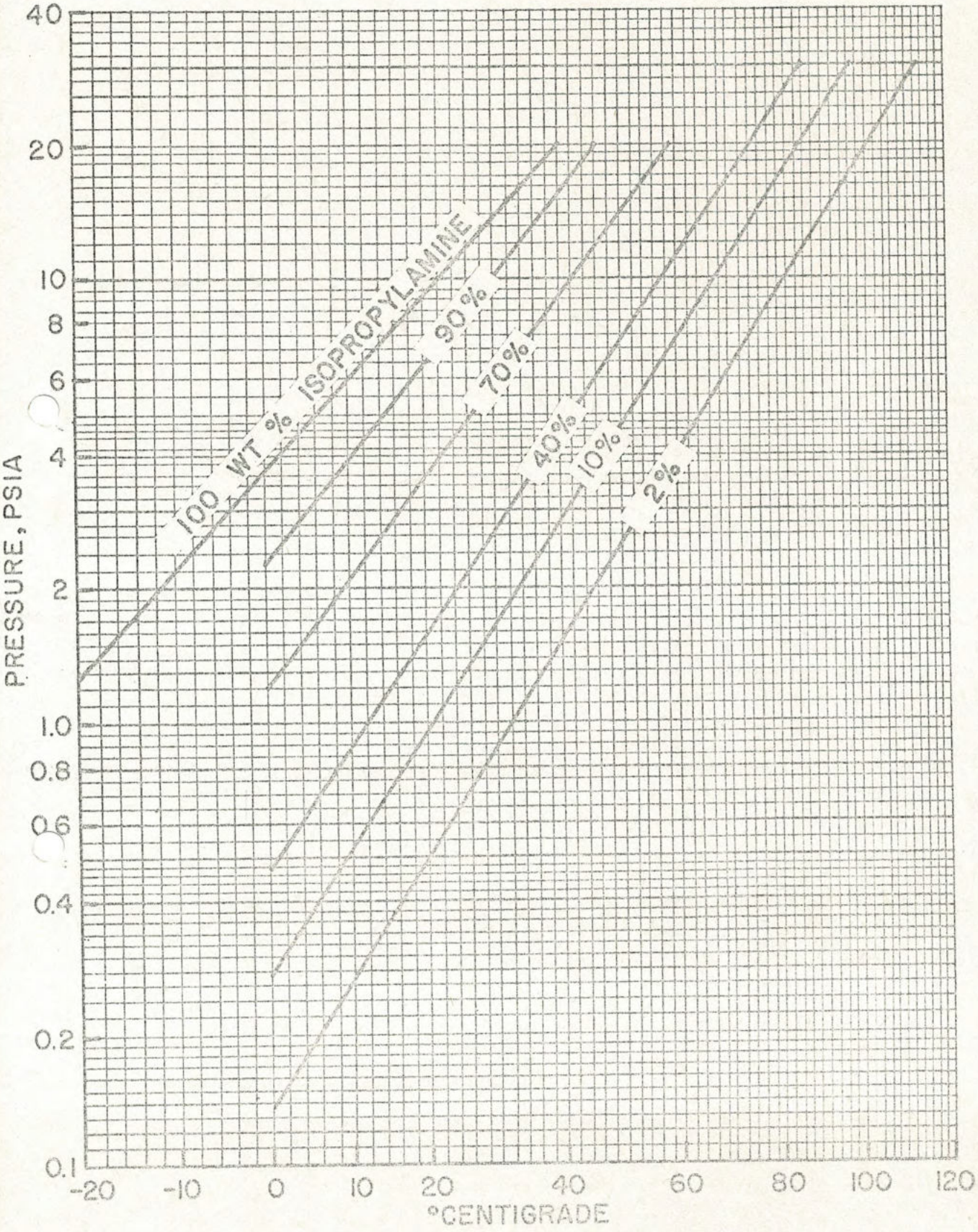

Fig. 35-2—Vapor pressure of aqueous isopropylamine from —20° C to +100° C.

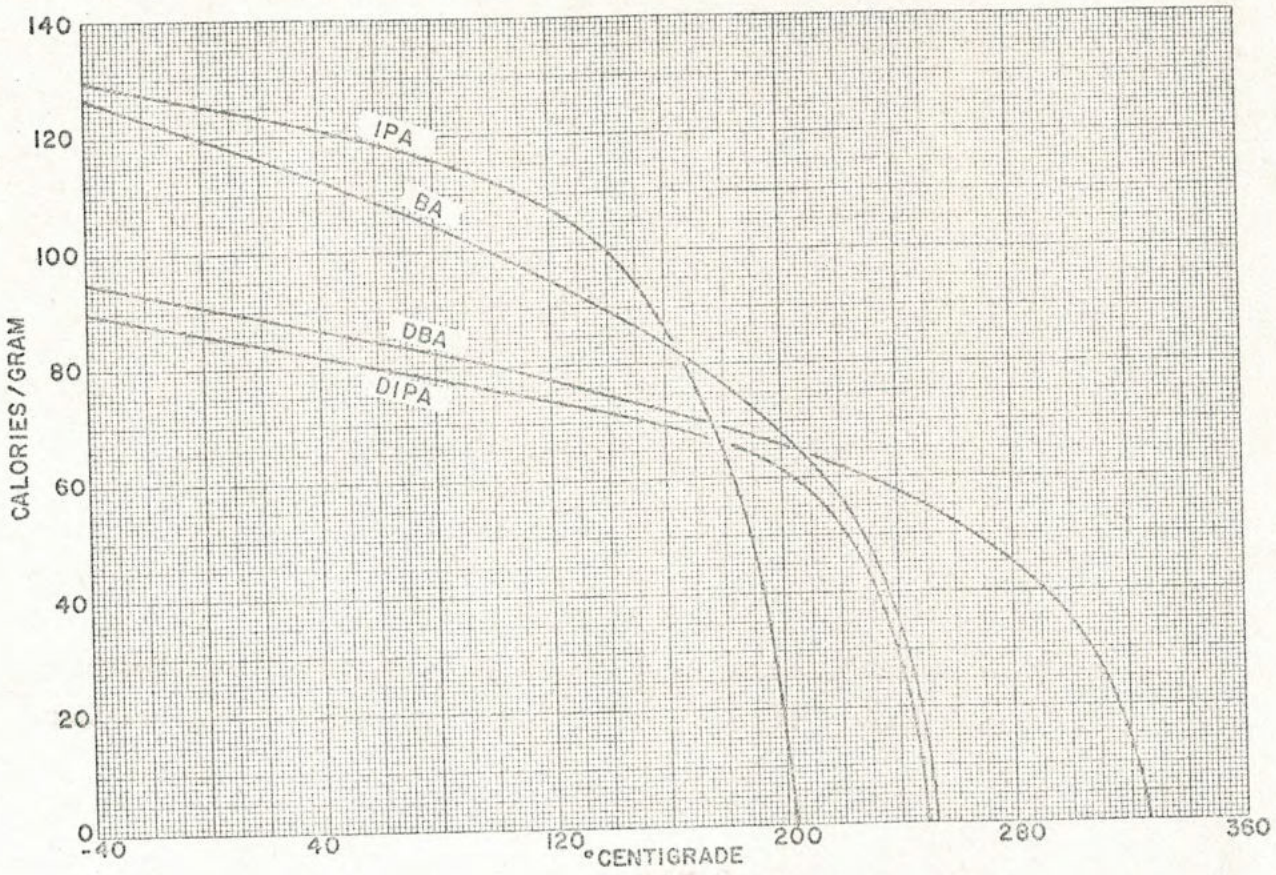

Fig. 35-3—Heat of vaporization of amines from —40° C to +320° C.

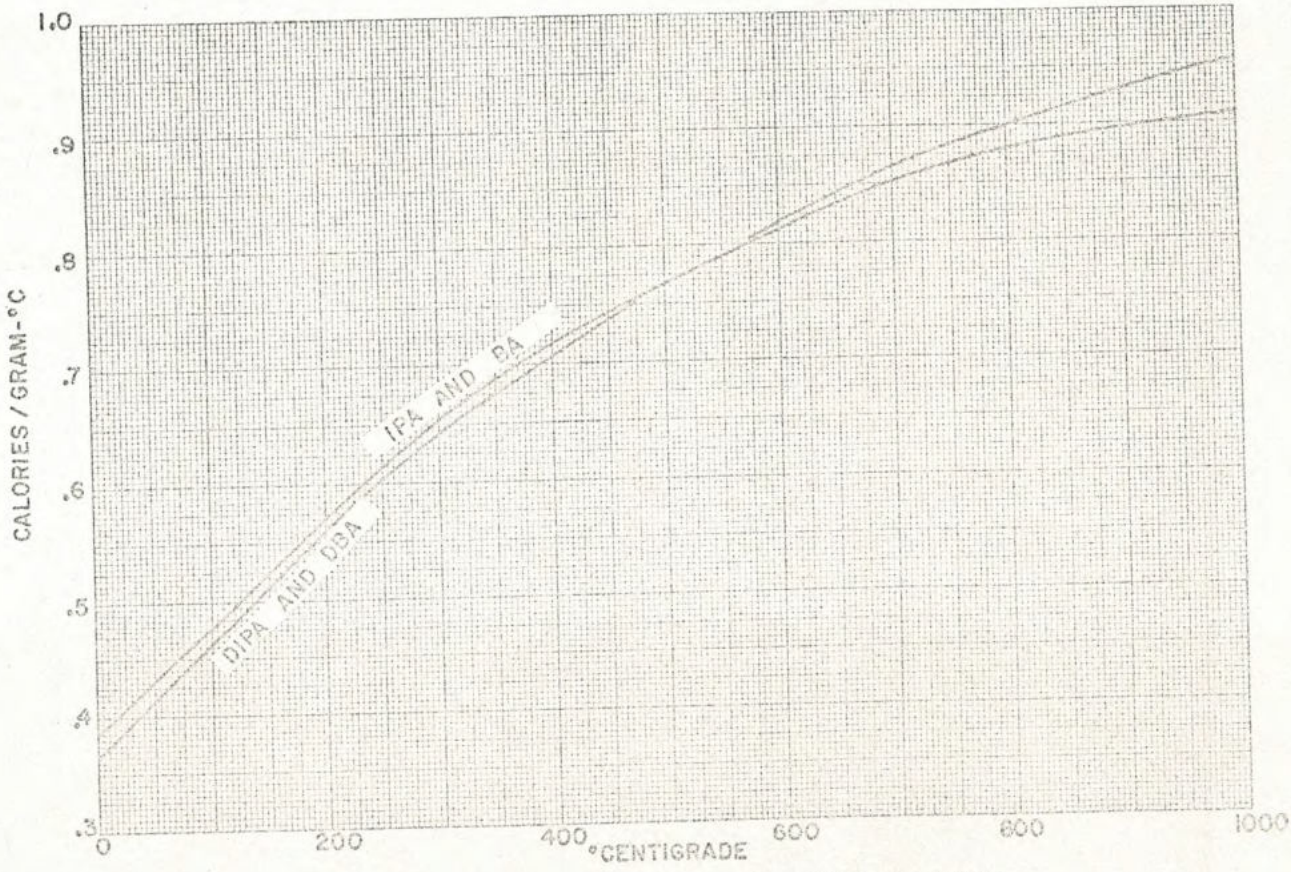

Fig. 35-4—Vapor heat capacity of amines from 0° C to +1,000° C.

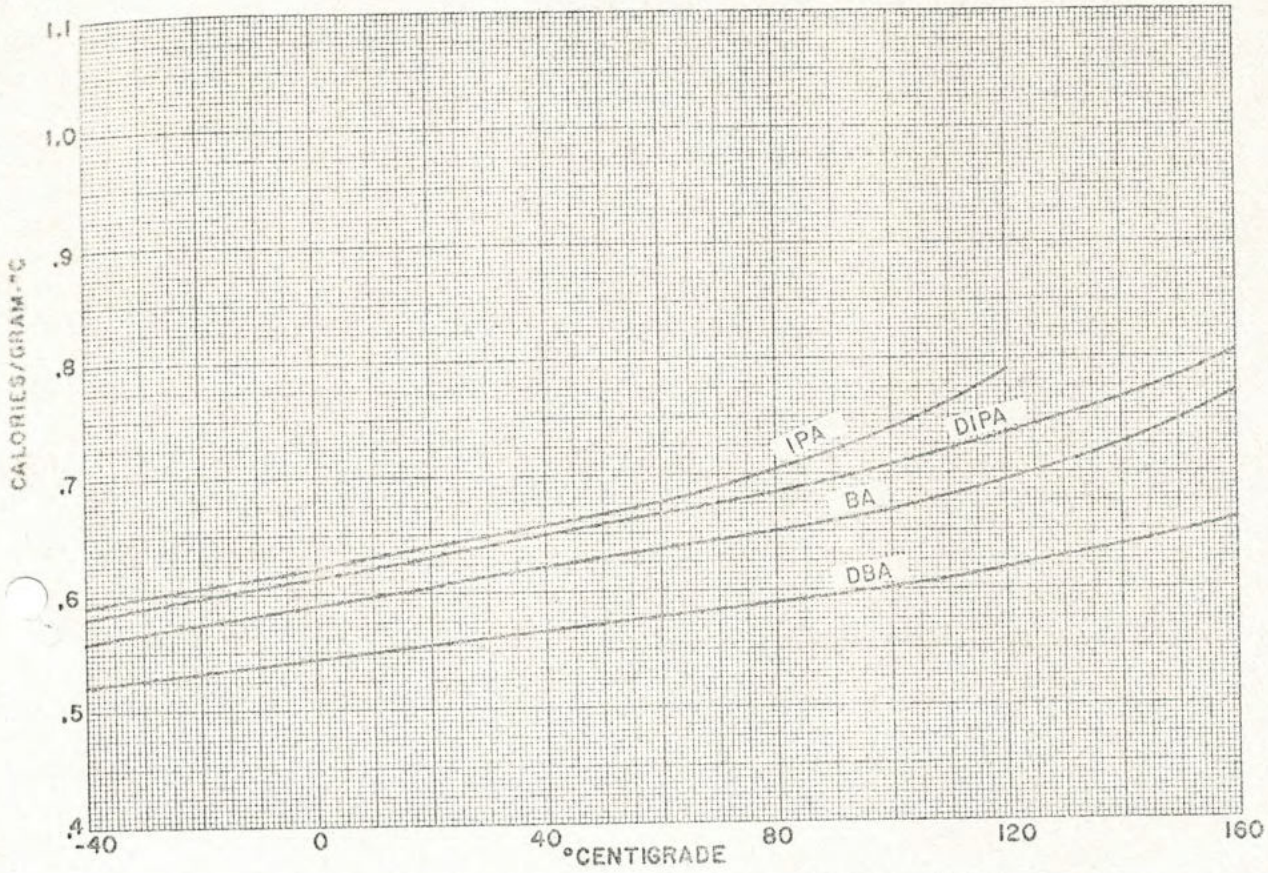

Fig. 35-5—Liquid heat capacity of amines from —40° C to +160° C.

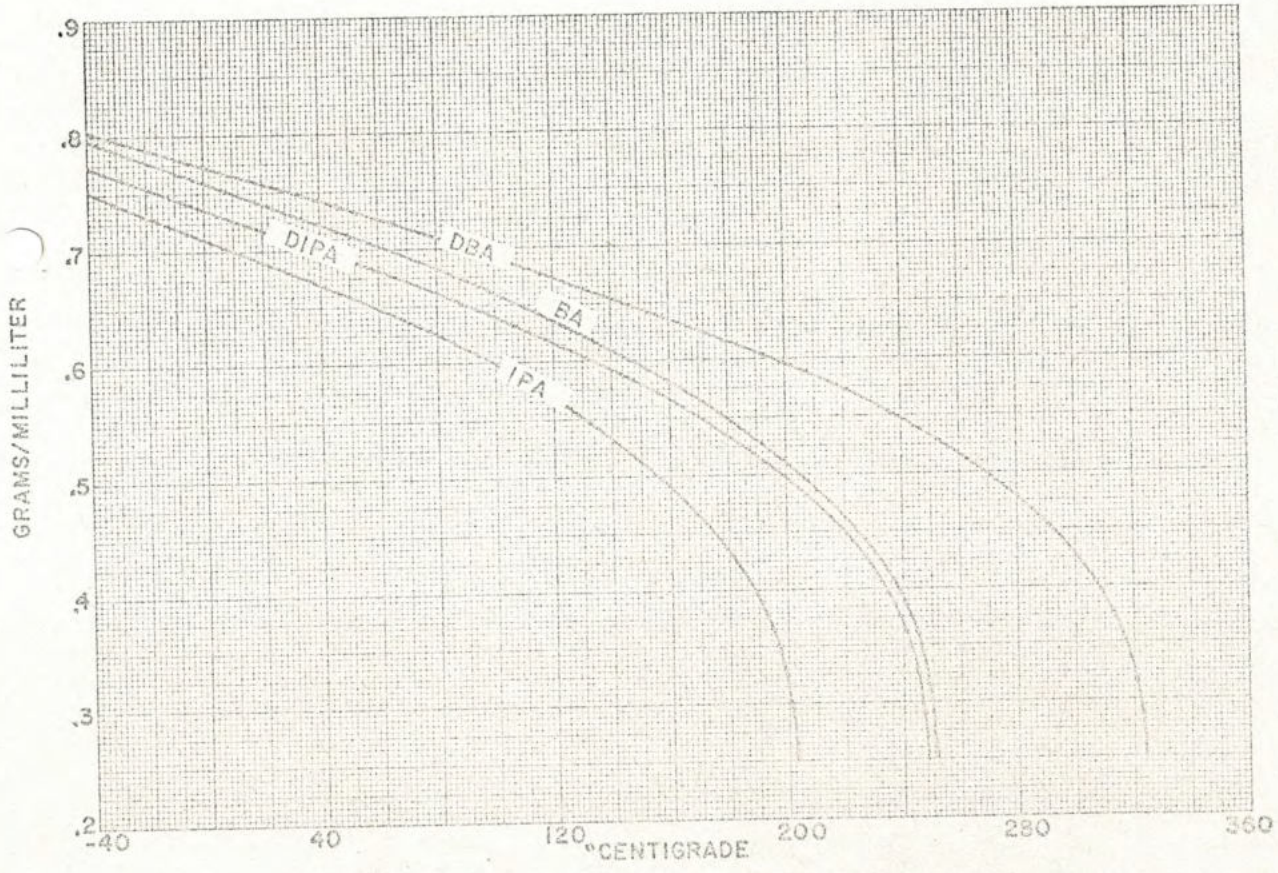

Fig. 35-6—Liquid density of amines from — 40° C to + 320° C.

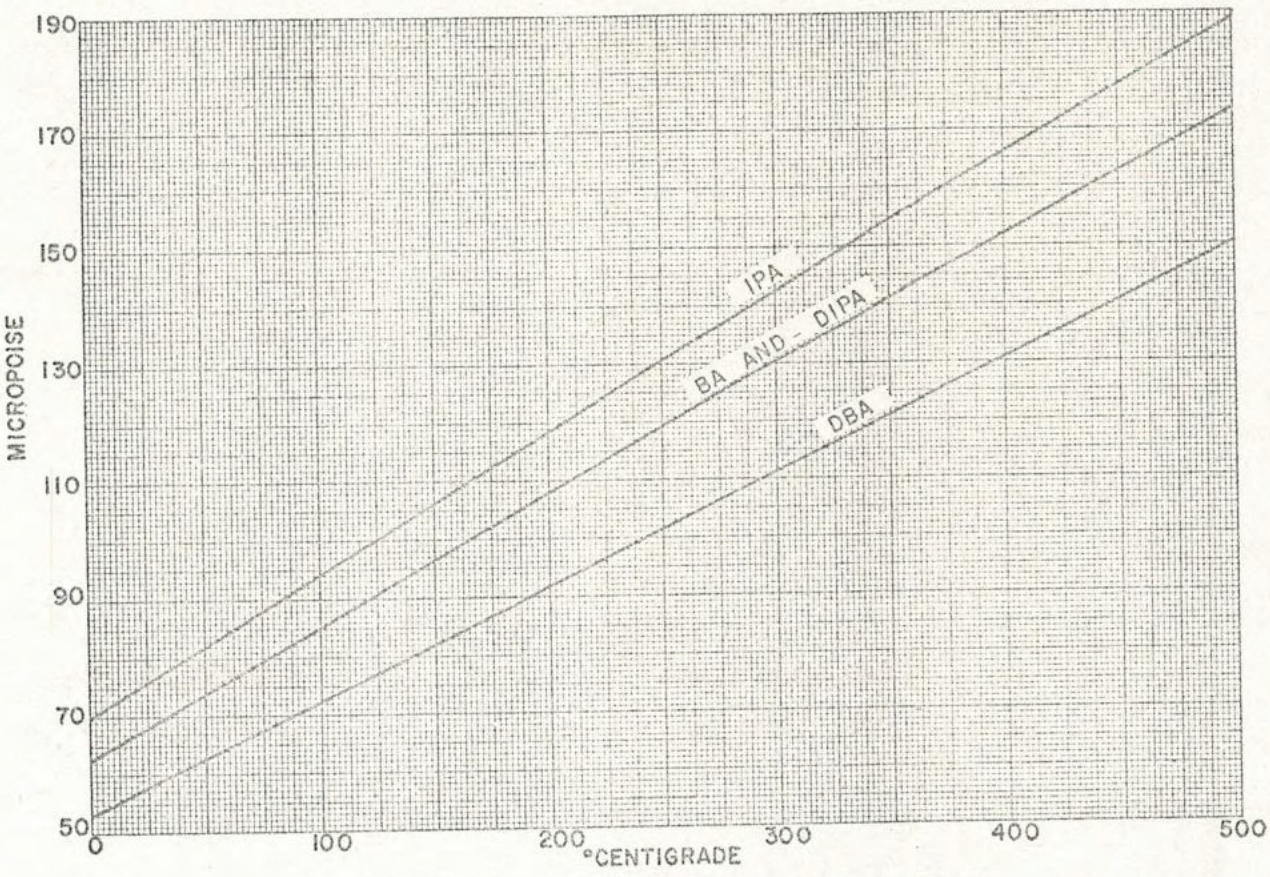

Fig. 35-7—Vapor viscosity of amines form 0° C to +500° C.

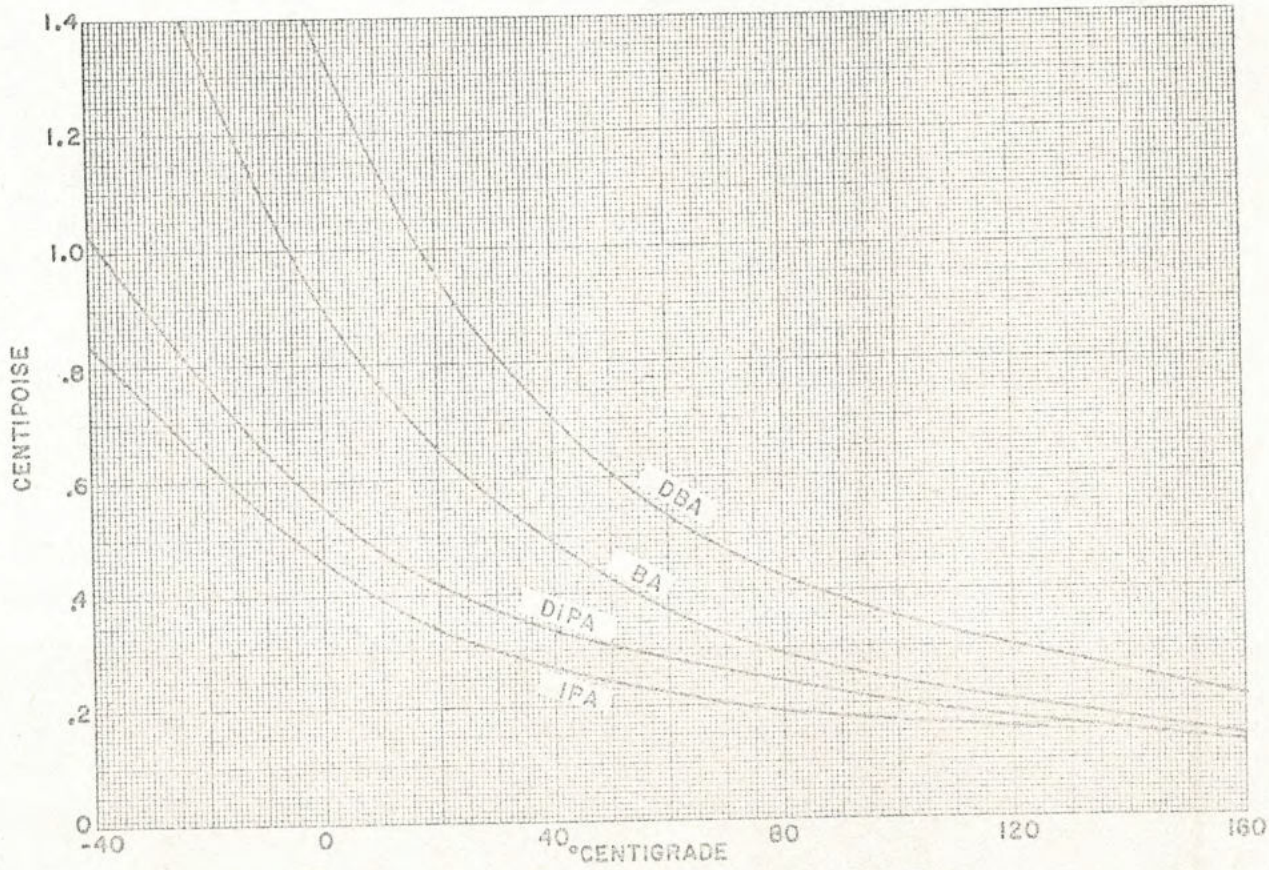

Fig. 35-8—Liquid viscosity of amines from —40° C to +160° C.

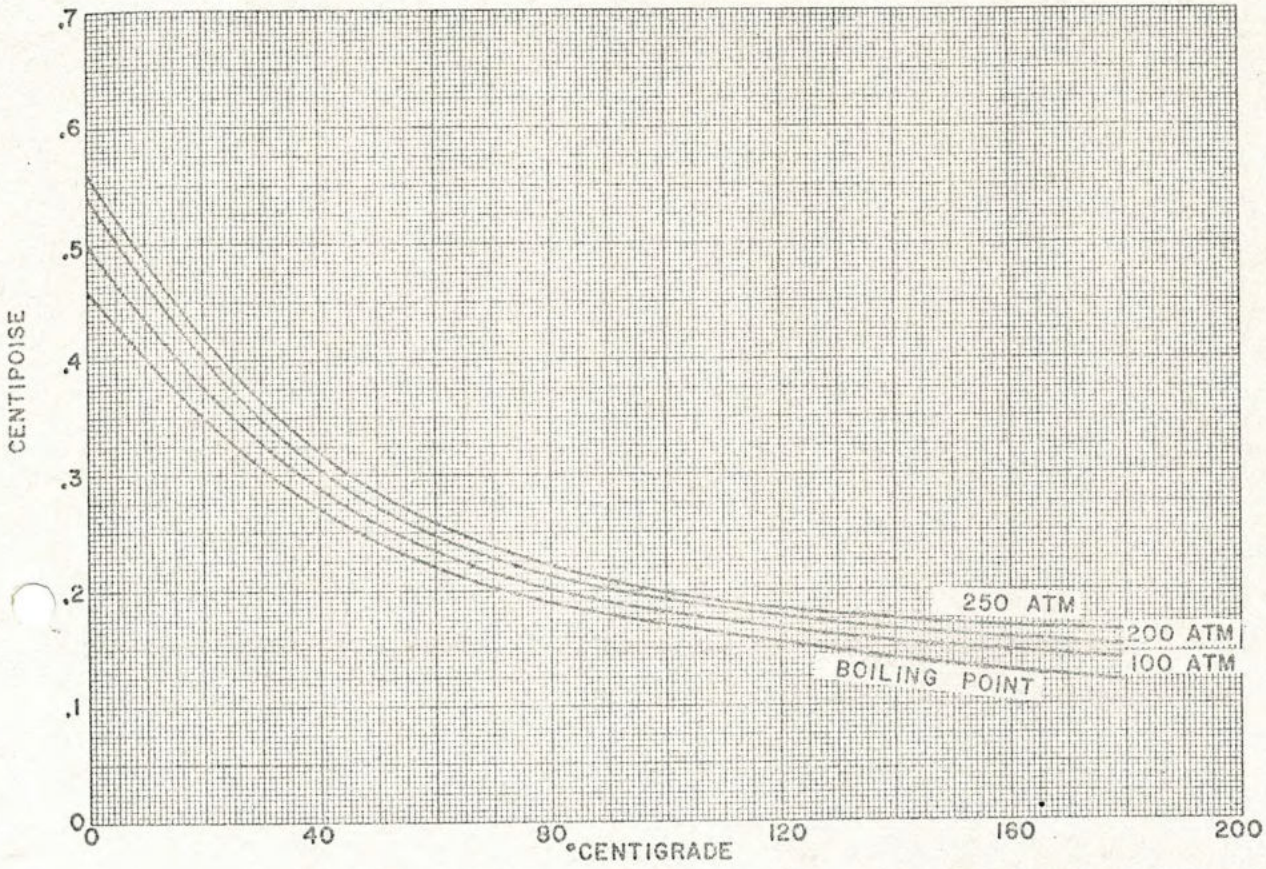

Fig. 35-9—Effect of pressure on isopropylamine liquid viscosity.

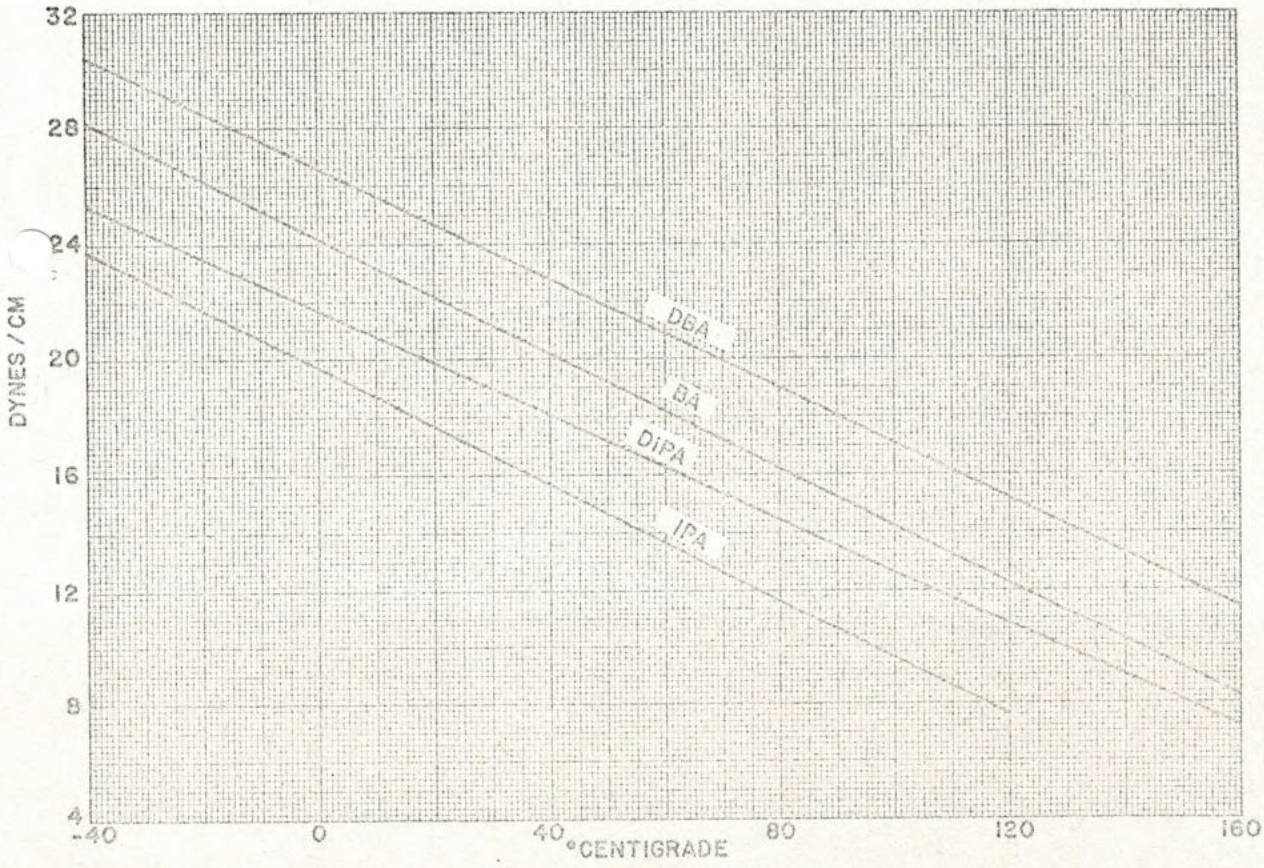

Fig. 35-10—Surface tension of amines from —40° C to +160° C.

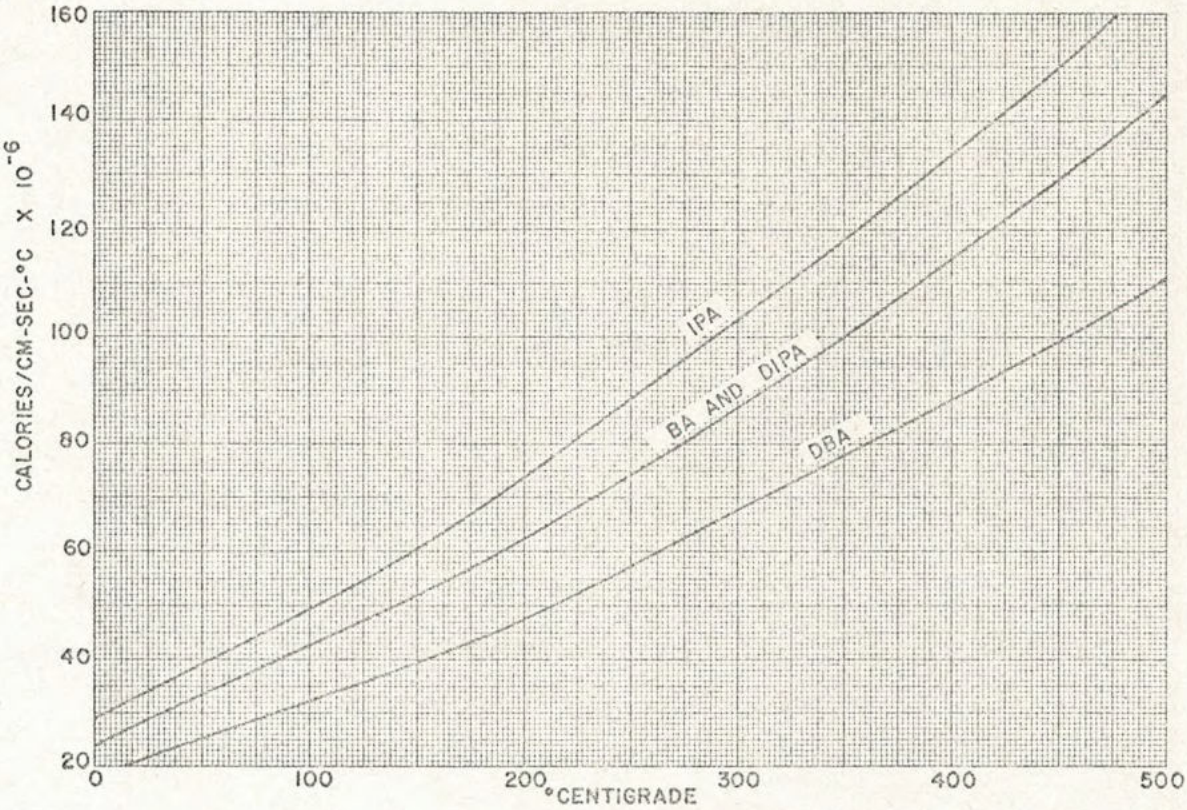

Fig. 35-11—Vapor thermal conductivity of amines from 0° C to +500° C.

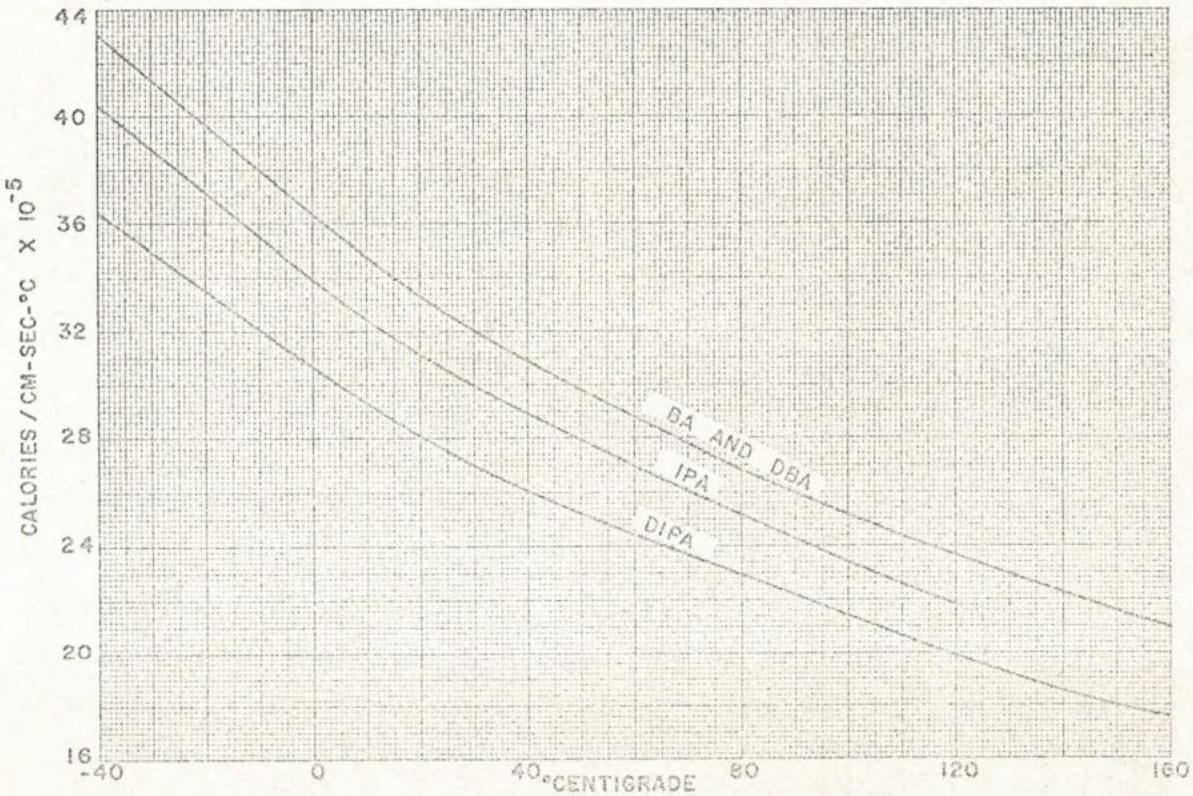

Fig. 35-12—Liquid thermal conductivity of amines from −40° C to +160° C.

Indexing Terms: Amines-9, Butylamine-9, Dibutylamine-9, Diisopropylamine-9, Isopropylamine-9, Physical Properties-7, Pressure-6, Properties/Characteristics/-7, Temperature-6.

Part 36, Nitriles, will appear in an early issue.