Physical Properties of Hydrocarbons

Part 38–Miscellaneous Nitrogen Compounds

From charts you can get these properties of four miscellaneous nitrogen compounds:

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

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THIS PART CONCLUDES the articles on nitrogen-containing compounds and covers dimethyl acetamide (DMA), dimethyl formamide (DMF), aniline and pyridine.

DMA and DMF are strongly polar solvents with high boiling points. They are widely used as reaction mediums, often boosting the reaction rate several fold. Additionally, they are solvents for many polymers and dyes.

Aniline production topped 250 million pounds in 1967. Most of this production goes into the manufacture of rubber chemicals, and lesser amounts into dye manufacture, hydroquinone and pharmaceuticals. Aniline is produced by the reaction of nitrobenzene and hydrogen at high temperature over a copper or nickel catalyst.

Pyridine is obtained in commercial quantities from coal tar. It is used as a solvent and in the preparation of pharmaceuticals.

Vapor Pressures and Critical Properties. The critical temperature and pressure have been reported for aniline[1,2,3] and pyridine[4,5,6,7] Kobe[7] also reports the critical density. The critical density of aniline and all the critical properties of DMA and DMF were estimated by the method of Lyderson.[8]

The vapor pressures of all four compounds have been measured up to the critical point.[1,3,7,9,10,11]

Heat of Vaporization. The heat of vaporization has been measured for DMA at the boiling point;[10] for DMF from 60 to 150° C;[11] for aniline from 31 to 184° C;[9] and for pyridine from 0 to 114° C.[6] The Kharbanda nomograph[12] has been used to extend the data to the critical point, with an average error of 2.5 percent and a maximum error of 4.1 percent when compared to 11 experimental values.

Heat Capacity. The vapor heat capacities are available from the literature for aniline[9] and pyridine.[6] The vapor heat capacities of DMA and DMF were calculated from the structural contributions proposed by Rihani and Doraiswamy,[13] with a probable error of 1-2 percent.

The liquid heat capacities have been measured for DMA from 20 to 80° C;[10] for DMF from 0 to 150° C;[11]

TABLE 38-1—Physical Properties of Miscellaneous Nitrogen Compounds

Compound	Boiling Point, °C	Freezing Point, °C	Molecular Weight	Critical Properties		
				T_c °C	P_c psia	d_c g/ml
Dimethyl acetamide (DMA)	166.1	−20	87.12	385*	591*	0.281*
Dimethyl formamide (DMF)	153.0	−61	73.09	374*	650*	0.276*
Aniline	184.4	− 6.1	93.06	426	769	0.32*
Pyridine	115.4	−41.5	79.10	347	818	0.312*

* Estimated.

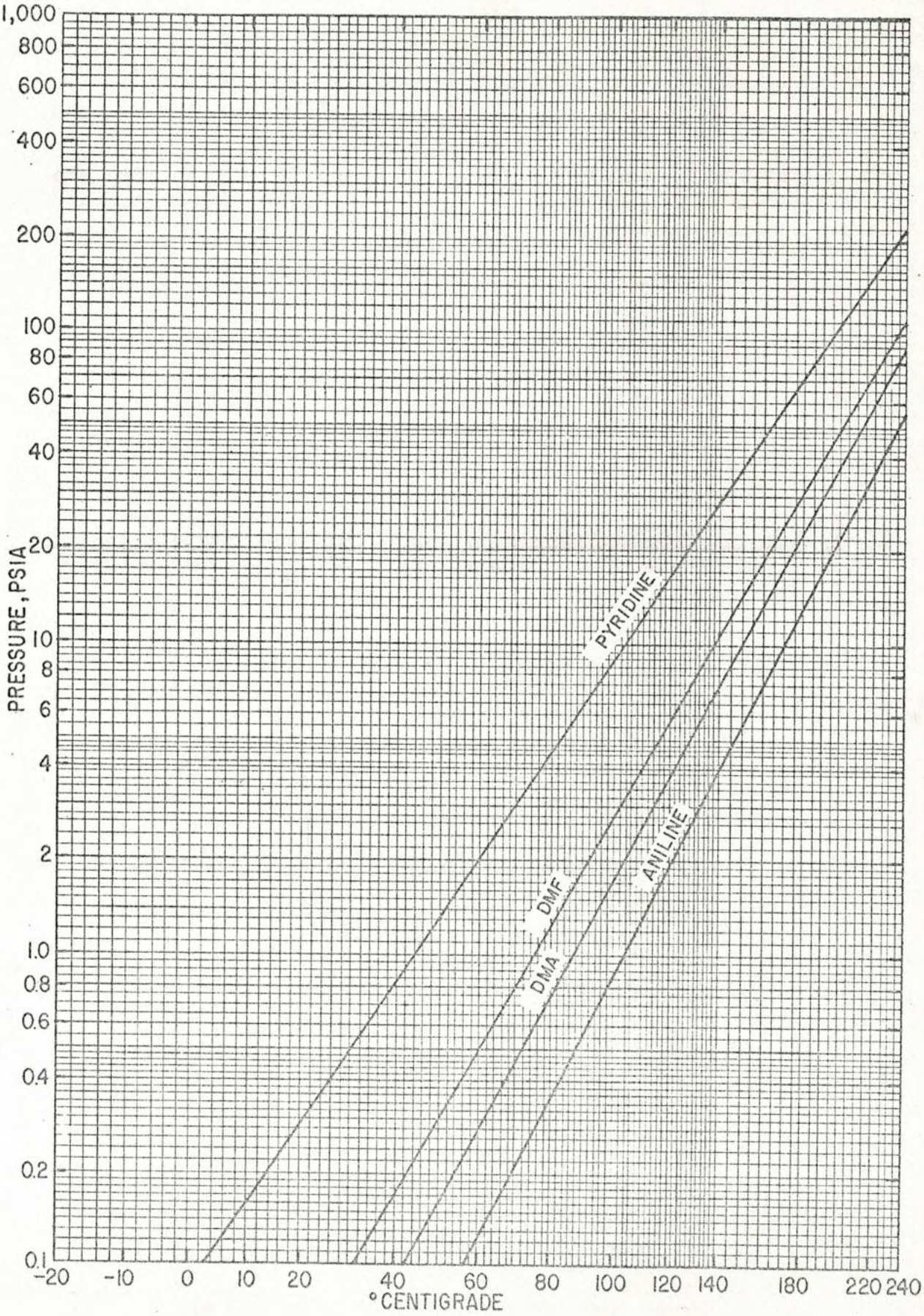

Fig. 38-1—Vapor pressure of miscellaneous nitrogen compounds from 0 to 240° C.

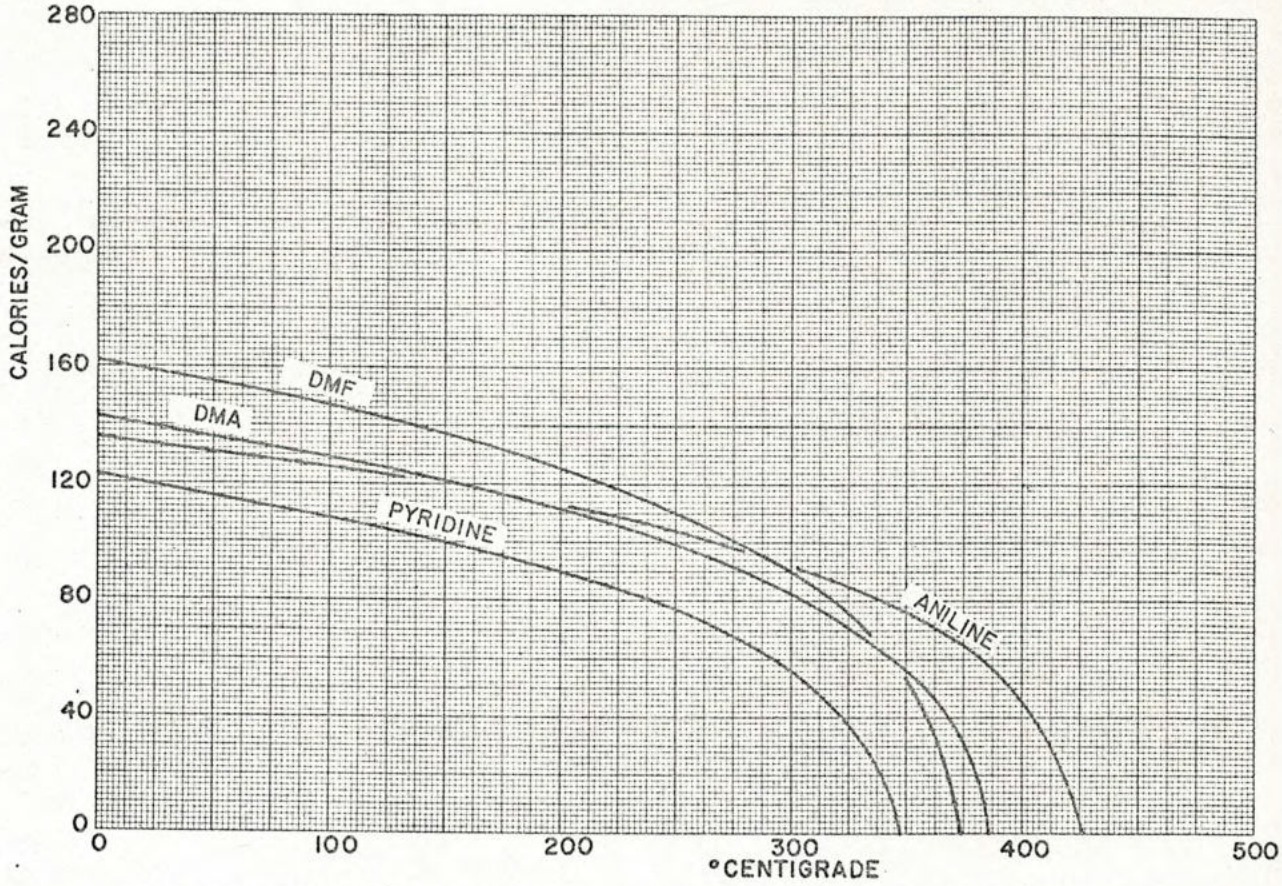

Fig. 38-2—Heat of vaporization of miscellaneous nitrogen compounds from 0 to 425° C.

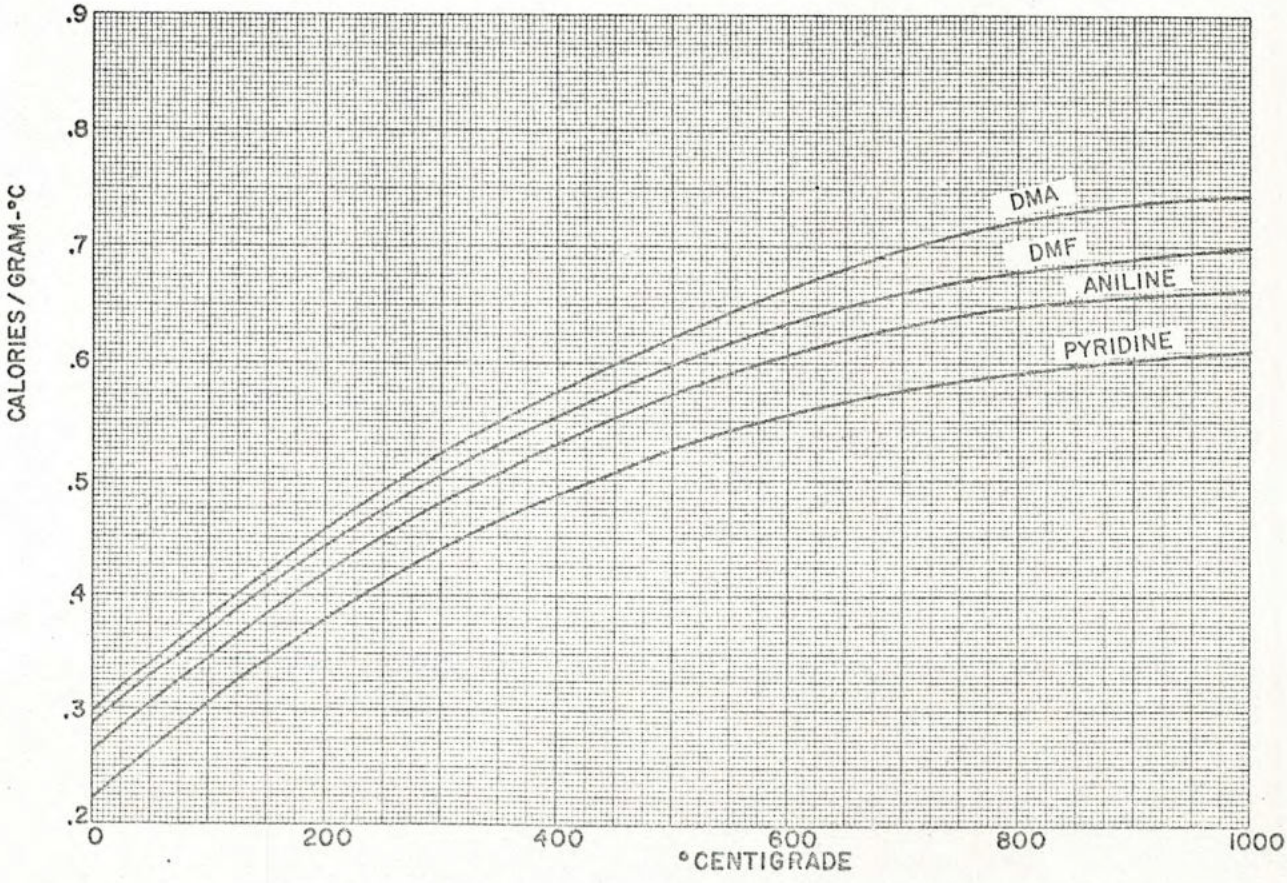

Fig. 38-3—Vapor heat capacity of miscellaneous nitrogen compounds from 0 to 1,000° C.

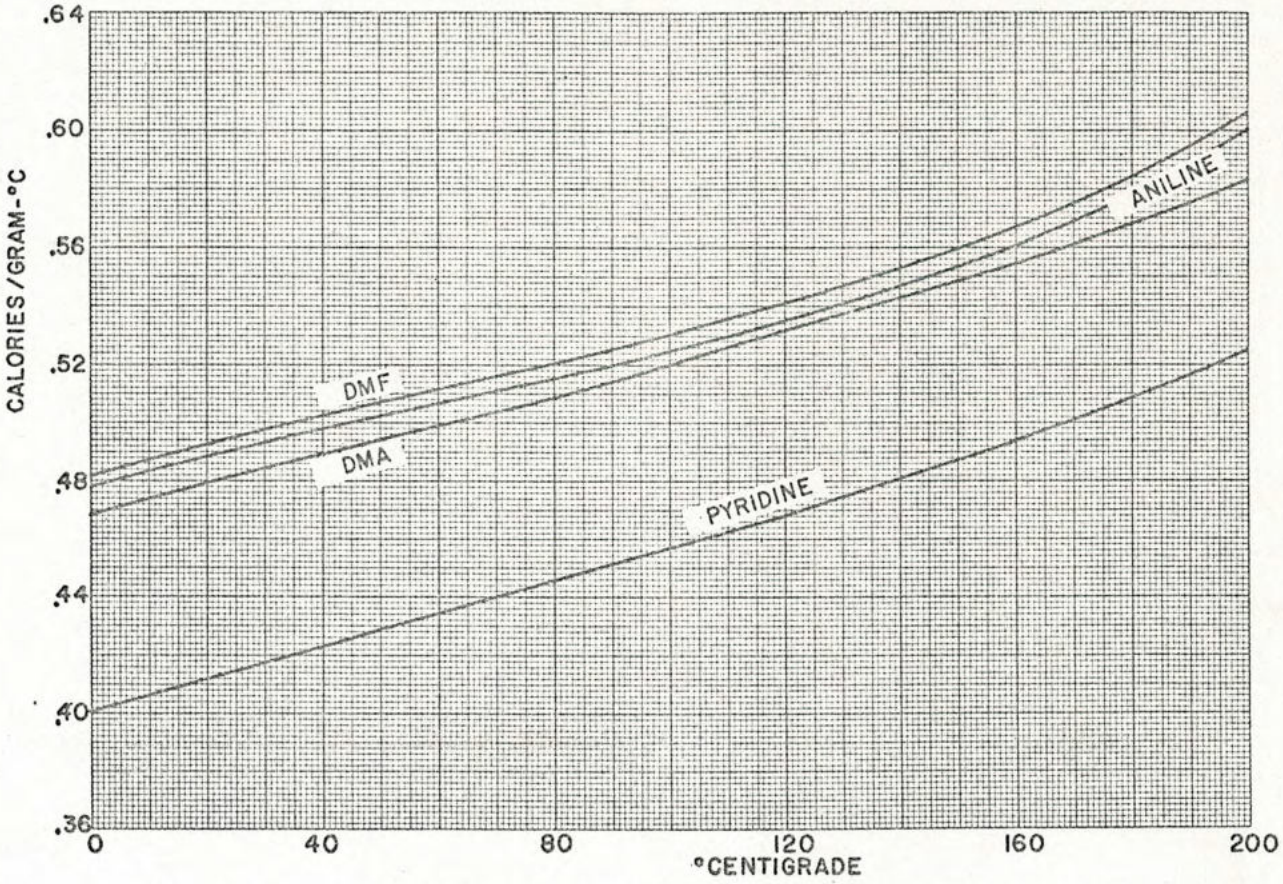

Fig. 38-4—Liquid heat capacity of miscellaneous nitrogen compounds from 0 to 200° C.

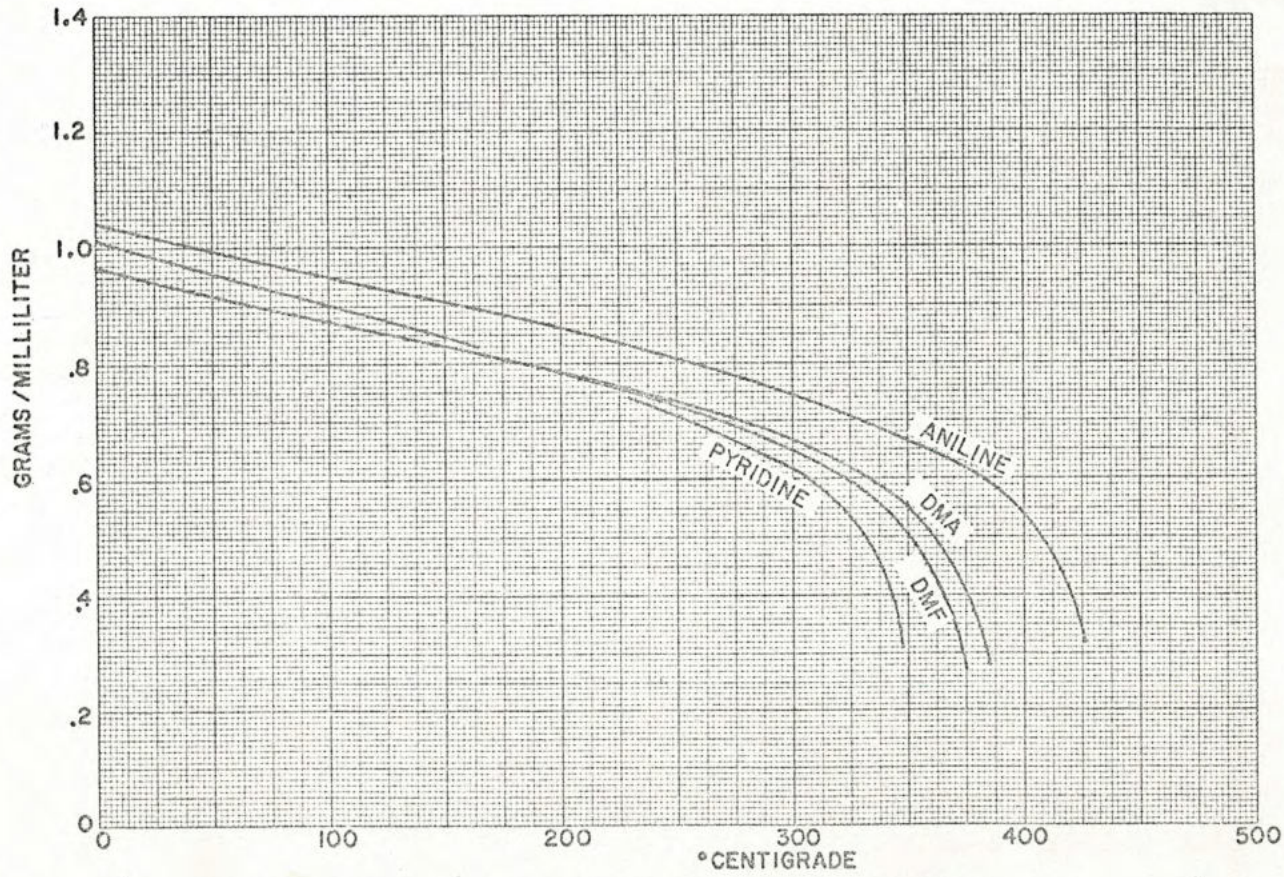

Fig. 38-5—Liquid density of miscellaneous nitrogen compounds from 0 to 425° C.

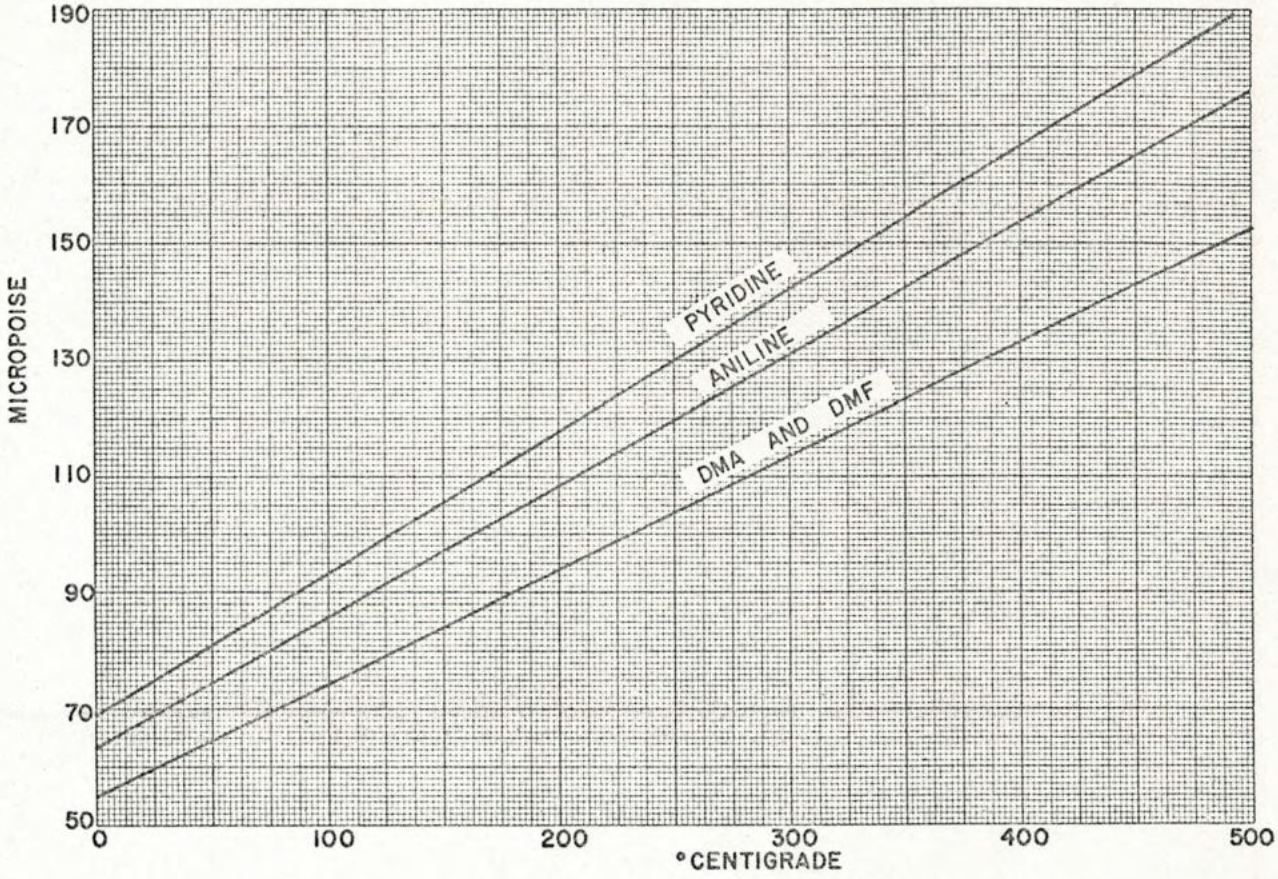

Fig. 38-6—Vapor viscosity of miscellaneous nitrogen compounds from 0 to 500° C.

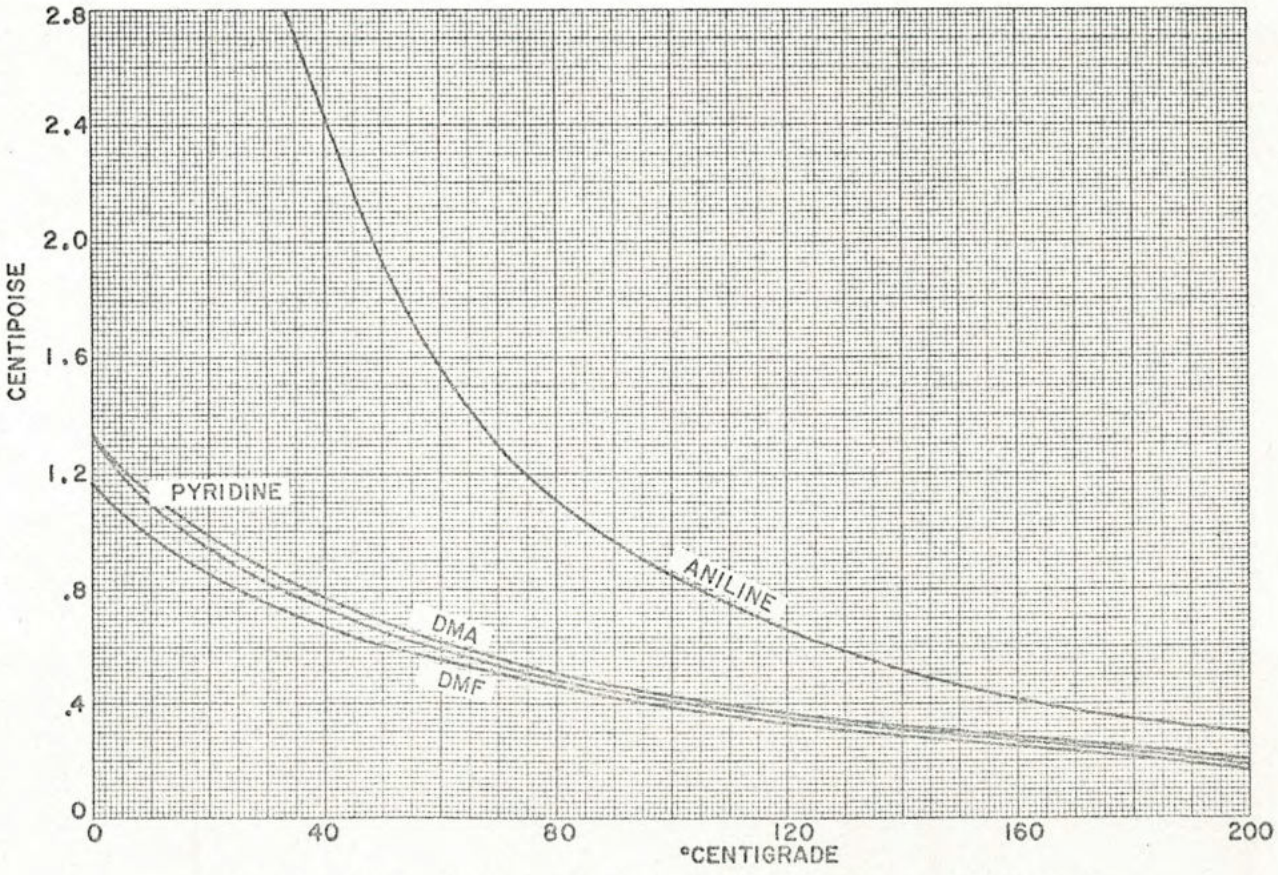

Fig. 38-7—Liquid viscosity of miscellaneous nitrogen compounds from 0 to 200° C.

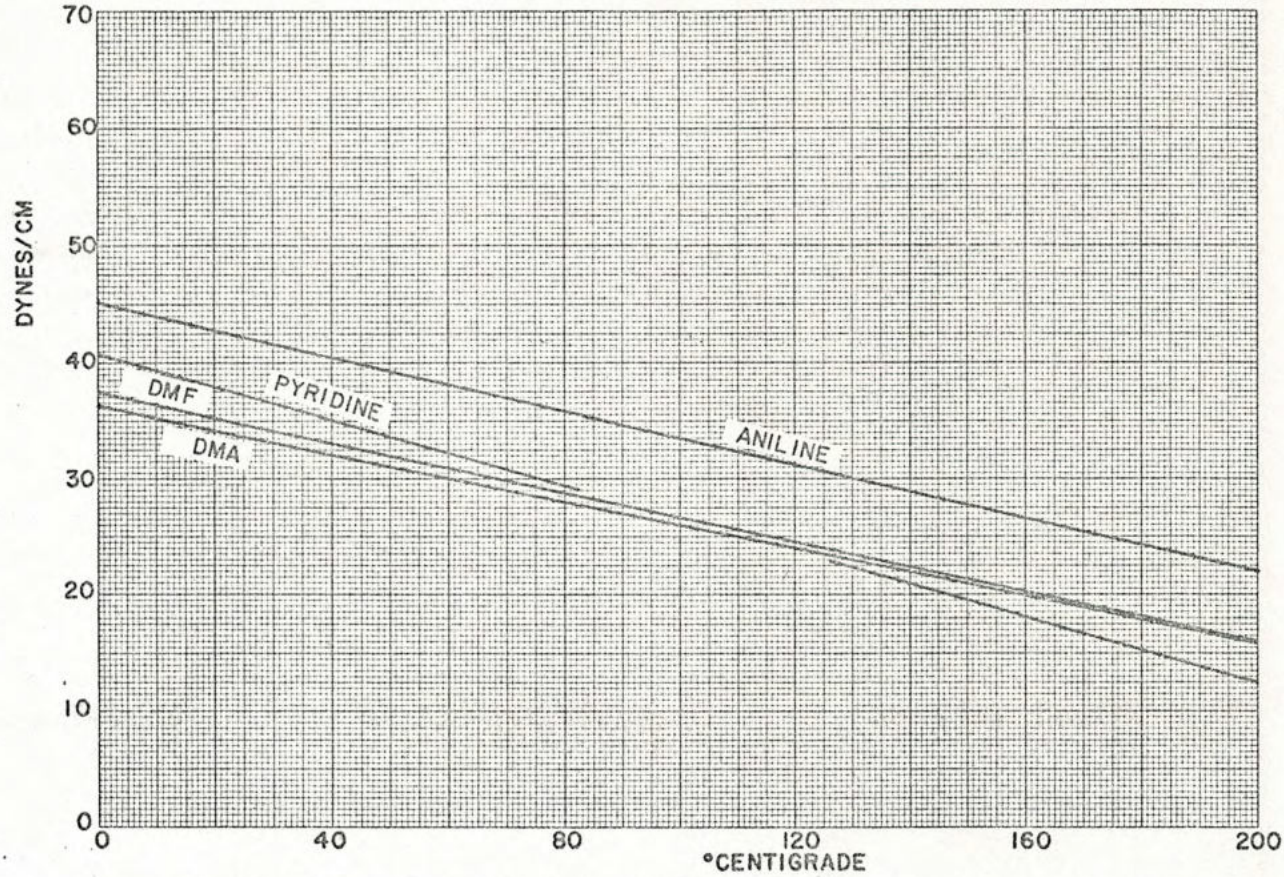

Fig. 38-8—Surface tension of miscellaneous nitrogen compounds from 0 to 200° C.

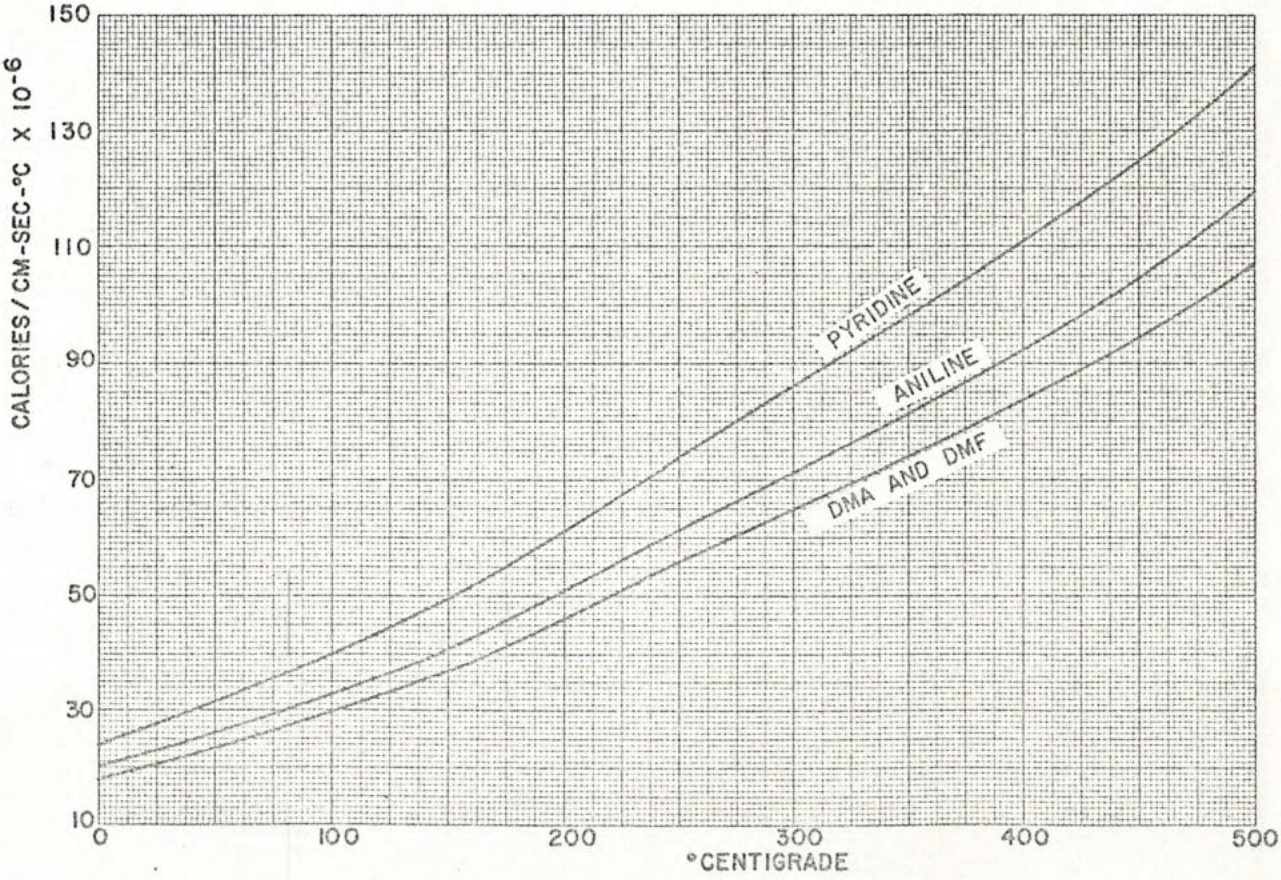

Fig. 38-9—Vapor thermal conductivity of miscellaneous nitrogen compounds from 0 to 500° C.

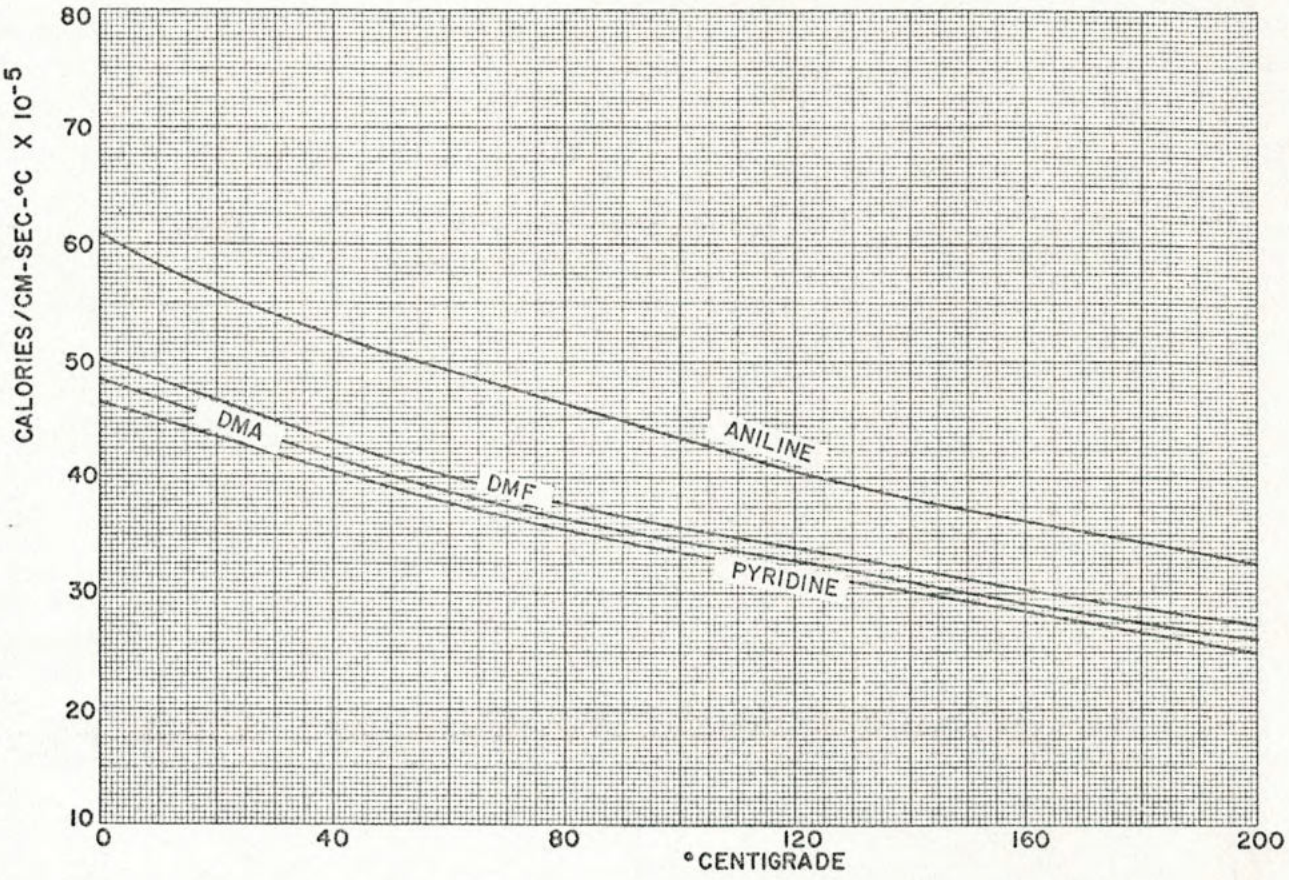

Fig. 38-10—Liquid thermal conductivity of miscellaneous nitrogen compounds from 0 to 200° C.

for aniline from 0 to 223° C;[1,9,14] and for pyridine at room temperature.[1] These data were extended over the 0-200° C range by the equation relating heat capacity to density. The error averaged 1.8 percent.

Density. Density data are available up to 100° C for pyridine[1] and up to 150° C for the other three compounds.[1,10,11,14] Lydersen's method[8] was used to calculate the densities up to the critical point, with an average error of 1.5 percent for seven points.

Viscosity. The vapor viscosities were estimated by the method of Bromley and Wilke.[15]

The liquid viscosities of DMF,[11] aniline[1,2,16] and pyridine[1,2] have been measured up to 120° C. Only the room temperature viscosity of DMA is available.[10] The data were extended by the equation proposed by Thomas,[8] with a probable error of 3 percent.

Surface Tension. Data are reported for aniline from 0 to 180° C;[1,2] for pyridine from 0 to 115° C;[1,2] and at room temperature for DMF.[11] The Sugden equation was used to calculate the surface tension of DMA and extend the data over the 0-200° C range for the other three compounds.[17]

Thermal Conductivities. The vapor and liquid thermal conductivities were estimated.[18,19]

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Indexing Terms: Amides-9, Amines-9, Aniline-9, Dimethyl Acetamide-9, Dimethyl Formamide-9, Physical Properties-7, Pressure-6, Properties/Characteristics/-7, Pyridine-9, Temperature-6.