Physical Properties of Hydrocarbons

Part 40-Toluene and Xylene

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ABOUT FIVE BILLION POUNDS of toluene will be consumed in the production of petrochemicals in 1970. Two-thirds of this will go into benzene production. The growth rate continues to be a husky 10 percent a year.

The polyester market is boosting para-xylene toward a two billion pounds per year giant. Only the possibility of new technology that uses toluene instead of para-xylene to produce polyesters clouds an otherwise bright picture. Ortho-xylene has also been booming as the phthalic anhydride market grows. Production could reach one billion pounds in 1970.

Critical Properties and Vapor Pressure. The critical properties of all four compounds have been experimentally determined.[1,2,3,4,5]

Vapor pressure data are available for toluene up to its critical point[6] and for the xylenes up to the boiling points.[6] The equation used in previous articles has been used to calculate the vapor pressures above the boiling points, with a probable error of 2-3 percent.

Heat of Vaporization. The boiling point heat of vaporization was calculated for each compound by the Giacalone equation.[7] Comparison with experimental data for toluene[4] and *p*-xylene[4] gave errors of 0.6 and 1.8 percent, respectively. The data were extended to the critical point by use of the Kharbanda equation.[8]

Heat Capacity. The vapor heat capacities are available from the literature.[5,9,10]

Liquid heat capacities have been measured from —84°C to +110°C for toluene;[4,11] from —49°C to + 45°C for *m*-xylene;[12] from —21°C to + 30°C for *o*-xylene;[12] and from 0 to 300°C for *p*-xylene.[4,12,13] The data were extended over the 0-200°C range by the equation, density times heat capacity equals a constant. The error for six points averaged 4.1 percent.

Density. The liquid densities up to the critical point are reported in the literature.[4,14,15,16]

TABLE 40-1—Physical Properties of Toluene and Xylene

	Boiling Point, °C	Freezing Point, °C	Molecular Weight	Critical Properties T_c °C	P_c psia	d_c g/ml
Toluene	110.6	−95.0	92.13	320.6	610	.2913
m-xylene	139.3	−47.9	106.16	343.6	526	.2822
o-xylene	144.4	−25.3	106.16	358.0	540	.2877
p-xylene	138.4	13.2	106.16	342.8	513	.2807

Viscosity. The equation proposed by Bromley and Wilke was used to estimate the vapor viscosities.[17]

Liquid viscosity data are available from —100°C to +50°C for toluene[4,18] and from 0 to 140°C for the xylenes.[4,15,16,18,19] The estimation method of Thomas[7] was used to calculate the viscosities at other temperatures. The error averaged 1.6 percent when compared to 10 experimental values.

Surface Tension. Surface tension data are reported in the literature from 0 to 140°C for all four compounds.[4,14,16,20] The data yielded a straight line which was extrapolated to 200°C.

Thermal Conductivity. The vapor thermal conductivities were estimated by the method used in previous articles.[21]

The liquid thermal conductivity of toluene has been studied by a number of investigators from 0 to 80°C.[22,23,24,25,26,27] Briggs has measured the thermal conductivity of the xylenes at 20°C.[27] The thermal conductivities were estimated from 0-200°C by the method of Robbins and Kingrea.[22] Compared to experimental data, the error averaged 4.0 percent.

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Indexing Terms: Computations-4, Heat-7, Hydrocarbons-9, Liquid Phase-5, Physical Properties-7, Pressure-6, Properties/Characteristics/-7, Temperature-6, Toluene-9, Vapor Phase-5, Xylene-9.

See charts starting on next page

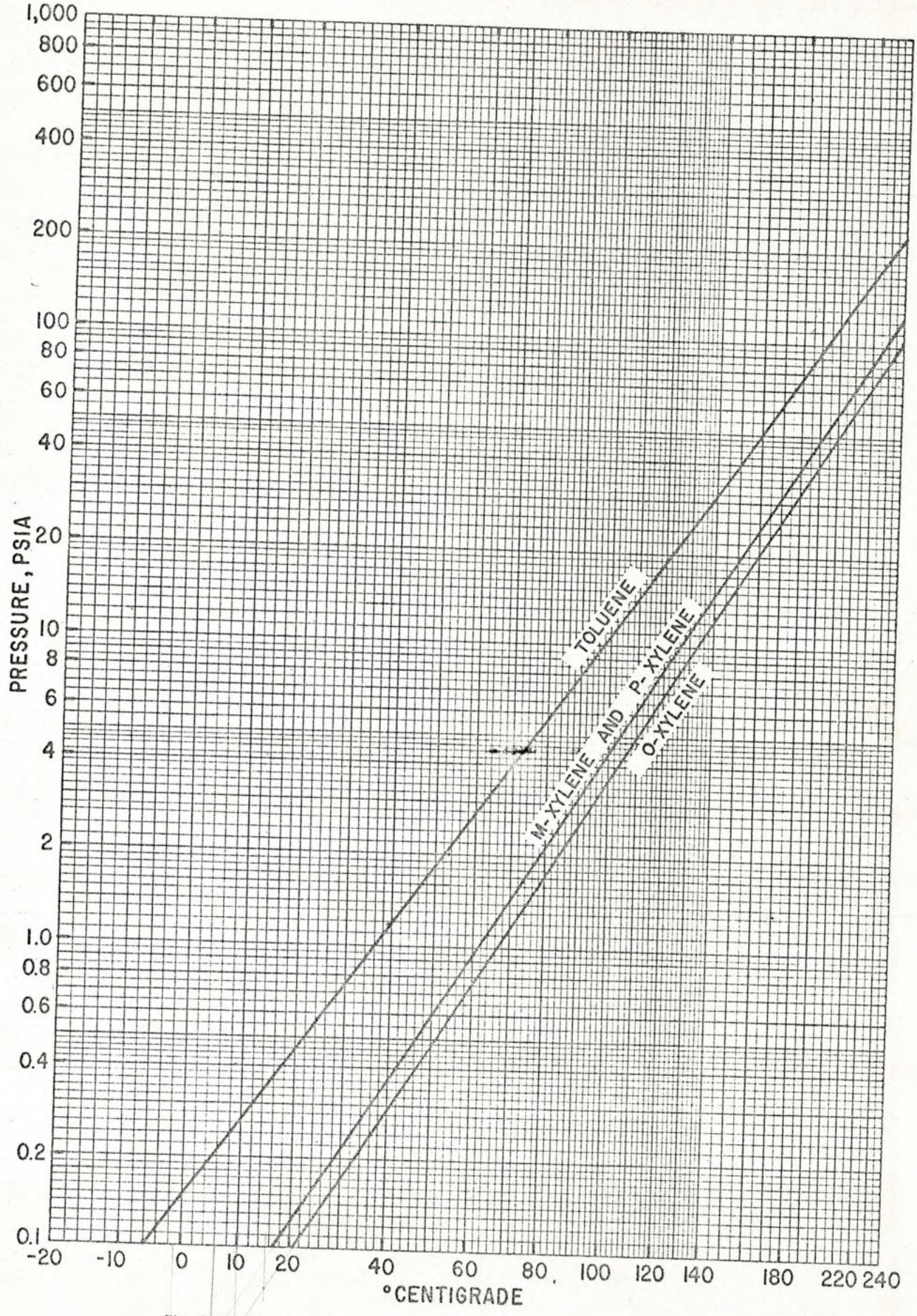

Fig. 40-1—Vapor pressure of toluene and xylenes from —20 to +240° C.

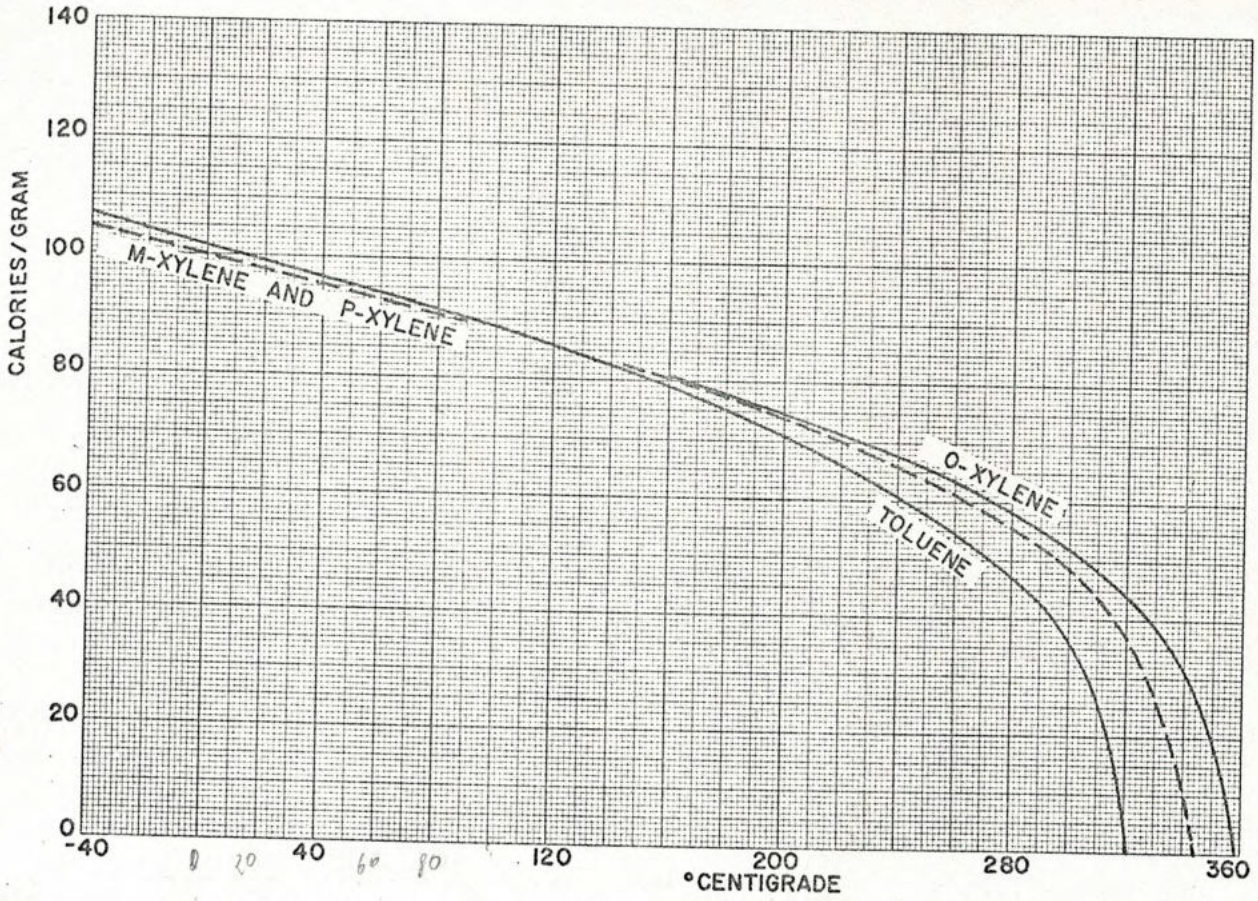

Fig. 40-2—Heat of vaporization of toluene and xylenes from —40 to 360° C.

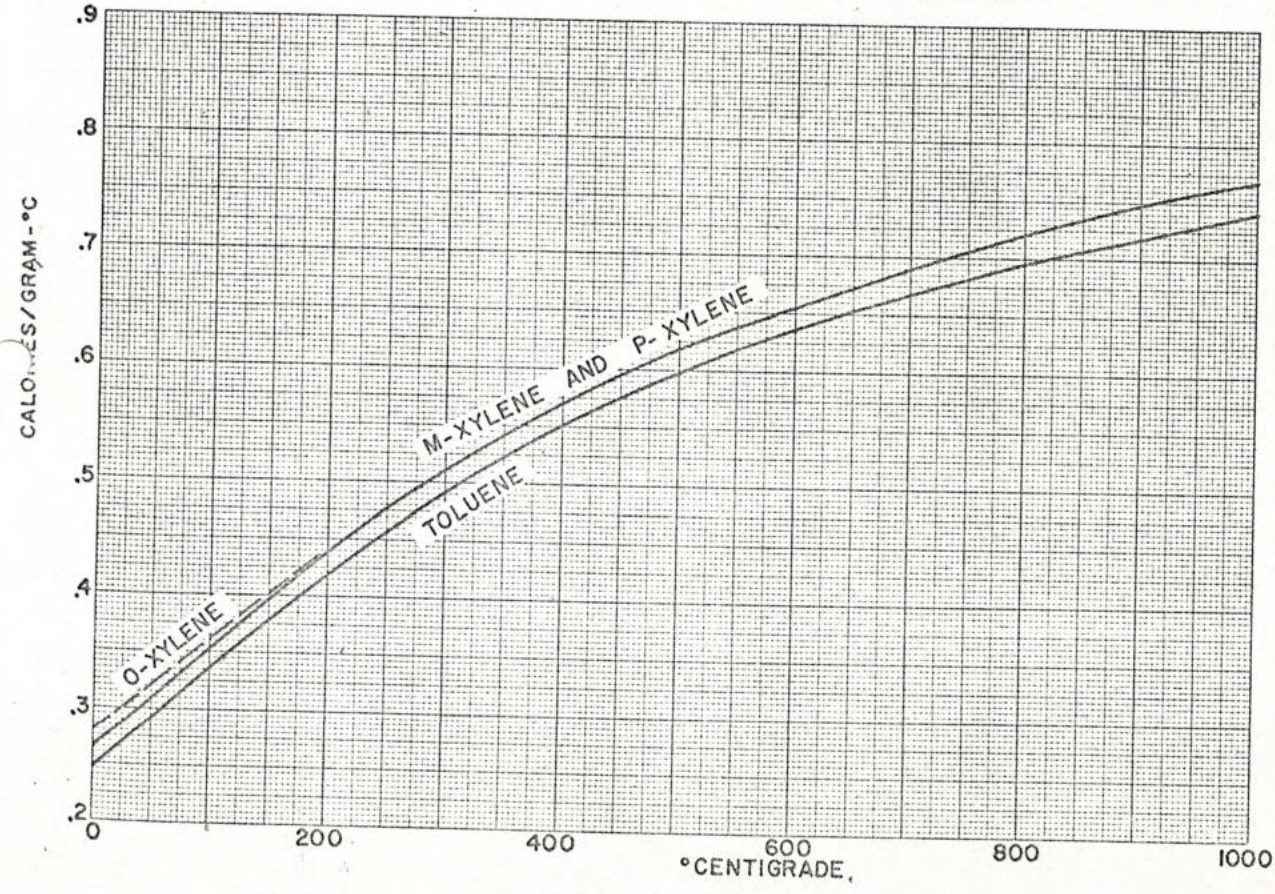

Fig. 40-3—Vapor heat capacity of toluene and xylenes from 0 to 1000° C.

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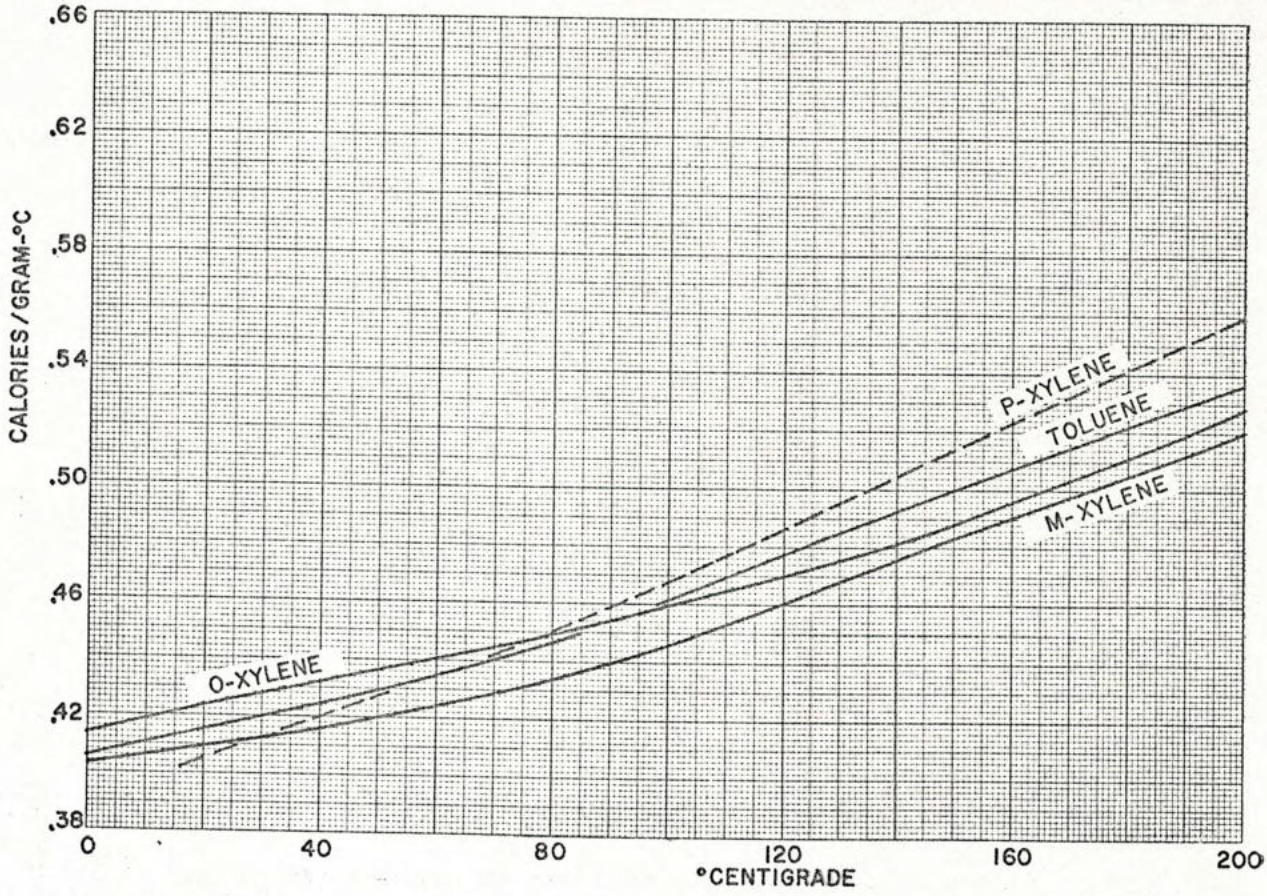

Fig. 40-4—Liquid heat capacity of toluene and xylenes from 0 to 200° C.

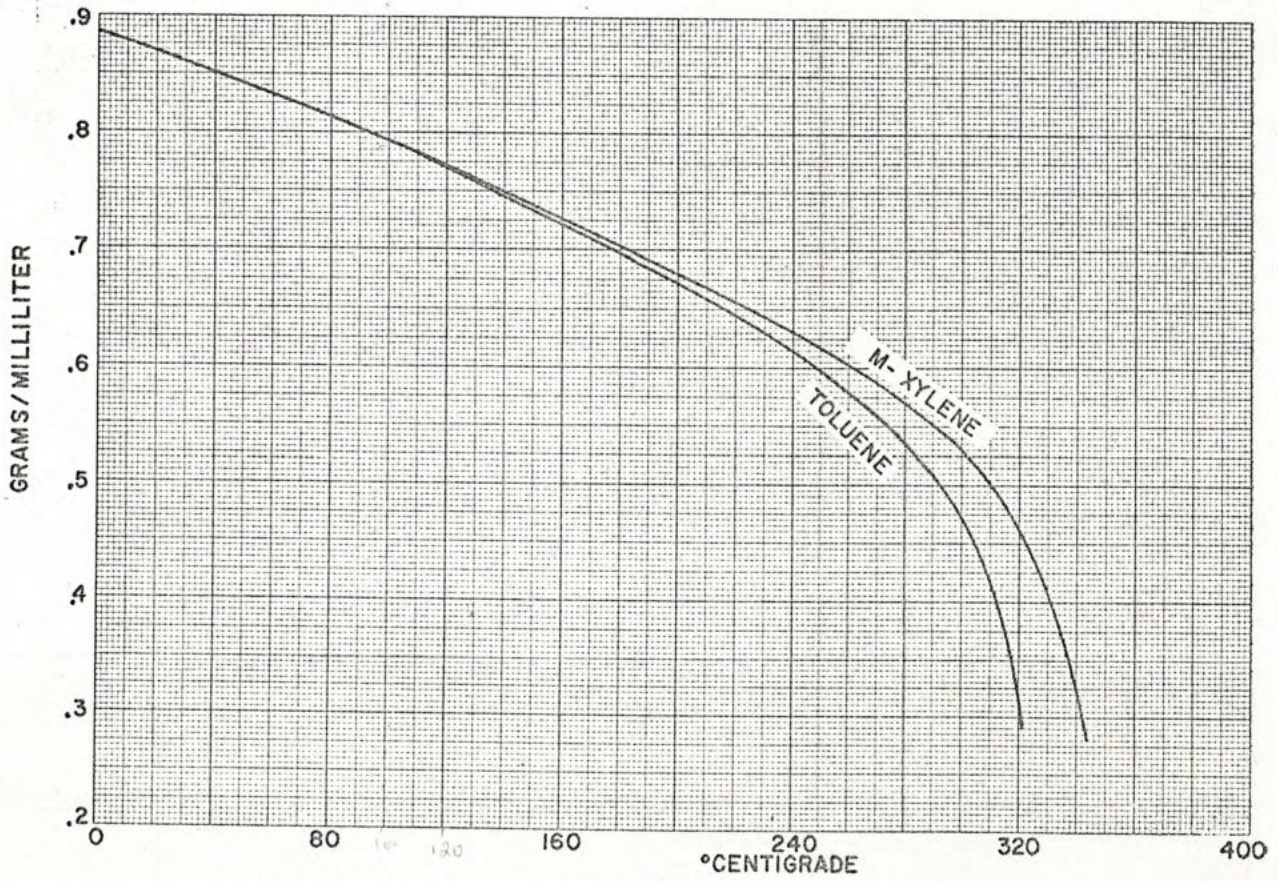

Fig. 40-5—Liquid density of toluene and m-xylene from 0 to 340° C.

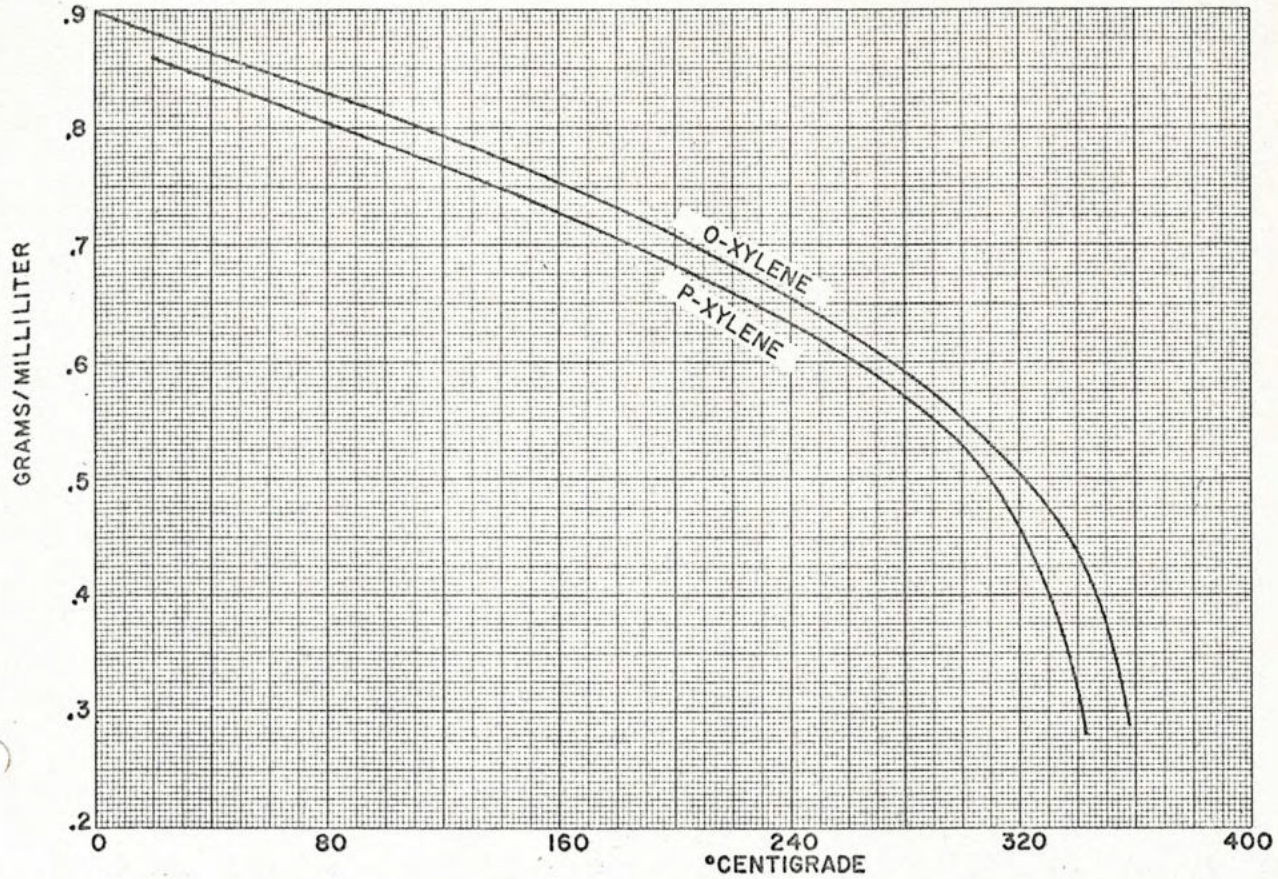

Fig. 40-6—Liquid density of o-xylene and p-xylene from 0 to 360° C.

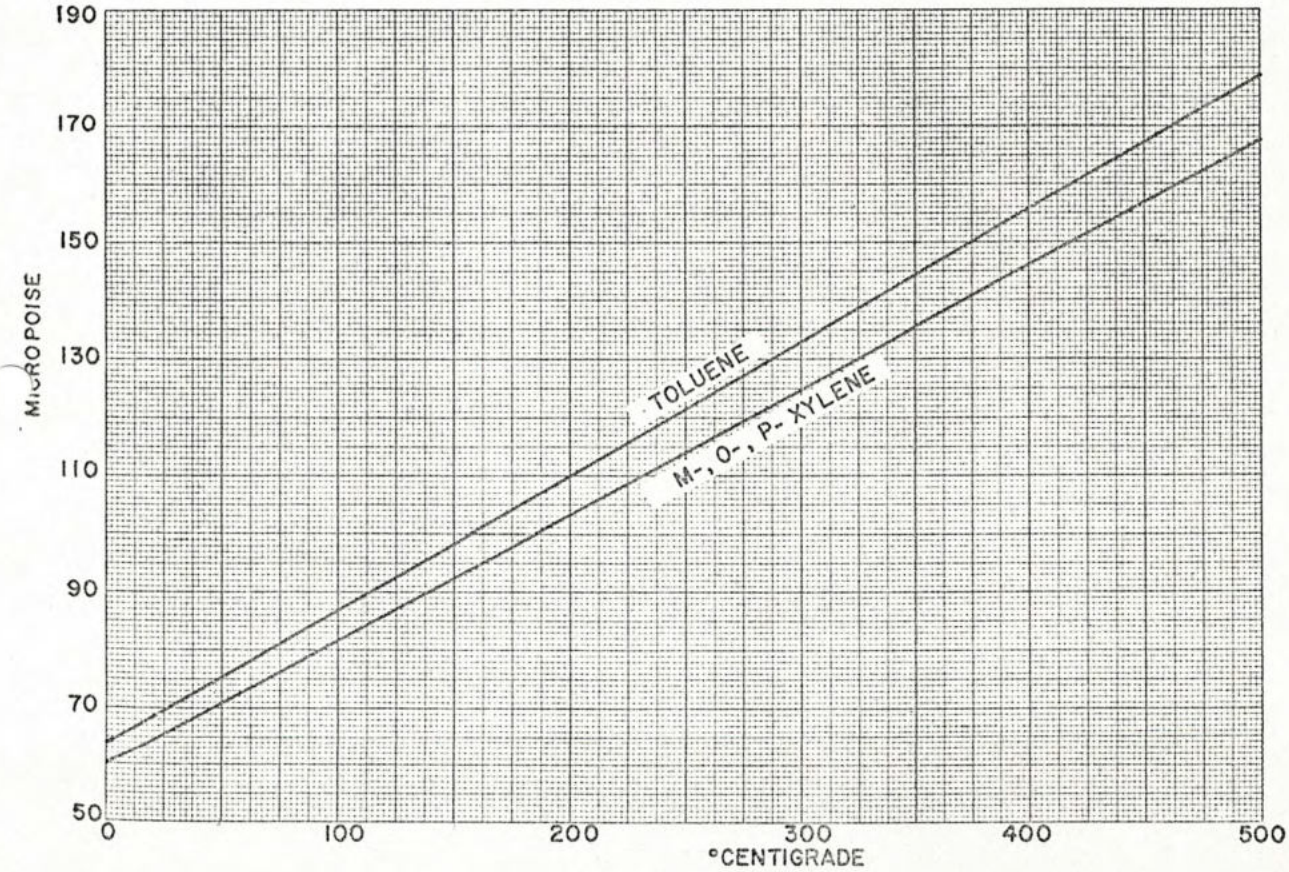

Fig. 40-7—Vapor viscosity of toluene and xylenes from 0 to 500° C.

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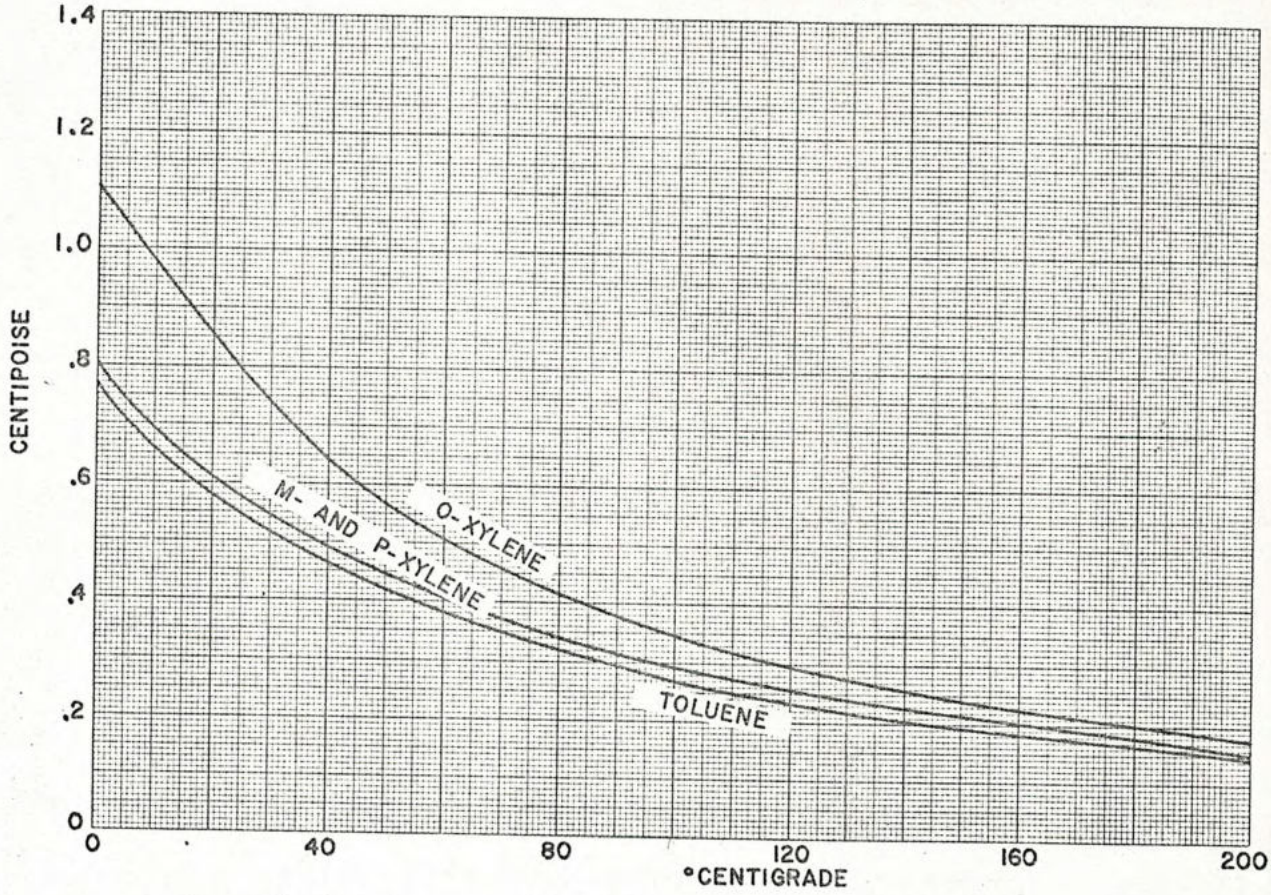

Fig. 40-8—Liquid viscosity of toluene and xylenes from 0 to 200° C.

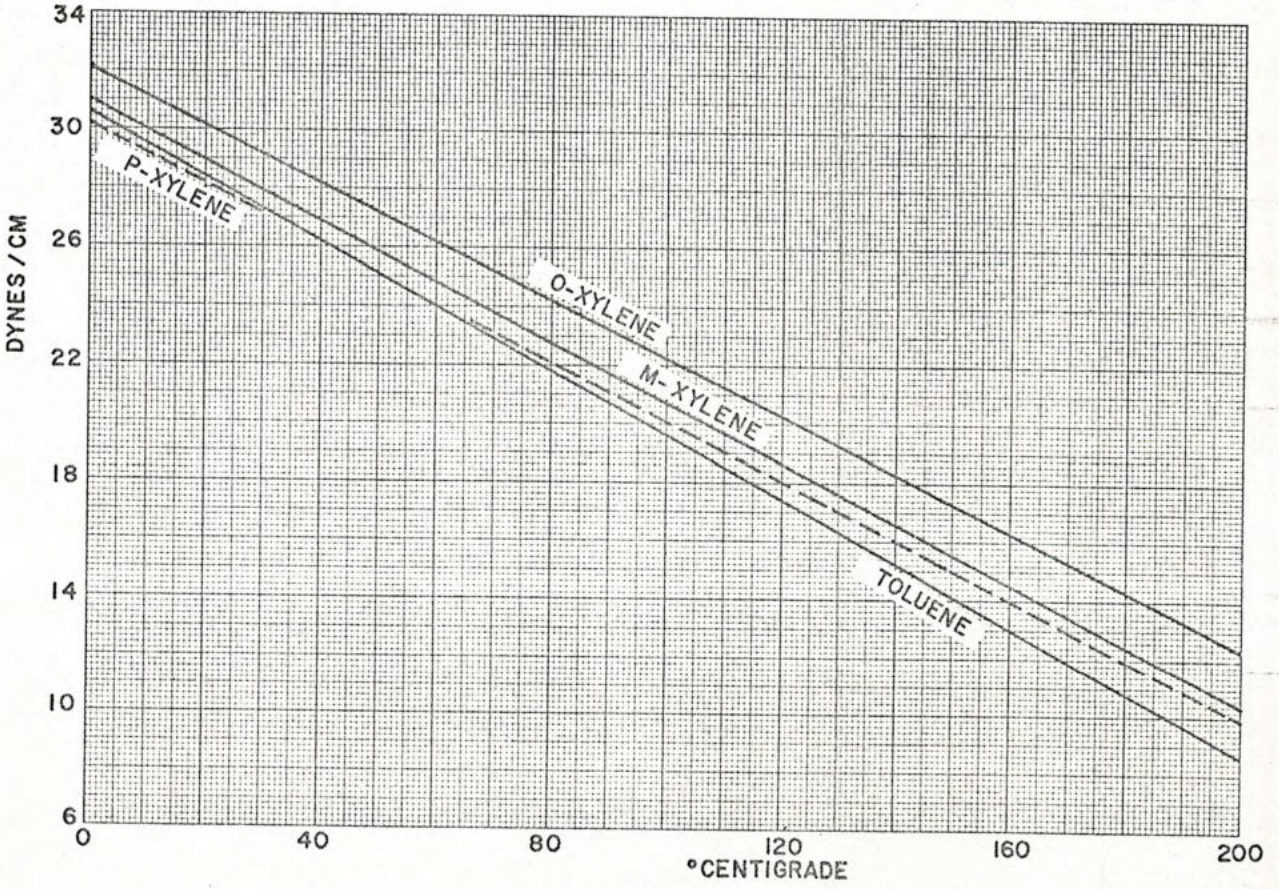

Fig. 40-9—Surface tension of toluene and xylenes from 0 to 200° C.

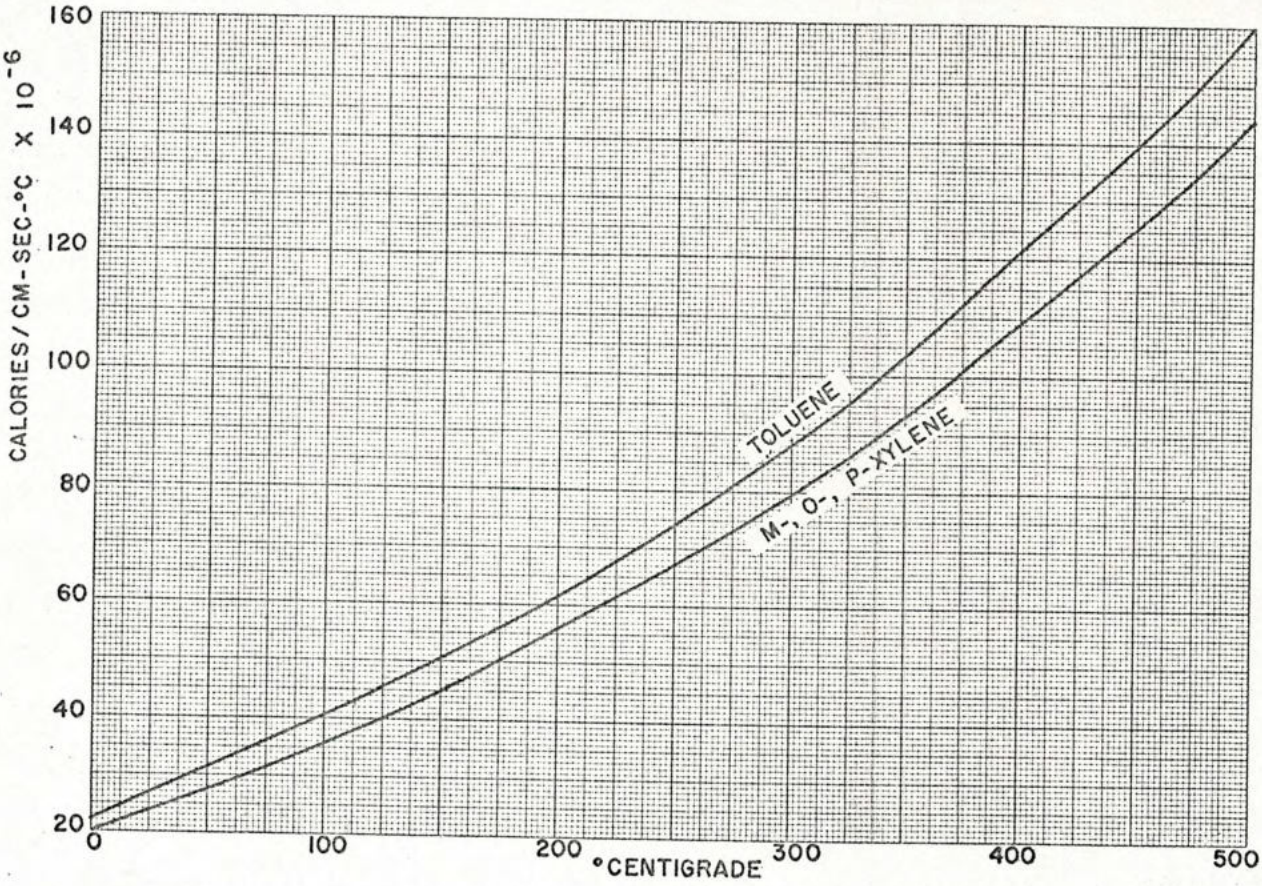

Fig. 40-10—Vapor thermal conductivity of toluene and xylenes from 0 to 500° C.

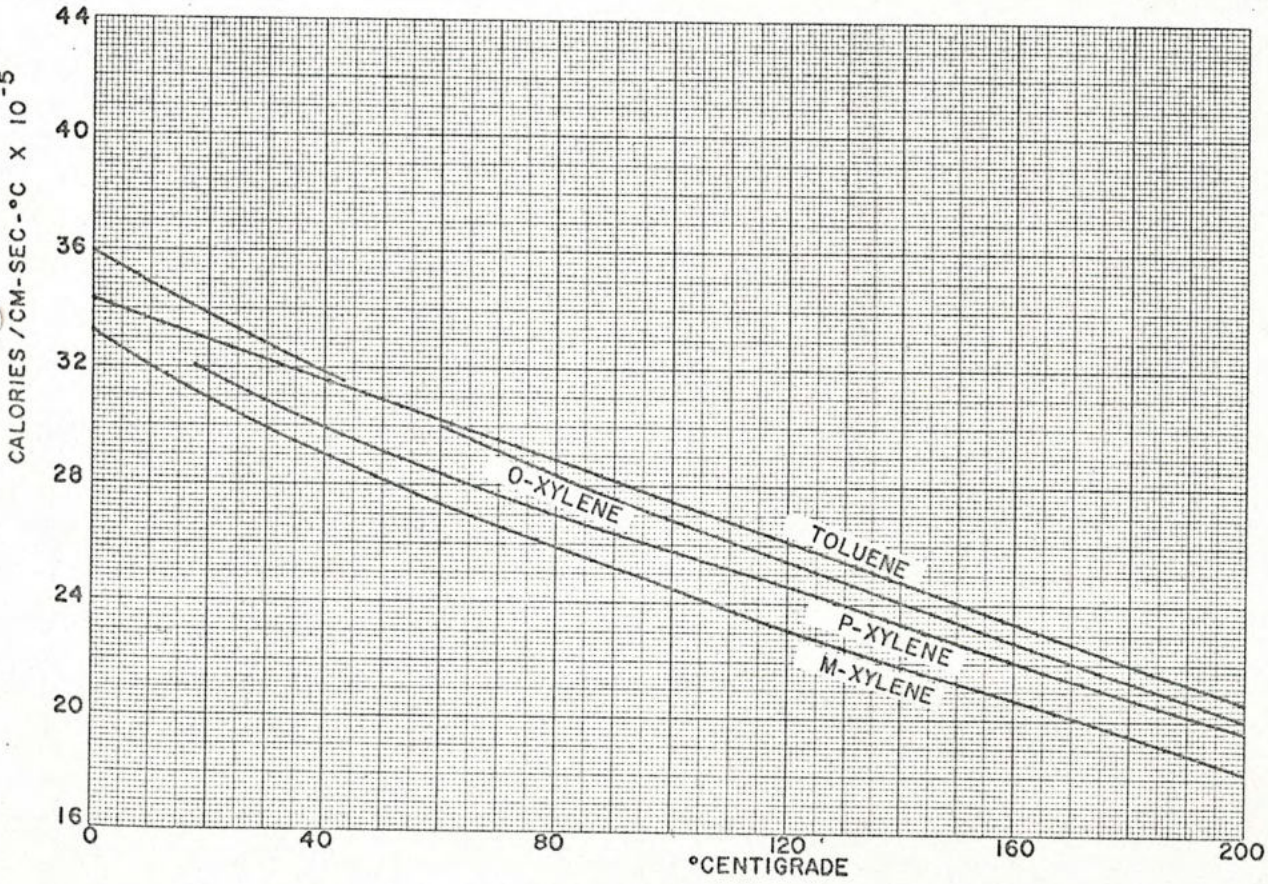

Fig. 40-11—Liquid thermal conductivity of toluene and xylenes from 0 to 200° C.

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