

Physical Properties of Hydrocarbons

Part 19—Chlorinated C₂'s

Robert W. Gallant

The Dow Chemical Co., Plaquemine, La.

PART 6 OF THIS SERIES presented the physical properties of the major commercial chlorinated ethylenes—vinyl chloride, vinylidene chloride, trichloroethylene, and perchloroethylene. In this part, we will cover four other products of the chlorination of ethylene. Three of these (*cis*-1,2-dichloroethylene, *trans*-1,2-dichloroethylene, and 1,1,2,2-tetrachloroethane) are byproducts of the production of other compounds and are generally put back into the process for their chlorine value. The fourth (methylchloroform) is an important commercial product in its own right. The combination of low toxicity and excellent degreasing properties has made 1,1,1-trichloroethane the popular choice in many applications, including cleaning missile fuel tanks.

The physical properties of these compounds have not been extensively studied and so it has been necessary to use estimation methods in many cases. The highly polar chlorinated compounds do not lend themselves to the excellent estimation methods used for hydrocarbons. Whereas errors of only a few percent are typical for hydrocarbons, estimation methods for chlorinated hydrocarbons often give errors up to 10 percent.

Critical Properties and Vapor Pressures. The only critical property data reported in the literature are the critical temperature and pressure of the dichloroethylenes.¹ The critical temperature and pressure of the other two compounds have been estimated by the method of Riedel,² with a probable error of $\pm 10^\circ$ on the temperature and ± 30 psi on the pressure. The critical density of all four compounds has been estimated by the method proposed by Vowles,² which should yield an error of less than 0.01 grams/milliliter.

Stull¹ reports the vapor pressures of the dichloroethylenes up to the critical point and up to the boiling point for the other two compounds. Additional data up to the boiling point have been provided by Kelelaar³ and Nelson.⁴ The data for methylchloroform and 1,1,2,2-tetrachloroethane have been extended to the critical point by the previously described method recommended by Miller.⁵ The error should be only a few percent.

Heat of Vaporization. The heats of vaporization have been determined only at the boiling points.^{3,6,7} The data have been extended by the Kharbanda nomograph of the Watson equation.⁸

Heat Capacity. Kobe has calculated the vapor heat capacity of all four compounds.⁹

There is only a limited amount of data available on the liquid heat capacity.^{6,10} The data of Stull¹¹ have been used for methylchloroform and 1,1,2,2-tetrachloroethane. The liquid heat capacity of the dichloroethylenes has been estimated at 20°C by the method of Johnson and extended over the -20° to $+100^\circ$ C range by the method of Chow and Bright.² The error here is typically 10-20 percent.

TABLE 19-1—Properties of Chlorinated C₂ Hydrocarbons

	Boil- ing Point °C	Melt- ing Point °C	Molec- ular Weight	Critical Properties		
				T _c °C	P _c psia	d _c g/ml
<i>Cis</i> -1, 2-dichloro- ethylene.....	59.0	-81	96.95	271	850	.44*
<i>Trans</i> -1, 2-dichloro- ethylene.....	47.8	-50	96.95	243	800	.44*
Methylchloroform (1, 1, 1-trichloro- ethane).....	74.1	-31	133.4	277*	640*	.464*
1, 1, 2, 2-tetra- chloroethane.....	145.9	-43	167.86	369*	574*	.503*

* Estimated.

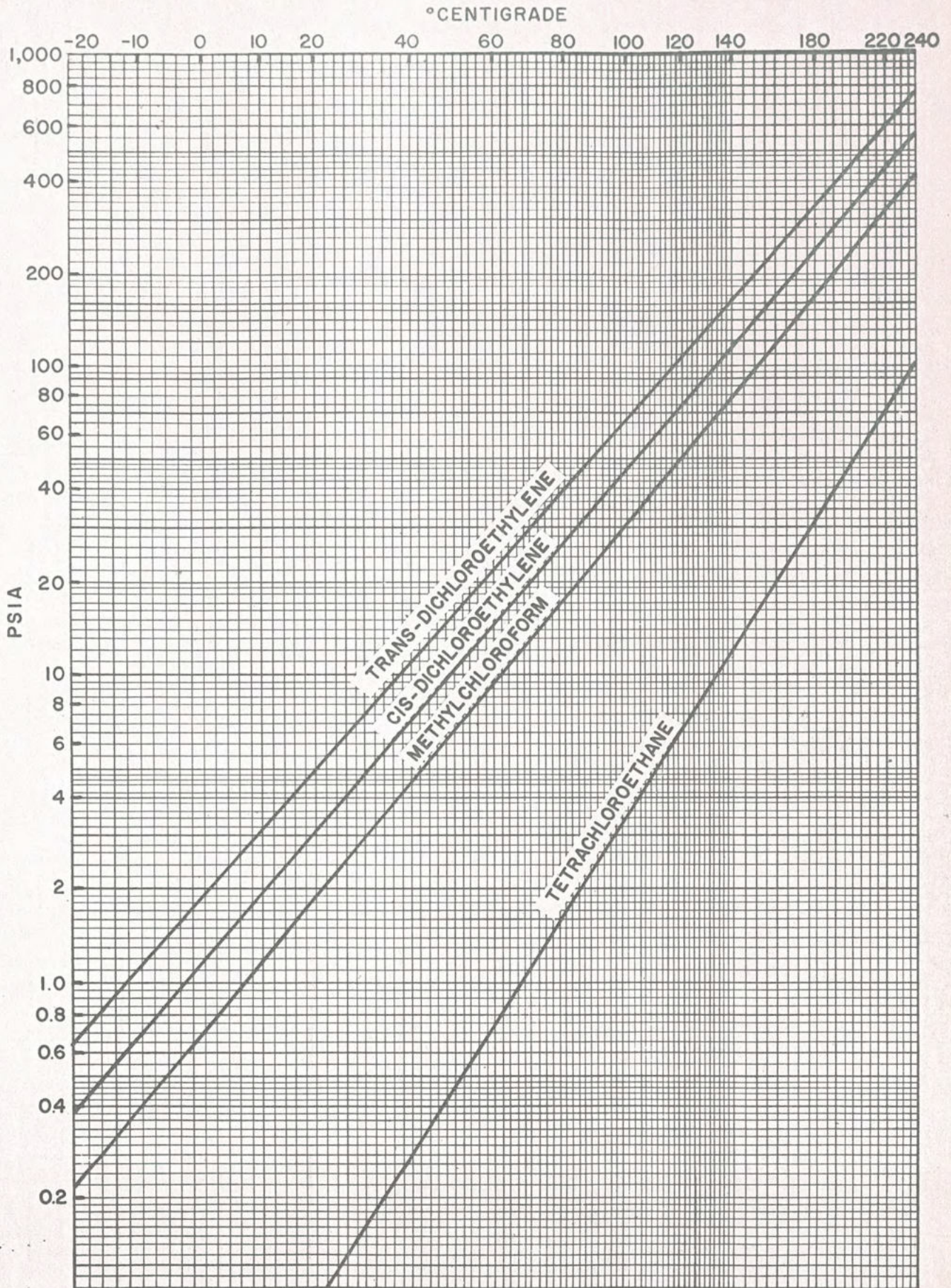


Fig. 19-1—Gives the vapor pressure for C₂ chlorinated hydrocarbons from -20°C to +240°C.

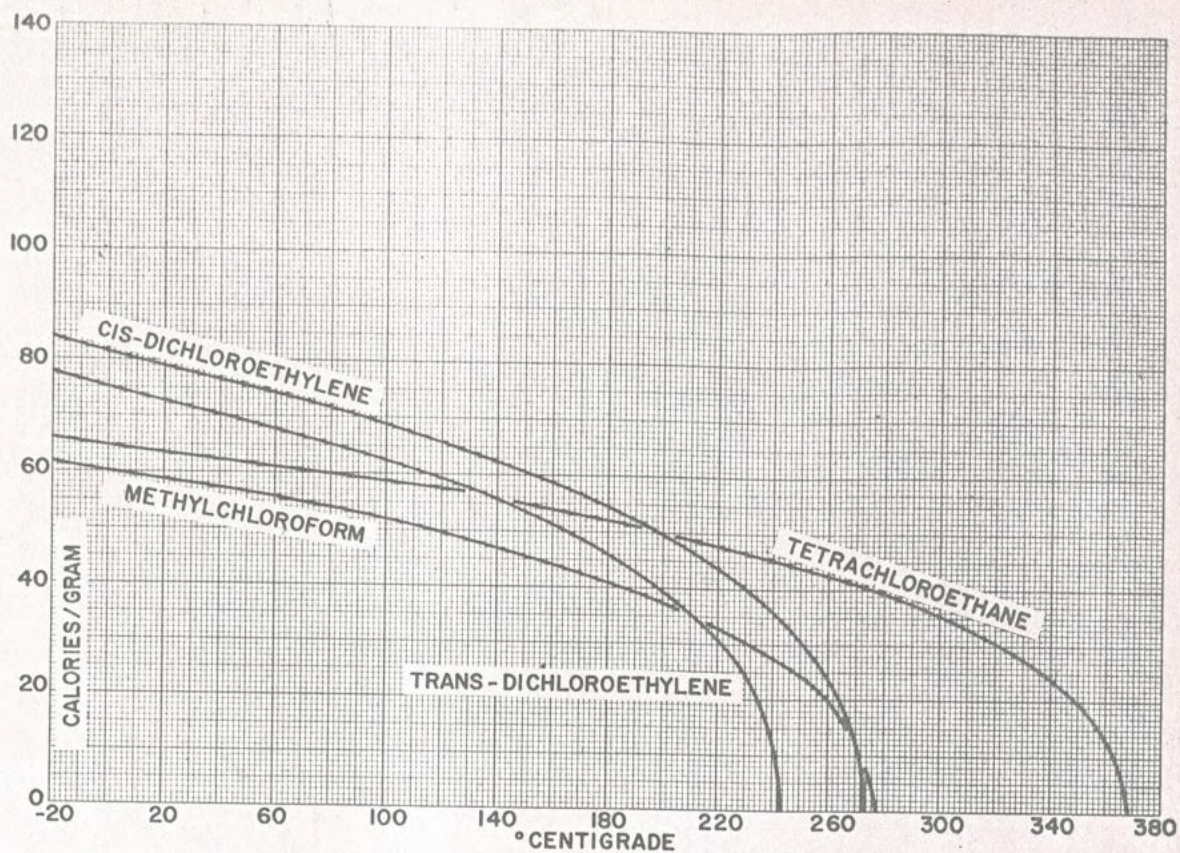


Fig. 19-2—Gives heats of vaporization for C₂ chlorinated hydrocarbons from -20°C to +370°C.

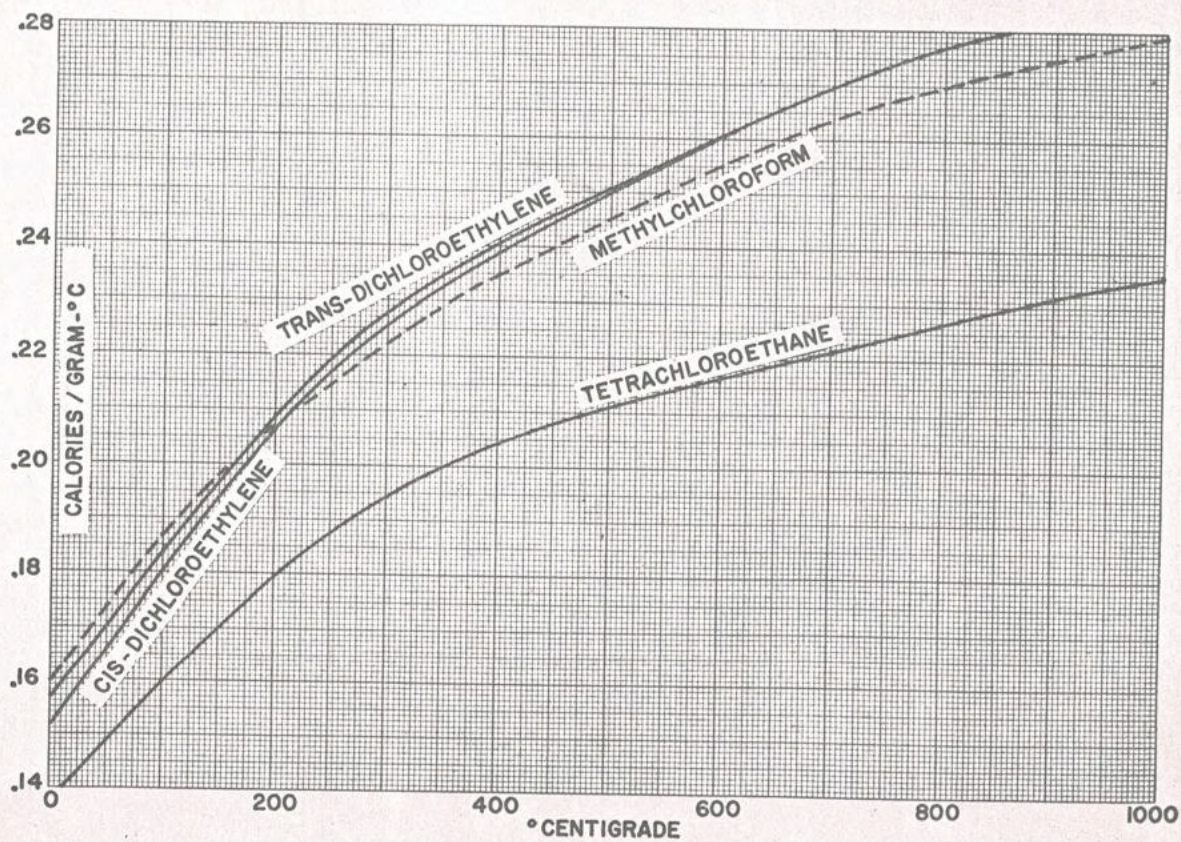


Fig. 19-3—Gives vapor heat capacity for C₂ chlorinated hydrocarbons from 0°C to 1000°C.

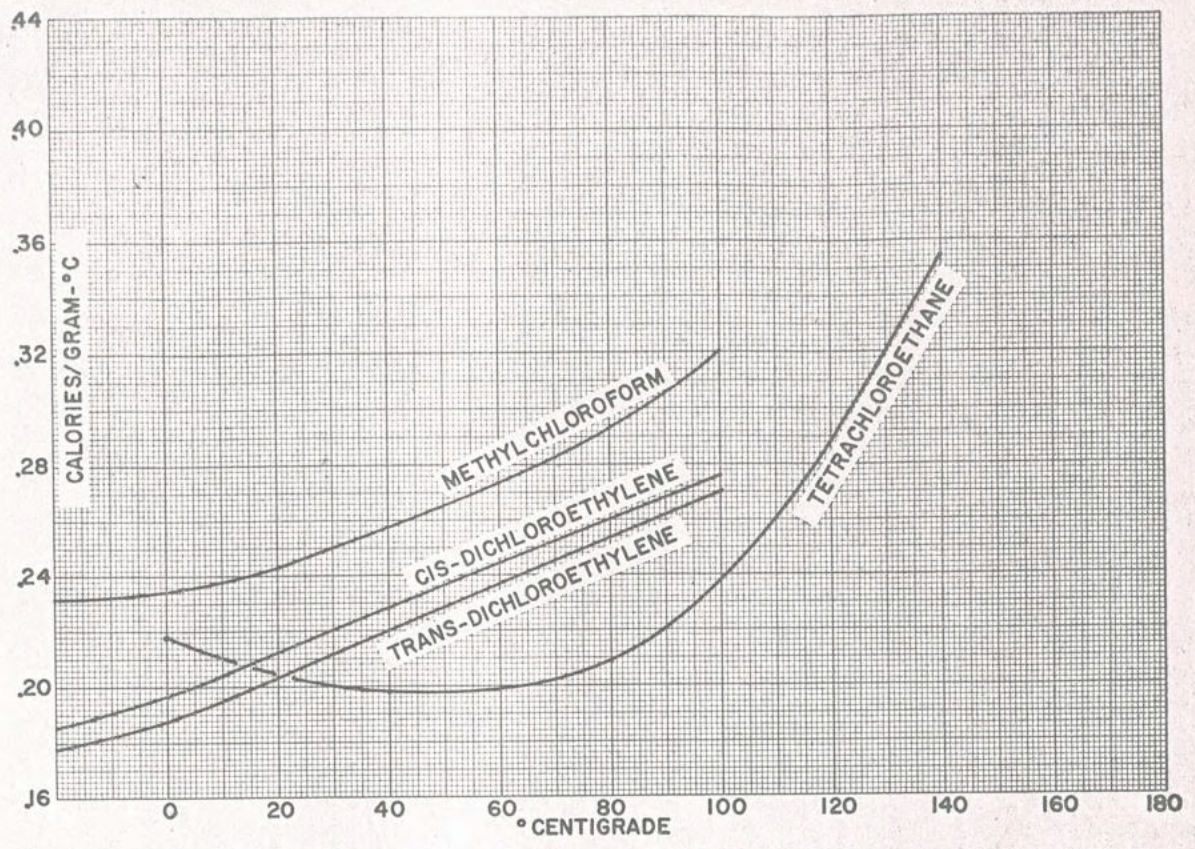


Fig. 19-4—Gives liquid heat capacity for C₂ chlorinated hydrocarbons from -20°C to +140°C.

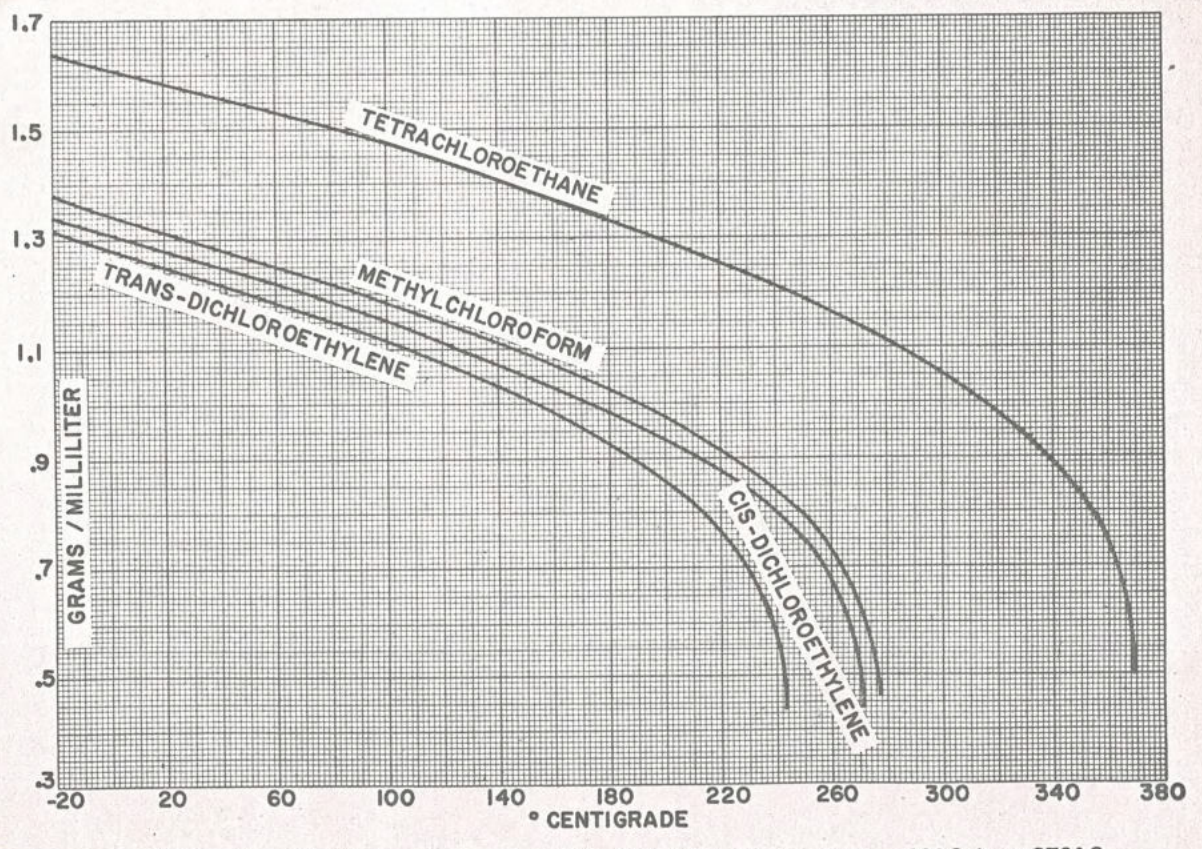


Fig. 19-5—Gives liquid density for C₂ chlorinated hydrocarbons from -20°C to +370°C.

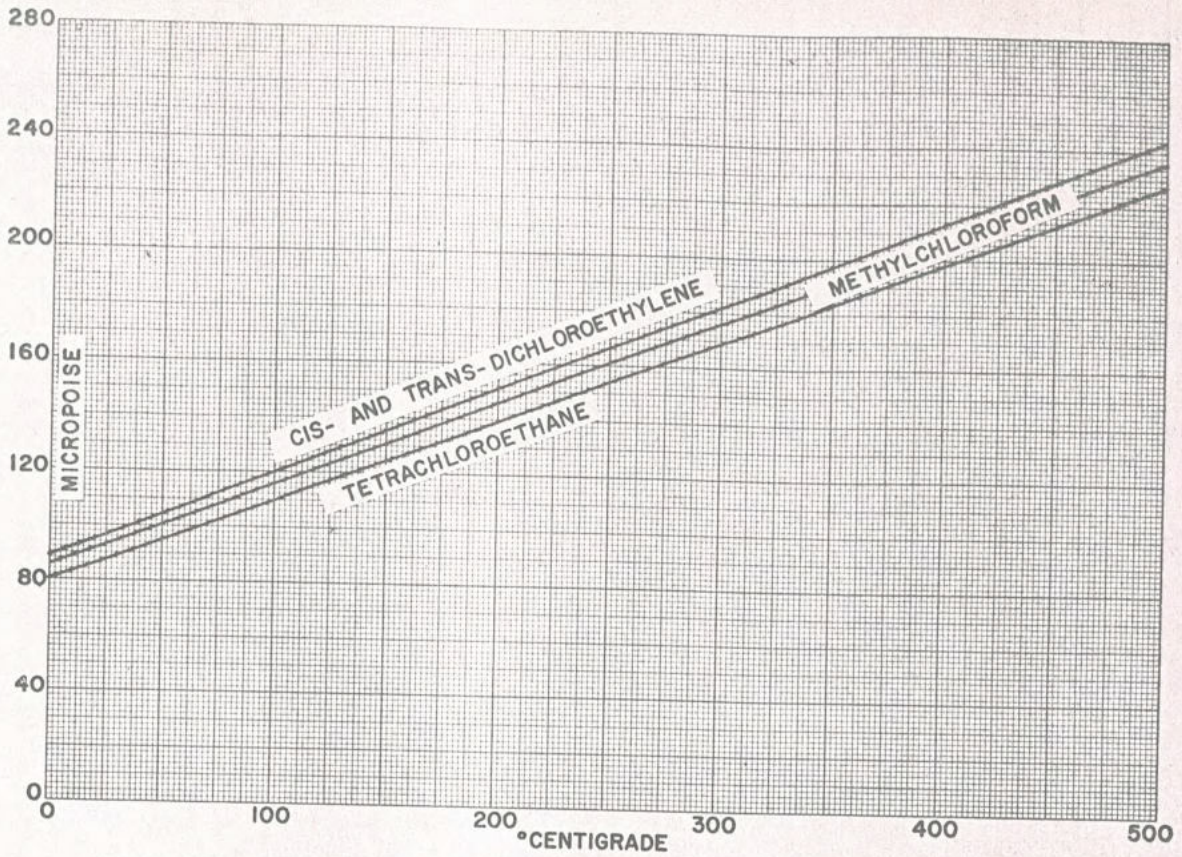


Fig. 19-6—Gives vapor viscosity for C₂ chlorinated hydrocarbons from 0°C to 500°C.

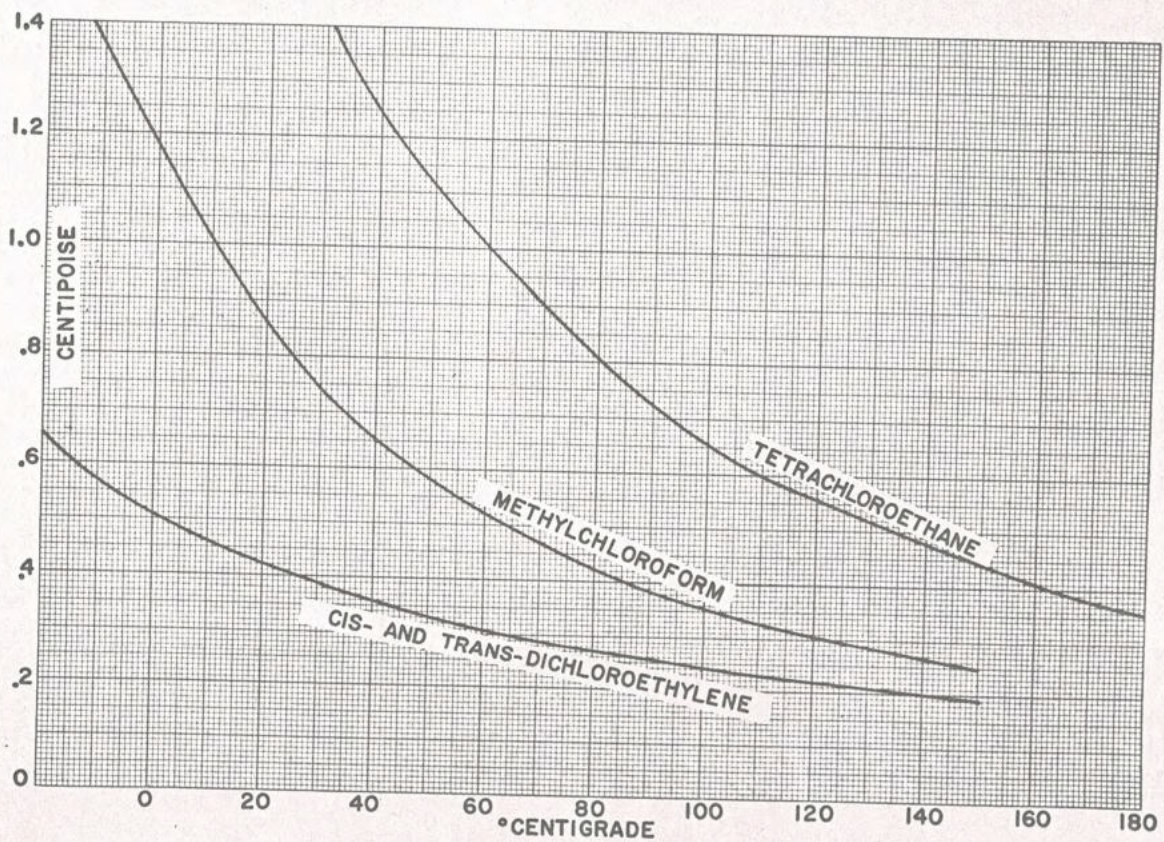


Fig. 19-7—Gives liquid viscosity for C₂ chlorinated hydrocarbons from -20°C to +180°C.

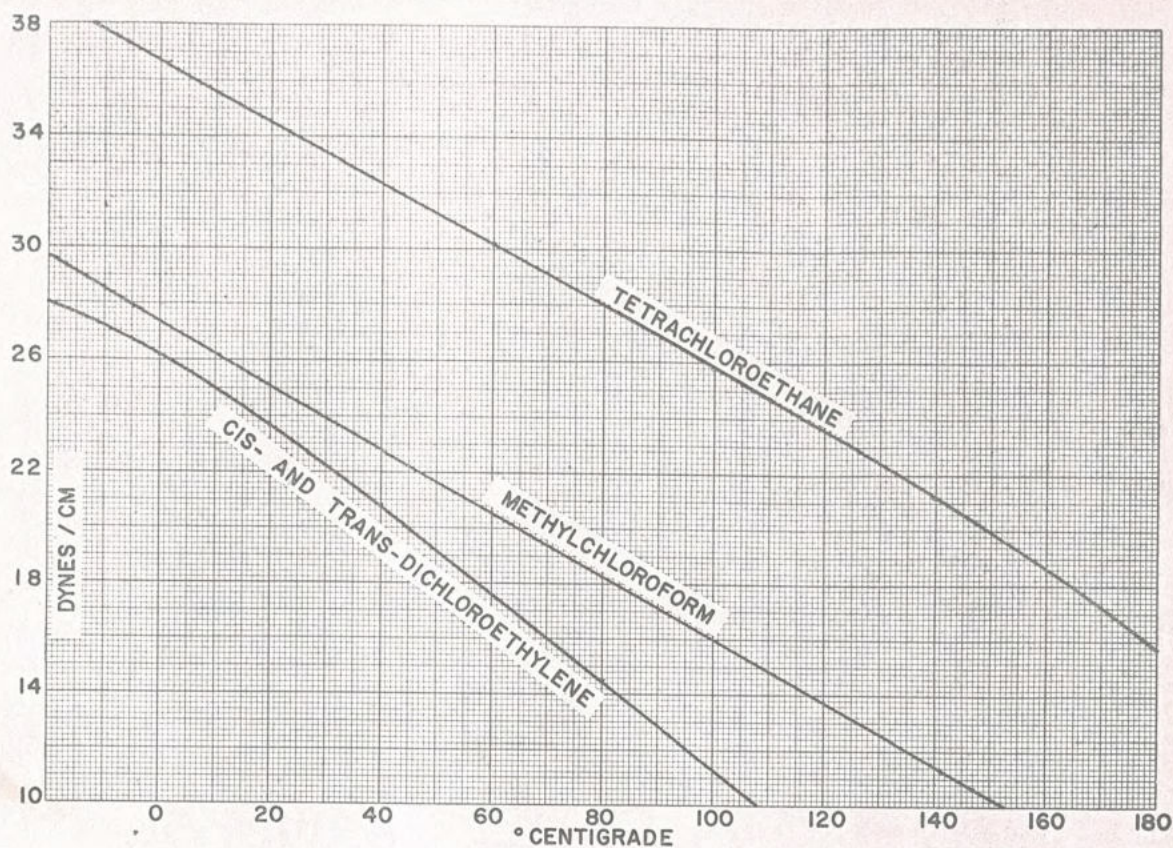


Fig. 19-8—Gives surface tension for C₂ chlorinated hydrocarbons from -20°C to +180°C.

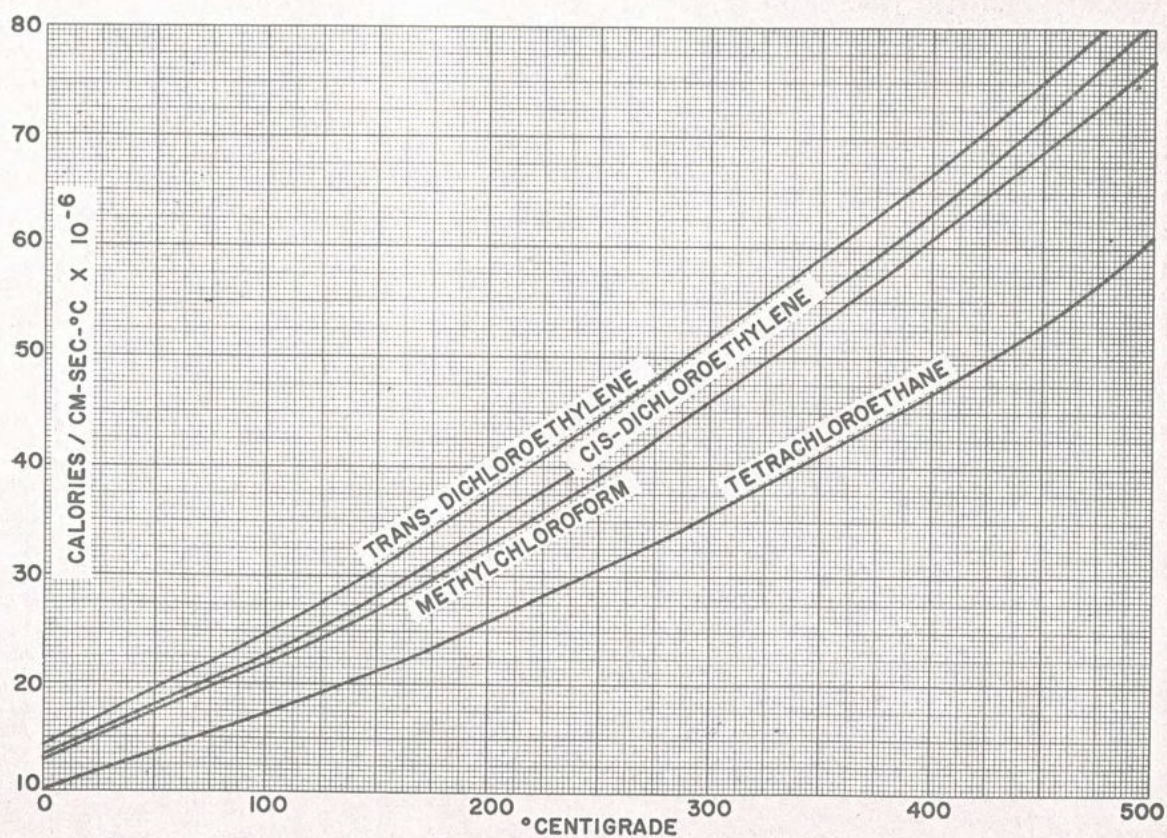


Fig. 19-9—Gives vapor thermal conductivity for C₂ chlorinated hydrocarbons from 0°C to 500°C.

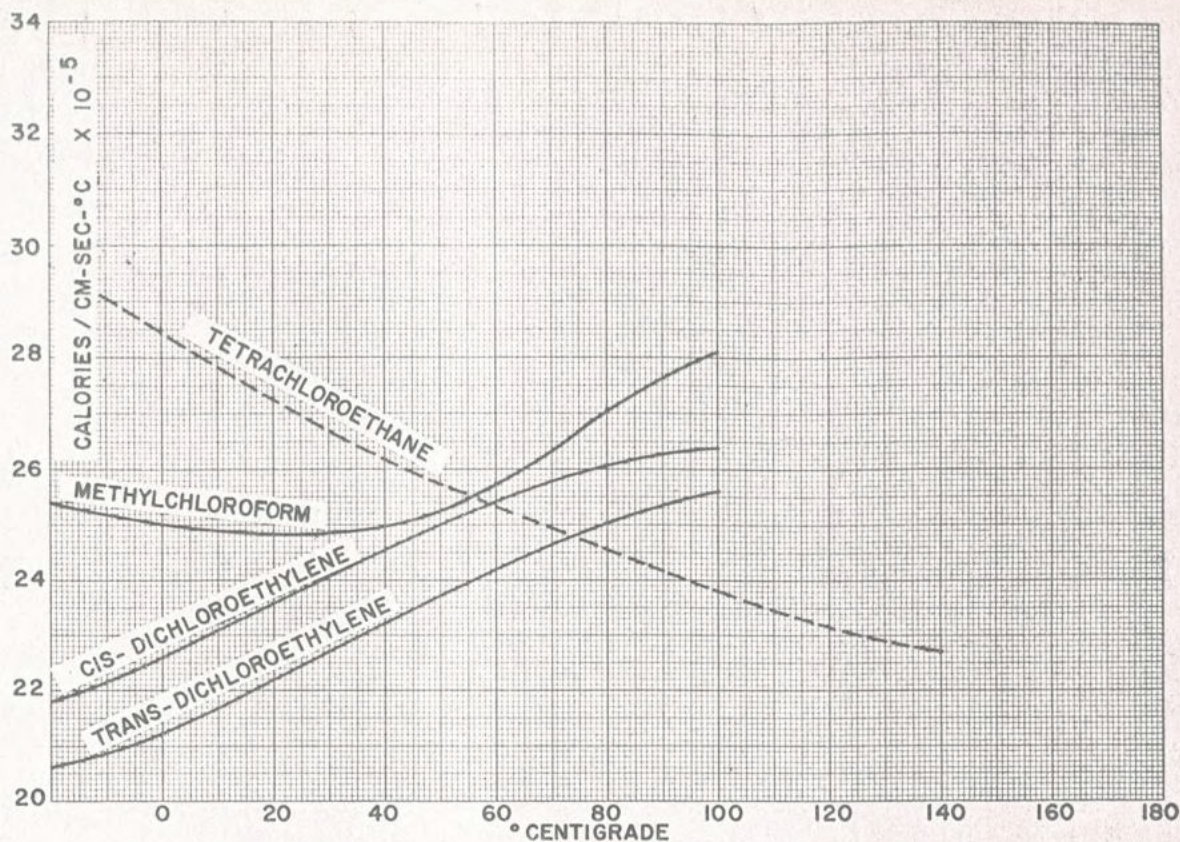


Fig. 19-10—Gives liquid thermal conductivity for C₂ chlorinated hydrocarbons from -20°C to +100°C.

Density. Only the room temperature densities have been determined.¹² The method of Lyderson, Greenkorn, and Hougen² has been used to estimate the density up to the critical point. These results agree within a few percent with data in the -20° to +120° C range provided by Stull.¹¹

Viscosity. The vapor viscosities have been estimated by the method of Bromley and Wilke.¹³ The liquid viscosities are based on the data supplied by Stull.¹¹

Surface Tension. The literature reports surface tension data only in the 0-40° C range.^{6,7,12} The data in the graph are based largely on the data of Stull.¹¹

Thermal Conductivity. The vapor thermal conductivities have been estimated by the method of Owens and Thodos.¹⁴

Very little data are available on the liquid thermal con-

ductivity. The wide scatter of the data among various researchers makes even these data of questionable value. Only the data of Mason¹⁵ on 1,1,2,2-tetrachloroethane appear reliable. The data for the other three compounds were estimated by the method of Robbins and Kingrea,¹⁶ with a probable error of ±10 percent.

ACKNOWLEDGMENT

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Indexing Terms: Computations-4, 1,2-Dichloroethylene-9, Heat-7, Liquid Phase-5, Physical Properties-7, Pressure-6, Properties/Characteristics-7, Temperature-6, Tetrachloroethane-9, Trichloroethane-9, Vapor Phase-5.

Part 20 "Halogenated Methanes" will appear in an early issue.



About the author

R. W. GALLANT is a group leader in the research and development department of The Dow Chemical Co., Plaquemine, La. His duties include process design, production plant trouble-shooting, pilot plant operations, product development, and process development. Mr. Gallant received a B.S. in chemical engineering from the University of Florida.