Physical Properties of Hydrocarbons

Part 2—C_2 to C_4 Monoolefins
Part 3—C_2 to C_4 Alkynes
Part 4—C_2 to C_4 Diolefins
Part 5—Chlorinated Methanes

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OF THE THREE DIOLEFINS, only one has reached strong commercialization. 1,3-butadiene continues to be one of the basic important monomers for synthetic rubbers. Its annual use is in excess of 2 billion pounds per year, 85 percent of which goes into styrene-butadiene rubbers. Because of its value and utility for over 20 years, the physical properties of 1,3-butadiene have been extensively covered. Very little data are available on the 1,2-butadiene or propadiene.

Vapor Pressure. Stull[16] presents extensive pressure data for all three compounds up to the boiling point. For 1,3-butadiene and propadiene, he presents data up to the critical point. Hachmuth[17] covers 1,2-butadiene up to 34 psia. Beyond this point, the line is extrapolated via the Cox chart method to the critical pressure of 653 psia.

Thermal Properties. The heat of vaporization has not been measured over a wide range for either propadiene or 1,2-butadiene and so these data have been extrapolated by the method of Watson, which relates the change in heat of vaporization with temperature to the reduced temperature. For six points this showed a maximum error of 4 percent and an average error of 2 percent. The heat of vaporization for the very low and very high regions was also extrapolated for 1,3-butadiene. The main source of data for this compound in the —18 to +60° C temperature range was the product data book by Texas-U.S. Chemical Co.

TABLE 4-1—Propadiene-Butadiene

Compound	Boiling Point °C	Freezing Point °C	Molecular Weight	Critical Properties °C tc	psi Pc	g/ml dc
Propadiene	−34.5	−136	40.06	120	760	0.247
1, 2-Butadiene	18.5	.....	54.09	171	653	.2468
1, 3-Butadiene	− 4.4	−108.9	54.09	152	628	.245

The vapor heat capacity for propadiene and 1,3-butadiene was taken from the data of Kobe. No reliable data were found for the vapor heat capacity of 1,2-butadiene and so this was assumed to be approximately the same as that for 1,3-butadiene. This is probably as accurate as any estimation method that could be used. The liquid heat capacities are once again estimated by the method of Schiff, except for the 1,3-butadiene for which the Texas-U.S. Chemical Co. product data book covers the —18 to +60° C range. Comparison of this data with the estimation method of Schiff showed a maximum error of 7.5 percent and an average error of 4.0 percent.

Liquid Density. The density for 1,3-butadiene is plotted from —40 to +60° C in the Texas-U.S. Chemical Co. product book. Data for propadiene and 1,2-butadiene are available for a few points in several handbooks. Francis[24] presents an equation for calculating the density of 1,3-butadiene from 0-140° C.

Viscosity. Once again, in order to cover a wide temperature range, it has been necessary to use the method of Thodos and Flynn,[34] although a fair amount of data are reported for 1,3-butadiene. The critical properties of all three compounds appear to be quite well established and so the error should be in the neighborhood of only a few percent.

Liquid viscosity was calculated by the method of Thomas, since there were no extensive reliable experimental data.

Surface Tension. Dreisbach[8] is the only source of data found for surface tension. These data have been extrapolated by the method of Othmer.

See Part 1 for list of references

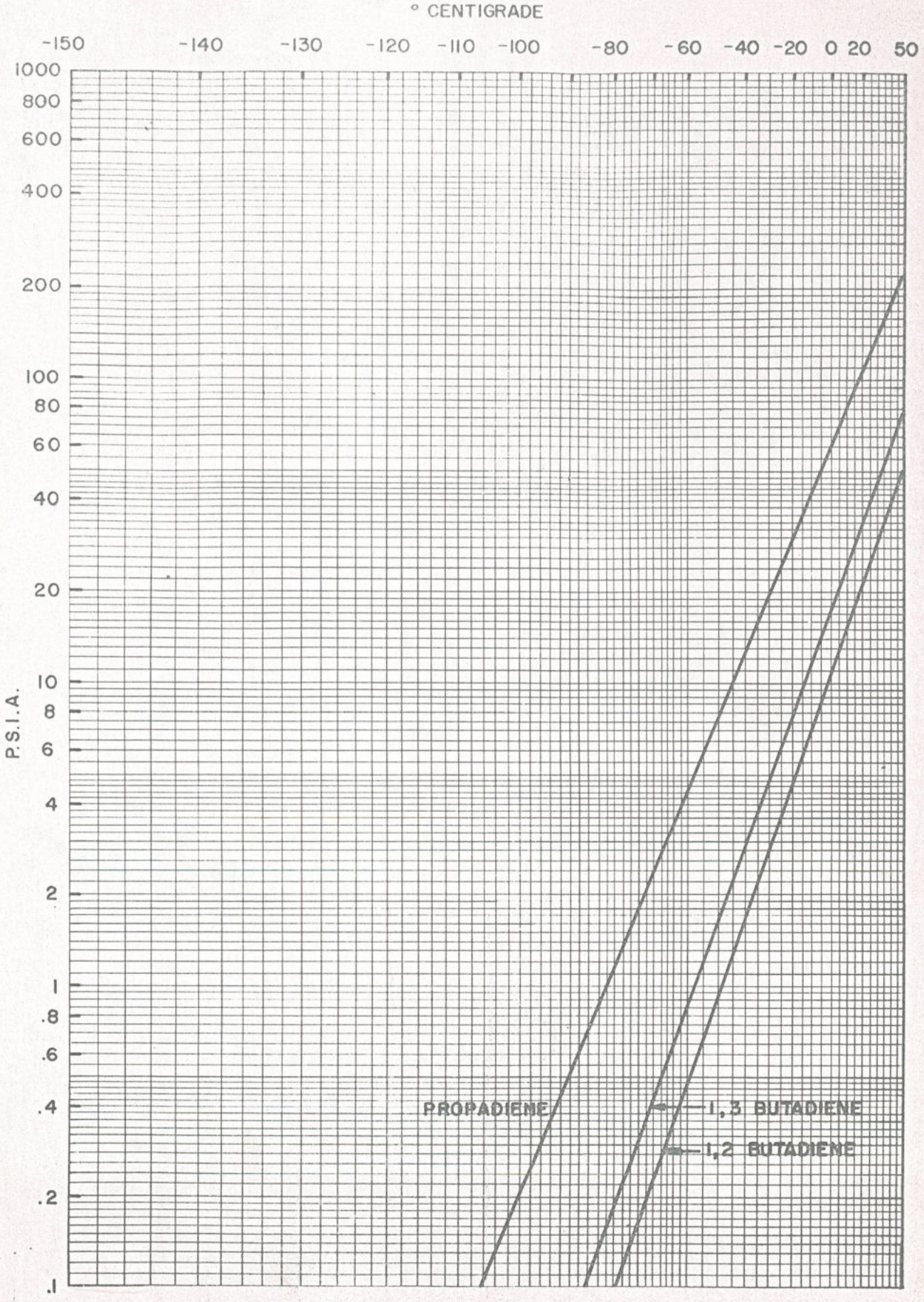

Fig. 4-1—Vapor pressure over a range of −150 to +50°C.

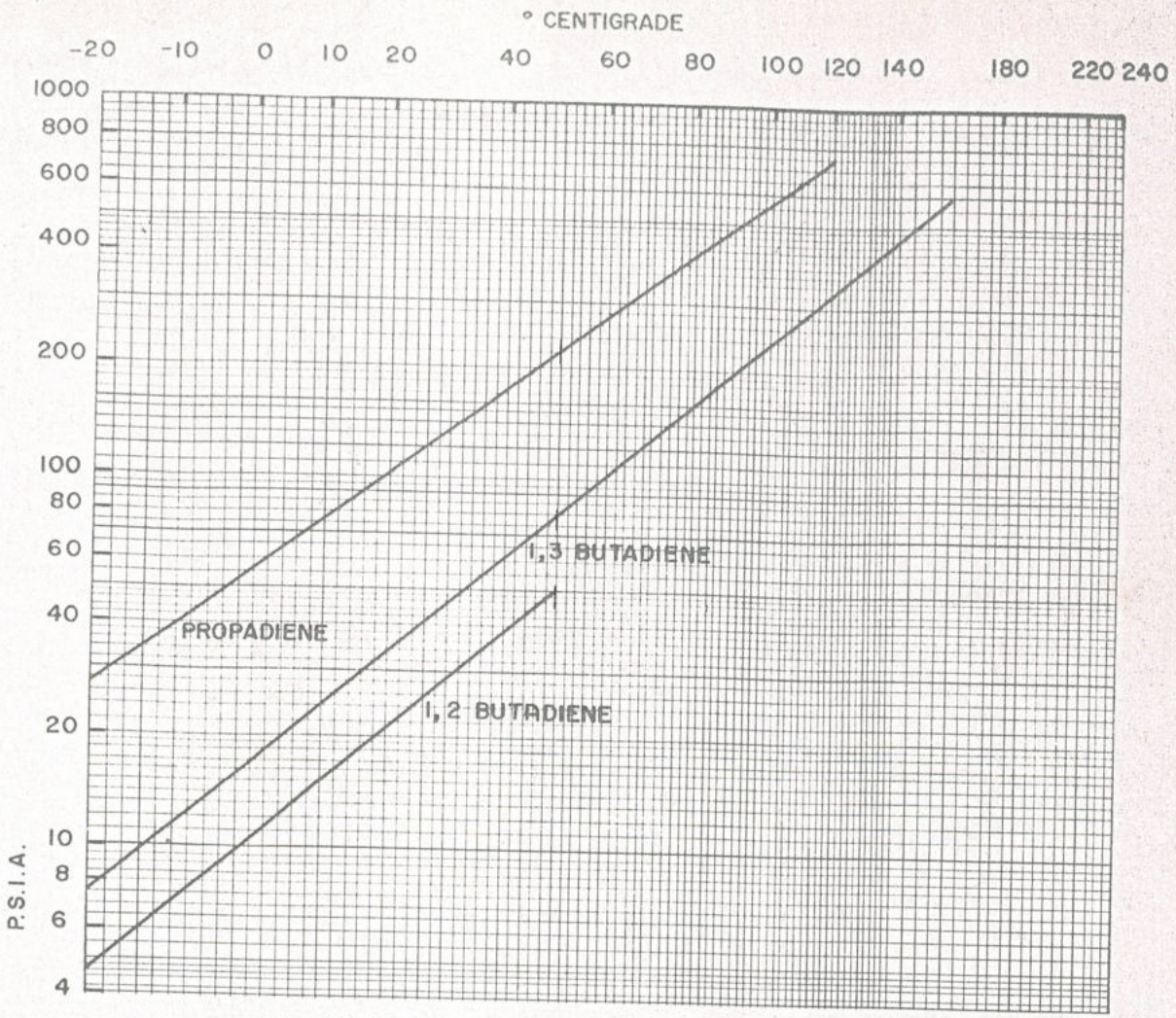

Fig. 4-2—Vapor pressure over a range of −20 to +171°C.

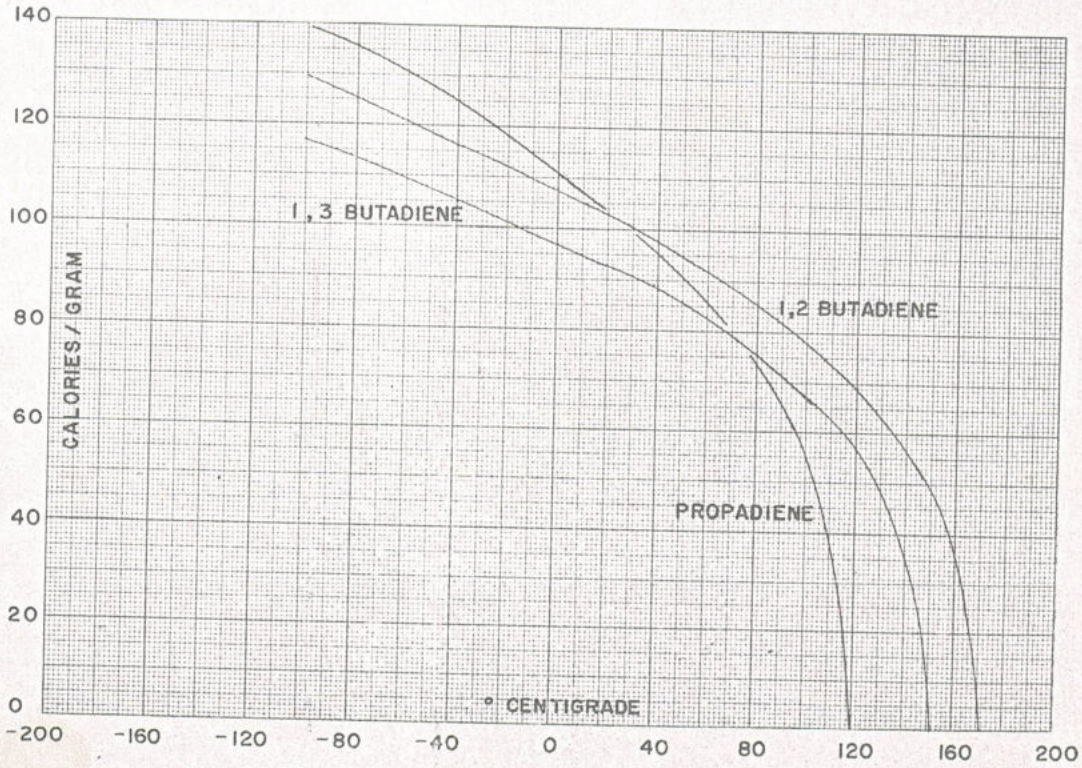

Fig. 4-3—Heat of vaporization over a range of −100 to +171°C.

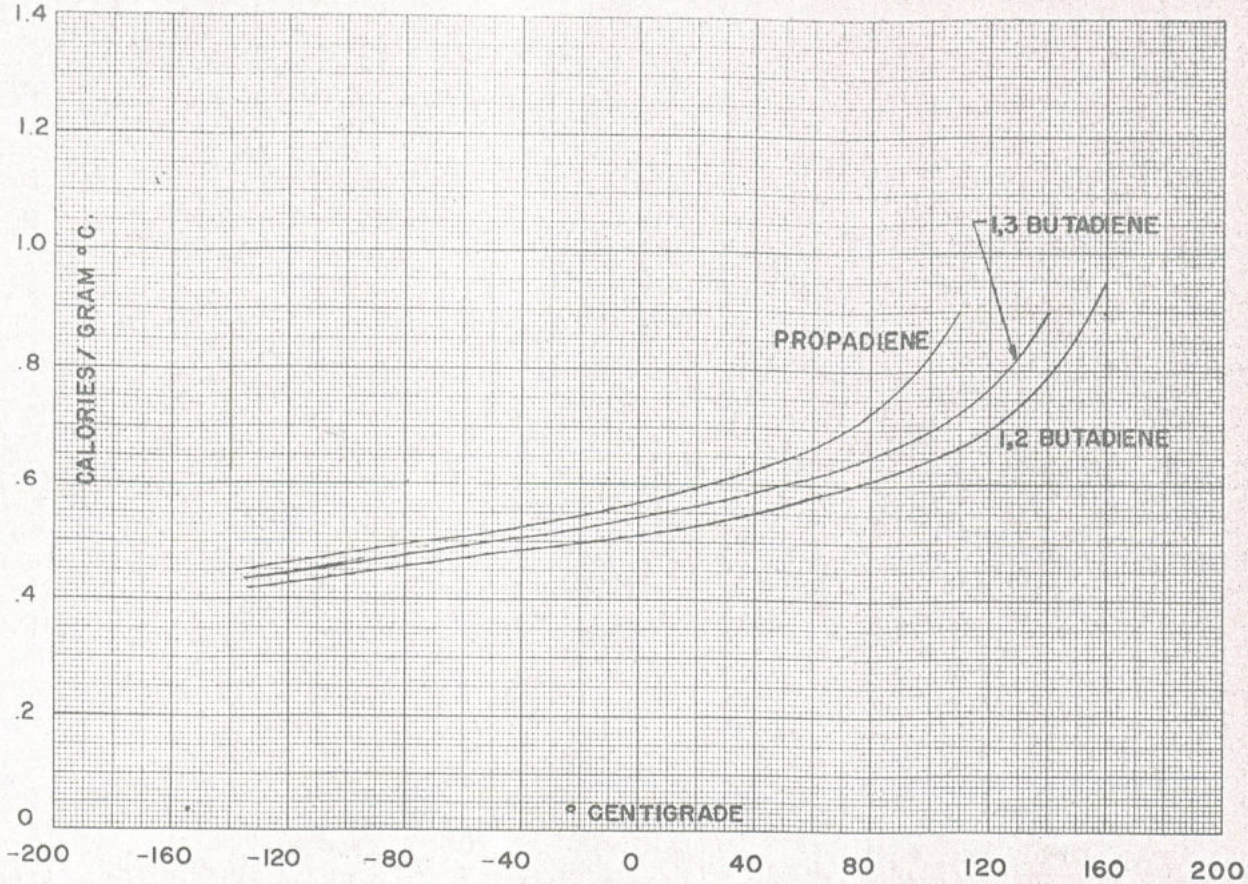

Fig. 4-4—Liquid heat capacity over a range of −140 to +160°C.

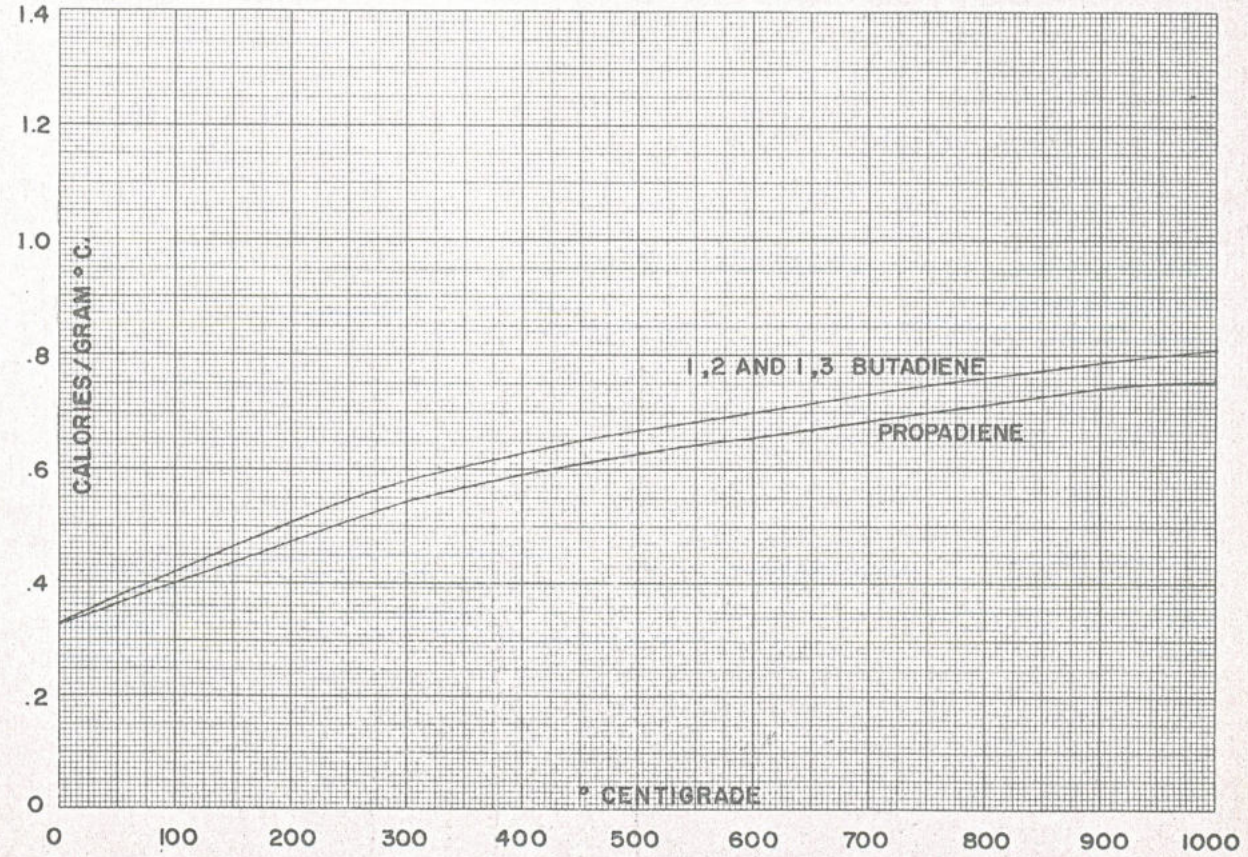

Fig. 4-5—Vapor heat capacity over a range of 0 to 1,000°C.

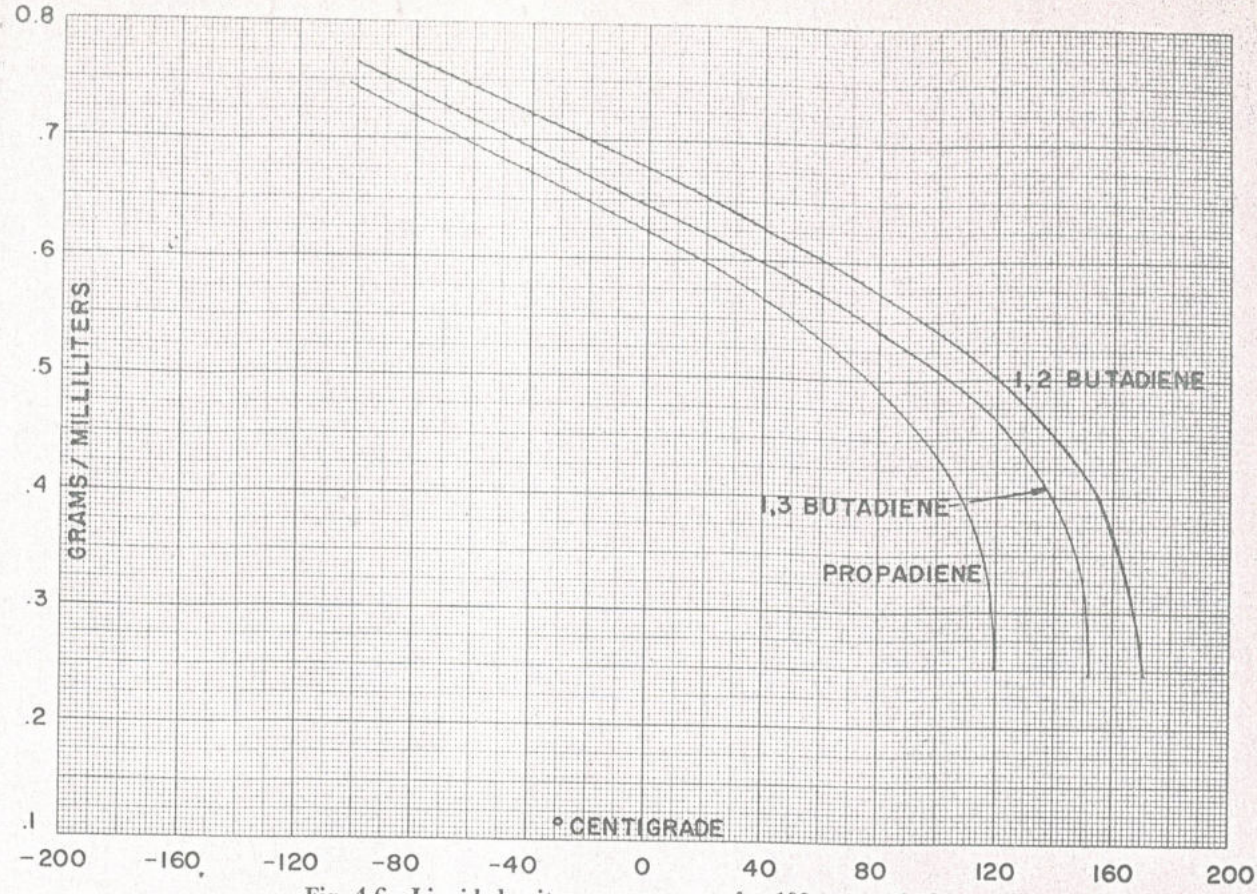

Fig. 4-6—Liquid density over a range of —100 to +170°C.

Editor's Note: The temperature scale is incorrect in Figure 3, Part 3, on C_2 to C_4 alkynes, (HYDROCARBON PROCESSING & PETROLEUM REFINER, September, Page 229). The scale should be from —160 to +240°F. Correct scale by shifting temperature 40° to right.

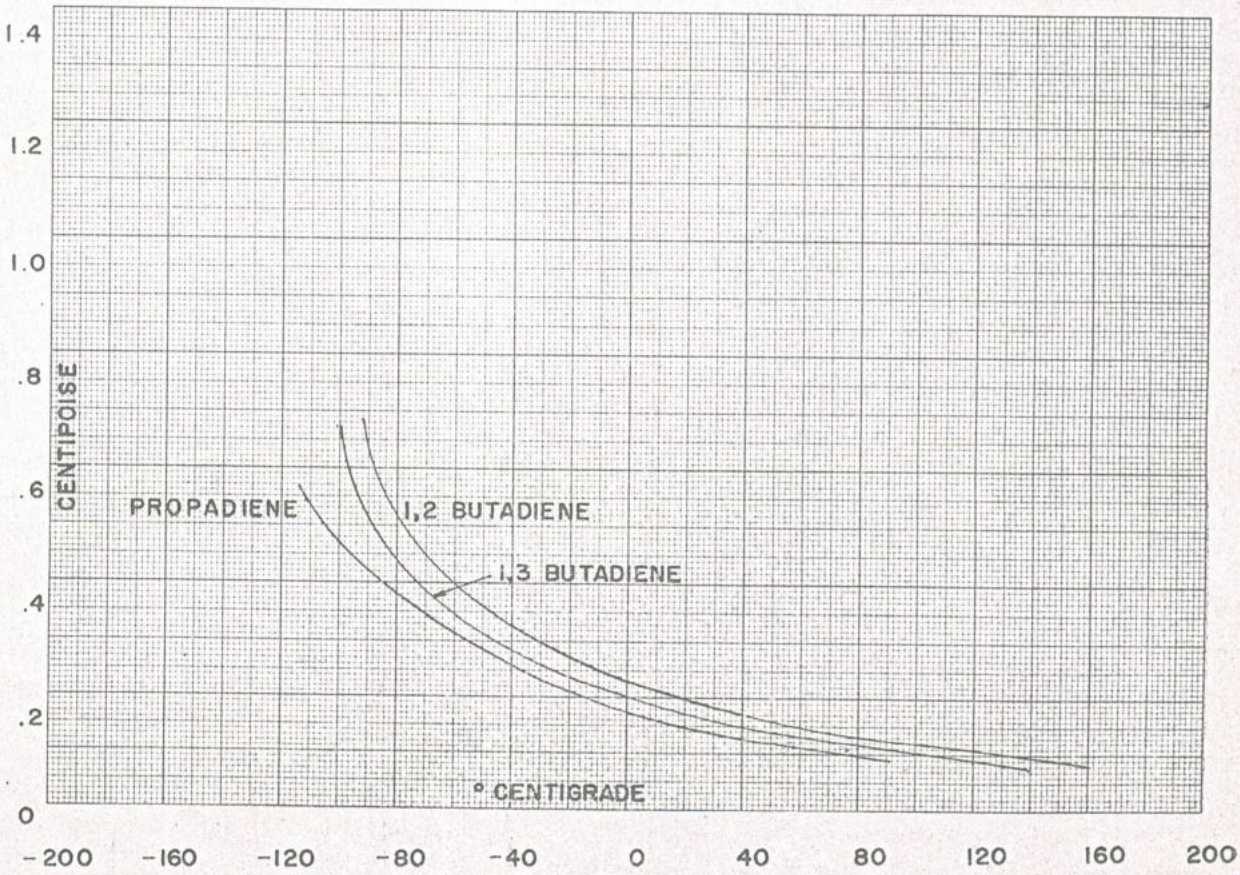

Fig. 4-7—Liquid viscosity over a range of —100 to +160°C.

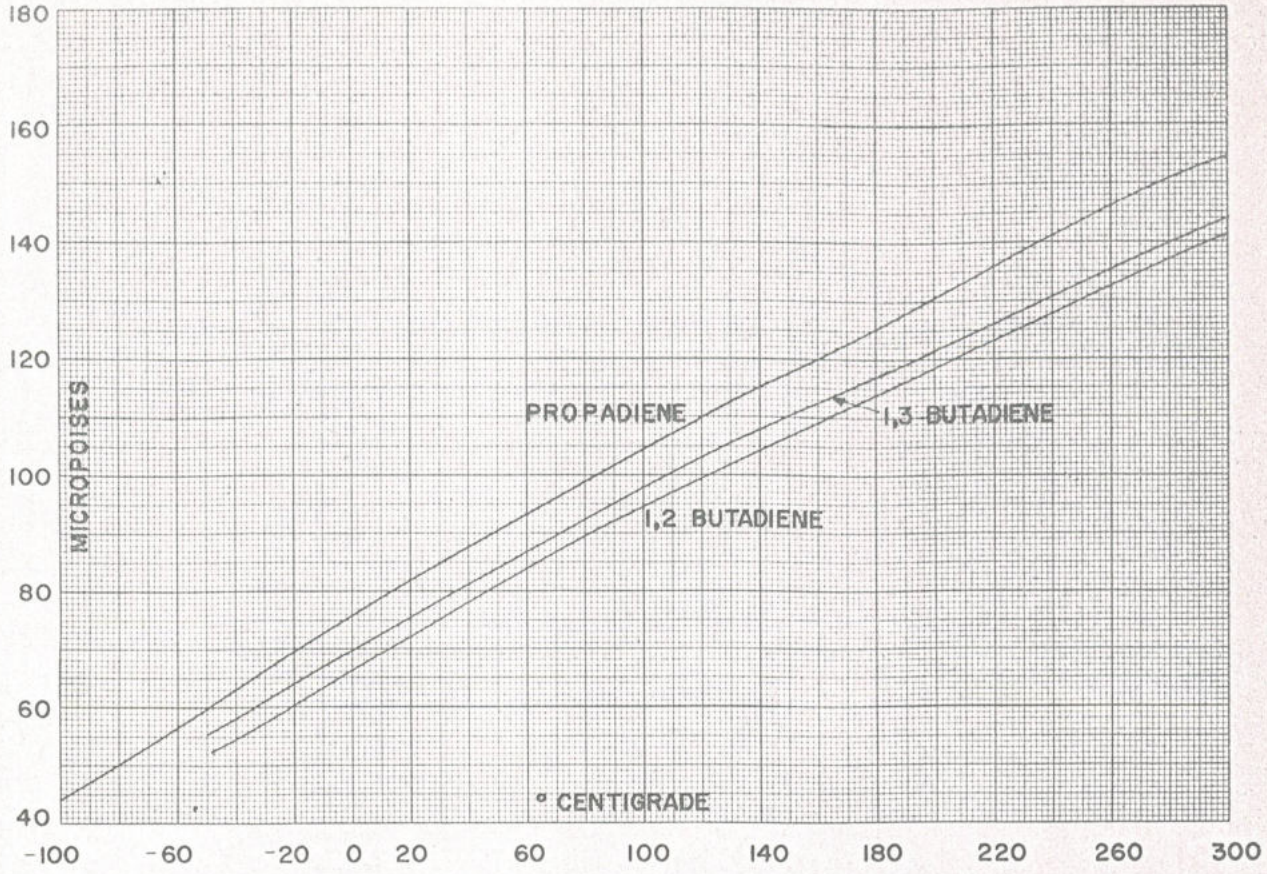

Fig. 4-8—Vapor viscosity over a range of −50 to +300°C.

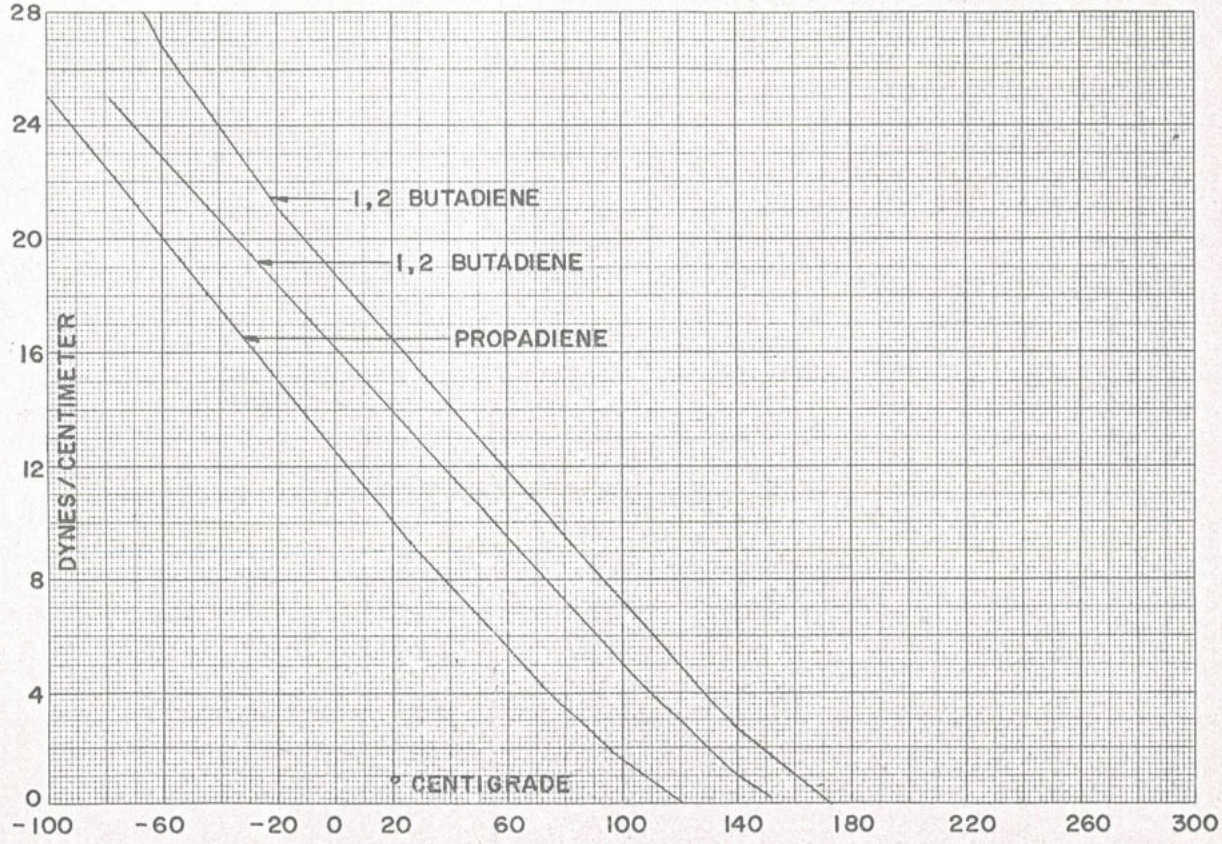

Fig. 4-9—Surface tension over a range of −100 to +170°C.

To be continued. Parts 1, 2 and 3 appeared in the July, August and September 1965 issues of HYDROCARBON PROCESSING & PETROLEUM REFINER.