Physical Properties of Hydrocarbons

Part 30–Acrylates

From charts you can get these properties for acrylates:

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

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THE ACRYLATES have been one of the fastest growing chemical groups. They are used almost exclusively in the preparation of polymers which find wide usage as surface coatings and textile, leather, and paper finishes. In 1967, sales of acrylates and acrylic acid will be about 200 million pounds. Methyl methacrylate continues to enjoy a growth rate of 10 percent a year, with most of its usage going into cast sheet, molding powder, and coatings. The sales for 1967 will be almost 300 million pounds.

There are a variety of manufacturing processes for acrylic acid. These include (1) reacting ethylene oxide and hydrogen cyanide, followed by acidic hydrolysis and dehydration; (2) carbonyl reactions using acetylene, carbon monoxide, and water; (3) acid hydrolysis of acrylonitrile, and (4) oxidation of propylene to hydroxypropionic acid, followed by dehydration. The esters are formed by adding the appropriate alcohol during the hydrolysis step.

The tendency to polymerize as the temperature increases has made high temperature physical property measurements almost impossible. Consequently, no data are available on the compounds above the boiling point or in the gaseous state.

Critical Properties and Vapor Pressure. The critical properties of all four compounds were estimated by the method of Vowles for critical temperature and density, and by Riedel's method for critical pressure.[1] Stull reports the vapor pressures up to the boiling point.[2] The vapor pressures above the boiling point were estimated by the previously used method described by Miller.[3]

Heat of Vaporization. Only the heat of vaporization at the boiling points has been reported in the literature.[4, 5, 6] These data have been extended by the use of Kharbanda's nomograph.[7]

Heat Capacity. The vapor heat capacities were calculated by the method of Rihani and Doraiswamy.[8]

The liquid heat capacities available from the literature at room temperature,[4, 5] were extended by the equation: heat capacity times density equals a constant.

TABLE 30-1—Physical Properties of Acrylates

Compound	Boiling Point, °C	Freezing Point, °C	Molecular Weight	Critical Properties		
				T_c °C	P_c PSIA	d_c g/ml
Acrylic Acid	141.0	14	72.03	380*	734*	0.342*
Mathyl Acrylate	80.5	<−75	86.09	272*	618*	0.322*
Ethyl Acrylate	99.6	−72	100.11	288*	533*	0.309*
Methyl Methacrylate	101.0	−48	100.11	290*	533*	0.309*

* Estimated.

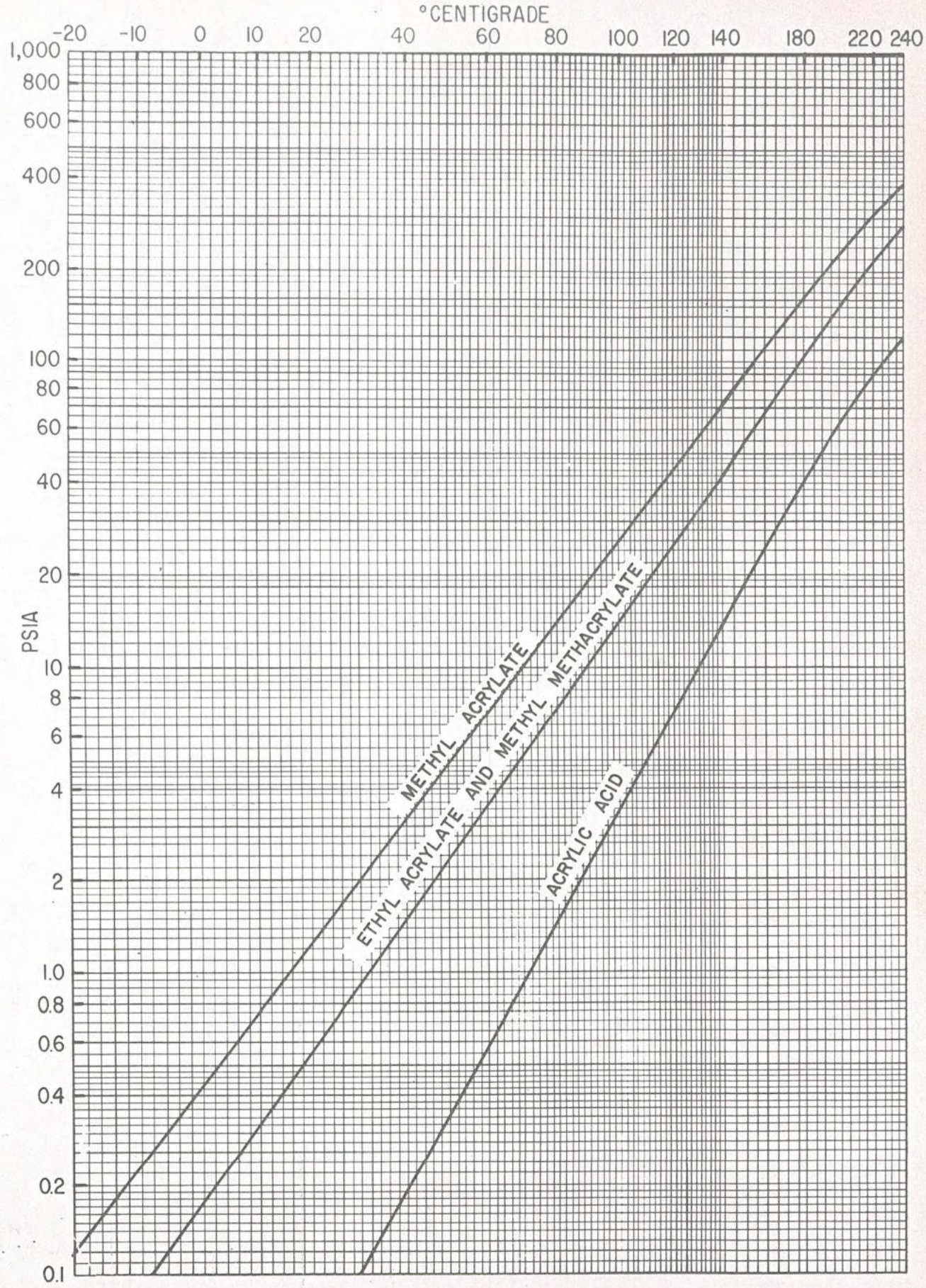

Fig. 30-1—Gives vapor pressure of acrylates from —20° C to +240° C.

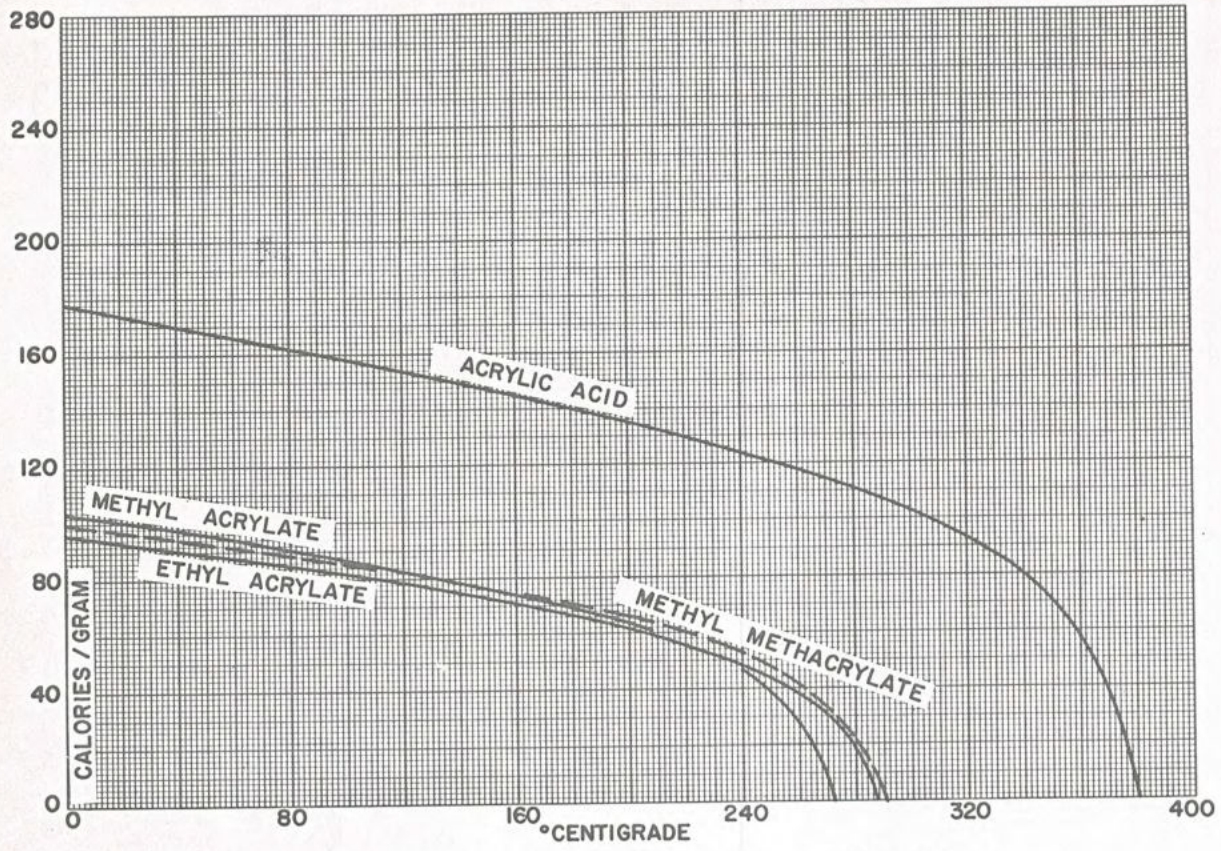

Fig. 30-2—Gives heat of vaporization of acrylates from 0° C to 380° C.

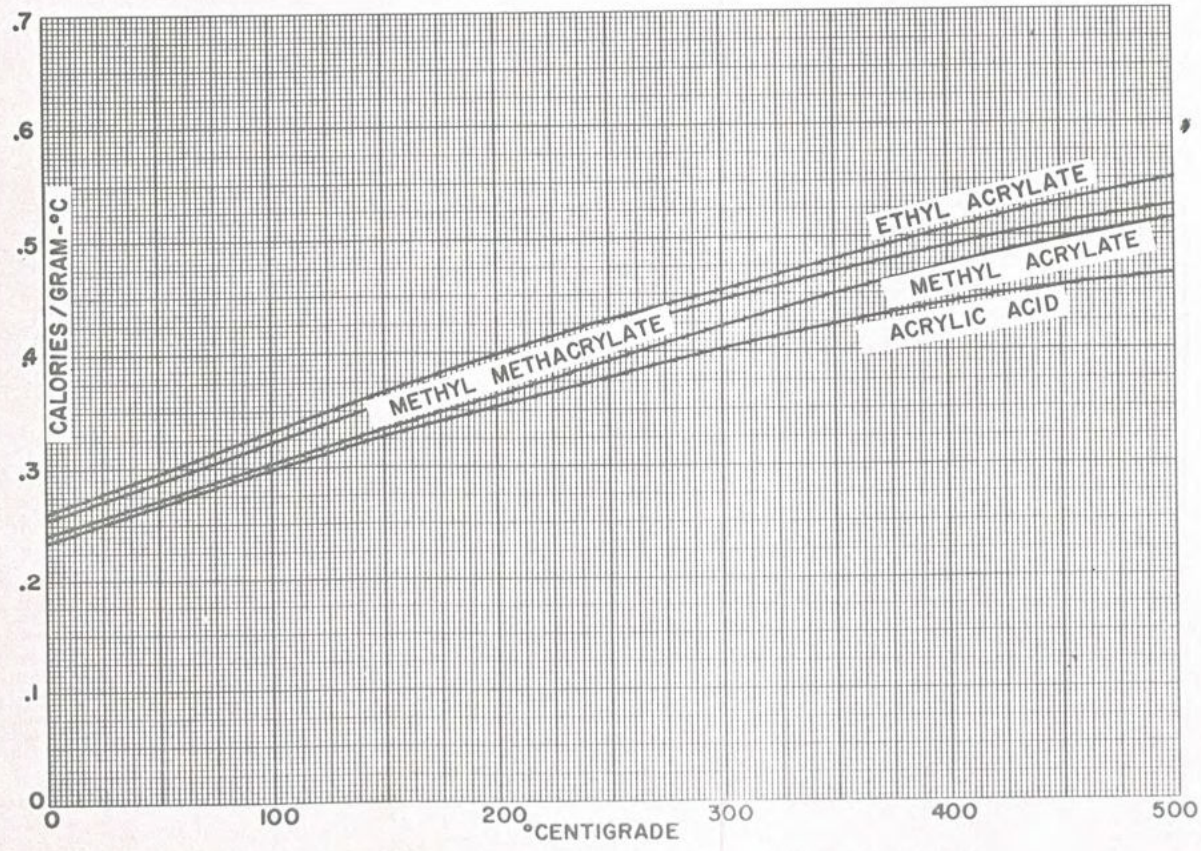

Fig. 30-3—Gives vapor heat capacity of acrylates from 0° C to 500° C.

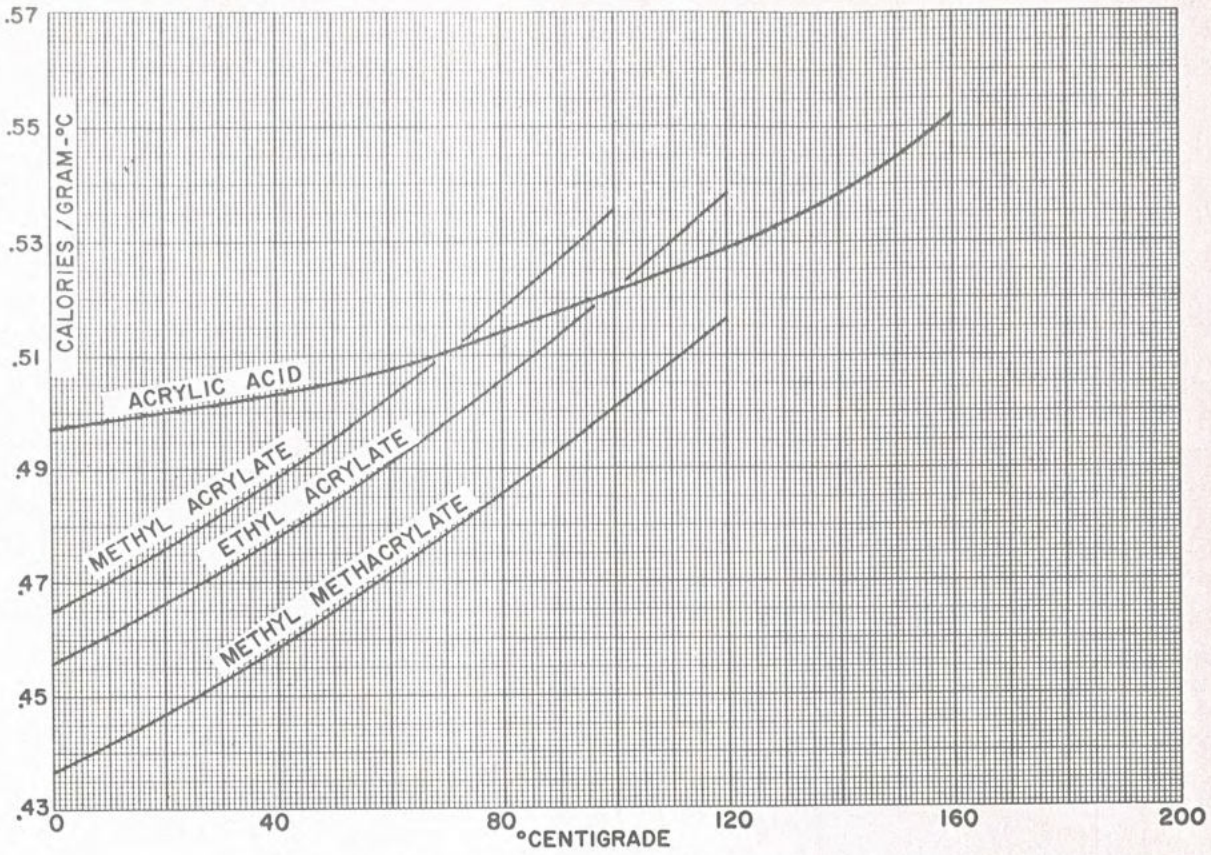

Fig. 30-4—Gives liquid heat capacity of acrylates from 0° C to 160° C.

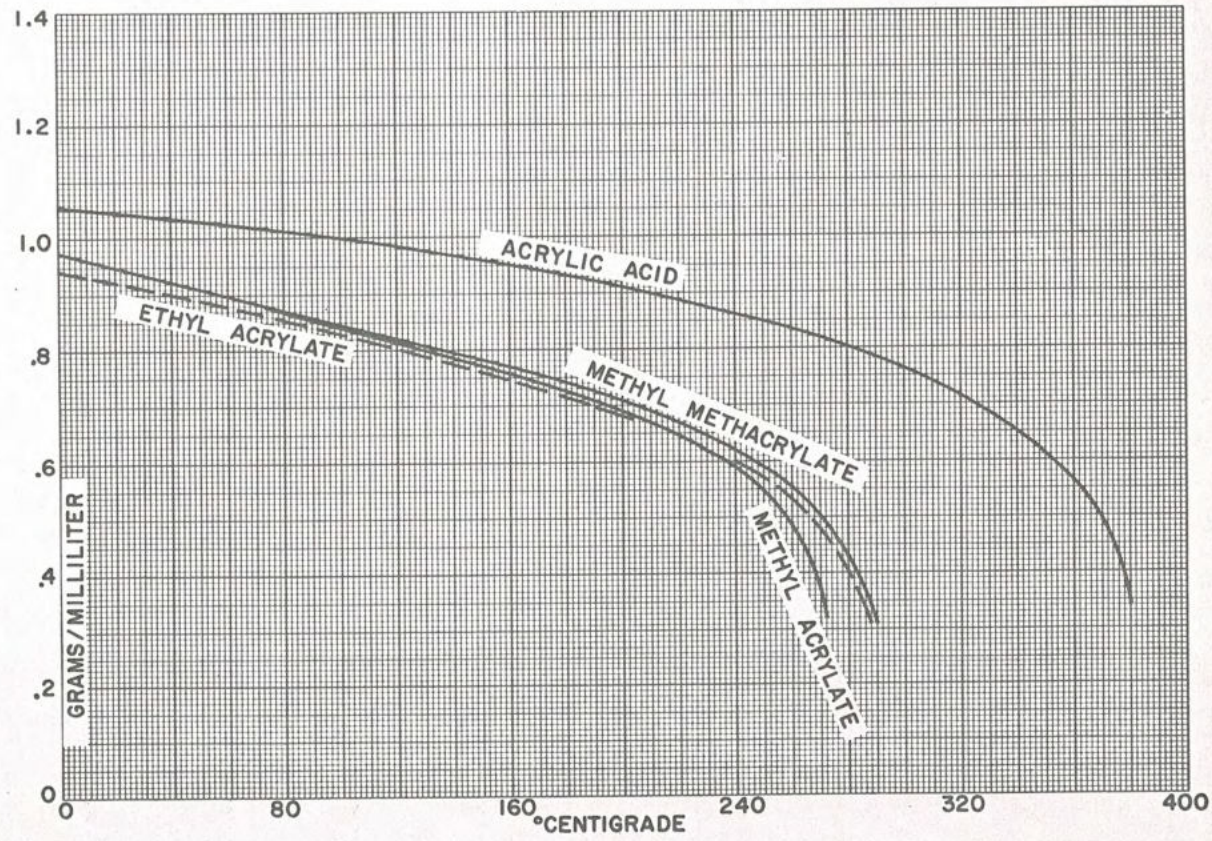

Fig. 30-5—Gives liquid density of acrylates from 0° C to 380° C.

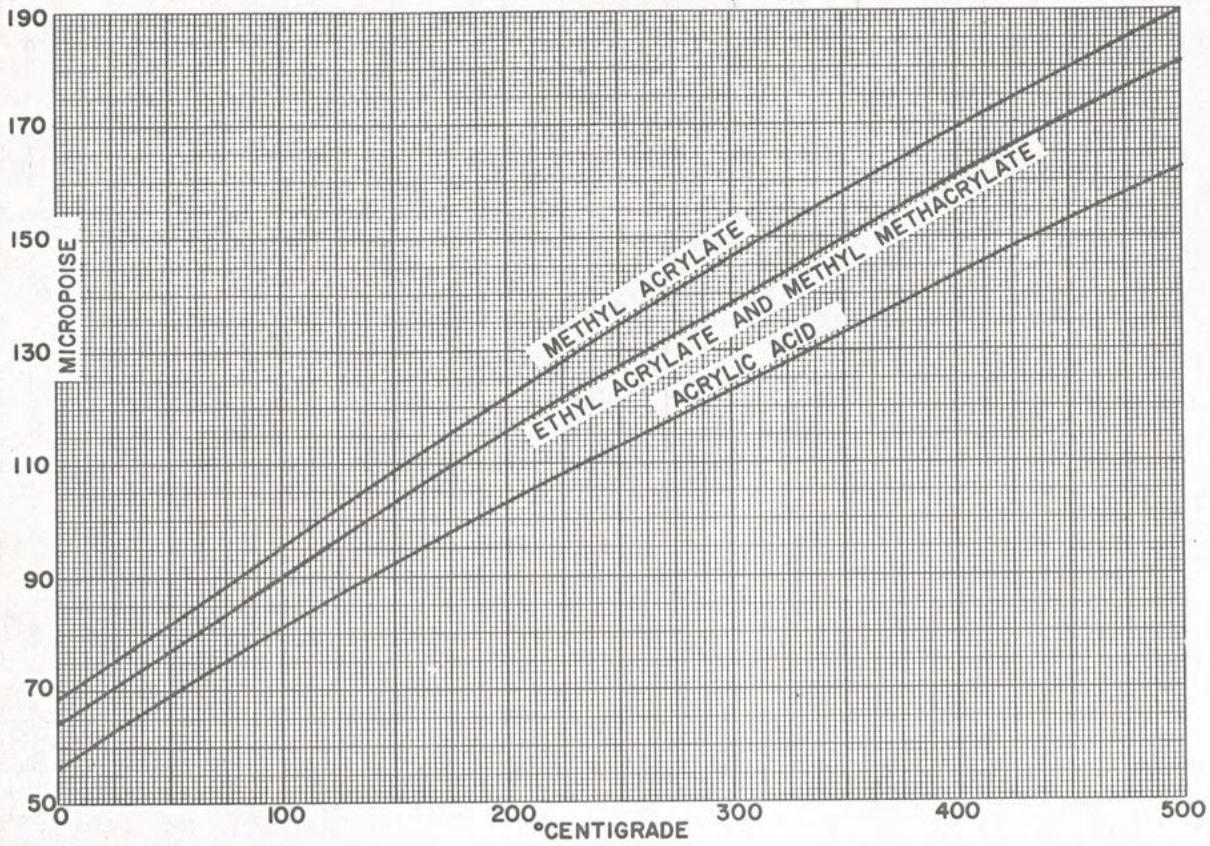

Fig. 30-6—Gives vapor viscosity of acrylates from 0° C to 500° C.

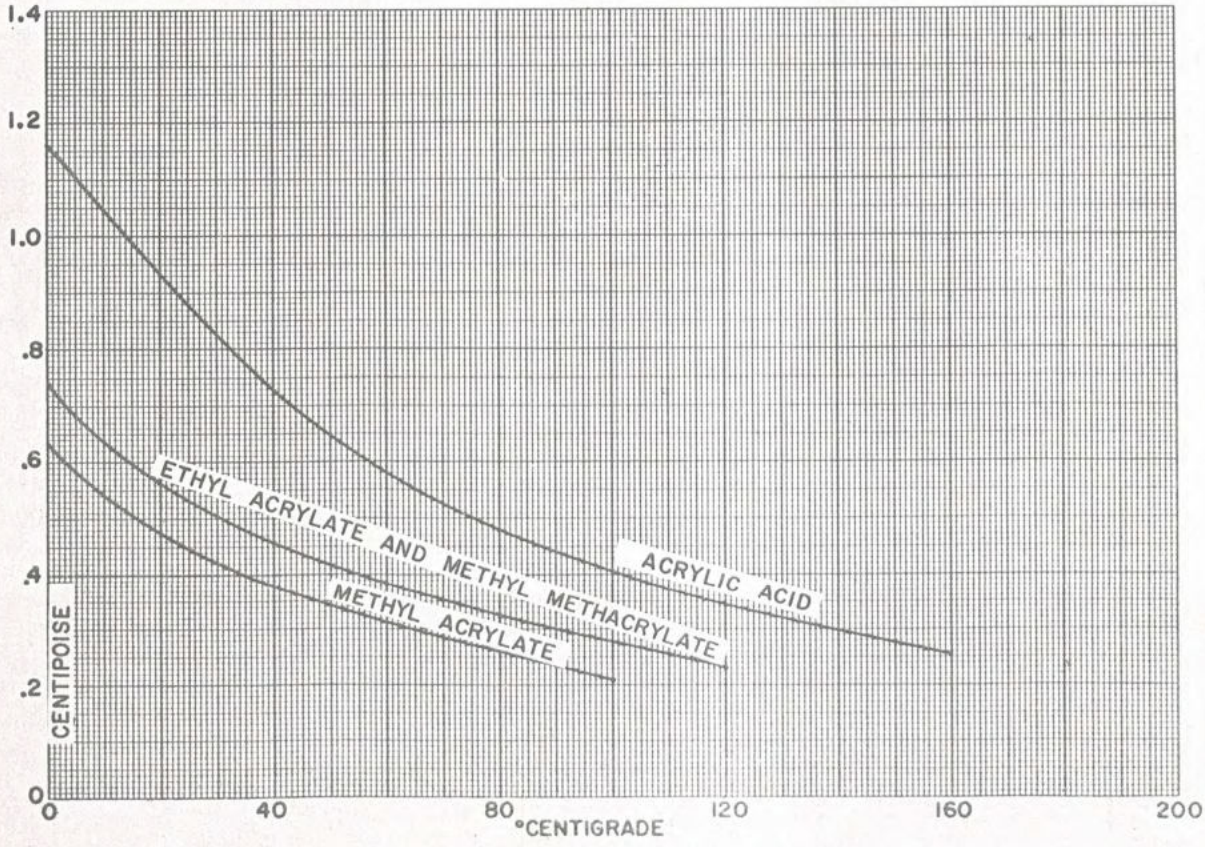

Fig. 30-7—Gives liquid viscosity of acrylates from 0° C to 160° C.

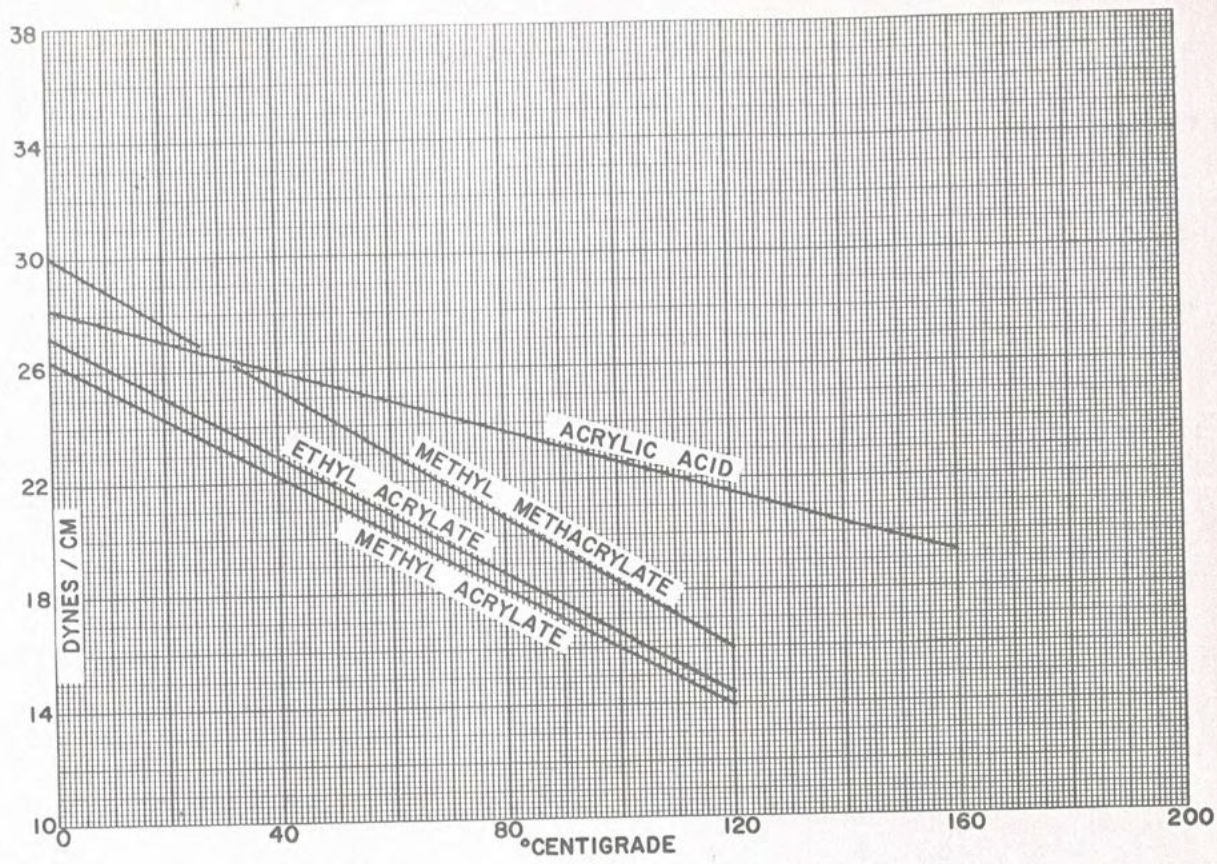

Fig. 30-8—Gives surface tension of acrylates from 0° C to 160° C.

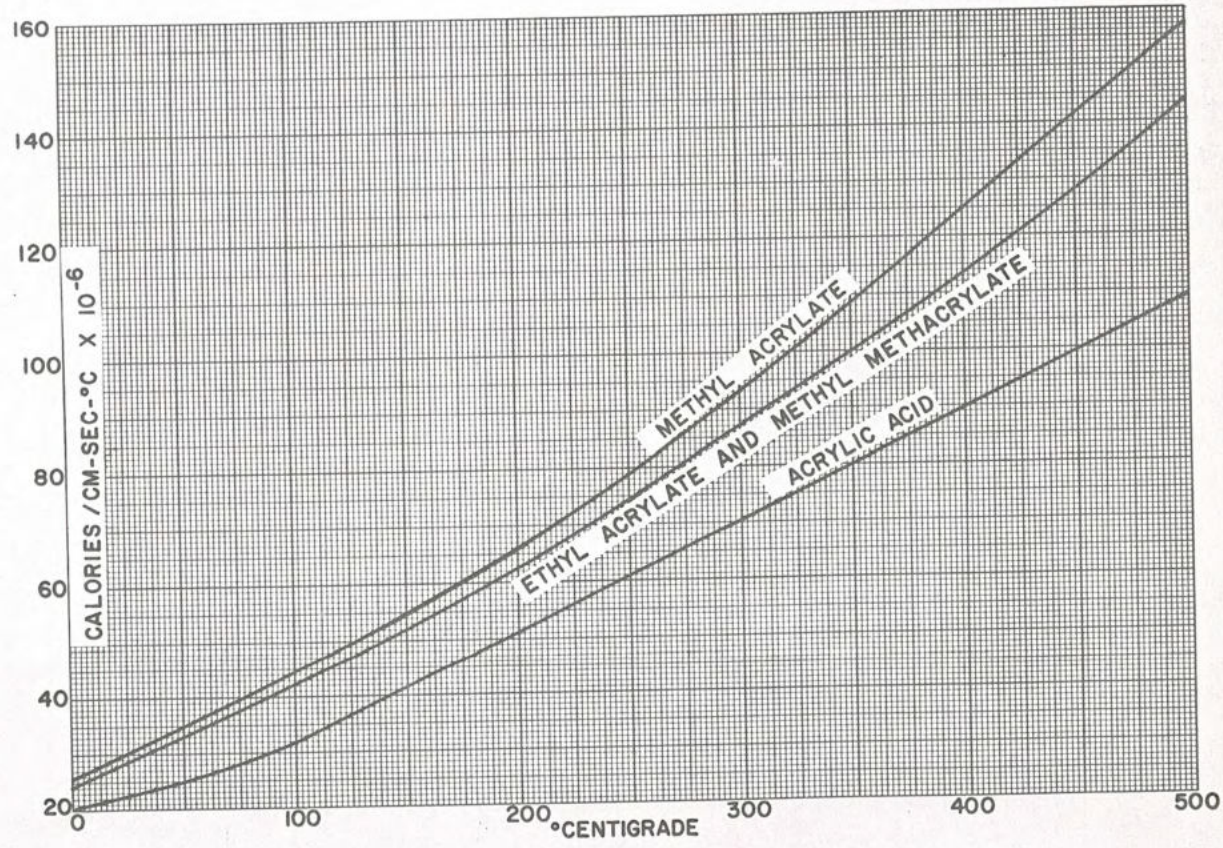

Fig. 30-9—Gives vapor thermal conductivity of acrylates from 0° C to 500° C.

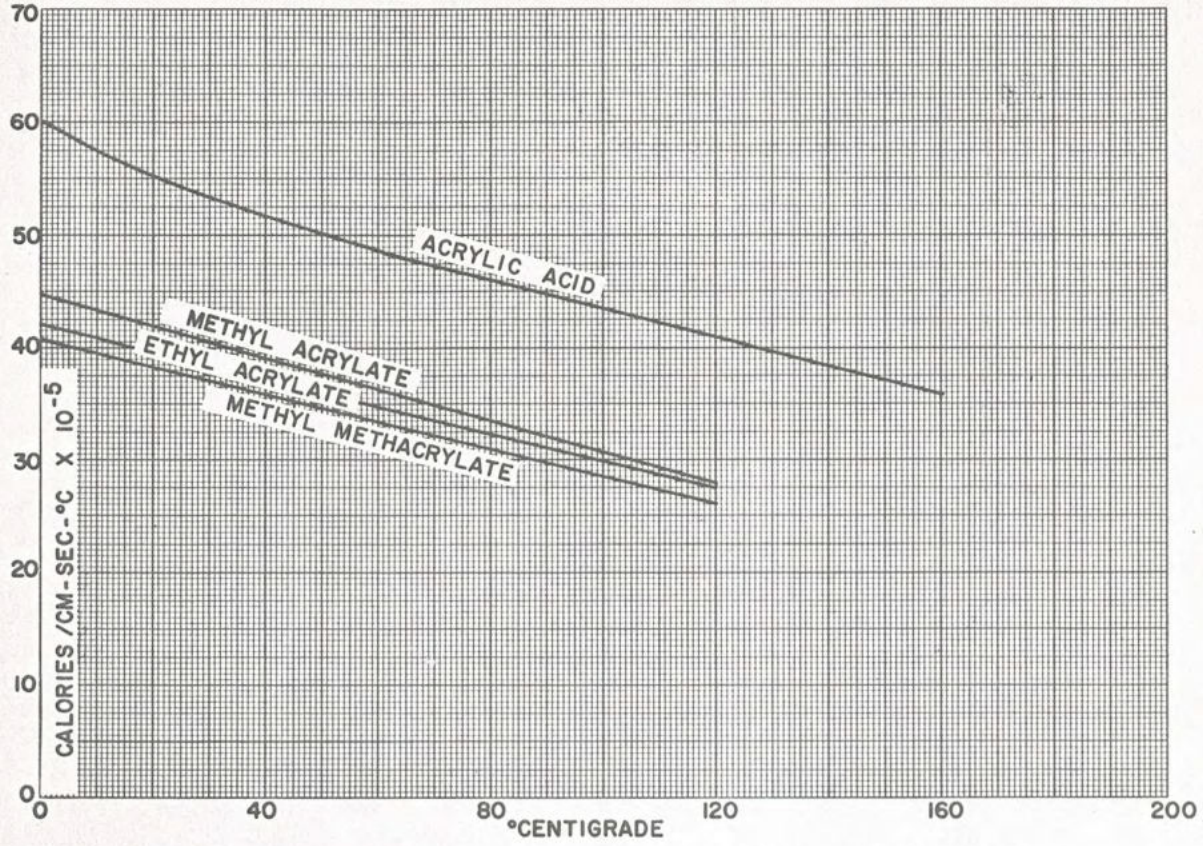

Fig. 30-10—Gives liquid thermal conductivity of acrylates from 0° C to 160° C.

Density. Matheson and co-workers have measured the density of methyl acrylate from 10-50° C[9] and methyl methacrylate from 0-75° C.[10] The room temperature densities of the other two compounds have been reported in the literature.[4, 5] The method of Lydersen and co-workers was used to estimate the densities from 0° C to the critical point.[1] When compared to the experimental data for methyl acrylate and methyl methacrylate, the average and maximum errors were 0.2 percent and 0.4 percent respectively.

Viscosity. The vapor viscosities were estimated by the method used in previous articles.[11]

Riddle reports data on the liquid viscosity of the acrylates from 0-70° C.[4] Only the room temperature viscosity of acrylic acid has been measured.[4] The liquid viscosities of all four compounds were estimated by Thomas' method.[1] The average error for 10 experimental values was 2.6 percent.

Surface Tension. Sugden's method was used to calculate the surface tensions of all four compounds.[12]

Thermal Conductivity. With no experimental data available, the vapor and liquid thermal conductivities were estimated.[13, 14]

About the author

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Indexing Terms: Acrylic Acid-9, Computations-4, Ethyl Acrylate-9, Heat Liquid Phase-7, Methyl Acrylate-9, Physical Properties-7.

Part 31 will appear in an early issue.