Liquid, Gas, and Dense Fluid Viscosity of Ethane

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THIS INVESTIGATION was conducted under one phase of a continuing effort to meet some of the increasing needs of industry for thermodynamic and physical property data of fluids for more extreme conditions and for improved generalizations of behavior. The investigation of the viscosity behavior of propane for wide ranges of conditions has been reported (*17*), that for butane is being prepared for release, and that for ethane is reported herein.

The new experimental data define ethane viscosity behavior for the liquid, gas, and dense fluid. These data are correlated with those of other investigators to determine the best values for considerable ranges of temperature and pressure. The concept of residual viscosity dependence on density is shown to yield significant rectification of the data for densities greater than 0.10 gram per cc.

The residual viscosity concept and the kinetic theory are utilized to extrapolate the data to elevated temperatures and pressures with an accuracy believed within ±2%. Recommended values for ethane viscosity are presented for temperatures from 70° to 460° F. and pressures from atmospheric to 10,000 p.s.i.a.

APPARATUS AND MATERIALS

A capillary tube viscometer of new design was utilized for the study of ethane viscosity behavior. The operation of the instrument is based on the principle of the Rankine viscometer, but an improved method is used for obtaining the pressure differential causing fluid flow. The viscometer is an absolute instrument and therefore does not require calibration; the instrument has been described, with estimates of the precision and accuracy of measurements (*8*).

The ethane used for this investigation was Phillips Petroleum research grade, certified 99.9 mole % pure. Mass spectrometer analyses indicated no impurities in the samples tested, so use of 90° F. and 715 p.s.i.a. for its critical point seemed valid.

EXPERIMENTAL DATA

To define ethane viscosity behavior adequately, it was necessary to obtain new data for a wide range of conditions. Data were obtained at 77°, 100°, 160°, 220°, 280°, and 340° F.; the pressure range was 200 to 8000 p.s.i.a. for the first four temperatures and 200 to 2000 p.s.i.a. for the last two. Data for both the liquid and gas were obtained at 77° F. At 100°, 160°, and 220° F. data were obtained both above and below the critical density, and at the two top temperatures all values are for densities less than the critical. Experimental values were not needed to determine the viscosity of the dense fluid at these temperatures.

Isotherms of ethane viscosity are presented in Figure 1. The isotherm values were plotted *vs.* pressure as data were obtained. A cross plot of viscosity *vs.* temperature (Figure 2) was prepared to locate questionable points and to check the internal consistency of the data. Portions of the experimental data have been omitted from Figures 1 and 2 for clarity. The data for high temperatures, omitted from Figure 1, are shown clearly in Figure 2. Detailed tables of the experimental data are available from ADI.

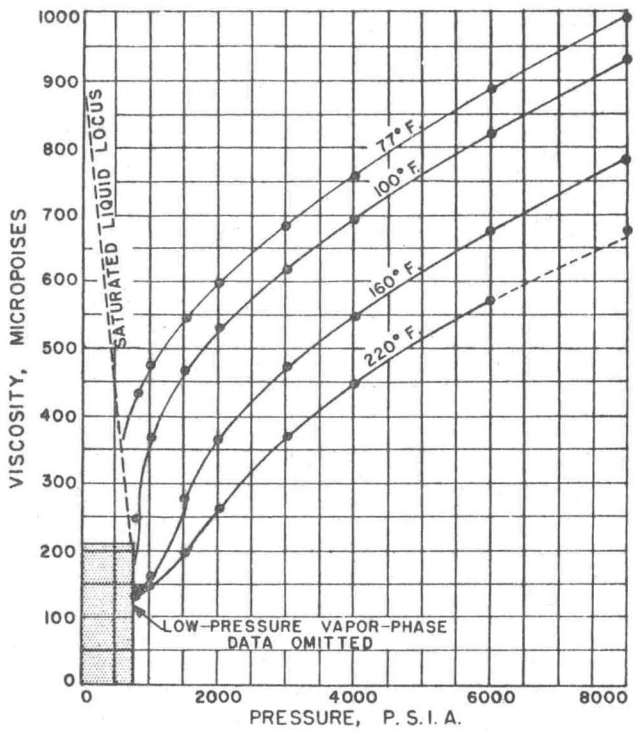

Figure 1. Experimental ethane viscosity *vs.* pressure

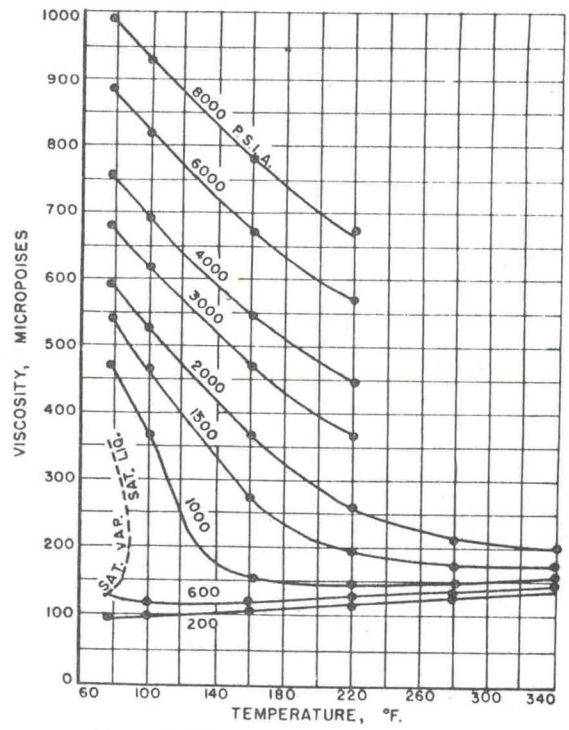

Figure 2. Experimental ethane viscosity *vs.* temperature