

Fig. 6.—COMPARISON OF P-V-T DATA OF REAMER *et al.* WITH IGT DATA FOR ETHANE-NITROGEN MIXTURES AT 40° AND 100° F

V. Comparison of IGT and Published Data

Recently Reamer, Selleck, Sage and Lacey¹⁸ published P-V-T data on three mixtures of ethane and nitrogen in the temperature range 40° to 400° F and at pressures up to 10,000 psia. Two of their isotherms were selected for comparison with IGT data. Fig. 6 gives this comparison at 40° and 100° F in a plot of compressibility factor versus composition for constant pressures of 200, 600, 1000, 1500, 2000, and 4000 psia. The comparison at 100° F is good, with a maximum deviation of

about 1.2% and an average deviation of about 0.3%. The comparison at 40° F is good for mixtures containing more than 50% nitrogen, and fair for the mixture containing 27.3% nitrogen.

At 40° F, for a 27.3% nitrogen mixture, the two-phase region is entered through part of the pressure range of the Reamer investigations, and would explain the greater deviation. The phase boundary data were not available when the Reamer work was done, else conditions outside the envelope would have been picked.

EQUIPMENT AND EXPERIMENTAL PROCEDURES

I. Materials Used

The ethane used was Phillips Petroleum Company's "Research Grade." It was stated to have a purity of 100.00%, and no impurities were detected in a mass spectrometer analysis.

The nitrogen used was obtained from Linde Air Products and was stated to be 99.99% pure. Mass spectrometer analysis did not show any detectable impurities.

Dew and bubble point data on both are given in Table 3.

II. Dew and Bubble Point Apparatus

In IGT Research Bulletin No. 17⁶ a literature survey was presented of methods for obtaining vapor-liquid equilibrium at low temperatures. On the basis of this survey, a modified "dew and bubble point" method was chosen as particularly suited to the investigation of binary systems at low temperatures. The apparatus (Fig. 7) employed in the present work is essentially the same as that used in the study of the methane-nitrogen system, except that the cell was modified through use of an O-ring glass-to-metal connector, and a 4000 psi deadweight gage was added to the pressure-measuring system, to enable working at the higher pressures encountered in the ethane-nitrogen system and permit collection of density data on the saturated liquid phase.

Table 3.—DATA ON PURE COMPONENTS USED TO PREPARE THE MIXTURES

Temp, °F	Ethane		Bubble Point from Literature
	Dew Point psia	Bubble Point psia	
20.0	293.7	296.6	—
0.0	—	221.6	218.9

Mass Spectrometer Analysis: 99.9+ % ethane. Based on this dew and bubble point determination and IGT phase equilibrium data,⁹ the impurity is estimated to be 0.12% methane.

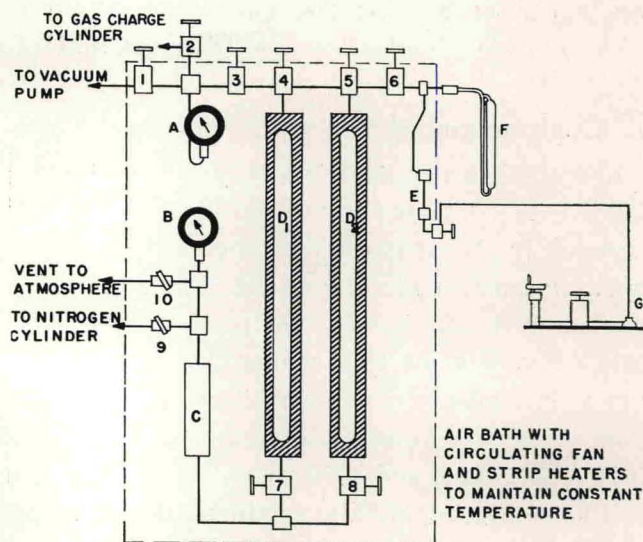
Temp, °F	Nitrogen		Calculated Vapor Pressure*
	Dew Point psia	Bubble Point psia	
-235.00	459.8	461.8	464.5

Mass Spectrometer Analysis: 99.9+ % nitrogen. Based on this dew and bubble point determination and IGT phase equilibrium data,⁸ the impurity is estimated to be 0.2% methane.

* Calculated with the Dodge and Dunbar formula:

$$\log P_{\text{atm}} = \left(\frac{-316.824}{T} \right) + 4.47582 - (0.0071707)(T) + (2.940)(10^{-5})(T^2)$$

T is in °Kelvin.



- A 1000 LB PRESSURE GAGE
 B 5000 LB PRESSURE GAGE
 C MERCURY RESERVOIR
 D JERGUSON GAGES, CAP. APPROX. 225 CC EACH
 E LUCITE SIGHT GAGE
 F GLASS EQUILIBRIUM CELL, 10 CC CAPACITY
 G FREE PISTON GAGE

Fig. 7.—IGT Phase Equilibrium Apparatus; Diagram above, and Photo at left

