

a maximum percentage of liquid at G , and the liquid vaporizes in a normal manner as the pressure is reduced still further from G to E . Since liquid is vaporized when the mixture at G is compressed to D at constant temperature, this process is called *retrograde vaporization*. The term applies to the vaporization of a liquid by the compression of a vapor in contact with the liquid. The terms "retrograde condensation" and "retrograde vaporization" may also be applied to isobaric phenomena when the phase change occurring is opposite to that which would occur if the same change in conditions were applied to a pure substance. The area represented by $CDIGC$ in Fig. 3-9 is the only part of the diagram where retrograde phenomena occur.

In the fluid near the critical point there occur color changes known as critical opalescence (3-70). Apparently molecular aggregations, though insufficient to cause a separation of phases, are of such a nature that light is scattered. Pressure reduction from the single phase to the border curve near the critical point causes the fluid to take on a reddish brown color with transmitted light or a bluish white color with reflected light. Color persists with time and in both phases for a short pressure range. It is more intense for mixtures containing higher-boiling hydrocarbons. The intensity is greatest at the critical temperature but may still be observed some ± 30 to 40°F from the critical temperature.

SOLUBILITY OF GASES IN LIQUIDS

In some cases the solution of a gaseous constituent in a liquid is measured and reported as solubility data. In these measurements, the vaporization of the liquid is neglected. It has been learned that the

volatility of the liquid can seldom be ignored at high pressures, and so the compositions of both phases are generally considered. Before 1896 Villard (3-72) conducted unique experiments in which he observed the vaporization of bromine, iodine, and paraffin wax by methane pressure to 4,000 psi and described his experiments as showing solubility of solids and liquids in gases. Markham and Kobe give references to solubility of gases in liquids at low pressure (3-41a).

The work of Dow and Calkin (3-18) showed the solubility of natural gas in crude oil. The early work of Sage and Lacey included the solubility of methane in various hydrocarbon liquids (3-59). Frolich and coworkers reported the solubility of methane, hydrogen, and nitrogen in miscellaneous liquids (3-20). Schoch and coworkers found the influence of the chemical nature of the solvent on methane solubility (3-65).

BINARY MIXTURES

The behavior of all possible mixtures of two substances is illustrated for the methane-ethane system by Fig. 3-10 from Bloomer, Gami, and Parent (3-8); for the methane-propane system by Fig. 3-11 from Sage, Lacey, and Schaafsma (3-58) and Akers, Burns, and Fairchild (3-1); and for the ethane-heptane system by Fig. 3-12 from Kay (3-30). The critical temperatures of the two pure substances are connected by the critical points of the mixtures of the two components. The vapor-pressure curves and the critical locus enclose the two-phase region for all possible fluid mixtures of the two substances.

It should be noted that a mixture with relatively small amounts of one constituent may have a relatively narrow border curve but that the border curve

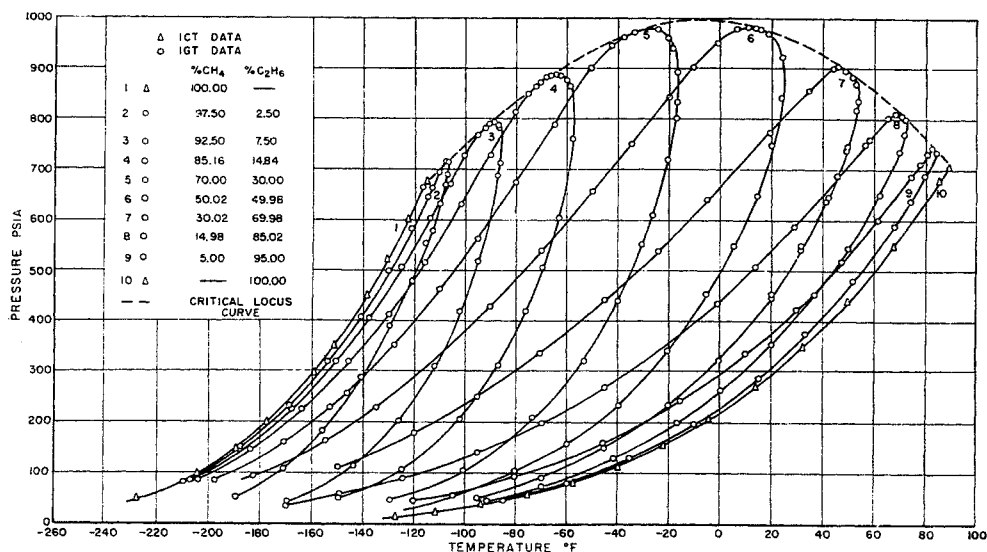


Fig. 3-10. Phase diagram of methane-ethane mixtures. (By permission from "Physical-Chemical Properties of Methane-Ethane Mixtures," by O. T. Bloomer, D. C. Gami, and J. D. Parent. Copyright 1953, Institute of Gas Technology. 3-8.)