20.1: Introduction- Phase Behavior as the Quintessential Tool

Optimal design and the safe and efficient operation of hydrocarbon production handling and processing systems strongly depends on accurate knowledge of fluid phase behavior. In fact, in contrast with other disciplines, the practice of petroleum and natural gas engineering centers around understanding the interaction between fluids and various environments, including the reservoir, pipeline, separator, pumps and compressors, etc. Another distinguishing characteristic is the complexity of the fluid involved here — petroleum. Whereas, for instance, mechanical engineers deal mainly with water (single-component system) and air (considered ideal for most applications), here we are dealing with complex hydrocarbon mixtures where the composition dependence of thermophysical properties is very strong.

Another complication is the wide range of pressures and temperatures associated with the processes of interest, from ultralow temperatures (LNG) to as much as 210 °F and pressures ranging from atmospheric to several thousand psia. Within these ranges, the fluid can transcend the three principal phases, namely gas, liquid, and solid, and worse yet, any combination of these.

The combination of the complex mixtures involved, the wide compositional variability from reservoir to reservoir, from system to system, and the wide range of pressures and temperatures to which systems are often subjected (e.g. a pipeline) make the phase behavior of these systems a very challenging undertaking. Unless one has a good descriptive and predictive understanding of the fluid’s phase behavior, their interactions and responses cannot be successfully described.

In these last two modules of the course, we will examine some of the applications of our current knowledge of phase behavior and thermodynamics in Petroleum and Natural Gas Engineering. The message we would like to provide is very simple: the phase behavior of the hydrocarbon system must be fully grasped in order to fully understand the responses of condensate and natural gas systems and optimize their performance. For example, maximization of condensate yield is virtually impossible without the tools for accurate prediction of just how much liquid will exist under given conditions of
pressure, temperature and composition. Therefore, having advanced predictive tools for the characterization of hydrocarbon phase behavior with the highest accuracy possible is the key to mastering the economics of hydrocarbon systems. In the next sections, we will explore some specific areas where the mastering of phase behavior concepts is a must.

Contributors and Attributions

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