CO2 Injection for Heavy Oil Recovery

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The ANS oil production is declining rapidly from the conventional resources also known as “light oils” over the past few decades. This calls upon further development of unconventional resources. These resources are reservoirs and fields containing heavy oils and tar sands that can be classified by their relatively low API gravity and high viscosities. With a decline in the production rate of conventional resources, it becomes significant to further enhance our understanding of these heavy oil resources and how their properties behave within the reservoir. These heavy oil reservoirs require secondary means of recovery due to the fact their high viscosity restricts the flow with primary recovery methods. Carbon dioxide and Miscible Injectant (MI) gas flooding are the principal secondary recovery methods that are being investigated to produce these heavy oils on the North Slope; however, several problems and challenges have been faced while employing such methods.

However, as stated earlier, despite the many benefits from this large reserve of heavy oils, some of the challenges have been hard to overcome such as difficulties in comprehending and characterizing the Pressure-Volume-Temperature (PVT) data and identifying the phase behavior changes as these solvent gases are injected into the oil. In the latter, the main issue faced is the formation of a second liquid phase as CO2 mole fraction is increased with varying pressures. One of the primary reasons this second liquid phase is difficult to analyze is because no commercially available reservoir simulator is capable of rigorously handling a 3-phase hydrocarbon flow (Wang and Lin, 2003).

The basic objective of this work is to help identify at what reservoir pressure and mole fraction of CO2 this second liquid phase occurs. This will be done by using a PVT cell as CO2 will be injected into the cell along with live heavy oil at a pressure and temperature. Through this process, a pressure-composition (P-X) diagram will be created that will help analyze at what pressure and mole fraction this second liquid phase is occurring. Once this is done, the second objective will be to identify the phase behavior of this same live oil injected with a combination of CO2 and an enriched MI gas to determine at what pressure and mole fraction this second liquid phase will disappear. It is essential in the development of heavy oil recovery to entirely comprehend the fluid properties of the reservoir fluid and how the phase behavior is changing with changing variables such as pressure and amount of injected gas. With such an abundance of heavy oil reserves and the constant decline in conventional production, advancements in analysis of highly viscous heavy oil could enhance the life of ANS reservoirs and thus the Alaska North Slope production.