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# Oil Recovery, Asphaltene Precipitation and Permeability Damage during Immiscible and Miscible Cyclic $CO_2$ Injections in Light Oil Systems

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## Abstract

Asphaltene precipitation and deposition phenomena occur in petroleum reservoirs as a change in pressure, temperature and liquid phase composition, whether during the primary production or enhanced oil recovery processes. These phenomena results in wettability alteration and permeability reduction of the reservoir rock which consequently leads to decrease in oil recovery. In this study, the recovery factor, asphaltene precipitation phenomena and oil effective permeability damage in the cyclic $CO_2$ injection process for a light crude oil system were experimentally investigated. The sample crude oil was taken from Bakken formation. First, the minimum miscibility pressure (MMP) of crude oil–$CO_2$ system was determined using vanishing interfacial tension (VIT) technique and found to be MMP = 9.18 MPa. Thereafter, series of secondary cyclic $CO_2$ injection tests were designed and carried out at operating pressures in the range of $P_{op}$ = 5.38–10.34 MPa, under immiscible, near-miscible and miscible conditions. The asphaltene content of $CO_2$-produced oil obtained from first and second cycles were measured using the standard ASTM D2007-03 method and the n-pentane was used as precipitant. After termination of each test, the original crude oil was re-injected into the system to determine the oil effective permeability damage after the $CO_2$ injection process and asphaltene precipitation phenomena.

Results showed that the oil recovery increases significantly with increased operating pressure in the range of immiscible to near miscible cyclic $CO_2$ injections. The oil recovery reached its maximum value at miscible cyclic $CO_2$ injection and further increase in operating pressure did not enhance the recovery process effectively. On the other hand, the precipitated asphaltene content in the system because of $CO_2$ injection was substantially higher in near-miscible and miscible cyclic $CO_2$ injection tests than that in immiscible ones. Furthermore, due to higher asphaltene precipitation in the miscible pressure range, the oil effective permeability damage of the core was drastically higher during near-miscible and miscible cyclic $CO_2$ injection scenarios.