Evaluation of Air Injection EOR to apply a Light Oil Reservoir with Low Oil saturation after water flooding

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Abstract

Air injection EOR operation for light oil reservoirs has been paid an attention as a low cost enhanced oil recovery process for more than 10 years. But, the actual application of the process is limited because of its complicated mechanism.

Firstly, Combustion Tube (CT) test which is one of the popular tests for the evaluation of in-situ combustion was conducted at two different initial oil saturations (40% and 17%) with the oil taken from our candidate domestic oil field. Results indicated higher oil recoveries (71% and 76%, respectively) even in the low oil saturation. Based on these results, we considered air injection would be a promising approach for our domestic oil field, in which most part of the oil reservoir has been already swept by water due to a strong aquifer support and especially some area is believed to be reached to irreducible oil saturation (13%). Following PVT experiments, Accelerating Rate Calorimetric (ARC) tests and CT tests, a thermodynamic model was constructed. Based on results of air injection simulation studies for the CT tests, with a newly constructed thermodynamic model, we concluded that the distillation process at high temperature (combustion) front would be a predominant mechanism of such higher oil recovery of the CT test.

Sensitivity studies were also conducted with various number of pseudo components using constructed thermodynamic model. These studies indicated number of pseudo components drastically affects to the distillation process of lighter hydrocarbons.

Air injection simulation was also carried out for the field-wide with a simplified sector model incorporated with the constructed thermodynamic model. The results indicated that oil bank can be formed by air injection but the injected air overrides the oil bank and causes early oxygen breakthrough in the case of low oil saturation reservoir,
resulting in a low incremental oil recovery. On the other hand, in the case of higher oil saturation reservoir, a larger oil bank is formed so that the timing of oxygen breakthrough becomes more moderate and a higher incremental oil recovery is expected. For example, more than 10% of incremental oil recovery will be expected if residual oil saturation is as high as 30%.

Finally, we concluded that air injection would be a valuable EOR even in the water-flooded reservoir, if residual oil saturation is still higher, but our candidate oil field has been entirely water-flooded and oil saturation is insufficient to apply the air injection.