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New Experimental Evaluation of the underlying formation water Influence on CO_2 diffusion in Decane and Crude Oil

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Abstract

CO_2 injection with the two-fold advantage of enhanced oil recovery and simultaneously decreased the atmospheric CO_2 concentration, has been considered as a promising method for enhancing the oil recovery especially from depleted reservoirs after primary and secondary production. During the investigation of oil recovery mechanisms by CO_2 injection, it was found that molecular diffusion plays a major role in the process of oil mobilization and recovery especially in tight reservoirs. Once CO_2 is injected into the reservoir, it will be forced to contact with the reservoir fluid which in most cases not only crude oil but also formation water. To investigate the efficiency of oil recovery by CO_2 diffusion, estimation of CO_2 mass transfer rate and the total amount of CO_2 dissolved especially with the presence of underlying formation water is very essential. In this work, a PVT cell was applied to conduct the CO_2 diffusion in decane/crude oil with and without the presence of formation water under constant initial pressure and different temperature conditions. The purpose of this study is to determine the mass transfer rate, amount of CO_2 dissolved and the required time to reach equilibrium, furthermore evaluate the effect of underlying formation water on the process of CO_2 diffusion in decane/crude oil.

The results from the experiments show that the process of CO_2 dissolution can be obviously divided into two different stages, in the first stage the pressure decay curve was steep and large amount of CO_2 was dissolved while in the later stage the pressure decay curve became flat and a long time was needed to reach the equilibrium state. Under high temperature condition, CO_2 diffusion rate was faster but the amount of dissolved CO_2 was smaller with an indication of higher equilibrium pressure than under the low temperature. With the presence of underlying formation water, mass transfer rate of CO_2 diffusion was faster and the system came to an ultima lower equilibrium pressure than without underlying formation water presence. Underlying formation water can play a role of traction and shows positive effect on the efficiency of CO_2 diffusion as an oil recovery mechanism. Together with an analytical calculation model for the experiments interpretation, all the findings can provide a basis to design parameters especially CO_2 amount and soaking time for the implementation of oil recovery by CO_2 diffusion.