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In Situ Raman Spectroscopic Study of the Diffusion Coefficients and Solubility:Indicates to Carbon Dioxide Injection into Hexadecane

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Injecting CO_2 into lean-oil reservoirs is not only a way to geological storage but also enhanced oil recovery. In the secondary displacements of oil reservoir by CO_2-injection, diffusion coefficients and solubility of CO_2 are key parameters to calculate the volume of CO_2 injected and the time to achieve the desired viscosity in the numerical simulation. Unfortunately, the experimental data on the CO_2 diffusion coefficient and solubility in liquid hydrocarbons under high pressure conditions are scarce.

Hexadecane has properties similar to the average properties of Brazilian heavy oil. Experimental data on the diffusion coefficients and solubility of CO_2 in hexadecane were reviewed by Nieuwoudt and Rand (2002), Rincon and Trejo (2001) and Breman et al (1994), indicating that the data in the literature were limited at relatively low temperatures and/or low pressures.

In this paper, the diffusion coefficients of carbon dioxide in hexadecane at different temperature and pressure were determined with in situ Raman spectroscopy. A model was established to describe relationship among diffusion coefficients, temperature, and pressure. The solubility of CO_2 in hexadecane was obtained from 298.15 to 473.15 K and 10 to 45 MPa.

The experimental results show that:(1) Solubility of CO_2 decreases with increasing temperature.(2) Increasing pressure increases the CO_2 solubility. in terms of the degree of influence,100K is similar with 10MPa.(3) Diffusion coefficients of CO_2 increases with increasing temperature. (4) Increasing pressure decreases the CO_2 diffusion coefficients, whereas the pressure effect on CO_2 diffusion coefficients is very weak.

Compared with traditional sampling and analytical methods, the advantages of our method include: (1) the use of in situ Raman signals for solubility measurements eliminates possible uncertainty caused by sampling and ex situ analysis. (2) it is simple and efficient, and (3) high-pressure data can be obtained safely.