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Laboratory Investigation of the Interaction Between CO_2 and Reservoir Fluids During the CCUS Process Using the IRHPOC Method

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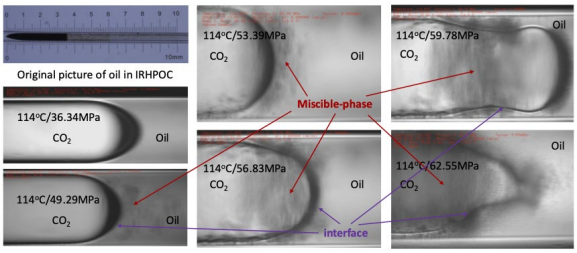

The **High-Pressure Optical Cell (HPOC)** is an innovative and powerful tool for studying **Carbon Capture and Storage (CCS)**. However, its application in **CO_2-driven Enhanced Oil Recovery (EOR) within the Carbon Capture, Utilization, and Storage (CCUS) process** is limited due to the **dark color of reservoir fluids and strong fluorescence**, which interfere with optical measurements.

To overcome these challenges, the **Infrared High-Pressure Optical Cell (IRHPOC)** integrates **infrared imaging with high-pressure optical cell technology**, enabling **real-time visualization of CO_2 interactions with reservoir fluids**.

In this study, **an oil sample from the Karamay oilfield in China** was injected into an HPOC, which was connected to an **automatic pump** for precise pressure control. The HPOC was placed on a **capillary stage for temperature regulation** and examined using an **infrared imaging microscope**. **Figure 1** illustrates the **CO_2-oil interaction process** as pressure increases under reservoir temperature conditions, clearly capturing **the miscible process at different pressure levels**. Additionally, the **reverse process highlights phase changes during pressure reduction**.

To further investigate the effect of chemical additives, **two additional oil samples with additives** were analyzed using the same method. **Figure 2** compares these results with **untreated oil**, demonstrating that **chemical additives enhance CO_2 interactions with reservoir fluids**. This finding is further supported by **slimtube and PVT experiments**, which show that **chemical additives improve CO_2 solubility in oil, lower the minimum miscibility pressure (MMP), and reduce the bubble point pressure**.