Fluid Sampling Monitoring at Yanchang CO2-EOR Demonstration Site, Ordos Basin, China

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Abstract

Carbon dioxide (CO₂) enhanced oil recovery (CO₂-EOR) is an important option of the carbon capture, utilization and storage (CCUS) technologies at the Yanchang Oilfield, the Ordos Basin, China. The CO₂-EOR is attracting much more attention than before in this region. In particular, "U.S.-China Joint Announcement on Climate Change" released at November 11, 2014 in reference to advancing major CCUS demonstrations on a new enhanced water recovery pilot project to produce fresh water from CO₂ injection into deep saline aquifers (CO₂-EWR) in the Yanchang Oilfield, this further speeded up the development progress of different CCUS technologies in the Ordos Basin, China. Either CO₂-EOR or CO₂-EWR, the injected CO₂ may leak and migrate into shallow aquifers or ground surfaces through a variety of pathways over a certain period. The potential leakage risk of CO₂ from the reservoirs drives the interests in monitoring of the CCUS projects. The Ministry of Environmental Protection of the PRC signed and released “Technical Guidelines on Environmental Risk Assessment for CCUS (on trial)” in 2016 as a specific response to the monitoring suggestion for the environmental risk indicators. During the process of CO₂ leakage, free CO₂ will constantly decrease by dissolving in groundwater or reacting with minerals, and correspondingly, chemical indicators will change. Thus, it is possible to monitor CO₂ leakage through geochemical monitoring of shallow aquifers. The potential effect of CO₂ leakage on the shallow aquifers may be inferred by numerical simulations and other methods in advance, so the location and scale of CO₂ leakage can be inversely delineated by distinguishing the changes in monitoring indicators of groundwater and soil gas accurately.

In this paper, we firstly addressed the status and the overall scheme developed for the CO₂-EOR Demonstration Project at the Jingbian site, the Yanchang Oilfield, the Ordos Basin, Shaanxi, China, under the funding support of China-Australia Geological Storage of CO₂ (CAGS) Program. Then, we are focusing on the fluid sampling monitoring as one of key monitoring indicators of leakage assessment, and the detailed monitoring plan was tailored for the Jingbian CO₂-EOR Block in the Yanchang Oilfield with consideration to the existing situation of monitoring technologies for CO₂-EOR activity and project planning in China. All the fluid samples were collected from different locations such as surface water ponds, groundwater wells, and monitoring wells around the CO₂ injection site. The specific designed multi-layer U-tube based samplers were installed in the monitoring wells at the Jingbian CO₂-EOR site. Three 200 m deep shallow monitoring wells were drilled for the samples of underground water and subsurface soil gases. Using 20 Baseline samples collected in 2016 at the Jingbian, and 22 monitoring samples collected in 2017, we found the tracks of some changes in the fluid chemistry and isotope composition. All the regular anions and cations,
e.g. Cl⁻, SO₄²⁻, Mg²⁺, Ca²⁺, Na⁺, K⁺ and HCO₃⁻, were analysed. In addition, total dissolved solids (TDS), pH, conductivity, salinity, oxidation-reduction potential (ORP), organic components, especially petroleum contaminants such as BTEX and PAHs, and isotopic analysis were also traced throughout the sampling analysis. Some of preliminary results can be addressed as follows: 1. The average salinity of formation water is 71.34 g/L, pH is 5.5, and the water belongs to CaCl₂ type at the Jingbian site according to the classification of China’s underground water standard. 2. The monitoring indicators for the subsurface water at the Jingbian site indicate good stratification characteristics, and the concentration level of each monitoring indicator decreases with increasing depth. 3. The application potential of the multi-layer U-tube based fidelity sampling technology was demonstrated for the subsurface environmental monitoring. The results of fluid samples provide some significant information for the coming monitoring activities during the implementation of large-scale CO₂-EOR or CO₂-EWR projects in the Yangchang Oilfield.