Streaming Potential Measurement at Supercritical CO_2 Condition

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Measurements of the zeta potential using streaming potential method are frequently used to characterise flows in subsurface settings owing to a broad range of applications of this petrophysical property; examples include CO_2 geological storage, hydrocarbon reservoirs, geothermal sources and freshwater aquifers. Many experimental studies of the zeta potential have been carried out covering a wide range of parameters including different rock mineralogy, brine concentration and composition, and temperature to understand the impact of each parameter. The capability of the streaming potential method to be used on intact rock samples, single-/ and multi-phase flows, wide range of salinity and temperature makes the method suitable for representation of typical subsurface conditions. However, none of previous studies reported such measurements at high pressure conditions typical for deep reservoirs. To adequately represent subsurface conditions of carbon geological storage sites, the minimum experimental pressure of 7.38 MPa and minimum temperature of 31°C, consistent with the supercritical CO_2, need to be used. Obtaining stable measurements of the streaming potential under these conditions is extremely challenging. We report a detailed design of a high-pressure experimental system and experimental protocol for streaming potential measurements that can be carried out at high pressure and elevated temperature. The novel experimental methodology of measuring the zeta potential using streaming potential method under high pressure and elevated temperature conditions is validated for both single- and multi-phase flows in intact rock samples. The obtained results are consistent with previously reported data obtained at low pressure thus supporting our confidence in applicability of both the apparatus and the experimental methodology for the streaming potential measurements at supercritical CO_2 condition.