

Research on The Regulation Mechanism of Direct Current Electric Field Electrolysis on The Characteristics of The Oil-Water Interface and Its Potential Applications in The Oil and Gas Field

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Abstract : In the domain of petroleum and gas production, the oil - water interface is of paramount importance, significantly influencing separation processes, fluid flow behaviors, and recovery efficiency. This study innovatively pioneers the utilization of electrolysis to modulate the properties of the oil - water interface, with the primary objective of enhancing fluid mobility and optimizing hydrocarbon recovery. This novel approach not only presents an innovative solution but also upholds environmental sustainability and operational efficacy. A series of experiments was meticulously designed, in which oil - water mixtures were subjected to direct - current (DC) voltages of 0V, 5V, 10V, and 15V. By employing advanced precision instruments, comprehensive measurements were carried out on the variations in oil - water interfacial tension, aqueous - phase cation concentration, pH value, crude - oil composition, and interfacial viscosity. A thorough exploration of the underlying relationships among these parameters was conducted to clarify the action mechanism of the DC electric field on the oil - water interface, thus providing a vital theoretical basis for optimizing oil and gas production techniques. The experimental results indicate that, under the influence of a DC electric field, the oil - water interfacial tension shows a remarkable decrease as the voltage increases. Specifically, when the voltage reaches 15V, the interfacial tension is reduced by nearly 20%. Simultaneously, the asphaltene content in crude oil decreases substantially, accompanied by a notable change in the ratio of saturated hydrocarbons to aromatic hydrocarbons. This is postulated to be a key factor contributing to the reduction in interfacial tension. Additionally, the increase in aqueous - phase cation concentration and the rise in pH value jointly promote the reduction of interfacial tension. Viscosity tests show that, under the same shear - rate conditions, the oil sample exposed to a higher voltage has the lowest viscosity, and as the shear rate increases, the viscosity of the oil sample exhibits a distinct downward trend. This research represents an innovative and environmentally - friendly strategy for regulating the oil - water interface, minimizing the dependence on chemical additives and alleviating environmental impacts. It provides novel perspectives and practical solutions for engineers involved in oil and gas extraction, potentially revolutionizing industry practices.

Keywords : oil - water interface, electrolysis, interfacial tension, hydrocarbon recovery

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