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Stages of change in the permeability of the chalk core during the injection of produced water and seawater

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Chalk reservoirs, because of their high porosity and very low permeability, represent one of the most interesting cases for carbonate engineering studies. They exhibit complex fluid-rock interactions due to their reactive surfaces and tight porous environment. Re-injection of co-produced water is an attractive strategy for managing the wastewater stream from oil wells, however, the reactive nature of carbonates and the permeability presents challenges with permeability loss. Identifying the stages and understanding the processes that occur during the reinjection of produced water into a well is necessary for planning correct technological operations to increase the permeability of the formation and the feasibility of these operations. This study examines the stages of permeability change during the re-injection of produced water and seawater from the Danish North Sea oil and gas fields. Using computed tomography, real core samples from the chalk formations were selected to be homogeneous without any open fractures. All experiments were carried out in a core flooding system simulating well conditions with respect to pressure and temperature. Produced water samples were taken from the Dan field to replicate the chemical and thermodynamic processes occurring in a real well as accurately as possible. As a result of the core flooding experiments, 3 stages of core permeability changes were identified (permeability increase, pressure stabilization, and permeability decrease). The processes occurring at each stage of the change in permeability were explained based on the data of the chemical composition of produced water from an ion chromatography-mass spectrometry, image analysis from a scanning electron microscope, measurement of particles size by a zetameter, as well as building a thermodynamic model of scale formation in ScaleCERE software.
These experiments provide new data for the process of changing the permeability of oil fields consisting of chalk reservoirs and additional evidence for existing theories.

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