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Investigation of chemical effects of long-term water flooding on reservoir rocks

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In tight chalk reservoirs, the rock surface is of particular importance. The polar compounds contained in oil are capable of adhering to the surface of the reservoir rock in competition with water molecules. Depending on the composition of the oil and reservoir conditions, the resulting surface has different properties, denoted in petroleum engineering as oil- or water-wet. The polar molecules form strong bonds with the surface of calcite crystal, leaving their hydrocarbon tail facing outwards, where they can interact with other compounds in oil through hydrogen bonding or van der Waals forces, forming a thick immobile layer of crude oil on the rock surface. The effective application of water-injection methods requires considering the interplay of brine, oil and surface in order to optimize solutions for a particular reservoir. Due to the complex nature of the phenomena, accurate simulations are computationally challenging, but the composition of the crude oil has a pivotal impact.

Over the lifespan of production processes in the reservoir, production conditions such as composition of the flooding fluid, the chemical composition of the contained crude oil and of the surface adsorbed material undergoes gradual change. These changes may result in significant alteration of the reservoir performance and require adapting production processes accordingly. The effect of the water flooding performed in the oil fields of the Danish North Sea has been investigated based on the composition of crude oil contained in drill cores. Samples were sourced from several geographical regions affected in varying degree by the water flooding.

Infrared (IR) spectroscopy has been used to perform chemical fingerprinting of the adsorbed oil to observe how properties of the surface may change in response to changing conditions. This information can then be used when designing injection strategies or to anticipate the reservoir response to production chemicals.