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MSc and BSc Thesis: *Surfactant flooding*

Topics on surfactant flooding are proposed below.

Background

Surfactants are a special class of molecules with both hydrophobic and hydrophilic parts. In surfactant flooding of oil reservoirs, surfactant products are added to the injection water to reduce the oil-water interfacial tension (IFT) and thereby mobilize capillary trapped oil. The theory in classic surfactant floods is based on water-wet oil sandstone reservoirs. It is now known that the wettability of these reservoirs is at mixed-wet conditions, and the classic theory for surfactant flooding can not been applied. The main objective of the proposed work is to enhance the present knowledge and competence on surfactant flooding at different wettability conditions and at different scales in sandstone reservoirs.

Thesis topics Surfactant flooding

1. Effect of pH and brine composition on established wettability conditions

The objective is to study the effect of pH and brine composition on wettability conditions established in sandstone rock.

Sandstone core plugs are saturated with brines of different compositions and pH. The composition of effluent is determined during brine injection. Wettability acquisition is then established by injecting crude oil and aging. During this step interaction between rock and the polar crude oil components is studied. After aging the wettability of the core plugs is characterized. The results are compared with results reported in the literature.

One student can work on this subject.

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2. Wettability of minerals during surfactant flooding

The objective is to study the wettability of different types of minerals in brines and surfactant solutions.

The minerals are mixed with brines and surfactant solutions. Pure minerals and minerals that have been exposed to crude oils are used. After mixing with the brine or surfactant solution, the wettability of the mineral particles is determined. The results are compared with results reported in the literature.

One student can work on this subject.

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3. Surfactant flooding in mixed wet reservoir

The student will run numerical experiment in order to investigate the effect that reduced interfacial tension (IFT) has on capillary trapping in a heterogeneous reservoir. Assuming that the rock capillary pressure scales with IFT, capillary contrasts on the scale of a few cm to a few tens of metres will be reduced in presence of surfactant, which potentially may result in increased or accelerated oil production.

The main parts involved are:

- Computation of effective properties (upscaled relative permeabilities) at different capillary numbers obtained by varying IFT. The steady-state upscaling software Flow2D will be used.
- Use Eclipse to simulate the displacement process (waterflood) at various IFT (surfactant model). Simulations on models with fine-scale description and upscaled properties will be compared.
- It will be used synthetic models.

One student can work on this subject.

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4. Steady-state versus unsteady-state core floods

Relative permeabilities are measured in core floods by the steady-state or the unsteady-state method. In the literature, we find different and often strong opinions about which method is the most representative for the process in the reservoir. The two methods should produce the same result in homogeneous cores (if properly corrected for core end effects), but very often core material will have various degrees of heterogeneities, and the two methods may differ significantly. The student will investigate the problem numerically by simulating the core experiments on "known" synthetic core samples. Capillary core end effects can be ignored to simplify the interpretation. Any appropriate simulation tool can be used, e.g., Eclipse. The following steps briefly describe the work:

For a given heterogeneous core with known properties:

- Simulate experiments (steady-state and unsteady-state)
- Compute "experimental" relative permeabilities from production history
- Simulate displacement in homogeneous core with "experimental" relative permeability and compare with displacement in original core.
- Repeat displacement in a long core (10 repetitions or more of short core). Compare heterogeneous case (original properties) with homogeneous case and "experimental" curves from steady- and unsteady-state.

One student can work on this subject.

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