IRIS
International Research Institute of Stavanger

P.O. Box 8046
4068 Stavanger, Norway
Telephone: (+47) 51 87 50 00
Fax number: (+47) 51 87 52 00
From: *Ingebret Fjelde*
Date: *5 September 2008*

CO_2 MSc Thesis topics

Topics on CO_2-foam and CO_2-flooding are described below.

CO_2 – foam

Background

Poor macroscopic sweep efficiency has caused problem in CO_2-flooding of many oil reservoirs. This means that the oil recovery has been lower than it could have been if more of the reservoir was contacted by injected CO_2. Methods that can improve the macroscopic sweep in CO_2-flooding have the potential to improve the oil recovery, give later CO_2 breakthrough and increase the CO_2 storage capacity for oil reservoirs. Macroscopic sweep efficiency usually includes vertical sweep, horizontal sweep and linear sweep. In fractured reservoirs the sweep of the matrix blocks is also important. Decrease of the mobility ratio will improve the macroscopic sweep. In CO_2-flooding this can be obtained by changing the (apparent) viscosity in CO_2-WAG, CO_2-foam and CO_2-soluble polymers.

Transport and retention in CO_2-foam processes in fractured chalk reservoirs will be studied in the project. CO_2-foam should in fractured reservoirs improve the macroscopic sweep efficiency of the fracture network. Transport of CO_2 from the fractures into the matrix blocks is an important recovery mechanism in fractured carbonate reservoirs. The cost efficiency for CO_2-foam processes will strongly depends on the retention of foaming agents.

Thesis topics CO_2 – foam

1. Transport rate of CO_2-foaming agents in fractured chalk matrix

CO_2-foam should improve the macroscopic sweep efficiency of the fracture network in fractured reservoirs. Transport of the foaming agent into the matrix blocks will reduce the cost efficiency of CO_2-foam, because the foaming agent will be retained in the matrix. The amount of foaming agent that is retained in the matrix will depend on the transport rate and retention level of the foaming agent in the matrix.

The objective is to determine the retention of CO_2-foaming agents in fractured chalk reservoirs compared to non-fractured chalk. The transport rate of the CO_2 foaming agent inside chalk matrix will be determined using outcrop chalk cores and fractured chalk models at different initial wettability conditions, water saturations and temperatures. In the experiments the concentration of the foaming agent in the chalk matrix and in the produced fluids will be determined as a function of time.

Two students can work on this subject.

2. Sacrificial agents for reduction of CO_2-foaming agents retention

Sacrificial agents are cheaper chemical products that can reduce the retention of EOR chemicals and thereby improve the cost efficiency of EOR processes. The sacrificial agents should block adsorption sites and thereby inhibit adsorption of EOR chemicals. If sacrificial agents can reduce the retention of CO_2-foaming agents, the cost efficiency of the CO_2-foam processes can be improved.

The objective is to determine the potential for sacrificial agents to reduce the retention of CO_2-foaming agents in chalk reservoirs. The retention of CO_2-foaming agents will be determined with and without sacrificial agents at different wettability conditions and temperatures. The production of foaming agent and sacrificial agent will be monitored during the experiments. These results will be used to determine the retention level.

One student can work on this subject.

3. CO_2-foam in fractured laboratory models

The transport of CO_2-foam in fractured laboratory models simulating fractured chalk reservoirs will be studied. The effective permeability of the fractured models will be varied in the range found in chalk reservoirs. These fractured models will be prepared of outcrop chalk used as analogous rock to the reservoir chalks. The objective is to determine how wettability conditions, water saturation and temperature will affect the transport of CO_2-foam in fractured reservoirs. The production of oil and foaming agent will be monitored in the floods.

One student can work on this subject.

4. Simulation of CO_2-foam in fractured models

Simulations of CO_2-foam processes in fractured laboratory models will be carried out to determine how the effective permeability, wettability conditions, water saturation and temperature will affect the transport of CO_2-foam. The results from simulations and experiments (above) will be compared.

One student can work on this subject.

Contact

Ingebret Fjelde
Senior Research Scientist
Direct phone number: (+47) 51 87 53 87
E-mail: Ingebret.Fjelde@iris.no

CO_2-flooding

Background

Carbon dioxide (CO_2) flooding has been reported to improve the oil recovery in many oil reservoirs. The leading mechanisms that favour CO_2-flooding are oil swelling, reduction of oil viscosity and mass transfer between phases which can lead to miscible CO_2-flood. Diffusion of CO_2 from fracture to the remaining oil in the matrix can be important for the CO_2 transport in fractured reservoirs. Diffusion processes are rather slow. Gravity, capillary forces and viscous forces can also contribute to transport of CO_2.

The solubility of CO_2 in water is much greater for CO_2 than for hydrocarbon gases. When CO_2 is injected to water-flooded reservoirs, carbonated water (CW, water saturated with CO_2) will be formed inside the reservoir. During co-injection and alternating injection of CO_2 and water (CO_2-WAG), the water will also become saturated with CO_2. CW has been reported to improve the spontaneous imbibition of brine and improve the oil recovery compared to water floods. CW will be transported as a water-phase in the reservoir, and will interact with the rock.

Thesis topics CO_2-flooding

1. Improved oil recovery by carbonated water in fractured reservoirs

The objective is to determine the effect of initial wettability conditions and temperatures on improved oil recovery by carbonated water. Spontaneous imbibition experiments with carbonated water will be carried our at different initial wettability conditions and temperatures. In the experiments, the production of oil will be monitored as a function of time. Core plugs of outcrop chalk will be used in the experiments.

One student can work on this subject.

2. Wettability alteration during CO_2-floods

The objective is to determine whether CO_2 can alter the wettability of chalk. CO_2 can decrease the solubility and increase the aggregation of asphaltene molecules. This may alter the wettability conditions and thereby also the relative permeability and capillary pressure curves. The wettability conditions will be characterised before and after flooding with CO_2 and carbonated water. Core plugs of outcrop chalk will be used in the experiments.

One student can work on this subject.

Contact

Ingebret Fjelde
Senior Research Scientist
Direct phone number: (+47) 51 87 53 87
E-mail: Ingebret.Fjelde@iris.no