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CO_2 – flooding: MSc and BSc thesis problems

Background

It has been reported that poor macroscopic sweep efficiency has been a problem in CO_2-floods of many oil reservoirs. This means that the oil recovery has been lower than it could have been if the whole reservoir was contacted by injected CO_2. Increase of macroscopic sweep in CO_2-flooding has therefore the potential to improve the hydrocarbon recovery, give later CO_2 breakthrough and increase the CO_2 storage capacity for oil reservoirs. In addition, it can reduce the CO_2 emission to air. 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 mobility ratio will increase the macroscopic sweep. In CO_2-flooding this can be obtained by using CO_2-WAG, CO_2-soluble polymers and CO_2-foam. Macroscopic sweep efficiency can also be increased by other methods, e.g. optimisation of well pattern, injection strategies and polymer gel.

CO_2-foam will in this project be evaluated for fractured carbonate reservoirs. Surfactant products have been designed for use in carbonate reservoirs. In CO_2-foam systems the apparent viscosity is higher than in pure CO_2. The properties of the CO_2-water interfaces are also different in CO_2-foam systems than in CO_2-WAG system. Diffusion of CO_2 from the fractures into the matrix blocks is an important recovery mechanism in fractured carbonate reservoirs. This mechanism will also be important for the CO_2 storage capacity of fractured reservoirs. It is important that the CO_2 diffusion rate is not dramatically reduced when flooding with pure CO_2 is replaced by flooding with CO_2-foam. Surfactants can form high viscous phases. It should be verified that the surfactants used as foaming agents in CO_2-foam do not dramatically reduce the CO_2 diffusion.

Thesis problems

Improvement of macroscopic sweep in CO_2 - flooding

1. Fractured models

Viscous flooding can give an important contribution to transport of fluids in fractured reservoirs. Transport of CO_2 and chemicals will be studied by viscous flooding of simplified fractured reservoir models with different effective permeability. Injection of CO_2-foam will be compared with injection of pure CO_2 and CO_2-WAG.

The oil production will be monitored and compared for the different injection methods.

After the injection is finished, the matrix will be analysed by visual inspection to determine the distance of CO_2-diffusion.

Simulations will be carried out to study CO_2-foam processes in fractured models.

One student can carry out the experimental study and one student can carry out the simulation study.

2. Retention of CO_2-foaming agents

Cost efficiency for CO_2-foam processes strongly depends on retention of foaming agents. Adsorptions of foaming agents onto rocks will be determined at different conditions. The potential for sacrificial agents (cheaper chemical products) to reduce adsorption of foaming agents will also be evaluated. For promising foaming agents thermal stability will be determined.

One student can work on this subject.

CO_2 – flooding mechanism

1. Spontaneous imbibition of carbonated water in fractured reservoirs

During co-injection and alternating injection of CO_2 and water (CO_2-WAG), water will become saturated with CO_2. This carbonated water will be transported as a water-phase in the reservoir. Spontaneous imbibition of carbonated waters will be studied for the main part of the reservoir.

One student can work on this subject.

2. Transport of CO_2 from fracture to matrix

Transport of CO_2 from fracture to matrix is important in CO_2-flooding of fractured reservoirs.

Effects of wettability on CO_2-transport in fractured reservoirs will be studied in simplified fractured models.

One student can work on this subject.

Contact

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