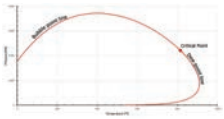
Petex

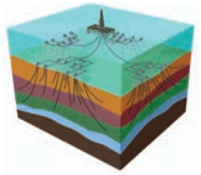
REVEAL

SIMULATOR FOR SPECIALISED RESERVOIR STUDIES

COMPLEX FLUIDS



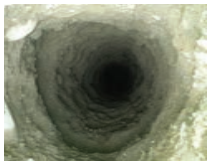
ADVANCED WELLS

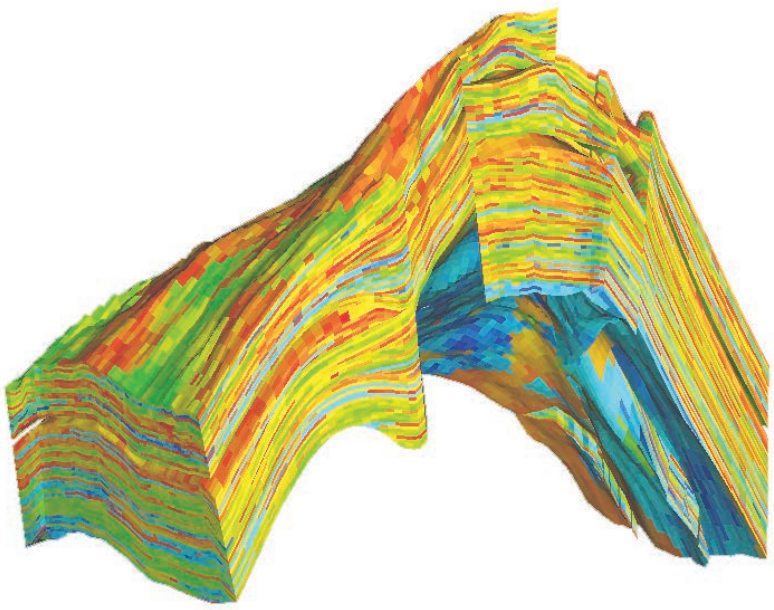


TEMPERATURE

GEO-MECHANICS AND FRACTURES

SCALE





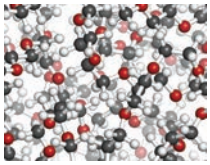
ROCK FAILURE AND SAND GENERATION

WATER CHEMISTRY

FILTERCAKE

STEAM

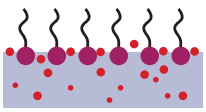
POLYMERS / GELS



ASPHALTENE / WAX

BACTERIAL SOURING

SURFACTANTS



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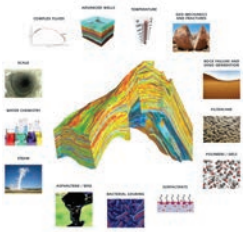
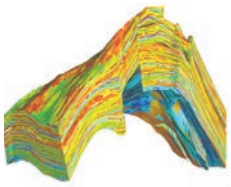


REVEAL

SIMULATOR FOR SPECIALISED RESERVOIR STUDIES

SPECIALISED RESERVOIR STUDIES



REVEAL is a specialised reservoir simulator that enables integrated reservoir and production studies to be performed. The key role of REVEAL is to bridge the gap between reservoir simulation and specialised studies that have traditionally been done in isolation of mainstream reservoir engineering domains. Such studies include thermal fracturing, production chemistry, solid transport, EOR and many others. The advantage of integrated studies lays in understanding the impact of production on reservoir performance and therefore overall field management. REVEAL can import and use existing reservoir simulation models as starting points for integrated studies. Links to surface network models through RESOLVE allow REVEAL to be part of a vendor neutral integrated model, as well as to take advantage of workflows that can operate on the reservoir model and dynamically utilise variables for advanced decision making processes. The uniqueness of REVEAL lies in the ability to model all of the effects described in the sections below in a single model. This is done by having all models activated working together to replicate reality as closely and consistently as possible.

TEMPERATURE

Temperature of injected fluids can have a significant impact on flow paths, recovery factors, rock mechanics, EOR mechanisms and many other physical processes that take place in a reservoir. These effects have not traditionally been captured when isothermal simulators are used. REVEAL is a fully thermal finite difference numerical simulator and as such, convective and conductive heat transport, as well as Joule-Thompson effects are included as part of the coupled pressure-flow-temperature equations that are solved. This enables REVEAL to be the ideal tool for understanding the effects of injection, where the temperature of the injected fluid is different to that of the reservoir.

GEO-MECHANICS AND FRACTURES

A reduction in temperature due to cold water injection will cause a reduction in stress that may cause thermal fractures. Similarly, increase of injection pressures will cause hydraulic fractures. To address this phenomena, rock mechanics calculations are coupled with flow and temperature calculations by directly linking a numerical finite-element model for fracture initiation and propagation to the finite-difference 3D simulation engine. Production fractures can also be modelled. The thermal fracture model is based on the pressure balance within the fracture and the reservoir stress field, including poro-elastic and thermo-elastic stress change effects. The elasticity of the rock determines the ability of the fracture to propagate, once the rock's critical stress intensity is overcome.

ROCK FAILURE AND SAND GENERATION

As a direct result of the rock mechanics calculations, criteria for shear and plastic failure modes exist in REVEAL that enable sand generation, transport and trapping calculations to be performed. The transport and trapping of sand is dependent on sand particle size and pore throat distribution of the rock. The solid trapping of the sand can also occur in the production wells, causing building up of skin.

FILTERCAKE

The Filtercake model enables the study of injection damage resulting from particulates in the injected fluid. The build-up of filter cake is calculated for the injection wells and associated fractures.

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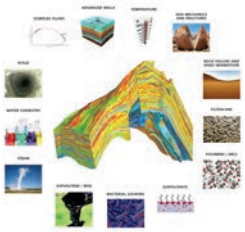

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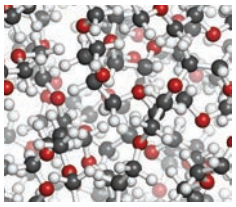
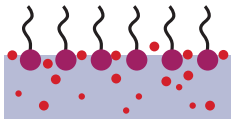
POLYMERS / GELS



Injection of polymers and gels is an important mechanism for controlling thief zones in reservoirs with layers of varying permeability. Thermal viscosity effects are essential in understanding performance of these techniques. REVEAL is able to assist in these studies through its ability to model gel, polymer, chelating agent, cross-linker and foam mobility control of the aqueous phase. The model captures kinetics, salinity, pH and temperature dependence, and the degradation of these agents.

SURFACTANTS



If a surfactant is injected, the interfacial tension between the water and oleic phases will reduce and an intermediate phase may be generated. This may favourably increase the mobility of heavy oils and produce residual oil. This is modelled in REVEAL by calculating an effective salinity resulting from the concentrations of the surfactant, polymer, alcohols, temperature and equivalent alkane number, then using a ternary diagram to calculate the phase saturations and concentrations of all components within the phases. The Alkaline Surfactant Polymer (ASP) process can also be modelled (using the water chemistry model available) which models the combined polymer and surfactant floods.

BACTERIAL SOURING

Sulphur reducing bacteria can thrive in an oil reservoir, provided the right conditions are present. This will give rise to H_2S production, that can have a significant impact in production processes. A souring model, catalysed by bacterial action, with partitioning of H_2S between the aqueous and oleic phases is present in REVEAL that can assist in analysing this phenomenon. Growth and respiration effects of the bacteria are based on carbon source and bacterial activity. H_2S can then partition and be transported in oil and water, enabling engineers to understand the severity of the challenge and what mitigating action to take.

ASPHALTENE / WAX

Wax deposition can create significant problems in fields where fluids have the potential to drop out paraffinic compounds. This depends on the the pressure and temperature conditions of flow and being able to understand this behaviour and create suitable operating envelopes is paramount in such situations. Wax and asphaltene precipitation (and consequent permeability reduction) is modelled by defining solubility characteristics (based on temperature) and plugging effects within the reservoir, according to pore throat size distribution.

WATER CHEMISTRY

REVEAL's comprehensive water chemistry capability with a large database of reaction species and reaction pathways allows to model reactive transport processes. Water chemistry calculations are used for many pH dependent processes such as ASP and polymer kinetics. The prediction of mineral dissolution and precipitation is modelled as the chemical species are transported and mixed within the reservoir. REVEAL also includes a water chemistry calculator, which allows batch water chemistry calculations to quality check brine composition and identify key species and minerals. REVEAL can accurately calculate the thermophysical properties of CO_2—brine mixtures over a wide range of pressure, temperature and salinity envelopes.

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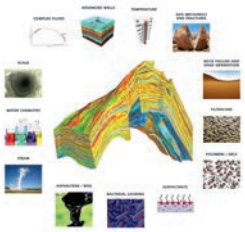

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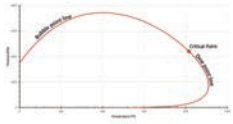
SCALE

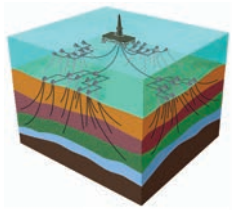
The mixing of incompatible waters due to water injection may result in scale deposition. Water chemistry calculations allows to identify scaling potential. Scale inhibitor and reversible/irreversible adsorption models are present to study the inhibitor squeeze treatments.

COMPLEX FLUIDS



REVEAL has a detailed PVT description which includes black oil and compositional complex hydrocarbon fluids such as retrograde condensates and non-hydrocarbon fluids such as CO_2 and N_2. Non-Newtonian fluids, where the apparent viscosity reduces with applied shear stress can also be modelled.

ADVANCED WELLS



Complex wells that include ICVs, ICDs, equaliser and other flow control mechanisms are being used extensively in the industry. Designing and being able to predict the behaviour and optimisation of these wells is an important aspect that engineers study in relation to these types of wells. Complex well geometries, including extended reach wells and multilateral wells with detailed well completions including annular flow, dual string completions, coiled tubing, inflow control devices, inflow control valves, isolation packers, gravel packs can be modelled in REVEAL. Friction losses and temperature changes along the wellbore are calculated and heat exchange (current and counter current) between the reservoir and the different components of the well is captured. REVEAL also allows the complex control of the wells such as fluid circulation in the well. Well geometry is independent of gridding and wells are coupled to fractures if present.

STEAM

A fully implicit steam injection model is present to model huff and puff and SAGD processes. REVEAL models can be created with the SAGD data object through RESOLVE, ensuring an appropriate gridding of the reservoir and linking of well pair to the reservoir grid. This auto generated models include a pre-heating and production schedule with control script to ensure automatic sub-cool control of the wells. The emphasis is given to production with the dynamic coupling and control of wells.

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