



Society of Petroleum Engineers

**SPE Training Course in conjunction with
SPE/IATMI Asia Pacific Oil & Gas Conference and Exhibition**

Formation Damage during Waterflood, PWRI and EOR

Pavel Bedrikovetsky and Abbas Zeinijahromi
Professor and Senior Lecturer, University of Adelaide
16 – 17 October 2017 • Bali, Indonesia

TENTATIVE DAILY ACTIVITIES AGENDA

Day 1	Topic	Venue
0900 – 1030	Registration and Welcome Coffee and Tea	To be confirmed
0900 – 1030	<p>Formation Damage in Production and Injection Wells: Methods for Prevention, Mitigation, Removal and Prediction</p> <p>We discuss physical phenomena of formation damage: precipitation, chemical reactions, straining, attachment, clay swelling, pore closure and collapse, water capillary barriers, asphaltenes, paraffins and bridging. Three common parameters to characterise those processes are skin factor, kinetics and formation damage coefficients. The exercises include calculations of those 3 parameters and estimation of well index decline. We show its applications to well and formation damage management.</p> <ul style="list-style-type: none"> • Additivity of skin factor for multiple formation damage mechanisms • Calculations of well index decline • Prediction and management of formation damage in production and injection wells 	To be confirmed
1030 – 1045	Coffee Break & Discussion	To be confirmed
1045 – 1200	<p>Deep Bed Filtration and External Filter-Cake Formation during Waterflooding</p> <p>In this session we introduce the theoretical basis for decline of well injectivity during waterflood and PWRI: deep bed filtration, external filter cake formation, cake stabilization and effects of varying oil-water mobility. The assumptions of the mathematical model are formulated, and simple analytical formulae are presented for skin factor prediction. The exercises include the production forecast, skin and impedance calculations, prediction of injection pressures and rates.</p> <ul style="list-style-type: none"> • Rock plugging by injected solid and liquid particles • Cake formation and skin developments • Type curves for injectivity decline 	To be confirmed
1200 – 1330	Networking Lunch	To be confirmed
1330 – 1515	<p>Laboratory Studies and Laboratory-Based Predictions of Formation Damage in Injection Wells</p> <p>We formulate core flooding with measurements of particle concentrations and pressure drop, and also the advanced tests with measurements of intermediate pressure points (so-called 3-point-pressure method). The exercises include calculations of kinetics and formation damage parameters from laboratory tests. Applications in several oilfields are presented.</p> <ul style="list-style-type: none"> • Characterisation of injectivity damage from laboratory and field data • Database for injectivity damage prediction from 120 core floods • Database for injectivity damage prediction from 34 well histories 	To be confirmed
1515 – 1545	Coffee Break & Discussion	To be confirmed
1530 – 1700	<p>Field Cases of Injectivity Decline: Its Prevention and Removal</p> <p>The Session includes numerous field cases of injectivity decline during waterflooding, produced water re-injection and disposal. The results of field studies, laboratory tests and laboratory-based modeling are presented. Well and water-management for those fields, including injectivity damage prevention, mitigation and removal are discussed.</p> <ul style="list-style-type: none"> • Produced water re-injection (PWRI) • Raw water injection • Produced water disposal 	To be confirmed



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Day 2	Topic	Venue
0900 – 1030	Registration and Welcome Coffee and Tea	To be confirmed
0900 – 1030	<p>Fines-Migration Damage in Production And Injection Wells We describe the physics of formation damage by migration of clays and sand particles, their attachment, mobilisation and straining in rocks with different wettability. The laboratory methodology including core floods, XRD and SEM is described in order to determine the model coefficients and predict productivity and injectivity decline at the well and reservoir scales. Numerous field cases are presented.</p> <ul style="list-style-type: none"> • Effects of salinity, pH and velocity on fines detachment and permeability damage • Laboratory-based mathematical modeling of fines migration • Simple analytical models to predict injectivity and productivity decline 	To be confirmed
1030 – 1045	Coffee Break & Discussion	To be confirmed
1045 – 1200	<p>Formation-Damage-Assisted Technologies of Oil and Gas Production This session describes numerous technologies where deliberately induced formation damage results in decrease of water production and increase of the reservoir sweep efficiency. Mainly we concentrate on fines-migration-induced damage, but also discuss deliberate precipitation of asphaltenes and paraffins in order to enhance sweep during CO₂-injection. Numerous field cases are presented.</p> <ul style="list-style-type: none"> • Fines-migration-assisted smart and low-salinity waterflooding in sandstone and carbonate reservoirs • Prevention of water-coning in oil and gas domes • Produced-water management by induced fines migration 	To be confirmed
1200 – 1330	Networking Lunch	To be confirmed
1330 – 1515	<p>Oilfield scaling We discuss sulphate and carbonate scaling during waterflooding. Simple analytical models correspond to laboratory test on commingled flow of injected and formation waters, and to quasi steady-state production of oil and water. The laboratory methodology is formulated along with field-scale predictions. The main application is the choice of injected water treatment in order to minimise the oilfield formation damage. The exercises include skin prediction. Several field cases are presented.</p> <ul style="list-style-type: none"> • Determination of kinetics and formation damage coefficients from laboratory tests • Upscaling and prediction at the well and reservoir scales • Prevention and mitigation of sulphate scaling 	To be confirmed
1515 – 1545	Coffee Break & Discussion	To be confirmed
1530 – 1700	<p>Course Summary The session includes skin induced by drilling, well completion and fracturing. The methods used have been developed in the previous Sessions. The exercises are: particle sizing in drilling fluids, thickness of external filter cake, and prediction of productivity decline.</p> <ul style="list-style-type: none"> • Formation damage during drilling and completion • Formation damage during fracturing • Lessons learned from Europe, Australia and Brazil 	To be confirmed