The University of Adelaide

RESERVOIR SIMULATION STUDIES OF FORMATION DAMAGE FOR IMPROVED RECOVERY ON OIL-GAS RESERVOIRS

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ABSTRACT

This thesis is dedicated to the development of new technologies for sweep improvement due to plugging of highly permeable channels and layers by injected or lifted or mobilized fines particles. The following methods of improved waterflood have been proposed in the thesis:

- Injection of raw or poorly treated water with consequent homogenization of the injectivity profile due to distributed along the well skin factor.
- Injection of low salinity or fresh water resulting in lifting of reservoir fines, their migration and further capture by the rock with permeability reduction and redirection of the injected water into unswept area.
- Injection of sweet water into watered-up abandoned wells during pressure blowdown in oil and gas reservoirs with strong water support.

In the above three cases, the proposal of the new technologies was backed by detailed reservoir simulations. In all cases, the application of the proposed improved oil recovery technology, as forecasted by reservoir simulation, leads to 3-15% of incremental recovery and 2-3 times decrease of the amount of produced and injected water.

The technology of raw water injection was developed using Eclipse waterflood BlackOil simulator with modelling of injectivity decline along the well due to plugging of porous media by injected particles. A new numerical procedure describing skin growth with time in each section of long horizontal wells have been developed and implemented into BlackOil Eclipse model. Different configurations of horizontal injectors and producers have been modelled resulting in production forecast with raw waterflooding.

The technology of low salinity water injection have been developed using Eclipse reservoir modelling with polymer injection option, which can describe mobilization of fines particles, their migration, capture and subsequent permeability decline. The main physics mechanism of incremental oil recovery found is the diversion of the injected water into unswept zones due to plugging the swept zone by capture particles. The incremental recovery, as obtained by reservoir simulation, is 12%. It may also result in 2 to 3 times decrease in water injection and production.

The proposal of a new technology of small bank of fresh water injection into watered-up and abandoned production wells result in lifting of reservoir fines, their migration and plugging the path for invaded aquifer water. It results in decrease of water production and prolongation of oil or gas production from wells.

DECLARATION AND STATEMENT OF ORIGINALITY

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Thi Kim Phuong Nguyen

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PUBILICATIONS

Peer-Review Journal Paper:

- Bedrikovetky, PG., **Nguyen, TKP,** Hage, A, Ciccarelli, JR, ab Wahab, M, Chang, G, de Souza, ALS, Furtado, CA 2011, 'Taking Advantage of Injectivity Decline for Improved Recovery during Waterflood with Horizontal Wells', Journal of Petroleum Science & Engineering, vol. 78, pp. 288-303.

Conference Paper:

- Zeini, A, **Nguyen, TKP**, Bedrikovetsky, P 2011, 'Taking advantage of fines-migration-induced formation damage for improved waterflooding (reservoir simulation using polymer flood option)', SPE 144009 prepared for presentation at the SPE European Formation Damage Conference, Noordwijk, The Nevetherlands, 7-10 June.