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Introduction

Near wellbore damage and remediation

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1. Introduction

This special issue on the near wellbore damage and remediation was developed from thirteen solicited papers. These studies report the recent advances on understanding, analyses, and formulation of a variety of near wellbore problems which are of practical importance for the petroleum industry. The presentation of these studies are made in two parts. Part I contains seven papers on hydrodynamic and mechanical processes and Part II has six papers on hydrodynamic and chemical processes.

2. Hydrodynamic and mechanical processes

Geilikman and Dusseault present a physics-based model for massive sand production resulting from the wellbore fluid pressure reduction to below a critical level. The model indicates significant fluid rate enhancement accompanying continuous sand production. The study shows that short-term enhancement of fluid production is dependent on the sand flux and radius of the yielded zone, while long-term enhancement is governed mainly by growth of a yielded, high-permeability zone around the wellbore. The model is shown to simulate the typical behavior observed in heavy oil wells in Alberta and Saskatchewan.

Bartusiak et al. report the results of an experimental investigation of surge flow velocity and volume required for perforation cleanup. This study determined that most of the surge flow volumes were ineffective in cleaning of perforations. It was observed that the cleanup process takes place immediately following the detonation and post-shot production flow improves the flow efficiency only a little even after several gallons of flow. The simulated reservoir design facilitated in this study was shown to provide realistic estimates of surge flow volumes.

Charles and Xie present a formulation which relates laboratory fluid-loss volume to cross-sectional area and permeability of core, applied differential pressure, and apparent viscosity, shear rate, and shear time of fluid in terms of a few dimensionless groups. The shift factors were used to account for the effects of polymer loading, fluid loss additive concentration, and temperature. The shift factors were found to be useful in eliminating the temperature effects during the investigation of the effects of the other variables on the dynamic fluid-loss. This approach is shown to provide a more convenient and accurate method for correlation of experimental data.

Hankins and Harwell address, via computer simulation, the feasibility of sweep improvement in surfactant assisted waterflooding. This process facilitates the chromatographic and phase behavior of a mixture of different surfactants to plug high-permea-

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bility zones in heterogeneous reservoir formations. This study reveals that low-permeability plugs can be formed selectively in high-permeability zones and the selectivity is high when the permeability contrast is large and the injection interval is short. The optimum plug location was determined to be between one-half and three-quarters of the way along the high-permeability zone.

Toulekima et al. investigate the effect of skin, skin location, production interval length and vertical-to-horizontal permeability ratio on the performance of horizontal wells in oilrim reservoirs. This study determined that the lower skin factors have more significant incremental effect on oil recovery than high skin factors, the productivity of horizontal wells is more impaired by formation damage near the toe-end rather than the heel-end, and greater vertical-to-horizontal permeability ratios and longer producing sections can help reduce the adverse effects of formation damage.

Berumen and Tiab investigate the pressure response of a hydraulically fractured well producing through a stress-sensitive porous formation by means of a two-dimensional model and present a method for interpretation and evaluation of the pressure responses from hydraulically fractured wells. This study provides an improved method for the analysis of pressure response, forecasting of fracture closure occurrence, and efficient programming of the stimulation operations for fractured wells in stress-sensitive formations.

Saleh et al. report the results of study of the formation damage in horizontal wells using a laboratory-scale model. The wellbore model was found to properly simulate the actual flow conditions encountered during the horizontal well completion and production. It was determined that longer mud circulation created greater damage, more damage occurred where the pressure overbalance was higher, and a 5–20-psi (34.5–138 kPa) drawdown pressure was required to initiate the well cleanup.

3. Hydrodynamic and chemical processes

Mansoori presents a model for determination of the conditions necessary for preventing asphaltene and other heavy organic depositions from petroleum fluids during petroleum production, transportation, and processing. The mechanisms of flocculation, deposition, and plugging of asphaltene, paraffin, and diamondoid are investigated and modeled. The applications of the predictive model on a number of case studies demonstrate that it is possible to alleviate the various formation damage problems by selecting precipitation-free production schemes.

Atkinson and Mecik discuss the thermodynamics of scale-forming minerals and analyze the effects of temperature, pressure, and non-ideal solutions. Predictive relationships and detailed analysis of the calcium carbonate scale formation are presented.

Chang and Civan present a practical model for chemically induced formation damage in petroleum reservoirs. This model considers a number of important phenomena including dissolution/precipitation, ion exchange, fines migration, clay swelling, and porosity/permeability alteration. A history matching method is used to determine the best estimates of the model parameters from laboratory core tests. The validity of the model is demonstrated by comparing the simulation results with some laboratory measured permeability impairment data.

Raines and Dewers examine the influence of the surface reaction rates and hydrodynamic conditions on the rates of dissolution and precipitation from aqueous solutions at mineral–water interfaces. The studies with calcite and gypsum indicate that both transport and surface reaction play important roles in the rate-determining step for aqueous reactions. An accurate rate law is presented for predicting calcite and gypsum mineral–water reactions over a wide range of hydrodynamic and saturation conditions.

The studies carried out for two oil reservoirs and one aquifer system by *Ohen et al.* indicate that mud acid stimulation may be damaging in the Niger Delta. They present methodology for laboratory evaluation of acid effectiveness and determination of optimum acid recipes for well stimulation. The procedure is demonstrated by designing an acid work for the Niger Delta reservoirs. The reservoirs were divided into a number of regions based on the hydraulic units concept that integrates the geological and petropyhsical properties of the petroleum-bearing rock. Pre- and post-stimulation indices, compressive strengths, critical velocities, visual inspection of cores at the end of acid flush, and iron sequestrate analysis were facilitated for determination of the optimum acid sequences for different hydraulic zones of the reservoirs.

Liu et al. present a two-dimensional geochemical reaction–transport simulator for analysis and design of matrix acidizing in petroleum reservoirs. The simulator implements a numerical solution of the system of equations of fully coupled fluid and species transport, rock–fluid reactions, grain growth and dissolution, and porosity and permeability alteration by mineral reactions. The simulator incorporates a large thermodynamic and kinetic database. The simulator is verified by comparing the results with laboratory core acidizing measurements. It is shown that high injection velocity and higher acid concentration can reduce mineral precipitation and formation damage problems. It is also demonstrated that the simulator can represent the fingering and wormholing phenomena encountered in heterogeneous reservoirs.