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A Model for Optimizing Performance of Produced Water Re-Injection Scheme in a Non Fresh Water Aquifer

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Abstract

A model for optimizing the performance of produced water re-injection scheme (PWRI) is proposed. The model progress current mechanisms in literature for Injectivity decline used in characterizing formation damage and well behavior prediction, by providing additional concepts beyond formation plugging, External Cake Build Up and Internal Filtration in classical deep bed filtration (concentration based) models. The additional mechanisms described in our paper for the model development includes Geochemical Reaction/Scaling, rate of Sedimentation/Adsorption of suspended particles, Thermal /Water Front Invasion rates, Oil/Water Mobility and Porosity Decline rates (void/particle size). This reasoning has led to the development of an alternative model advancing the classical deep filtration models. The mechanisms as well as the geometrical grid designs and transport particulate flow models provided a 2-D flow filtration models incorporating 1) Mass Molecular Diffusion 2) Geochemical Reaction and 3) Non Constant porosity in an elliptically curvilinear cylindrical ($r\theta z$) geometry as against Cartesians coordinates which were not considered in previous models. The General transport scheme also included Mass (Filtration, and Permeability damage) Transport 2) Momentum Transport (Injectivity Performance decline) 3) Energy Transport (Thermal Invasion) solved simultaneously to provide the injectivity decline models and providing minimum data inputs to optimize performance. The numerical basis was used of finite volume element to solve the resulting partial differential equations. Data were provided by the Nigerian Department of Petroleum Resources (DPR) to validate our new model in a computer simulator programme developed in MATHLAB. The results of simulation show close correlation with field observations which has provided basis for designing produced water injection schemes at minimal costs, making for improved environment compliance performance, and significantly improving oil recovery schemes using produced water.

Keywords
Produced Water, Optimization, injectivity decline, external cake, internal filtration, deep bed filtration, finite volume, elliptically curvilinear cylindrical geometry,