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Roadmap for Revitalizing of Complex Field Using Numerical Modeling: A case study from GOS (GUPCO)

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Abstract

Nowadays, geological and reservoir models are essential tools used for the design and the optimization of oil and gas field development. At the same time, building reservoir model is technically complex and requires nontrivial approaches and solutions. This paper describes the experience of using modeling to support drilling and development optimization of one of the most complex reservoirs in Gulf of Suez. A distinctive feature of the publication is a compilation of tools of geological and simulation modeling, including experience in dealing with applications for the period from the start of field development to the end of production in addition to different development alternatives which helped in achieving the maximum hydrocarbon production.

Approaches to the building of geological and simulation models of a complex productive formation are described. These models incorporate a large number of different facies data, which was used to manage uncertainties and risks accompanied with the field development. This paper sheds light on significance of integration between Geological and Dynamic data, which helped a lot in managing key uncertainties and risks by generating different development scenarios and applying different options.

Finally, the model was used to propose a full realization for developing the field and increase the oil production. GUPCO is one of the largest E&P Companies in Egypt and Middle East. It has a vast infrastructure with a large number of wells, platforms, pipelines and offshore facilities. GUPCO's peak production exceeded 600,000 BOPD in 1983 while it produces around 100,000 BOEPD today from more than ten geological formations in Gulf of Suez (GoS). GUPCO produced more than 4.6 billion STBO which represent more than 43% of Egypt's total cumulative oil to date. And in spite of that, we still have many opportunities and success yet to achieve. As one of the petroleum industry leaders, GUPCO was and will always seek success and excellence in managing its assets. For more than fifty years, GUPCO used to follow the highest standards available in petroleum industry, and applied them in all areas to achieve that outstanding excellence. From day one, GUPCO realized that understanding subsurface features and optimizing recovery from different fields are the key areas among all. As a result, GUPCO had made concerted efforts in those areas in specific.

Managing giant fields is not an easy task; it requires special knowledge and experience to manage such critical asset since each 1% increment of oil recovery means tens of millions of oil barrels. And because GUPCO has four giant fields, it was serious for us to do our best to maximize their value. GUPCO started that early whilst exploration phase, appraisal, development and currently in maturity phase. Along these different phases, we utilized wide spectrum of tools starting from basic technical elements (e.g. flow equations, DCA, MBE, PTA… etc.) reaching to state-of-the-art techniques and technology available (e.g. Numerical Modeling, Artificial Intelligence and EOR) at which GUPCO uses numerical reservoir simulation extensively, utilizes neural network in different applications, and already applied TAP (Thermally-Activated Particles) technique which is called commercially BrightWater® to improve sweeping efficiency, and also studied feasibility of Low Salinity Waterflooding which is planned to be implemented in near future after upgrading water injection facilities.

Well integrity represents an objective/solution for protecting human life and environment while retaining oil production rate during the life of the well. Characterization of cement behavior plays an important role in ensuring the well integrity and can be effectively considered when it comes to the prevention of casing failure. In this research, firstly, petrophysical data at one of the wells drilled into Maroon Oilfield in southwest of Iran was used to build a one-dimensional geomechanical model of the formation encompassing the well, based on which geomechanical characteristics of the formation were estimated. Subsequently, mechanical parameters of the cement sheath used in the considered well and the friction parameters of the cement-formation contact surface were determined via laboratory tests on samples of the cement. Next, using the obtained data and considering the environmental conditions in the well, a reference numerical model was constructed for a particular section of the studied well utilizing ABAQUS Software followed by analyzing the wellbore stability under existing conditions. Finally, sensitivity analysis and parametric studies were performed to investigate the impact of friction parameters of contact surfaces, and mechanical properties of the cement on the well integrity. The results indicated that, higher Young's modulus and/or lower Poisson's ratio, cohesion, and friction angle in the cement sheath further contributed to larger plastic strains in the sheath. Moreover, with increasing the friction of

formation-cement and cement-casing contact surfaces, plastic strain of the cement was observed to decrease. In the parametric analysis, the coefficient of friction between cement-formation and cement-casing has decreased by about 45% and 60%, respectively, and the amount of PEEQ in cement increases by up to 30 mm.