Humma Marrat Reservoir, Partitioned Neutral Zone (PNZ) Case Study – Part 2: Reservoir Evaluation and Optimization

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A design of experiments (DoE) workflow was used to evaluate the Jurassic-age Humma Marrat reservoir in the Partitioned Neutral Zone (PNZ). The Humma Marrat reservoir consists of productive limestone and dolomite intervals separated by very tight limestone and/or shaly limestone zones. The reservoir was discovered in 1998 and produces from five wells. Additional delineation wells were drilled in 2005.

Connectivity and volumetric uncertainties were evaluated using 13 earth models defined by parameter combinations given in a Plackett-Burman design of experiments (DoE) table. The response variable was cumulative oil production through 30 years. Parameters included in the first level DoE analysis were structural uncertainty (seismic interpretation and time-to-depth conversion), facies distribution, porosity and Sw histograms, original oil/water contact, porosity semivariogram range, permeability multiplier, fault compartmentalization, and fault transmissibility. Only the porosity histogram emerged as statistically significant.

The second level DoE focused on “traditional” dynamic uncertainty parameters including aquifer support, rock compressibility, heavier oil distribution, kv/kh, PI multiplier, Sorw, and krw@Sorw. An additional uncertainty included in the second level analysis was the extent to which the Humma structure may be open to the south towards the Jauf structure in Saudi Arabia. This was studied using a pore volume multiplier in the the southern-most portion of the model. Only the earth model and PI multiplier uncertainties were statistically significant.

The results of the DoE analysis were used to define the reservoir models for development optimization. The P50 model was used to screen development options that included well spacing, well type, and horizontal well length. Economic analyses were conducted to select the optimum development scenario using the P10, P50, and P90 reservoir models.