History Matching of Multiple Wells with Actual Downhole ICD Configuration in a 5-Spot Pattern Reservoir Development

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Agenda

- Field and Reservoir Overview
- Workflow
- Data Pre-processing
- ICDs Pressure Calculation
- Well Performance: Comparison of ICD Model with Positive Skin Approach
- Conclusion
Field and Reservoir Overview

- Field is located in shallow waters of UAE
- Field consists of several stacked carbonate reservoirs
- Reservoir development is based on 5-spot pattern WI
- Wells are completed with ICDs based on expected heterogeneity
- All wells are equipped with permanent downhole pressure gauges
- Field is developed on the principles of Digital Oil Field (Real-time continuous Data)
- Compositional Simulation Model with more than 7 components.
Inflow Control Devices (ICDs)

- ICDs are designed to improve horizontal Well performance and efficiency by balancing inflow within the well drain length. This ICD completion is designed based on heterogeneity.
Positive-Skin Approach Model

- Skin value represents the degree of damage or stimulation.
  - Positive skin value represents the damage in the wellbore.
  - Negative skin value represents the stimulation or acidization job.

- ICDs create additional $\Delta P$ across the Well-bore.

- To mimic this additional $\Delta P$ in History Matching, a positive skin is introduced.

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Workflow

Digital Oil Field Data
• Quality checking of the real-time data
• Conversion of high frequency data to low frequency data
• Creation of a daily rate history matching model

Positive Skin Models
• Creation of a base case run without the implementation of skin along the well section
• Selection of appropriate well-wise positive skin to mimic ΔP across ICDs
• History Matching exercise based on the defined criteria

ICD Model History Matching
• Preparation of NETool well completion models
• Export of well-wise full downhole completion structure (with ICDs) from NETool to Nexus
• Run the ICD model with the final History Match
• Compare the results of ICD run with Positive Skin approach
NETool – Nexus Integration

- NETool is a steady-state numerical simulator used for Downhole completion (ICDs) of complex wells.
- Nexus is a simulator used for fluid flow for one or multiple assets, and model the reservoir, wells, and surface and subsurface facilities as a single system for the most comprehensive representation of asset behavior.

The direct export functionality from NETool to Nexus results in significant saving of time with regards to pre-processing of the data.
ICD Models in Nexus (Nozzle ICDs)

- Calculations for Nozzle ICDs are based on Bernoulli’s equation
- Nexus predicts the subcritical pressure drop across the ICDs
- Diameter of the nozzle, a dimensionless discharge coefficient and the number of nozzles are used as input parameters
- Calculated “mix density and viscosity” are used in case of multi-phase flow
Well-A Performance Matching

- Both models show good match during first 2 years production History
- ICD model shows more realistic response after oil rate dropped by more than 50%
- ICD model provides more flexibility to compare and match the PLT data
- For such wells, final HM needs to be run with the ICDs to verify the positive skin approach
Well-B Performance Matching

- Excellent match found between both the models (only 20 psi difference).
- Positive skin approach is also valid because the oil rate is not declining significantly.
Conclusions

- Nexus provides robust solution in terms of ICD modeling
- NETool to Nexus integration saves significant time during data pre-processing
- Nexus pressure hydraulic calculations are consistent with other standalone applications
- Using positive skin approach should be verified with ICD model to validate the final HM model
- Wells with significant drop in oil rate compared to the initial rate should be run and history matched using the full ICD model

Publication will available with paper number “SPE-196701-MS”.
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