Water Coning: A Mitigation Investigation

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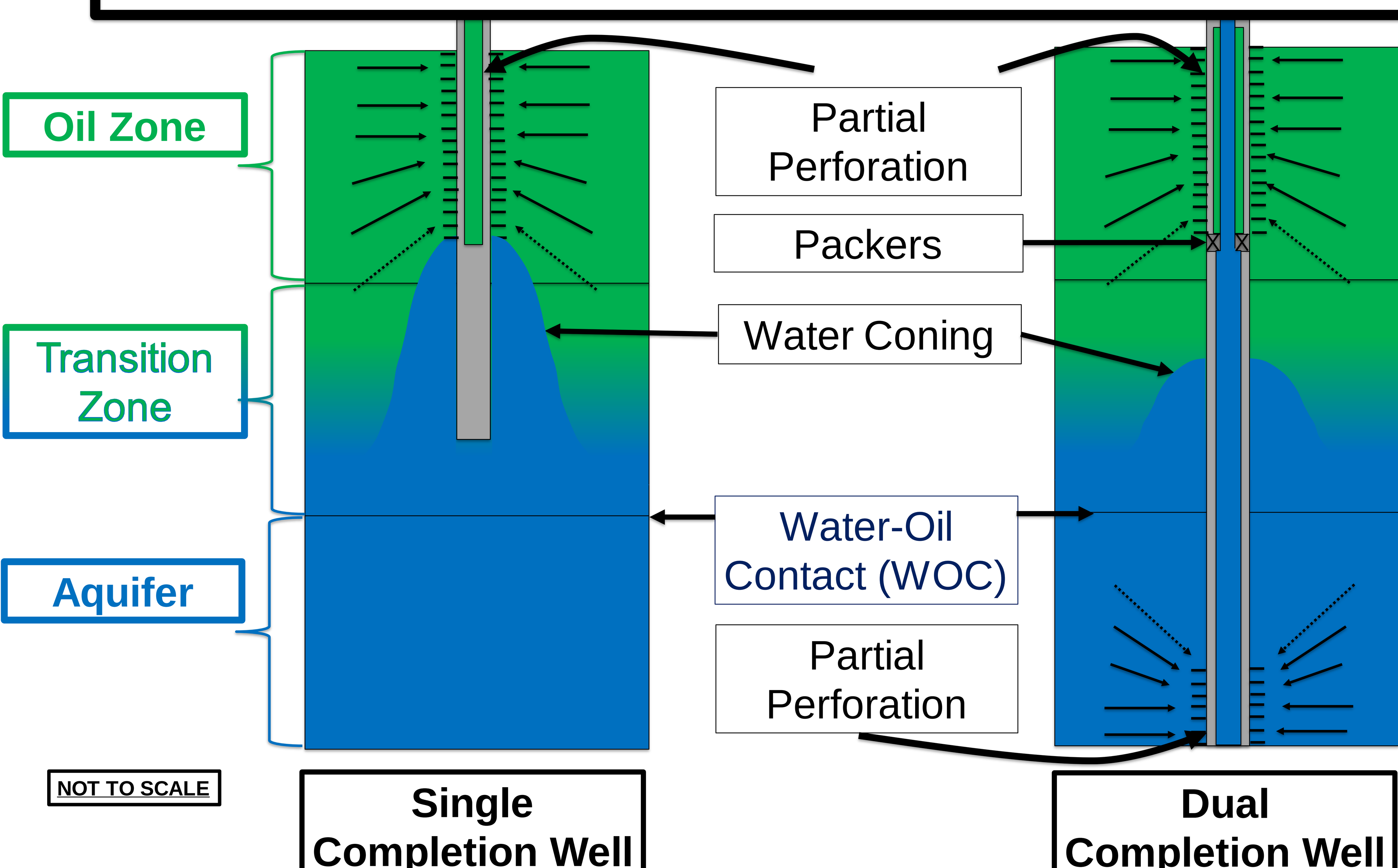
Background

- Oil typically co-exists with an aquifer underlying the oil zone.
- Water production from the aquifer via water coning action poses a major problem to the economic life of an oil well.
- Means to control water coning primary include a partial perforation of the oil producing well in the oil zone and low oil production rates.
- Water production poses environmental concerns in addition to oil production limitations and economic constraints.

Objectives

- Investigate a dual completion well to control water coning which may provide economic and environmental advantages over a single well case.
- Conduct a basic economic analysis that accounts for oil, gas, and water production along with well drilling/completion and operational costs.

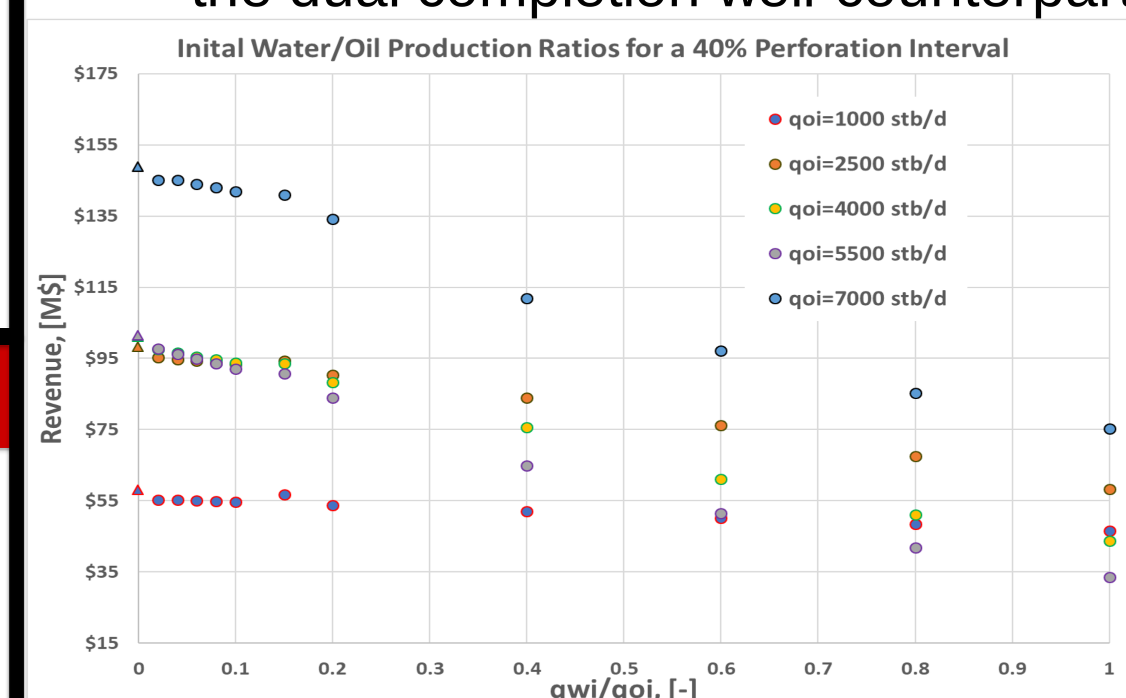


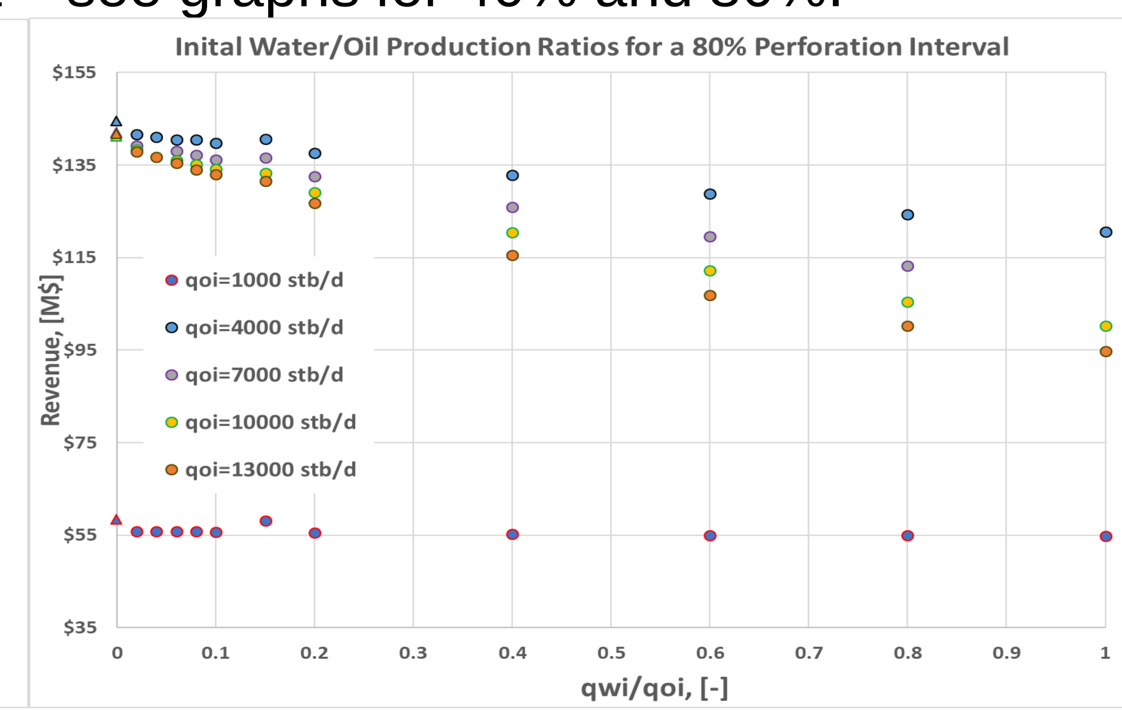
Methodology

- Compare the performance of a single partially-completed well in the oil zone with a dual partially-completed well both in the oil zone and aquifer.
- Use a commercial black oil simulator (Eclipse): 2-D cylindrical coordinates (r, z) to model a 209 ft heterogeneous oil bearing zone & a 150 ft underlying aquifer.
- Conduct a sensitivity study to determine the optimum number of radial (30) and vertical (127) grid blocks to be used in the study.
- Create multiple single-well completion scenarios with 10%, 20%, 40%, 60%, and 80% perforated oil column intervals staring from the top of the oil zone.
- Use the same perforation intervals in the aquifer for the dual completion well.
- Run simulations for various initial oil rates, initial water rates, and perforation scenarios - initial water production rate less than or equal to the oil rate.
- Account for drilling, completion, operational, and water production costs.

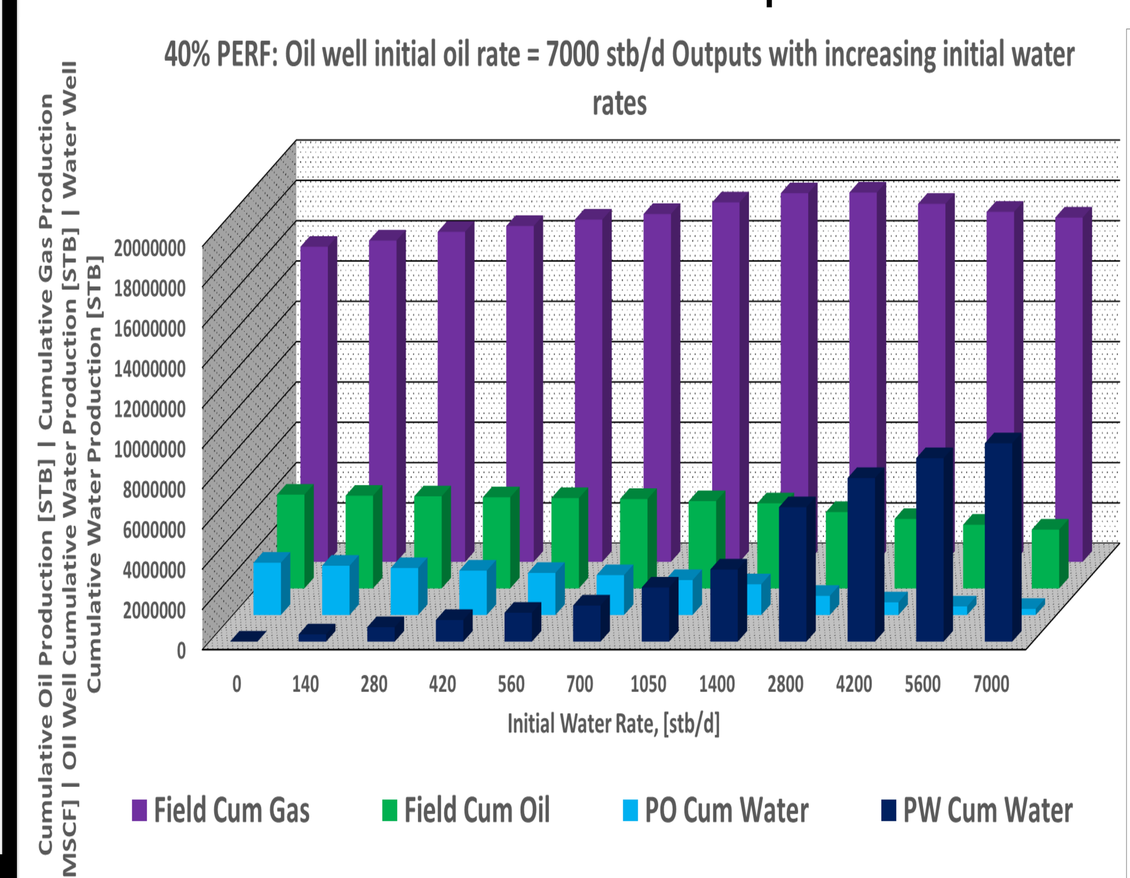
Results

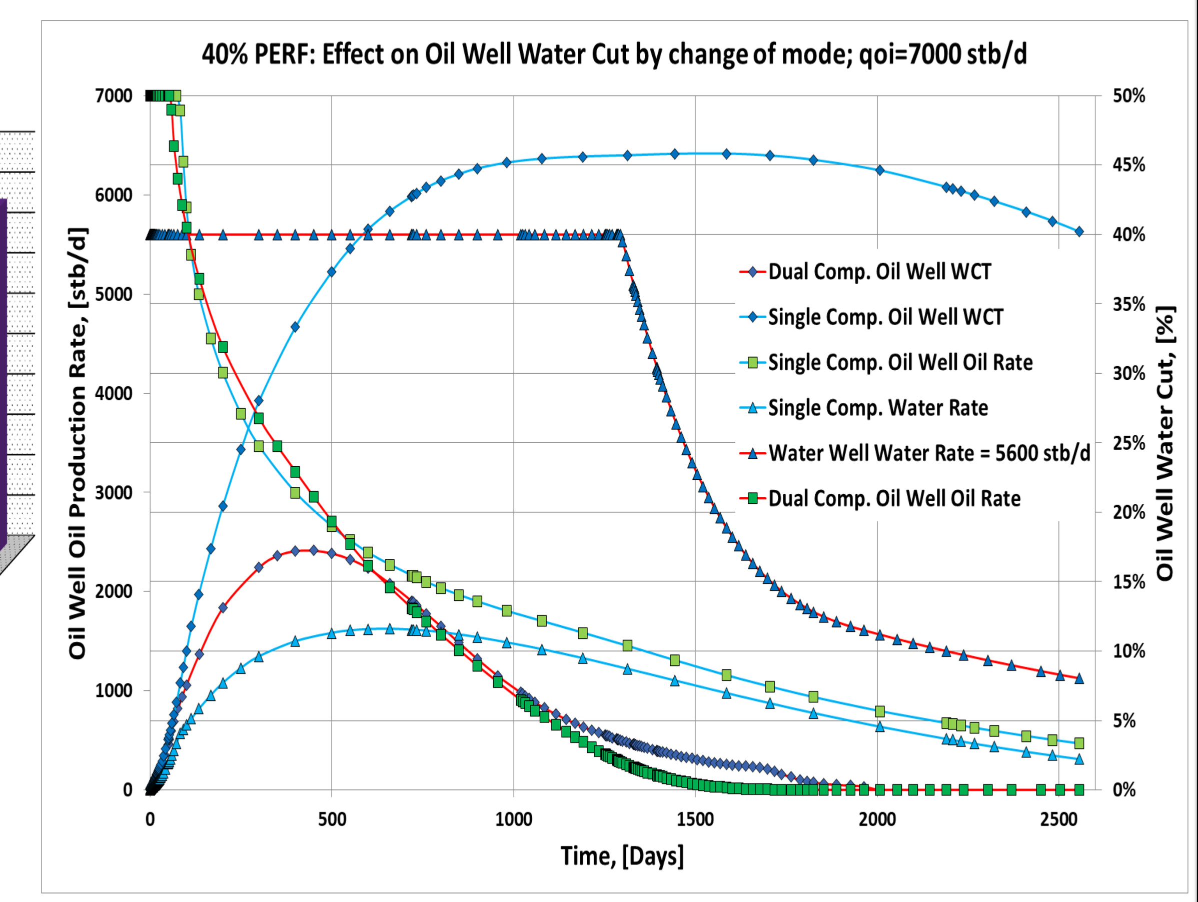
- For all perforation cases, simulation results from over 300 initial oil and initial water rate combinations show that the single well outperforms economically the dual completion well counterpart – see graphs for 40% and 80%.





- For a 40% oil zone perforation, producing the water-well completion at a higher initial water rate reduces the cumulative oil production for the same production period as the reservoir energy is depleted more rapidly.
- The oil-well water cut (WCT) for a dual completion well is maintained at lower levels compared to the single-well one. Following increasing WCT periods, both display a WCT reduction trend due to the effects of well operating restrictions and water production from the water-well completion.





Conclusions

- A single well always dominated economically over its WOC mirrored dual well completion counterpart both on cumulative oil produced and economic criteria.
- The cumulative amount of produced water in the dual completion well scenario is always higher than the single well case one.
- For the dual completion well, depletion of reservoir energy due to produced water increases the amount of produced gas. The observed decline of cumulative gas at high water rates is a combined effect of energy depletion and well life.

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