OPTIMIZATION OF INFILL WELL LOCATIONS IN WAMSUTTER FIELD

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Task 2.0
Technology Status Assessment

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Current State of Technology

A large number of operators are currently drilling wells in tight gas sand reservoirs. One of the key issues they are facing is the optimal well spacing to maximize economically producible reserves. For tight gas reservoirs with extremely low permeabilities, the well spacing has to be smaller to ensure that the gas can be recovered in a reasonable amount of time. Many operators are continuing to explore the possibility of drilling on a smaller spacing since they are observing the presence of virgin pressures at the infill well locations. The optimal well spacing is a trade-off between incremental cost and incremental reserves associated with infill drilling. Thus, our ability to accurately predict the incremental reserves is of paramount importance here. Until now, this has been an outstanding challenge in tight gas sands.

The current industry practice for the infill well potential determination uses primarily one of the two approaches. The first one is based on decline curve analysis whereby an operator uses the well production history to determine the EUR (economic ultimate recovery). Then, using volumetric calculations, the operator will determine the gas in place. Knowing the approximate recovery expected from a typical gas well, the operator will determine the number of wells needed to deplete the gas reservoir and the well spacing. Such decline curve analysis relies on simplistic assumptions regarding reservoir properties and cannot adequately account for the complex sand continuity and heterogeneity typically present in tight gas sands. Also, in most cases, the infill well drilling is conducted using a “blanket drilling” approach without regard for the necessity to drill infill wells in some areas; whereas, developing other parts of the reservoir without infill wells. The second approach relies on detailed numerical simulation study by generating fine-scale geological descriptions, upscaling of geologic models and history matching of existing wells. The history of matched wells is then used to predict the potential of infill wells. A common source of error here is in the upscaling step which often merges pay and non-pay, thus artificially increasing the sand continuity and reducing the infill benefits. Furthermore, history matching can be cumbersome, time consuming, and man-power intensive and is rarely used except by large operators.
Development Strategies

As more and more oil and gas companies face the need for developing optimal in-fill well drilling locations for tight gas sands reservoirs, existing technology may not be able to answer all the questions. The technology proposed in the project plans to address the following issues:

- Many of the tight gas sands consist of multi-stacked intervals. Some of these intervals may be more continuous than the others. Also, when drilling infill wells, some of pay zone intervals may be at the virgin pressure; whereas, others may be partially depleted. Identifying the zones and estimating the relative contributions from the virgin and the partially depleted zones will be critically important in determining the feasibility of the infill wells. We will develop better geostatistical methodology to generate reservoir descriptions consistent with the geological and dynamic continuities observed in tight gas reservoirs.

- Many of the sand intervals have complex internal structures. On a gross scale, they may appear continuous, but on a fine scale, due to the complexity of facies changes, these sands may contain barriers. We need to properly account for these barriers so that we can correctly determine the dynamic continuity away from the well bore. In particular, any upscaling of the fine-scale geologic models must preserve pay and non-pay juxtapositions so that the sand connectivity is not artificially enhanced. This is often the case in the current reservoir modeling practice, resulting in artificially low predicted incremental benefits associated with infill drilling. We will use streamline simulation procedures as well as development of transmissibility modifications to ensure that fine scale connectivity is appropriately captured.

- In deciding the infill drilling well locations, it is possible that certain areas of the reservoir may be adequately depleted with the current well configuration; whereas, certain other areas may require infill well drilling to deplete the reservoir more efficiently. Based on a proper representation of the dynamic continuity of the sand and orientation of the fractures, the potential locations of the infill wells need to be high graded. Also, we need to eliminate the areas where adequate drainage has been observed from further consideration. By properly accounting for dynamic continuities in the reservoir, we will develop screening methodology to high grade areas where there is a bigger potential for in fill well locations.
Future

The proposed work will concentrate on the Wamsutter Field in Wyoming. The Wamsutter field covers about 2,000 square miles and is one of the largest tight gas sand resources in North America. The field has already produced more than 2 TCF (trillion cubic feet) of gas and is expected to recover an additional 6 TCF. The field is currently being developed using 80-acre spacing. Determining the best possible method of developing the field on 40-acre spacing will have a significant impact on the reservoir performance and potential improvement in additional reserves. The current data on 80-acre spacing indicates that each of the new 80-acre spacing well adds about 60-70% of the original reserves from 160-acre spacing well (SPE 109565). If we successfully determine the high graded locations of 40-acre spacing wells, it would potentially double the well locations in the Wamsutter field and can increase the potential reserves by as much as 40% (approximately 3 to 4 TCF). This is a significant addition to the existing reserves in the Wamsutter field. The increase in potential daily production is difficult to determine since it would depend on the rate at which these wells are drilled. However, based on the projected rates, it is possible that the rates from the field can increase by as much as 10-20% per day.

The completed project is expected to deliver the following new methodologies:

- A new methodology which couples geological continuity with geostatistical approach so that reservoir images can be constructed which are consistent with dynamic continuity.
- A technique for determining connected sands to a given well based on streamline simulation methodology
- An approach to high grade various areas of reservoir based on determination of virgin vs. depleted sands in potential in fill wells