Application of Ensemble Variance Analysis in the Development of the Wheatstone Field Startup Strategy
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Abstract

Commencement of initial field production is a unique opportunity to acquire reservoir surveillance information that can inform future reservoir performance. When a field is perturbed from original conditions with first production, there is potential for reservoir property uncertainty reduction by observing pressure measurements at non-producing wells with downhole pressure gauges and comparing the observed signal to a range of simulation model results.

The Wheatstone field, located offshore northwest Australia, has recently commenced production start-up to supply gas to the Wheatstone LNG facility. The operational guidelines required each development well to commence with a single well cleanup flow to the Wheatstone platform. The initial single well cleanup flows of the Wheatstone field allowed scope for the selection of a well flow sequence with observation at non-producing wells.

The recommended sequence of initial cleanup flows was designed with a focus on reducing reservoir uncertainties via the use of Ensemble Variance Analysis (EVA). EVA is a statistical correlation technique which compares the co-variance between two sets of output data with the same set of inputs. For the Wheatstone field well cleanup flow sequence selection, the EVA workflow compared the full field Design of Experiments (DoE) study of field depletion and a series of short early production reservoir simulation DoE studies of the gas field. The co-variance between the two DoE studies was evaluated. The objective of the EVA approach was to determine the startup sequence that would allow for the best opportunity for subsurface uncertainty reduction. This objective was met by ranking multiple cleanup flow sequence scenarios. The key factors considered for sequence selection ranking were the impact on business objectives such as future drilling campaign timing and location of infill wells, as well as insights on reservoir connectivity, gas initially in place and permeability.

The recommended sequence of well cleanup flows uses super-positioning of pressure signal to boost response at observation wells, which improves measurement resolvability. The selected sequence preserves key observation wells for each manifold and reservoir section for as long as possible before those wells were required to be flowed to meet operational requirements. Operational constraints and variations of the startup plan were considered as part of the evaluation.
Figure 1—Location map of the Wheatstone and Iago fields and Wheatstone Project infrastructure, Western Australia.