Geothermal in the Oilfield: An Operational Example from Nevada, USA, and a Template for the Middle East

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Abstract

Geothermal resources present in sedimentary basins occupy a much larger area across the planet than do the locations of near-surface medium- and high-temperature geothermal resources. With the presence of both surface facilities and existing oil and gas wells, geothermal is an option for co-production alongside oil and gas operations and for end-of-field-life field conversion are viable options rather than plugging and abandonment. This presentation demonstrates the geoscience and operational considerations of a geothermal deployment using a technical example from Blackburn Field, Nevada, USA, and the lessons for deployments at locations in the Middle East.

The Blackburn operation has accumulated more than 3000 runtime hours as of February 2024. The project in its initial phase generated geothermal power coproduced from existing oilfield operations. Blackburn Field is a conventional waterflood discovered in the early 1980s. The field now produces approximately 4200 barrels of fluid per day with an average water cut of 99.3%. Produced fluids have a temperature of as high as 115° C at the wellhead and close to 95° C following separation at the central tank facility. Geothermal power production is accomplished with a 75 kW organic Rankine Cycle unit utilizing twin-screw compressor technology and dry air radiator cooling. Important uncertainties that this feasibility study seeks to minimize are fluid sourcing, injector to producer fluid flow, and a better understanding of reservoir heterogeneity, both from lithologic and structural perspectives. Initial results from a time-series of deuterium and oxygen-18 is that the reservoir waters match both the modelled and actual precipitation isotope values from late winter snow, however the age of the fluids is unknown. No seasonal variation is seen in a one-year data collection effort, suggesting mixing and deep reservoir sourcing that is cutoff from annual aquifer recharge in the nearby ranges. 3D seismic data shot in the 1980s and recently reprocessed shows considerable reservoir compartmentalization.

Nevada is a basin and range province, formed by the accumulation of terranes by accretion during the mid Paleozoic age. The close proximity to the active margin melting zone drives high geothermal gradients in basins from California to Colorado as well as fracture-driven hydrothermal and epithermal systems throughout the region. Many of the basins in the western United States are filled with both clastic and carbonate lithologies.

Although the geology of the Arabian Shield landmass has very difference provenance from the western United States, it shares the similarities of clastic and carbonate basins in proximity to volcanic terranes with elevated geothermal gradients. The Middle East has considerable geothermal power generation potential in areas with high water cut fields and water floods and naturally elevated geothermal gradients as well as in areas with steam flood operations.