

Subsurface Assurance FEED Study Validates a Centralized CRI Project in Oso Field, Ecuador

Advanced fracture simulation and injection testing analysis determine suitable injection zones and identify optimal operational parameters

CHALLENGE

Identify, evaluate, and design cuttings reinjection (CRI) technology for a centralized facility in an area with limited space and restricted permitting process for landfill disposal.

SOLUTION

Execute a front-end engineering design (FEED) study to examine the basis of the design, surface and subsurface technical conditions, and implications to identify an environmentally feasible location for a centralized CRI facility.

RESULTS

- Validated suitable subsurface formation for CRI and waste containment for environmental compliance.
- Assessed capability of the subsurface formation and waste domain to accommodate high volumes of waste.
- Evaluated well design for CRI.
- Determined the operational parameters and injection conditions for proper equipment design.
- Outlined the high-level risks to the CRI project and proposed mitigation options.



Identifying acceptable location for a centralized reinjection facility

An operator in the Oso field in Ecuador sought a suitable location to handle large volumes of slurry for reinjection. However, an increase in the waste generated from drilling activities would also increase environmental and social risks. The objective for the operator was to identify and validate a centralized CRI facility area that would not negatively affect the community or environment.

Conducting a FEED study to evaluate feasibility and identify optimal parameters

M-I SWACO suggested implementing a FEED study to evaluate the subsurface and environmental feasibility of CRI and to identify the optimal operational and injection parameters for an environmentally safer, efficient, and cost-effective CRI. M-I SWACO first modeled the fracture propagation behavior using a fully planar 3D hydraulic fracturing simulator. Applying these techniques to the validation of subsurface conditions made it possible to identify containment and confinement formations and verify that the fracture domain was an acceptable distance from nearby wells and geological hazards.

The FEED study also included the selection of surface equipment for the project. Evaluating surface equipment considers the waste volume and streams involved in the process, including utilities and footprint. A centralized facility requires additional considerations for logistics and sufficient onsite temporary storage under high-volume scenarios. The surface equipment needs and sufficient space for temporary onsite storage were identified and included in a proposal for the necessary size of the facility.



Workflow diagram for FEED study.

Validating the centralized CRI facility concept

Once the FEED study was completed, and prior to initiating operations, a complete set of injectivity tests was performed to deliver the first direct evaluation of injection pressure needed to conduct CRI operations. The test provided a reference line for the in situ parameters of the disposal formation, the means to calibrate the geomechanical model, and alignment of the hydraulic fracture simulations results.

Previously, a third-party vendor performed an injection test in the same area without considering all subsurface parameters, including the poroelasticity effect and the multiple fracturing complexities in the injection formation. The vendor’s results indicated poor feasibility of CRI injection because of high pressures and the inability to inject more than 2.5 bbl/min [0.40 m³/min].

CASE STUDY: Subsurface assurance FEED study helps operator determine optimal CRI operations, Ecuador

FEED engineers at M-I SWACO proposed a new procedure that considered the presence of the high poroelasticity conditions in the formation as a result of the technical subsurface evaluation. The new procedure included a correction in injection fluid properties to mitigate the effect of the poroelasticity while performing the injection test.

M-I SWACO performed the formation injection tests and deployed pressure analysis techniques to calculate the subsurface parameters for calibrating the geomechanical model previously constructed for the field and to verify

the pressure conditions expected during operations. The assessments helped identify vertical fracture growth and reduced poroelasticity in the formation, allowing injection of up to 7.5 bbl/min [1.19 m³/min].

The new injection test results validated injectivity in the formation and demonstrated the importance of an adequate procedure and integrated subsurface assurance approach before the injection of the first slurry batch. Tests were completed without reaching the maximum allowable surface pressure—even at 7.5 bbl/min.

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