Petroleum Development Oman (PDO) selected the Amal oilfield in Southern Oman as the site for its solar enhanced oil recovery (EOR) pilot utilizing enclosed trough technology. The system produced its first steam in December 2012 and has been in regular operation since February 2013. The 7MWt system feeds steam to the field’s main injection header at the same pressure and steam conditions as Amal’s gas-fired once through steam generators (OTSGs).

Data collected during the first 12 months of operations validates the technical feasibility of deploying GlassPoint’s enclosed trough technology to generate solar steam for EOR in desert oilfields.

Solar Resources in Oman
The solar radiation in most parts of Oman and the Gulf region is at a high enough level to produce solar steam suitable for EOR. The deserts of Oman receive DNI (direct normal irradiance) of over 2000 kWh/yr in most locations, with higher altitudes reaching over 2500 kWh/yr. The location of the solar EOR pilot receives 2057 kWh/yr.

How the Enclosed Trough Works
The enclosed trough solar steam generator was designed specifically for oilfield deployment.

- There are no solar panels in a GlassPoint system. Instead, large curved mirrors are suspended inside an agricultural glasshouse.
- The mirrors automatically track the sun throughout the day, focusing sunlight on a stationary boiler tube containing water.
- The concentrated sunlight heats the water to produce high-pressure steam to customer specification.
- The steam is fed to a field’s existing stream distribution network for injection.

Oilfield Performance and Integration
Actual performance of the pilot matched modeled performance within a few percent, and the system continues to exceed contracted performance targets. During the first 12 months of operations, the solar field achieved 98.6% uptime and continues to improve to be over 99%, significantly exceeding expectations.

An 80m³ insulated water tank was added to the system during the year to improve overall performance. The tank removed direct dependence on water supply, and allowed the recovery of waste heat into the feed water during transient periods.

Steam quality is controlled via a separator and re-mixing system. Steam is separated in a vessel and the flow of steam vapor and liquid measured, the two are then re-mixed at the target steam quality, generally 75%.
Year-End Conclusions
• The enclosed trough can deliver a reliable source of steam for thermal EOR
• System is effective in desert oilfield environments, withstanding severe dust and sand storms
• Important technology enhancements were tested and proved for future large-scale deployments

Sandstorm Operations
The enclosed trough is equipped with a proven automated washing system to maintain high optical efficiency and reduce costs and water use.

A severe dust storm was observed in early April 2013. During this event, winds exceeded 40km per hour for over 24 hours, with peak gusts over 60km/hour. Surface visibility was reduced to less than 100 meters. The plant continued to operate during the storm, producing 48 tons of steam.

The automated washing unit proved particularly effective, fully restoring system performance from 88% of capacity to 100% performance overnight.

Soling resulted in an average of 2.5% per day reduction in output, with a single wash cycle restoring 100% of performance. Three days without washing resulted in a 7% loss in performance. The high levels of soiling underscore the significance of automated washing for Middle East solar deployment.

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