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# The Well And Reservoir Management Strategy For The Thermally Assisted Gas-Oil Gravity Drainage Project In Oman

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### Abstract

Gas Oil Gravity Drainage (GOGD) of a fractured low permeability carbonate reservoir is to be enhanced by steam injection. Based on encouraging pilot results the full field development is being installed – the first of its kind in the world. A well and reservoir management strategy is put in place to ensure delivery of the promised oil.

The key areas to be managed include the heat distribution throughout the reservoir monitored by microseismic and temperature measurements in strategically placed wells, the oil rim in the fractures monitored by pressure gradients in wells, the amount of matrix oil saturation reduction monitored by periodic coring and production logging, the cap-rock integrity monitored by a combination of surface deformation, microseismic and reservoir temperature and pressure measurements. Furthermore, the management of the raw water supply and produced water disposal reservoirs is essential to ensure adequate water availability and disposal capacity as without which the project can not be operated.

The learnings from the pilot created a better understanding of the reservoir processes and provided a significant insight into the well and reservoir management challenges and operational issues. Therefore, the pilot made possible the management of many of these challenges upfront during design.

A well and reservoir management strategy is prepared along with the smart field value loop process: measure-analyse-decide-execute. Static, dynamic and geomechanical fractured reservoir models are built to

manage this extremely complex system. Additionally, a well and reservoir heat management strategy is put to effectively manage heat injection and heat distribution. A plan is put in place for data acquisition, integration and analysis in addition to the data format and interfaces between the measured field data and model results. Further, a plan is put to facilitate the seamless interaction and collaborative works between subsurface engineers and field operators.

### Introduction

In the North of the Sultanate of Oman, the world's first full field Thermally Assisted Gas-Oil gravity Drainage project is being constructed. It is in a highly fractured carbonate field with an oil viscosity in the order of 200 cp, hence cold Gas Oil Gravity Drainage (GOGD) in this reservoir would be economically unattractive. Reservoir heating through steam injection will significantly lower the oil viscosity and increase the GOGD rate by a factor of about 100 and increase the field oil recovery.

The Thermally Assisted GOGD (TAGOGD) development concept is novel and it has been piloted in the field and was found to be attractive. The attractiveness of the concept stems from the fact that the fractures in the reservoir help to effectively distribute the steam and collect the oil. This type of development requires significantly fewer wells than a conventional steam flood. Given the lack of large-scale analogues for steam injection into fractured carbonate reservoirs and the uncertainty in the recovery efficiency outside the pilot area, the main focus of the development planning has been on building a flexible plan that can be adapted to a wide range of scenarios.

The project development overview is shown in figure 1. Raw water supply is obtained from a shallow aquifer into the steam generation plant. The steam will be mainly generated by three Heat Recovery Steam Generators (HRSGs), which utilize hot exhaust gas from a power plant, and are supplemented by duct firing with a blend of sweet pipeline gas and produced gas. This steam is injected into the fractures in the crest of the reservoir and these fractures help to distribute the steam in the reservoir. The oil in the matrix is heated and drains down by gravity through the matrix into the fracture oil rim. From here it is produced into the production facility. The aquifer influx is produced via dedicated Aquifer Pump Off (APO) wells outside the steam zone. The produced