

Improved Oil Recovery in a Heterogeneous Carbonate Reservoir by a Judicious Application of Flood Piloting and Modelling Techniques

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1. Introduction

The subject reservoir is an heterogeneous carbonate formation of a giant Onshore field located in the United Arab Emirates. The reservoir is under-saturated and can be sub-divided into a lower permeability (2-4 mD) upper sub-zone and a slight higher permeability (14-20 mD) lower sub-zone. The reservoir properties also degrade downflank. With this kind of zonation, vertical and lateral heterogeneity the peripheral water injection alone will not be enough to sustain the production and the expected recovery factor will be in the range of 20%.

Several studies were performed screening a number of development options. The studies indicated that for this kind of reservoir heterogeneity, crestal gas-WAG injection coupled with peripheral water injection would be the optimum development option. Three field pilots were initiated to evaluate the effectiveness of the proposed development option; two crestal pilots to evaluate gas and water injection to be followed by WAG and one peripheral water injection pilot to evaluate the effectiveness of the water flood in the downflank area.

The pilots have been in operation for quite some time (> 4 years) and met most of initially set objectives. The sweep efficiency derived from the crestal gas and water pilots revealed a higher recovery factor to the level of 57%. Model predictions satisfactorily match field observations. Simulation studies indicate that WAG injection on those pilots further boost the recovery up to 65 %.

2. Key Features

- Field overview and reservoir characteristics
- Development options screening
- Field pilot results, including pilot layout, field observations, performance analysis, sweep efficiency and scale-up to for full field application.
- Reserves uncertainty assessment

3. Conclusions

- Detailed reservoir characterization and flow simulations studies are essential to screen different development options.
- Field piloting of the selected option is a requirement before full-field implementation.
- Pilots provided the means to measure success and evaluate the overall sweep efficiency under different recovery processes.
- Integration of field observation data and simulation results is a requirement to:
 - Reduce key performance uncertainties
 - Enable recovery optimization and reliable quantification of benefits of field-scale gas-WAG injection
 - Formulate a robust development plan.

4. References and Bibliography

Speaker's Biography

Hafez H. Hafez is a Senior Reservoir Engineer with ADCO- Abu Dhabi for 25 years dealing with reservoir studies and management. Previously he worked for 5 years in GUPCO - Egypt as operation and reservoir engineer dealing with different reservoir aspects.

He is the author and co-author of a good number of SPE papers and presented in different conferences, forums and workshops.

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