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An Integrated Workflow for Gas Injection EOR and a Successful Application to a Heterogeneous Sandstone Reservoir in the Southern North Sea

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Abstract

This study describes an improved engineering workflow to perform technical evaluation and screening of gas injection EOR. A successful case study demonstrates how field data, engineering analysis and simulation are integrated to precisely model gas injection EOR. This workflow can be adaptable for any type of reservoir and can be utilized as a fast-track screening workflow for gas injection EOR.

The target for this study was the Gyda reservoir located in the southern part of Norwegian North Sea in the Norwegian Continental Shelf. The reservoir is of heavily faulted heterogeneous shallow marine sandstone. As the measure of heterogeneity, a Dykstra-Parson's coefficient¹ (V_{DP}) of more than 0.8 has been measured from core plug data.

For the purpose of building a tool that can be utilized for gas injection EOR study, a five-step workflow has been implemented:

1. High resolution vertical geologic modeling to capture heterogeneity
2. Flow-based rock typing to model fluid displacement in detail,
3. Application of a commercial optimizer for adjustment of fault transmissibility to assist and accelerate the process of history match
4. Inclusion of gas miscible modeling with a simplified 1D Todd and Longstaff representation of phase mixing
5. A combined engineering and economic approach to establish gas injection strategy.

The results of this case study confirmed the capability of the described workflow to model gas injection EOR for the heterogeneous sandstone reservoir. Potential gas channeling in high permeability streaks and an improved displacement by gas was precisely modeled by the workflow. Injection strategies, such as WAG, SWAG and gas injection have

been screened by the model, leading to a conclusion in relatively short period of time.

Introduction

The Gyda Field is located in Block 2/1, 270 km southwest of the city of Stavanger Norway, 43 km north of the Ekofisk Centre and 28 km south-east of the Ula Field. The water depth is around 65 to 70 meters (Fig.-1). The production license was awarded in 1977 and the field was discovered in November 1979. Gyda was declared commercial in 1986 and PDO was approved by Norwegian authorities in June 1987, and production commenced in June 1990.

Gyda has been developed with an integrated steel production, drilling and quarters (PDQ) platform. Liquid and gas processing capacity is 70,000 stb/d and 54 mmscf/d, respectively. Oil is piped to the Ekofisk Centre via a 20 inch pipeline tied into a T-junction with the Ula pipeline, and then on to Teesside in UK. Gas is transported through a dedicated 12 inch pipeline to the Ekofisk Centre and sold to the Ekofisk Group (Fig.-2). An extension of the license period to 2018 was granted in 2006.

Annual oil and gas production to date is shown in Fig.-3. During 1988 and 1989, a total of eight template wells was pre-drilled and production started with the maximum capacity of 70,000 stb/d in 1990. The field has been developed with a water injection scheme. Water injection at Gyda commenced in February 1991 and as of June 2008, there are 15 active production wells and 7 active water injectors. Oil production has been maintained above 10,000 stb/d by successful application of infill drilling. Water production is around 26,000 stb/d as of June 2008 and average production water cut is 68%.

After 28 years of development and production, the Gyda field is now categorized as a mature field experiencing typical challenges of declining oil production and increased