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Evaluation of Chemical Flood Potential for Mangala Field, Rajasthan, India - Laboratory Experiment Design and Results

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Abstract

In 2004, Cairn opened up a new petroleum province with significant hydrocarbon discoveries in Rajasthan, India. The largest field, Mangala, contains +1 billion barrels of waxy and moderately viscous (7-20cp) oil in high-quality fluvial clastic reservoirs. Production startup under waterflood is planned for 2009.

Because of the unfavourable waterflood mobility ratio, early EOR implementation is a key to improving oil recovery and reducing water production. EOR screening studies identified aqueous-based chemical flood methods as most suitable for the Mangala conditions, so detailed laboratory studies were designed to evaluate the potential of both polymer and alkali-surfactant-polymer (ASP) flood processes. Fluid-fluid work involved cation exchange capacity study of the rocks, screening and optimization of the ASP slug formulation based on IFT and adsorption measurements, phase behaviour evaluations, polymer rheological and transport property studies, and thermal stability studies. This was followed by a series of linear corefloods on native-state cores to define relative permeability, polymer rheology, dynamic chemical retention, and suitable polymer types and concentration for chemical floods. The best chemical formulations from the linear corefloods were then used in a series of radial corefloods to decipher differences in chemical solutions and quantify incremental oil recovery.

The experiments confirmed Mangala to be an excellent chemical flood candidate. They showed ASP flooding to be the most effective process, with an incremental coreflood recovery of ~30% STOIIP above waterflood; while a basic mobility-control polymer flood showed an incremental coreflood recovery of ~15% STOIIP. The next step in the Mangala EOR evaluation process will be an ASP pilot test in the field, which will begin simultaneously with the startup of oil production.

This paper presents the approach adopted in designing the laboratory programme and discusses the laboratory results and their implication on chemical flood design for the field.

Introduction

The Mangala field, discovered in 2004, is located in the northern Barmer Basin in the state of Rajasthan in northwest India, as shown in Figure 1. The basin is a Tertiary rift, predominately consisting of Palaeocene-Eocene sediments. The Mangala structure is a simple tilted fault block, dipping at around 9° to the southeast. Depth of the Mangala structure at the Fatehgarh reservoir level is around 600 mSS and the oil–water contact is at 960 mSS, so the overall gross oil column is 360 m. The current estimate of stock tank oil initially in place (STOIIP) is 1,293 MMbbls.

The main reservoir unit in Mangala is the Fatehgarh Group, consisting of interbedded sands and shales. The group has been sub-divided into the Upper Fatehgarh Formation dominated by sinuous, meandering, fluvial channel sands, and the Lower Fatehgarh



Fig. 1: Location map of Barmer Basin, India.