Comprehensive EOR Screening of a Large Heavy Oil Field

Many of large fields suffer from low recovery factors and declines in primary production due to low oil gravity (<22 API) and viscosities above 100 cP. The studied field contains in excess of 1 billion barrels in place. 75% of the STOIIP comprises 20 API oil with 120-160 cP viscosity while the remainder comprises 16 API with 800 cP viscosity. Complicating matters, the three main sandstone reservoirs vary from braided fluvial streams in the Aradeiba, to thick sheet sands in the Upper Bentiu and thinner sands separated vertically by thin shales in the Lower Bentiu.

The Study commenced with static and dynamic modeling carried out through 2009. Following the history match it was recognized that primary and secondary recovery could only recover at best 10% of the oil in place. Therefore a considerable number of EOR techniques have been assessed in order to recommend suitable development options for this field. In the absence of a miscible gas option, Eclipse simulation schemes were developed for the following 10 recovery mechanisms:

1. Natural depletion
2. Water flood
3. Chemical EOR – polymer and ASP
4. Thermal EOR – CSS, steam flood, SAGD and in-situ combustion
5. Immiscible Gas EOR – Nitrogen and WAG

The preliminary approach was to run a base 40 acre scheme for 10 years each reservoir, to allow the 10 techniques to be reduced to a more manageable set of more effective techniques. The three most promising techniques, ASP, steam flood/CSS and insitu combustion were then developed to optimise pattern spacing and injection rates for each technique. Thereafter, facilities schemes and notional costs were developed so that economic feasibility could be used to select the preferred technique going forward.

EOR has been found to be economically and technically feasible on this field with highest economic recovery across all reservoirs from Steam (CSS/Flood/SAGD). Utilising crude oil as fuel is the most attractive option, with all reservoirs optimized on +/- 20 acre spacing. There is scope for thermal recovery to take RF above 30% overall. Optimisation potential also exists with, for example completions to reduce breakthrough, injection tapering, SAGD H-wells on 40/80 acres. Steam will therefore be proposed as the EOR technique for the next phase of the project, pilot design.

ASP came out as a viable option for the Upper Bentiu at 40 acre spacing and a similar UTC to steam. However, the overall potential for ASP is much lower, especially in the more viscous oil, and the potential field RF is in the 18-24% range. Insitu combustion with air provides high recovery but at high well density (6-10 acres) and is NPV negative due to air injection and well Capex and power Opex, even with burning crude for power. All other options, such as Polymer, N2, WAG, provided insufficient recovery to justify any further investigation.

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Workshop brief contents

1)Introduction and geology of propose field

2) EOR Sectors and Base Recovery

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4) Chemical EOR Techniques & Recoveries

5) Facilities, Wells & Costs

6) Economic Feasibility: Scope for Economic Recovery

7a) Recommended way Forward

7b) some other heavy oil recovery method in other countries