

## ABSTRACT

### Optimisation of a Saturated Oil Reservoir using Numerical Simulation

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Eight horizontal wells and one deviated well were drilled in the Immortelle field off the East Coast of Trinidad since August 1994. The Immortelle horizontal well program was aimed at developing a 50-foot oil column overlain by a large gas cap and underlain by an aquifer. The reservoir management plan was to produce the oil reserves in the 16 Sand reservoir before producing the gas cap to supply a fast growing gas market on the island of Trinidad.

A black-oil numerical reservoir simulation model for the 16 Sand reservoir was built using an in-house software called GCOMP. The model had grid dimensions of 36 X 52 X 23, where each block had 200 feet by 400 feet size and the vertical layers varied in thickness. There were several modifications made to the model in order to achieve a good reservoir characterization. A major period of this study was spent on matching the historical and predicted production performance. These modifications involved the initial quality control of the actual production data that was used to compare with the modeled output. Well completion location was also adjusted as well as some of the reservoir characteristics. These reservoir characteristics include the sealing of faults, adjusting the pore transmissibility and the strength of the water drive. The match was considered good when compared at a full field level. But on a couple of individual wells the matches of the water and gas production were not of the best.

A previous analysis of the 16 Sand was undertaken and the recoverable oil reserves was in the order of 12.531 MM barrels with the existing wells. However, this current study suggest it to be 11.867 MM barrels of oil after production history matching with data up to and including 1997 for all well in 16 Sand reservoir. Therefore the previous model was over estimating recoverable oil reserves by 0.664 MM barrels.

Four prospects were generated for the matched reservoir model using a combination of cumulative production plots and oil saturation maps. Economics were done on all four prospects of which two wells were recommended to be a part of the drilling program scheduled to start on 01-01-1998. Both wells would monetize 2.2 MM barrels of oil and 25 BCF of gas where a net profit of US\$6.53 MM would be gained from a pay-out period of under 3 years using a 10% annual discounted rate. By placing the two additional wells in the 16 Sand reservoir from this study the ultimate recovery was increased to 14.1 MM barrels of oil. Hence the recovery factor was increased from 21% to 25% noting that both simulation



runs used an economic limit of 100 barrels/day of oil for each well at US\$12.50/barrel of oil and US\$ 0.8/MCF of gas.

Sensitivity analysis was done on 'PROSPECT 3' which was one of the chosen wells to be drilled, when the sensitivity was tested on capital investment, operating cost, oil price and gas price. It was found that the capital investment was the most sensitive and the least sensitive was operating cost. Also from the matched model, by June 2004 (10 years from initial development of 16 Sand reservoir), only IMM-8, IMM-15, IMM-2 and IMM-5 would be on production which would give rise to further possible economic side-tracks into the 16 Sand oil column thus increasing the recoverable oil reserves.

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