

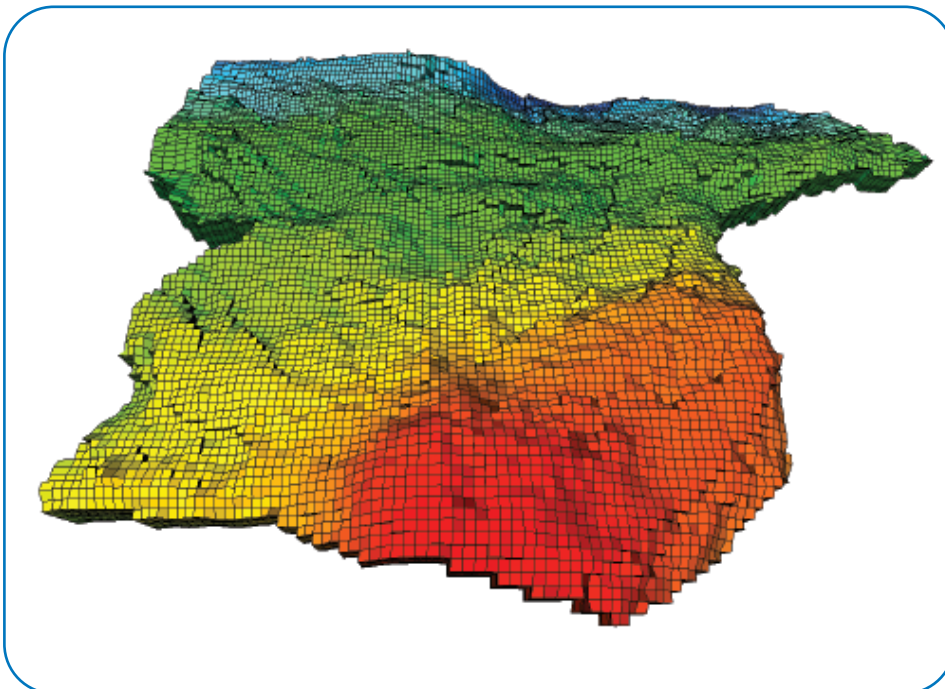


Reservoir Performance Analysis and Prediction

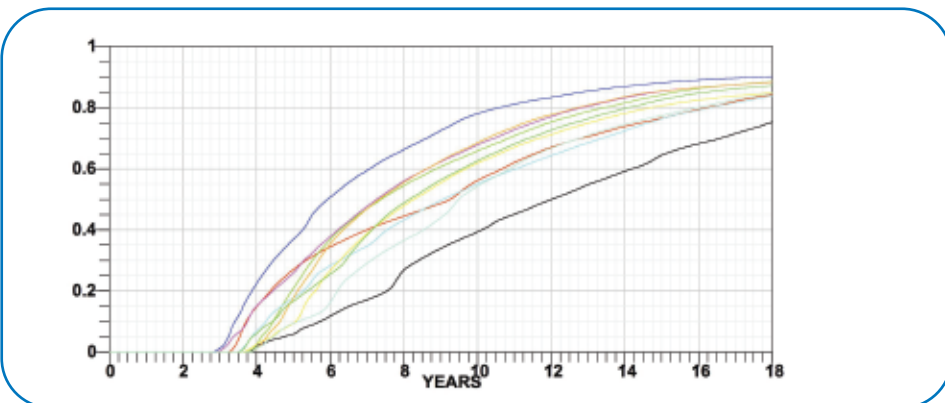
Introduction

Reservoir performance analysis and prediction is integrated within our project planning, project management and multi-disciplinary integrated teamwork approach. This means that we assess the client's needs, then formulate and execute a fit for purpose work scope to help the client make good decisions for reservoir development or reservoir management.

Depending on the nature of the problem, the project objectives and the amount of time and data available we can employ classical reservoir engineering such as material balance or decline curve analysis as well as state of the art reservoir simulation modelling. We may also employ a combination of techniques to provide greater confidence in the results, for example material balance supported by analogue field performance data or reservoir simulation supported by decline curve analysis.



Full Field Reservoir Simulation Model



Watercut vs Time: Watercut Forecasts from Simulation Modelling Showing Range of Uncertainty from 10 Geological Model Realisations

Our expertise includes:

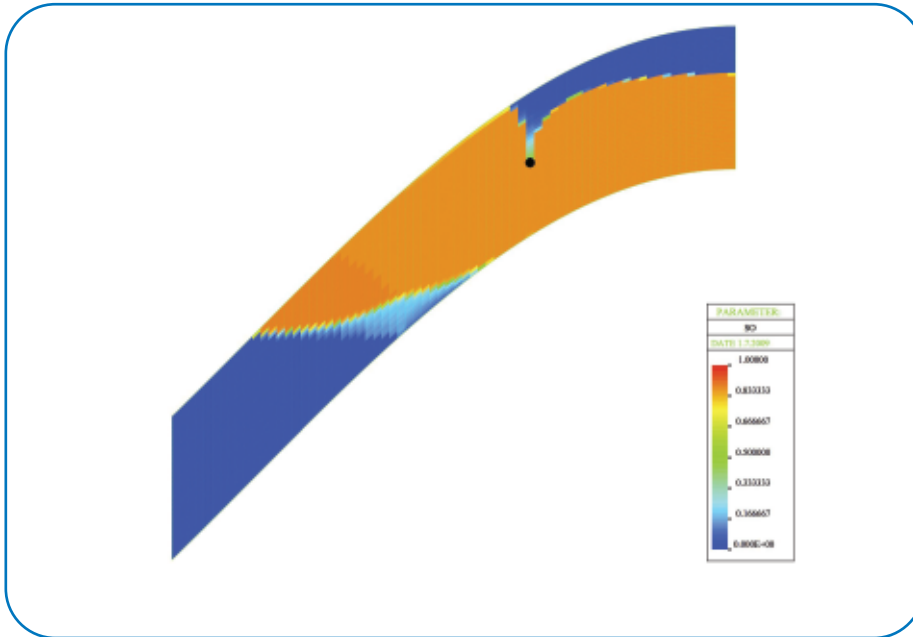
- > Reservoir Performance Analysis
- > Forecasting and Simulation
- > Natural and Artificial Fractures
- > High Angle/Horizontal Wells

for oil reservoirs:

- > Depletion drive
- > Solution gas drive
- > Waterflooding
- > Thin oil columns
- > Heavy oil recovery
- > Miscible gas injection
- > Immiscible gas injection

for gas reservoirs:

- > Tight gas recovery
- > Gas condensate recovery by depletion or dry gas cycling
- > Coal bed methane



Reservoir Simulation Model Showing Water Encroachment and Gas Coning into a Horizontal Well

Baker RDS has extensive experience of a large number of different petroleum reservoirs and recovery mechanisms.

We also perform analysis and production forecasting for fields at all stages of development ranging from exploration through appraisal, early production to very mature fields.

Decline Curve, Material Balance and Analytical Model Forecasting

Decline curve forecasting is suitable where there are well established production decline trends (e.g. mature fields) and the objective is to predict production under the existing operational conditions.

Material balance is a common forecasting method for depletion drive in oil and gas reservoirs. It assumes the reservoir is tank-like which may not be appropriate for low permeability or compartmentalised reservoirs. However, material balance models can be used where there is little reservoir data and/or reservoir uncertainties are large. RDS commonly

employs the commercial MBal/Prosper¹ tools for material balance analysis. This type of model can readily be extended to Integrated Production Modelling by including the surface flowline and production facilities. This is appropriate for short term production forecasting and optimisation.

RDS also has expertise in production analysis and forecasting with analytical transient flow models as available in the commercial software packages Pansystem² and Saphir³. This type of model is most suitable for depletion drive where the well drainage area remains constant over time.

Reservoir Simulation Modelling

Reservoir simulation modelling is the mainstay of reservoir performance analysis and production forecasting in the petroleum industry. This is the only forecasting technique which really accounts for complexities in the reservoir description such as heterogeneity, structure, faulting together with multi-phase flow, well geometry and detailed well/production scheduling. We

find that reservoir simulation studies are most successful where they are closely integrated with RDS Reservoir Description services and particularly when delivered through RDS Core Teams.

RDS has considerable experience of conducting simulation studies with industry standard commercial simulators Eclipse⁴ and VIP⁵. We perform simulation studies which are tailored to the project objectives and the quantity and quality of available data. We try to keep the model as simple as possible and only add complexity when required to meet the project requirements. This means that we don't waste time and money including factors which do not impact the reservoir management decisions. For example, in an appraisal or pre-development situation it may be more appropriate to investigate multiple geological scenarios with a simple model rather than a complex simulation which only addresses a single geological model. Conversely, for mature fields with a large amount of well data and production history, a detailed model is more suitable e.g. to resolve infill drilling targets.

History matching is a significant issue for producing fields and especially mature fields. RDS has substantial experience of history matching particularly for waterflood developments and gas reservoirs. Probably the most important issue is to understand the ranges of uncertainty and what parameter changes are realistic. These could be reservoir description parameters, but also there are errors associated with measured production and pressure data. Again, for history matching, RDS recommend integration with our Reservoir Description services and delivery through a Core Team to achieve a technically superior result whilst saving time and money.

Software Vendors

- 1 Petroleum Experts
- 2 eProduction Solutions/Weatherford
- 3 Kappa Engineering
- 4 Geoquest/Schlumberger
- 5 Landmark/Halliburton