Reservoir Performance Analysis and Prediction

Introduction
Reservoir performance analysis and prediction is integrated within our project planning, project management and multi-disciplinary teamwork approach. This means 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 modeling. We may also employ a combination of techniques to provide greater confidence in the results, for example, material balance supported by analoge field performance data or reservoir simulation supported by decline curve analysis.

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

Our expertise includes:
- Reservoir performance analysis
- Forecasting and simulation
- Natural and artificial fractures
- High-angle/horizontal wells

Full field reservoir simulation model

Watercut vs time: watercut forecasts from simulation modeling showing range of uncertainty from 10 geological model realizations
Baker Hughes Reservoir Development Services (RDS) has extensive experience with 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 and 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 compartmentalized 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 be readily extended to integrated production modeling by including the surface flowline and production facilities. This is appropriate for short-term production forecasting and optimization.

RDS also has expertise in production analysis and forecasting with analytical transient flow models 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 modeling**

Reservoir simulation modeling 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, and 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 conducting simulation studies with industry-standard commercial simulators Eclipse⁴ and VIP⁵. We perform simulation studies 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 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, especially mature fields. RDS has substantial experience of history matching particularly for water flood 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 there are also 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 while saving time and money.

**Software Vendors**

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