N950: Applied Reservoir Simulation

Instructor(s): Jim Gilman

5 Days	Competence Level: Skilled
Classroom Course	
Computer Usage	

Summary

This course is an overview of reservoir simulation concepts and assumptions and discusses data selection, preparation and integration; the strengths and weaknesses of various types of models and modelling strategies; the computing environment and the steps required to create a credible model. The concepts will be illustrated via ECLIPSE software, but the concepts are applicable to other simulation packages.

Learning Outcomes

Participants will learn to:

1. Formulate concepts in order to justify, propose and design reservoir simulation models.
2. Develop simulation data requirements and assemble appropriate data.
3. Compose data preparation guidelines and synthesise / integrate dynamic data to create data files for reservoir models.
4. Formulate production data for integration with the reservoir simulation process.
5. Evaluate model outcomes and adjust data in order to enhance history matches and generate forecasts for selected development options.
6. Assemble and use simulation results for reservoir evaluation and study documentation.

Duration and Training Method

This is a five-day classroom course comprising lectures and hands-on simulation activities (approximately 50/50 ratio). Participants will be provided a basic geologic description, basic fluid descriptions, relative permeabilities, capillary pressure data, initial conditions, and historical rate data. These data will be input into the simulator with minimal reformatting, where participants will perform a history matching exercise. The simulation result will be compared to historical data and with results from others in the class, thus highlighting how different input assumptions can affect the simulation results.

Who Should Attend

This workshop is intended for individuals who use ECLIPSE or similar software for reservoir simulation studies. Participants are assumed to have some background in simulation concepts and in running basic simulation models. Prior experience using ECLIPSE or a similar simulator is required.

Prerequisites and Linking Courses

Whilst there is no formal prerequisite for this class, participants are expected to have a basic understanding of reservoir modelling simulations.

N961 (Strategic Reservoir Simulation), delivered in Europe, covers similar reservoir simulation topics.

Nautilus also offers a number of classroom and field courses on building reservoir models, including N058 (Reservoir Characterisation and Geostatistical Modelling in Field Development), N345 (Geomodeling for Unconventional Reservoirs) and N012 (Reservoir Modelling Field Class (Utah, USA)).

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Course Content

The workshop begins with an overview of general reservoir simulation concepts and assumptions, followed by a discussion of data preparation and history matching techniques. Significant time will be allocated for hands-on application of the simulator. Topics of discussion include introduction to reservoir simulation, introduction to ECLIPSE, grids, aquifers, PVT data, rock and fluid data, initial conditions, and time-dependent data. The class builds upon a single example simulation which applies many of the most common elements of a simulation study. The class will not use all the auxiliary tools for preparing simulation data (e.g. 3D geomodels, PVT programs or vertical-flow performance analysis). However, the application of such software in the simulation workflow will be discussed. The specific software to be used will be Eclipse black-oil for simulations, Eclipse Office for xy plotting, and Floviz for 3D visualization. Third party visualization software such as, S3GRAF or TECPLOT RS, may also be used depending on license availability.

The course will generally follow the basic outline shown here, but all the material may not be covered in detail depending on the level of experience of the participants with the ECLIPSE software. The order of presentation of the material is subject to change, depending on the level of student familiarity with the various topics.

Review of Reservoir Simulation

- Assumptions and Sources of Error
- Finite Difference and Material Balance
- Simulator formulations (e.g. Streamline, finite element)
- Preparing Data and History Matching
- Review of Simulator Features and Data Structure
- Overview of auxiliary Software (e.g. geomodels, PVT, SCAL, VFP, visualization)
- Editing files and Running the Simulator
- Introduction to Workshop Problem(s)

Building and Running a Simulation File

- Reservoir Simulation Grids and Model Types
  - Gridding Considerations
  - Geologic Descriptions (2D and 3D)
  - Upscaling from 3D Descriptions
  - Aquifer Descriptions
- Fluid Physical Property Data (PVT data)
  - Discussion of laboratory data
  - Overview of PVT data generation
- Rock-Fluid
  - Discussion of laboratory data
  - Relative Permeability and Capillary Pressure Assumptions
  - Hysteresis

  - Rock Compaction
  - Surface Tension Effects
- Initialization (Initial Pressures, Saturations, and Compositions)
  - Specifying Initial Conditions
  - Using end-Point scaling for initial saturation variability
  - Non-equilibrium initialization
- Well Completion and Rate/Pressure Data
  - Incorporating well connection data
  - Incorporating a historical rate deck and user file
  - Incorporating VFP Tables
  - Other Special Data Types (e.g. ptt, PLT, formation tester pressures, tracer)
- Advancing the Simulator Through Time
  - Convergence Criteria
  - Making your model run better – data issues and stability

History Matching and Forecasting Reservoir Performance

- History Matching Methodology
  - Volumetric Adjustments
  - SCAL and PVT Considerations
  - Integration with Characterization
  - Assisted History Matching
- History Matching Workshop Problem
  - Volumetric Considerations / Aquifer
  - Contacts / Initial Conditions
  - Permeability
  - PVT and SCAL
  - Special Well Data
- Forecasting Methodology
  - Optimizing recovery from the workshop problem
  - Water and / or Gas Injection
- Review of Participants Workshop Results

Special Features and Auxiliary Programs (as Time Permits)

- Overview of Special Features
  - Local grid refinements, compositional and well models
- Using Networks for Surface Facilities
- Basics of Compositional Simulation and EOS
- Dual-porosity/dual-permeability for fractured reservoirs

Open Work Session

- Requests by participants (as time permits)