Hydraulic Fracturing Using GOHFER Basic Course (4.5 days)

This course targets individuals who are new to the GOHFER software or those who want a refresher course. The course objective is to demonstrate, along with class participation, the GOHFER project workflow with actual data while discussing individual inputs, functions and features of the software. Upon completion of this course each student will have a basic understanding of the information needed to build individual projects within the software, as well as the ability to interpret the simulation results. Examples will include a complete tight gas vertical well project, a single lateral horizontal well project, and a multi-lateral horizontal well project.

Course progression: The instruction moved from foundational fracture-model assumptions to a complete vertical-well workflow, then to a single horizontal lateral, then to a full 3D multiwell pad with depletion and zipper-frac sequencing, and concluded with independent production-data analysis.

Session 1 — Course Framework, GOHFER Fundamentals, and Project Setup

Learning objectives

- Understand the course structure, example progression, and production-focused design philosophy.
- Differentiate GOHFER's measured, laboratory-validated approach from conventional linear-elastic fracture models.
- Recognize the distinction between a numerical simulator and the earth/well model supplied by the engineer.
- Create and configure the initial vertical tight-gas project.

GOHFER features demonstrated

- Software startup, version/build and license information, recent-project list, and local project storage.
- New-project creation; oilfield versus metric units; multiple-treatment-well option with transverse fractures.
- Project tree, treatment and reference wells, well survey, tubular data, well information, coordinate systems, and LAS/CSV input paths.
- High-level tour of petrophysics, DFIT calibration, treatment design, simulation output, production forecasting, production analysis, stress shadowing, 3D geomodel exchange, and batch/cloud execution.

Engineering theory discussed

- Limitations of linear-elastic fracture mechanics, PKN/KGD and pseudo-3D assumptions, compliance, fracture closure, net pressure, and fracture toughness.
- Process-zone stress as a reservoir-condition fracture-extension criterion measurable from DFIT data.
- Nonlinear and inelastic rock behavior; stress shadow evolution; poroelastic stress components and the role of pore pressure.
- Coupled fluid/proppant transport, realistic proppant conductivity, near-wellbore screenout, production transients, drainage volume, and effective versus gross fracture length.

Practical exercises performed

- Create the "Vertical Tight Gas" project in a local working folder.
- Select project units and the multiple-well/transverse-fracture configuration.
- Use the treatment well as both treatment and reference well; delete the redundant reference well.
- Review the default survey, enter the treatment-string ID, inspect tubular data, and begin importing the well log.

Session 2 — Vertical-Well Log Processing and Petrophysical Model Construction

Learning objectives

- Resume and manage an existing project efficiently.
- Understand how imported log curves are mapped, checked, corrected, and converted into modeled reservoir properties.
- Identify the minimum useful log suite and the uncertainty introduced by limited or indirect measurements.

GOHFER features demonstrated

- Opening recent projects, closing individual screens, map and directional-survey views, depth-scale controls, and automated log processing.
- LAS curve assignments and QC of density porosity, bulk density, neutron porosity, gamma ray, resistivity, and derived GOHFER curves.
- Synthetic corrected gamma ray and cascading recalculation of gamma-ray-dependent properties.
- Log display, curve editing, correlations, cutoffs, net-pay definition, and geologic-section inputs.

Engineering theory discussed

- Gamma-ray response, uranium correction, clay-volume estimation, lithology and matrix grain density.
- Effective versus total porosity; saturation and permeability correlations; Biot coefficient.
- Dynamic-to-static elastic-property conversion, Young’s modulus, Poisson’s ratio, stress estimation, and process-zone stress.
- Why logs are indirect, vertically averaged measurements and why DFIT calibration is still required.

Practical exercises performed

- Reopen the vertical tight-gas project and review well orientation assumptions.
- QC the imported LAS data and align density-porosity and matrix-density assumptions.
- Correct the gamma-ray response below the pay interval and regenerate dependent curves.
- Work through the log-analysis tree and prepare reservoir, rock-mechanical, and pay-property curves for gridding.

Session 3 — Grid Construction, Treatment Schedule, and Initial Simulation

Learning objectives

- Convert processed log data into a discretized fracture-model grid.
- Build design and actual treatment schedules and understand the project directory structure.
- Prepare a simulation suitable for later diagnostic calibration and pressure matching.

GOHFER features demonstrated

- Grid Setup, asymmetric fracture grid, node height/width, top and bottom boundaries, and graphical lithology/property displays.
- Averaging log data into grid cells and inspecting grid-property curves.
- Treatment-well setup, perforations, wellbore/reservoir fluids, pumping-schedule tables, and schedule import/editing.
- Run Engine controls and initial engine-output displays.

Engineering theory discussed

- Cartesian discretization, spatial resolution, numerical averaging, and the resolution limits of logging tools.
- Relationship among grid size, computational effort, fracture geometry, and heterogeneous rock properties.
- Fluid volumes, slurry versus clean rate, proppant concentration, pipe/perforation friction, tortuosity, and pressure components.
- Differences between a planned design schedule and the field-recorded pumping history.

Practical exercises performed

- Build the vertical X–Z grid around the target interval and verify pay and bounding layers.
- Enter perforations and reservoir/wellbore fluid properties.
- Create a design pumping schedule, then import and map the actual field schedule.
- Run the treatment and review preliminary pressure and geometry output in preparation for DFIT calibration.

Session 4 — DFIT Analysis and Pressure-Match Calibration

Learning objectives

- Extract measurable reservoir and fracture parameters from an injection/falloff test.
- Use diagnostic results to calibrate the geomechanical model and interpret a field pressure match.
- Distinguish instantaneous shut-in pressure from fracture-extension pressure.

GOHFER features demonstrated

- Diagnostics creation; import and mapping of time, pressure, and rate data; event-line placement and synchronization.
- Test Events, logarithmic-time displays, step-rate/step-down analysis, G-function analysis, closure selection, and after-closure analysis.
- Derived wellhead and bottomhole pressure, fluid and well-configuration inputs, perforation efficiency, and tortuosity estimates.
- Transfer of diagnostic results into the model and comparison of simulated versus measured treatment pressure.

Engineering theory discussed

- Wellbore storage/blowdown, compressibility, fracture extension, closure stress, and pressure-dependent leakoff.
- G-function normalization, injected fracture volume, leakoff behavior, after-closure flow, permeability, and initial pore pressure.
- Relationship between fracture-extension and closure pressure as a measure of process-zone stress.
- Importance of a clean first injection and why repeated pre-frac injections can invalidate falloff interpretation.

Practical exercises performed

- Import the diagnostic dataset and set pretest, extension, shut-in, and falloff events.
- Estimate effective open perforations and near-wellbore losses from the step-down response.
- Pick closure and analyze after-closure data for reservoir parameters.
- Update stresses and related inputs, rerun the vertical treatment, and begin matching measured pressure behavior.

Session 5 — Final Vertical-Well Match, Sensitivities, and Production Forecasting

Learning objectives

- Complete and judge a post-job pressure match without overfitting uncertain data.
- Evaluate how selected calibration parameters change pressure, geometry, and placement.
- Convert simulated fracture geometry into a realistic production forecast.

GOHFER features demonstrated

- Engine composite plots, legend/display controls, schedule and fluid editing, reruns, and case comparison.
- Calibration inputs including sand exponent, transmissibility-related controls, and fluid-friction assumptions.
- Production task creation, well/reservoir/completion inputs, forecast controls, and comparison with actual production.
- Copying treatment cases and running job-size or parameter sensitivities.

Engineering theory discussed

- Uncertainty in post-job ISIP caused by supercharge, altered pore pressure, proppant placement, and residual deformation.
- Fluid friction, perforation friction, tortuosity, near-well effects, pressure matching, and non-uniqueness.
- Proppant-pack damage, multiphase and non-Darcy effects, effective conductivity, drainage geometry, and transient flow.
- Optimization against predicted production and economics rather than maximum created fracture dimensions.

Practical exercises performed

- Refine the final pressure match by revising flush-fluid and friction assumptions.
- Review proppant distribution and fracture geometry after the calibrated run.
- Create a production forecast for the vertical well and compare forecasted and field production.
- Run comparative treatment-size/sensitivity cases and interpret why larger treatments do not always create proportional production gains.

Session 6 — Single-Lateral Horizontal Project and 3D Grid Setup

Learning objectives

- Transition from a vertical-well model to a single horizontal lateral with transverse fractures.
- Understand fracture-flow sensitivity to transmissibility and fracture-width exponent.
- Build a spatially oriented horizontal-well earth model from survey, log, and structure data.

GOHFER features demonstrated

- Copying/closing projects and creating a new single-lateral project.
- Importing the reference and treatment-well surveys, setting locations/elevations, and checking map orientation and stress azimuth.
- Log import and accelerated QC using the workflow learned in the vertical example.
- Longitudinal and transverse grid construction, geologic structure/geosteering, and stage setup.
- Run-parameter controls for transmissibility and width exponent.

Engineering theory discussed

- Node-to-node flow, harmonic-average fracture width, Navier–Stokes-based transmissibility, and apparent slurry viscosity.
- Effect of rough fracture walls and width exponent on pressure gradient, width, height, and length.
- Stress orientation, well azimuth, transverse versus longitudinal fractures, and heterogeneous structure along a lateral.
- Why rate and viscosity influence flowing pressure gradients but do not alone “hold” a fracture open.

Practical exercises performed

- Review a width-exponent sensitivity from the vertical-well project.
- Create the single-horizontal-shale project and import directional and reference data.
- Verify well/stress orientation and process the logs for the new model.
- Build longitudinal and transverse grids, establish structure along the lateral, and prepare the first stage.

Session 7 — Horizontal-Well Perforations, Acid Fracturing, and Multistage Design

Learning objectives

- Design stages and perforation clusters for a transverse horizontal well.
- Construct and interpret an acid-fracture schedule.
- Understand how staged treatments and fluid/proppant choices are represented.

GOHFER features demonstrated

- Grid display options and export of 3D earth-model properties in GSLib format for other applications.
- Perforation entry, cluster placement, stage creation, schedule table, flush calculation, and wellbore-fluid definition.
- Acid-job types and inputs for straight, emulsified, and gelled acid; acid concentration and reaction modeling.
- Stage copying, output review, and preparation of subsequent horizontal stages.

Engineering theory discussed

- Acid mass transfer versus reaction-rate limitation, diffusion, kinetics, and changing reaction-product properties.
- Carbonate dissolution, calcium/magnesium products, carbon dioxide generation, density change, and convective mixing.
- Perforation allocation, fracture initiation, transverse/longitudinal growth, and the role of anisotropy.
- Grid resolution and the interpretation/export of spatial petrophysical and geomechanical properties.

Practical exercises performed

- Export selected grid properties and review interoperability with Petrel, DecisionSpace, CMG, and related tools.
- Place a near-toe perforation cluster for the first stage.
- Build and run a non-propped acid-fracture schedule.
- Create additional plug-and-perf stages with multiple clusters and examine treatment results.

Session 8 — Sequential Stress Shadowing and Horizontal Production

Learning objectives

- Understand how earlier stages alter later-stage fracture initiation, allocation, and geometry.
- Build repeatable sequential stages with correct perforation and shadow references.
- Evaluate production from a multistage horizontal completion.

GOHFER features demonstrated

- Copy Design/Job, perforation-table editing and sorting, automatic flush-volume calculation, and stage-shadow selection.
- Shadow files, cumulative shadow history, engine-run options, and multidimensional stage-output displays.
- Horizontal production setup and aggregation of stage/fracture contributions.
- Comparison of stage geometries and production consequences.

Engineering theory discussed

- Stress superposition, stress-shadow stabilization after successive stages, cluster competition, and perforation erosion.
- Longitudinal fracture initiation from a pressurized horizontal wellbore and subsequent transverse growth.
- Low stress anisotropy, tangential stress, lithologic variation, random breakdown, and plugged/inactive perforations.
- Current-model treatment of stored shadow states versus a continuously evolving poroelastic/thermal stress field.

Practical exercises performed

- Copy Stage 3 to create Stage 4 and reposition clusters at the next measured-depth interval.
- Sort perforations before calculating flush volume and verify shallowest-to-deepest order.
- Reference the prior stage shadow and run the next stage in sequence.
- Review fracture interference and create/review a horizontal production forecast.

Session 9 - Multiwell Pad Model Demonstration

Session objectives

- Demonstrate the complete multiwell pad modeling workflow in a common 3D coordinate system.
- Show how GOHFER integrates well, log, surface, structure, and 3D geomodel data for multiwell fracture simulation.
- Demonstrate parent/child interaction, zipper-frac sequencing, cumulative stress shadowing, and dependent batch execution.
- Review multiwell outputs used to evaluate fracture geometry, overlap, allocation, communication, and development efficiency.

GOHFER Features Demonstrated

- Multiwell project creation within a shared 3D coordinate system and model volume.
- Well construction using wellhead coordinates, coordinate conversion, KB elevation, directional surveys, and MD/TVD relationships.
- Map and 3D visualization for checking well spacing, azimuth, trajectories, datums, and geomodel coverage.
- Import and integration of LAS data, surface or structure maps, and GSLib property cubes.
- Creation of a geomodel core or pseudo-log and mapping of selected 3D properties into GOHFER curves.
- Property quality control using distributions, heat maps, curve overlays, and the GSLib viewer.
- Representation of pore-pressure depletion and comparison of parent/child interaction cases.
- Reusable stage-design templates for perforation and pumping-schedule inputs across multiple wells.
- Stage Shadowing map, graphical sequencing, list-based reordering, and Save Order workflow.
- Shadow-group creation and automatic assignment of stages to cumulative stress-shadow states.
- Dependent multi-stage execution through the Batch Queue or server.
- Map and 3D review of fracture geometry, stimulated volume, overlap, allocation, and potential interwell communication.

Engineering Theory Discussed

- Use of a common spatial reference, coordinate system, and vertical datum for integrated multiwell modeling.
- Spatial interpolation and resampling of lithologic, mechanical, and reservoir properties from a 3D geomodel.
- Physical consistency and uncertainty of geologic, petrophysical, geomechanical, and reservoir inputs.
- Hydrostatic gradients, pore-pressure calibration, and the distinction between matrix permeability and stimulated-system permeability.
- Reservoir depletion, effective-stress changes, and their influence on fracture propagation in parent/child developments.
- Stress shadowing and cumulative stress-and-strain superposition from previously created hydraulic fractures.

- Influence of well spacing, stage spacing, treatment order, and bounding stress fields on fracture geometry and confinement.
- Zipper-frac sequencing concepts, including outside-in, inside-out, and one-direction development strategies.
- Fracture competition, diversion, treatment allocation, overlap, and potential interwell communication.
- Chronological dependency in multi-stage simulation and the effect of sequence changes on subsequent stress states.
- Interpretation of fracture geometry and stimulated volume in the context of multiwell development efficiency.