Advanced Well Test Analysis

Summary

Well testing has been in place for over 50 years. The benefits of using this technology have been published in numerous technical articles. A popular method for pressure data interpretation has been published back in year 1950 by Horner and still today can be applied. Presently most of pressure transient analysis is carried out by commercial software which can handle quiet complex pressure data interpretation using analytical or numerical linear or non-linear solutions as well as considering permeability and porosity dependency on pressure for non-conventional reservoirs.

However, and in spite of testing technology and software development advances, pressure data interpretation and test design are not an automated technique, it requires of professional human intervention to be successful. Course main objective is to learn how to carry out a well test analysis and to know how derived results are used to identify in quite a fast way compared to other methods, the reservoir model associated to the drainage area of the well and to determine the parameters related to the reservoir flow capacity as well as the evaluation of present well productivity which are results derived from Pressure Transient Analysis (PTA).

Some of the companies that have been taking Advanced Well Test Analysis course by Giovanni Da Prat:
Learning Objectives

- To provide participants with a sound understanding of both practical and advanced methods currently in use for pressure transient analysis
- Understand why, when and how to test a well and in the right way
- Understand the principles of fluid flow through porous media and Nodal analysis.
- Learn how to interpret pressure transient data acquired in both conventional or non-conventional oil or gas reservoirs
- Learn about pressure data quality control and well test design for exploratory and development wells
- Understand the application of well test analysis to evaluate reservoir and well parameters that are directly responsible of both reservoir and well performance
- Understand that results derived from pressure transient analysis are an added value in defining in quite a short time the Reservoir Model associated to the well’s drainage area
- Learn about current reservoir testing models that are used for pressure transient analysis and the expected pressure and derivative response
- Understand when to use either a linear or nonlinear analytical or a numerical solution for pressure data interpretation

Course Added Value

The participant will carry out practical exercises using a commercial specialized software that will be available throughout the duration of the course.

Who Should Attend:

This program is addressed to professionals working in reservoir and production engineering and need to learn about well test analysis or to get an updated on well test modern interpretation methods.

- Reservoir and petroleum engineers
- Production engineers
- Exploration and development geoscientists
- Well test engineers

Course Duration

5 Days = 4.0 Continue Education Units = 24 Professional Development Hours
Instructor

Giovanni Da Prat is the president of DA PRAT a consulting firm located in Buenos Aires, Argentina. He has over 30 years experience in the oil and gas industry, dedicated mainly to productivity evaluation of exploratory and development wells both on shore and offshore as well as field production optimization and well test analysis. In addition and also a major activity over the years has been the training of more than a thousand oil and gas professionals in his area of expertise.

Da Prat’s experience, before becoming an independent consultant includes working for both oil and gas operating and service companies. He worked during nine years for Schlumberger as the district reservoir engineer, in charge of providing technical support in MDT and testing data design and interpretation, based initially in Bogota and final assignment in Buenos Aires.

He also worked during three years for Halliburton based in Caracas, as the regional reservoir engineer in charge of providing technical support in DST and testing data design and interpretation.

Initial working experience was with Intevep R&D company based in Venezuela for a period of six years, as the production unit head, in charge of directing applied research projects aimed to solve well and reservoir productivity issues, such as formation damage, asphaltine deposition, development of appropriate testing models for data interpretation, naturally fractured reservoirs and artificial lift methods optimization, including application to heavy and extra heavy oil reservoirs.

He has been the author and co-author of several technical articles in the area of well test interpretation and reservoir engineering. Most of them are published in the SPE.


Da Prat holds an MS in Geophysics and a Ph.D in Petroleum Engineering, both from Stanford University and a BS in Physics, from the Universidad Central de Venezuela.

He was the promoter and the technical co-chairman of the SPE- ATW workshop: Testing exploratory wells: Rig or Rigless? carried out in Puerto La Cruz, Venezuela on March, 2006.

Mr. Giovanni was an SPE distinguished Lecturer. “Well Testing Management. Impact on Reservoir Evaluation and well productivity”.

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5 Days Course Agenda

Day 1

A brief introduction is given to well testing and well test analysis methodology also referred as Pressure Transient Analysis. Well testing objectives as well as type of tests are presented.

- Well Testing definition and applications

Reservoir and well information derived from pressure data analysis is emphasized and the learning methodology used in this course aimed to become familiar with pressure transient analysis methodology is presented.

- Well Test Interpretation- Learning methodology

Day 2

The diffusivity equation and basic solutions are presented that will be used for pressure transient analysis. It has been derived applying the continuity in an elementary reservoir volume and integrating the Darcy's law which is the basic equation that relates rates with pressure, but only valid for stationary conditions, and the equation of state for the fluid present in the reservoir.

- Darcy's Law. Diffusivity Equation. Infinite radial Flow solution
- Limited drainage area solution. Pseudo steady state Constant Pressure
- Pressure derivative. Reservoir Models used for pressure data interpretation
- Aspects Considered for Model Construction

A few reservoir models and the expected pressure response is presented. Also, the expected pressure response considering well conditions, reservoir type, drainage area discontinuities and limits is introduced.

- Examples of Reservoir and Well Models used for interpretation
  - Hydraulically Fractured Well
  - Double Porosity
  - Radial composite
  - Partial Penetration
  - Horizontal Well
  - Non-conventional reservoirs

Day 3

The introduction of wellbore storage effects and skin factor on the expected pressure response are presented. Wellbore storage effects will always be present no matter the type of test. Wellbore storage effect is easily recognized on the pressure response, initial pressure data trend shows a unit slope tendency in log-log diagnostic plot, no information from reservoir can be obtained during pure wellbore storage period, is like having the well
disconnected from the reservoir.
- Skin effect. Wellbore storage effect
- Drawdown pressure analysis
- Pressure Build up analysis
- Superposition principle
  - Interpretation example
  - Application of the superposition principle in space
- Average reservoir pressure Determination
  - Interpretation example
- Interference testing
- Non Unique Reservoir Model Solution

Calculation method to determine the average reservoir pressure at the time of testing and the meaning of the sometimes-called false pressure P* in a buildup period are presented. Interference testing both basic test and pulse testing are introduced. Finally, and quite an important issue is the non-uniqueness of the solution or reservoir model derived from pressure transient analysis were emphasis has been given to the integration of geology, seismic and petrophysical models is available during testing time.
- Average reservoir pressure Determination. Interpretation example
- Interference testing. Deconvolution Method
- Non Unique Reservoir Model Solution

Day 4

The solution to the diffusivity equation for the case of gas reservoirs is presented. In the case of gas, the diffusivity equation is not linear and the pseudo pressure potential or real gas potential is introduced that linearize the equation and solution are expressed in terms of pseudo pressure m(p). Initial pressured acquired in gas well is converted to m(p) and pressure analysis methodology is similar to oil presented.

- Back pressure tests: Flow after flow, Isochronal, and Modified Isochronal

the objectives of an extended test are introduced. During short term time test, like a DST, the presence of a discontinuity or fault may be identified in the drainage area from data analysis, also after a short time test it may happen that the reservoir pressure just happens to decline, inferring that a small reservoir size or drainage area is associated to the well.
- Test Objectives
- Pressure behavior for a sealing outer boundary
- Pressure behavior for a constant pressure outer boundary
- Example inspired on field case
Day 5

The analysis of pressure data acquired in injector wells is introduced. The solution or model that represents the expected pressure is derived solving the diffusivity equation both in the water and in the oil bank.

Also, the expected pressure response for a well that has been hydraulically fractured is presented. Basically 3 models can be applied to match real pressure data.

- Introduction. Mobility ratio definition. Fall off test interpretation
  - Example inspired on field case
- Average injection pressure. Step rate test
- Interpretation models for hydraulically fractured wells
  - Infinite conductivity
  - Uniform flux
  - Finite Conductivity
  - Non-conventional reservoirs

The expected pressure response or model to analyze pressure data acquired in a horizontal well is presented. In addition, the three models used to analyze data in a two-porosity reservoir are presented, Pseudo steady state, transient Slabs and transient sphere.

- Horizontal wells. Expected production rates. Skin effect. Expected pressure transient behavior
- Sensitivity study to C, L, and kz/kr
- Diffusivity Equation from two porosity reservoirs
- Expected transient pressure response
  - Pseudo steady state flow regime
  - Interporosity transient flow regime
- Sensitivity study to C and λ parameters