Petroleum Engineering 613
Natural Gas Engineering
Syllabus and Administrative Procedures
Spring 2002

Petroleum Engineering 613
Texas A&M University/College of Engineering
Lecture: TR 11:10 a.m.-12:30 p.m. RICH 301

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Help/Work Sessions: As necessary, likely to be in the evenings.

Texts: (Available at MSC Bookstore, can also be ordered directly from SPE (probably at reduced rates), you must be an SPE member — SPE (800) 456-6863)

1. Lee, W.J. and Wattenbarger, R.A.: *Gas Reservoir Engineering*, SPE (1996).

Reference Materials:

1. Reference materials (notes, papers, some text materials, homework, etc.) will be located at:

5. Policy on Regrading
   a. Only in very rare cases will exams be considered for regrading; *e.g.*, when the total number of points deducted is not consistent with the assigned grade. Partial credit (if any) is ***not*** subject to appeal.
   b. Work which, while correct, cannot be followed, will be considered incorrect — and will not be considered for a grade change.
   c. Grades assigned to homework problems will not be considered for regrading.
   d. If regrading is necessary, the student is to submit a letter to the instructor explaining the situation that requires consideration for regrading and the material to be regraded must be attached to this letter. The letter and attached material must be received within one week from the date returned.

6. The grade for a late assignment is ***zero***. Homework will be considered late if it is not turned in at the ***start of class*** on the due date. If a student comes to class after homework has been turned in and after class has begun, the student's homework will be considered late and given a grade of zero. ***Late or not, all assignments must be turned in***. A course grade of ***Incomplete*** will be given if any assignment is missing, and this grade will be changed only after all required work has been submitted.

7. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or collaborating on an assignment where collaboration is not specifically allowed will be removed from the class roster and given an "F" (failure grade) in the course.

Petroleum Engineering 613
Natural Gas Engineering
Course Description, Prerequisites by Topic, and Course Objectives
Spring 2002

Course Description

Graduate Catalog: Flow of natural gas in reservoirs and in wellbores and gathering systems; deliverability testing; production forecasting and decline curves; flow measurement and compressor sizing.

Translation: From the reservoir through the sales line—we will try to study every aspect of natural gas systems. PVT properties, flow in porous media, flow in pipes and thermodynamic properties will be studied. We will use the Lee and Wattenbarger and the ERCB texts as guides — as well as numerous technical papers that go into much more depth of detail for a particular problem. We will focus on well testing, deliverability analysis, and decline curve analysis, as well as wellbore flow phenomena.

Prerequisites by Topic

- Differential and integral calculus
- Ordinary and partial differential equations
- Thermodynamics
- Fluid dynamics and heat transfer
- Reservoir fluid properties
- Reservoir petrophysics

Course Objectives

The student should be able to:

- Estimate oil, gas, and water properties pertinent for well test or production data analysis using industry accepted correlations and laboratory data.
- Sketch pressure versus time trends and pressure versus distance trends for a reservoir system exhibiting transient, pseudosteady-state, and steady-state flow behavior.
- Derive the steady-state and pseudosteady-state relations for gas flow (including rigorous and semi-analytical relations for boundary-dominated flow behavior). In addition, the student must be able to derive, in complete detail, the pressure, pressure-squared, and pseudopressure forms of the diffusivity equation for a real gas.
- Derive the material balance equations for a volumetric dry gas reservoir, an "abnormally-pressured" gas reservoir, and a water-drive gas reservoir. The student should also be familiar with the generalized (i.e., compositional form) of the material balance equation for a gas condensate reservoir.
- Derive and apply the conventional relations used to calculate the static and flowing bottomhole pressures for the case of a dry gas. The student should also be familiar with proposed techniques for wet gases.
- Derive/present models for wellbore storage and phase redistribution (gas systems).
- Derive the "skin factor" variable from the steady-state flow equation and be able to describe the conditions of damage and stimulation using this skin factor. The student should also be familiar with models for "variable" skin effects due to non-Darcy flow, well cleanup, and gas condensate banking (radial composite model).
- Analyze and interpret flow-after-flow (4-point) and isochronal flow tests.
- Derive the analysis and interpretation methodologies (*i.e.*, "conventional" plots and type curve analysis) for pressure drawdown and pressure buildup tests (liquid or gas reservoir systems). Also, be able to apply dimensionless solutions ("type curves") and field variable solutions ("specialized plots") for the analysis and interpretation of well test data.
- Design and implement a well test sequence, as well as a long-term production/injection surveillance program. This includes the design of single and multipoint deliverability tests.
- Analyze production data (rate-time or pressure-rate-time data) to obtain reservoir volume and estimates of reservoir properties for gas and liquid reservoir systems. The student should be able to use "decline curves," "decline type curves," and other techniques of analysis for production data.
- The student should be familiar with the reservoir engineering tools used to analyze/interpret the performance of the following gas reservoir types:
  — Gas condensate reservoir systems
  — Low permeability/unconventional reservoirs
  — Low pressure gas reservoirs