PETE 602 – Well Stimulation

Instructor: H.A. Nasr-El-Din, Professor, Texas A & M University

HOURS: MWF: 1:50-2:40 AM

Grader: Mohamed Sarwar

TEXT: Several text books will be used, including, but not limited to:

- Petroleum production Systems, Economides et al., 1993
- Acidizing Fundamentals, Williams et al., 1979
- Hydraulic Fracturing, SPE Reprint Series, 1990
- Reservoir Stimulation, Economides and Nolte, 3rd Ed., 2000
- Well Construction, Economides et al., 1998
- Multilateral Wells, Hill et al., 2008
- Reservoir Formation Damage, Civan, 2000
- Recent Advances in Hydraulic Fracturing, Gidley et al., 1989

GRADING:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
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<tr>
<td>Mid-term exams (2)</td>
<td>40%</td>
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<tr>
<td>Final Exam</td>
<td>40%</td>
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Work during the semester will consist of homework assignments, a class project, and a final exam. Homework must be turned in to me at the start of the class at which it is due.

SUBJECT MATTER:

The course is designed for engineers who deal with well performance enhancement. The course will go through various techniques that can be used to enhance productivity of oil and gas wells. This is followed by overview of acid and hydraulic fracturing, matrix treatments for carbonate and sandstone formations. Issues related to candidate selection, treatment design, selection of acid additives, lab testing, acid placement, QA/QC, job execution, and treatment evaluation will be discussed in detail. The course will end with introducing new technologies for carbonate and sandstone acidizing. Field cases will be given to highlight problems and how lab testing was used to find cost effective solutions to these problems.
COURSE OUTLINE:

Introduction
- Mineralogy of oil and gas reservoirs
- Well types based on function
- Well types based on completion
- Matrix versus fracture acidizing
- Formation damage issues

Acid Types and their Reaction with Various Rocks

a. Carbonates – Chemistry Issues
- Inorganic and organic acids
- Reaction kinetics
- Acid Retarders:
- Emulsified acids
- In-situ gelled acids
- Viscoelastic surfactant-based acids
- In-situ generated acids
- Chelates as stimulation fluids

Carbonates – Physics Issues
- Acid flow in carbonate rocks
- Wormhole patterns
- Optimum injection rate
- Modeling of matrix acidizing

b. Sandstone Formations – Chemistry Issues
- Chemistry and mineralogy of clays and feldspars
- Mud acids and their reactions with silica and silicates
- Retarded HF-based acids
- Chelating agents
- Impact of mineralogy on acid selection
- Field cases

Sandstone Formations – Physics Issues
- Flow of HF-based acids in sandstone rocks
- Models to predict acid propagation in sandstones
- Impact of acidizing on rock strength

Acid Additives
- Criteria used for selecting acid additives
- Corrosion inhibitors
- Corrosion inhibitors for organic acids
- Corrosion inhibitors for CRA
- Iron control agents
- Hydrogen sulfide scavengers
- Low-surface tension surfactants
- Drag reducing agents
- Mutual solvents
- Scale inhibitors
- Anti-sludge agents
- Clay Stabilizers
- Damage due to acid additives

**Reaction Kinetics**
- Methods to measure reaction rate
- Surface reaction kinetics
- Mass transfer kinetics
- Impact of additives
- Effect of clays
- Temperature effects

**Acid Placement Techniques**
- Bull heading
- Drill pipe
- Coiled tubing
- Methods to extend CT reach in long horizontal wells
- Entry into various laterals in multilateral wells
- Field cases

**Acid Fracturing**
- What is acid fracturing?
- Candidate selection
- Fluid selection
- Rock and fluid properties
- Lab testing before the job
- Fracture conductivity
- Field testing
- Simulation
- Job execution
- Field examples

**Hydraulic Fracturing**
- What is hydraulic fracturing?
- Rock mechanics
- Proppant characteristics
- Fluid selection
- Lab and field testing
- Methods to control proppant flow back
- Damage due to polymer residue
- Field cases

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Coursework Copyright Statement: (Texas A&M University Policy Statement)

Suggested for Inclusion in Your First Day Handout or Syllabus

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