Petroleum Engineering 602
Matrix Acidizing
Credit 3: (3-0)
TR 9:35 – 10:50 a.m.

Catalog Description: Design and analysis of well stimulation methods, including acidizing and hydraulic fracturing as well as the causes and solutions to low well productivity.

Prerequisites: Graduate classification in the Department of Petroleum Engineering or instructor approval

Required Textbook: Several textbooks will be used including, but not limited to:

Class/Lab Schedule: TR 9:35-10:50, Lecture

Topics Covered:
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 an 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, all of which will be discussed in detail. The course will end with an introduction new technologies for carbonate and sandstone acidizing. Field cases will be presented to highlight problems and how lab testing is used to find cost effective solutions to these problems.

The specific course workflow is as follows:

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
- *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

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 CRAIron 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

Learning Outcomes: At the end of the course, students will be able to:

1. Name different types of rock formations and describe their petrophysical properties as they relate to oil recovery;
2. Explain how individual formation components react with and respond to the physical and chemical processes inherent in oil recovery treatments from stimulation through completion;
3. Understand and measure how acids and acid additives react with formation components;
4. Understand and articulate the hydraulic fracturing process and how acid fracturing relates to it;
5. Apply course knowledge to real-world examples from the field.

Method of Evaluating Course Outcomes

<table>
<thead>
<tr>
<th>Homework</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>30%</td>
</tr>
</tbody>
</table>
Final presentation 30%

Work during the semester will consist of homework assignments, a class project, and a final exam. Homework must be turned to me at the start of the class at which it is due.

Last Modified By: Hisham A. Nasr-El-Din, Professor and Holder of John Edgar Holt Endowed Chair, Department of Petroleum Engineering, RICH 710, (979) 862-1473, 
hisham.nasreldin@tamu.edu

Office hours: TR 2:00 – 3:00 p.m.

ADA Policy Statement: (Texas A&M University Policy Statement)

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe that you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities at White Creek, or call 845-1637.