New Projects Named

Based on their ranking by company members of the Steering Committee and available funds, the following are the 5 proposals selected (with GARs for 8 students) to become funded projects as of 1 September 2010:

**Halliburton Center for Unconventional Resources:**
Fracture Modeling and Flow Behavior in Shale Gas Reservoirs using Discrete Fracture Networks (Schechter, Lane)

**Chevron Center for Well Construction and Production:**
Minimizing Water Production from Unconventional Gas Wells (Lane, Schechter)

**Schlumberger Center for Reservoir Description and Dynamics:**
Rapid, Probabilistic Reserves Estimation Methods for Hydraulically Fractured Horizontal Wells in Shale Gas Reservoirs (McVay, Lee)
Occurrence of Multiple Fluid Phases across a Basin, in the Same Shale Gas Formation - Eagle Ford Shale Example (Ayers, McCain)

**Center for Energy, Environment, and Transportation Innovation:**
Re-Use of Produced Waters and Hydraulic Fracturing Fluids (Nasr-El-Din) (revised 9/1/2010)

These projects are intended to span multiple years with funding awarded for the first year at this time. Continued funding will be dependent on available funds and satisfactory progress of the projects. The next Request for Proposals (RFP) round will begin during the Fall of 2010, with announcements planned for Spring 2011 for funding to begin September 2011.

In addition to these 5 new projects, there are 27 research projects currently active in the Crisman Institute. All are funded entirely by Crisman, except where noted.

**Halliburton Center for Unconventional Resources:**
Reservoir Compaction and Casing Integrity in the Texas Gulf of Mexico Coast, Part II (Schubert)
Gas Shales–Geomechanics/Completions (Ghassemi) *Note: funded by RPSEA but has matching Crisman funds*
Continued Development of PRISE (Holditch)
Advanced Hydraulic Fracturing Technology for Unconventional Tight Gas Reservoirs (Hill, Zhu) *Note: funded by RPSEA/DOE but has matching Crisman funds*

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Transport Properties Characterization of Tight Gas Shales (Ghassemi)

Modeling Shale Gas Reservoir Performance (Blasingame)

Fracture Fluid Re-Use and Optimization (Lane)

Experimental Studies of Non-Thermal EOR Methods for Heavy and Light Oil Recovery (Barrufet, Lane)

Investigation of Hybrid Steam-Solvent Injection to Increase Efficiency of Thermal Oil Recovery Processes (Barrufet, Mamora)

Combustion Assisted Gravity Drainage (CAGD): An In-situ Combustion Method to Recover Heavy Oil and Bitumen from Geologic Formations using a Horizontal Injector-Producer Pair (Barrufet, Mamora)

Chevron Center for Well Construction and Production:

Reducing the Risk of Cement Failure in High Pressure, High Temperature (HPHT) Conditions, Rock Mechanics Aspects through Analytical and Finite Element Method Approaches (Schubert, Teodoriu)

Optimization of Horizontal Well Performance in Low-Permeability Gas Reservoirs (Zhu)

Transient Multiphase Sand Transport in Horizontal Wells (Falcone)

Hydraulically Fractured Well Performance in High Rate Wells (Ehlig-Economides)

Acid Fracture Performance—Scale-Up of Fracture Conductivity (Hill)

Reaction of Organic Acids with Calcite (Nasr-El-Din)

Quantitative Analysis of Amphoteric Surfactant (Nasr-El-Din)

Viscosity of Polymer-Based In-situ Gelled Acids during Well Stimulation (Nasr-El-Din)

Cleanup of Drilling Mud Filter Cake (Nasr-El-Din)

Schlumberger Center for Reservoir Description and Dynamics:

Reservoir Geomechanics: Thermo-Poroelastic Analysis of Rock Deformation and Damage (Ghassemi) Note: funded by DOE but has matching Crisman funds

Application of Adaptive Gridding and Upscaling for Improved Tight Gas Reservoir Simulation (King)

Measurement and Correlation of Gas Viscosities at High Pressures and High Temperatures (Falcone, Teodoriu)

Low Salinity Water Flooding in Sandstone Reservoirs (Nasr-El-Din) (revised 9/1/2010)

Characterization and Simulation of Discrete Fracture Networks (Schechter)

Stochastic History Matching, Forecasting, and Production with the Ensemble Kalman Filter (Jafarpour)

Center for Energy, Environment, and Transportation Innovation:

Low Impact Oil and Gas Activity; Environmentally Friendly Drilling Systems (Burnett, Beck)

CO₂ Sequestration, Environmental (Nasr-El-Din)
When the Petroleum Engineering Department first moved into the Joe C. Richardson Building, all the teaching labs were outfitted with brand new test equipment, including the drilling fluids lab that was funded by an endowment from Texaco. However, after many years of use, this equipment became worn and outdated, and was in dire need of replacement. Since Texaco had merged with Chevron, Steve Holditch decided to approach Chevron to discuss the upgrading of the drilling fluids lab. The response was a generous gift of $690,000, which has been used to completely replace all the drilling fluids testing equipment. New equipment was purchased and installed in the summer of 2009, just in time to begin the 2009-2010 academic year.

This new equipment allows our sophomore Petroleum Engineers to use the same equipment utilized by mud engineers in the field to perform daily mud checks. By running tests on different types of mud, and seeing for themselves the effect of different contaminants on drilling mud, the students can begin to understand the importance and complexity of drilling fluids. These tests also allow our students to gain a firm understanding of rheology itself as well as the rheological properties of all fluids that petroleum engineers deal with on a day to day basis.

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In the early 1990's, Mike and Joanne Cone, along with the Tri-C corporation, provided funds for the department to purchase a new Digitran RS 3000 Derrick Floor Drilling Simulator. This simulator was used extensively to teach MMS approved well control courses all through the 1990's, even as it was utilized in undergraduate and graduate drilling courses. Time took its toll on the simulator and, by the early part of this decade, the drilling simulator started to become obsolete. Thanks to Chevron's gift, the Digitran simulator was upgraded into the state of the art DrillSym 5000 simulator. Completed in January 2010, this upgraded simulator now has the capability to simulate the entire drilling process, including drilling, circulating, running leakoff tests, drilling problems, tripping pipe, running casing, cementing, and well control. There are modules for land, platform, jackups, and floating drilling rigs, Kelly drive and top drive. This simulator will again be utilized in both undergraduate and graduate drilling courses, as well as industry courses.

For more information on the Chevron Drilling and Completions Fluid Lab, please contact Dr. Jerome J. Schubert.
Flow Assurance in Deepwater Drilling

1.5.5 Wellbore Temperature Profile while Mud is being Circulated

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Objectives

The estimation of fluid temperatures during drilling and circulation requires an understanding of the thermal processes which occur inside the wellbore. This knowledge may be used to predict the behavior of drilling fluids and drilling equipment in the extreme temperatures of the down-hole environment.

The objective of this research is to develop computer models to estimate the temperature distribution and its variation with circulating time for steady-state and transient heat transfer in deepwater drilling like conventional riser drilling and riserless drilling.

Approach

Analytical solutions

Many models have been developed for both steady-state flow and pseudo-state heat transfer. However these models are basically for onshore drilling. With Deepwater Drilling challenges, it is necessary to amend these onshore drilling models.

Numerical Solutions

Numerical solutions include a steady-state heat transfer model and transient heat transfer model. Numerical solutions can be used for more complicated boundary conditions, anisotropic formation thermal properties, and different wellbore configurations with real well-logging data. The transient heat transfer model is based on implicit finite difference method, which requires a large-scale sparse matrix to solve it. Although the implicit difference method leads to a more complicated calculation, it guarantees the iteration will converge.

Significance

In the calculation, the circulation rate for the forced convection overwhelms the heat transfer phenomena. The thermal properties of drilling fluid also have obvious effects on the temperature profile for a given well. The geometry of a well does not have important effects on the temperature distribution.

Accomplishments

• Developed the numerical steady-state simulator with visual basic for deep-water drilling
• Conducted sensitivity analyses with certain cases
• Derived the implicit finite difference model for transient heat transfer model
• Performed some example calculations with sparse matrix solver

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Future Work

• Continue working on the transient heat transfer model
• Integrate the heat diffusion by friction in drillpipe, annulus, and drillbit into the model
• Compare the numerical heat transfer models with analytical heat transfer models
• Compare the temperature profile with real-time logging data

Temperature profile in the riserless deepwater well.
Cement Fatigue Failure and High Pressure, High Temperature Well Integrity

Objectives

This research tries to give a better understanding of cement fatigue and failure, especially for high pressure, high temperature (HPHT) wells. We will develop equations specific to well cement from experimental data. We will also develop new failure mechanisms, crack initiation and propagation, and failure theories, and then predict fatigue life of cement related to HPHT wells.

Approach

A lab test will be carried out to get the properties of cement. The experiment will involve the following steps: specimen fabrication, test specimen preparation, static compression tests, fatigue test, and data analysis. The water cement ratio, temperature, and pressure will be the three variables considered. According to obtained data, we will use ANSYS software to simulate the cement failure in the well operation, develop the failure theory, and predict the fatigue life of cement.

Accomplishments

In the lab test, two cement systems were used, Class G cement with 0.45 W/C and WFK 6/2 cement with 0.45 W/C, which is swelling cement. The two cement systems were cured in three different conditions: room condition, 75°C with atmospheric pressure, and 100°C with 18 MPa. Fig. 1 showed that cement cured with high temperature has a much higher early strength. The compressive strength of cement cured at 100°C would go down a little with time within the first 14 days. From simulation, Fig. 2 and Fig. 3, the bond between the cement and the casing is weakest, which has the smallest available life for the zero-based cyclic load. For the loading variation changing from 0.5 to 0.75, the cement available life sharply decreases to zero. This loading variation should be avoided in the well operation.

Future Work

Continue to use ANSYS to study the specific failure process of the cement and use probability theory to do probability analysis.
For more information on other research projects, please visit the Crisman website: http://www.pe.tamu.edu/crisman/

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