THE UNIVERSITY of TULSA

Department of Petroleum Engineering

DRILLING RESEARCH PROJECTS
ADVISORY BOARD MEETING
NOVEMBER 7th, 2011

EXECUTIVE SUMMARIES
AGENDA
THE UNIVERSITY OF TULSA
Drilling Research Projects
Advisory Board Meeting
The DoubleTree Hotel at Warren Place
6110 S. Yale Avenue
Tulsa, OK 74136

AGENDA

Monday, November 7th, 2011

CLASSIC CONTINENTAL BREAKFAST
The DoubleTree Hotel at Warren Place
Tulsa Learning Theater
7:45 a.m.

INTRODUCTION
Stefan Miska 8:15 a.m. – 8:35 a.m.

PROGRESS REPORTS
Rahul Gajbhiye 8:35 a.m. – 8:55 a.m.
Review of Research Works Related to Hole Cleaning

Yahya Hashemian 8:55 a.m. – 9:20 a.m.
Experimental Study and Modelling of Barite Sag in Annular Flow

Duc Nguyen 9:20 a.m. - 9:45 a.m.
Smear Effect in Casing Drilling-The Effect of Casing Dynamics

Goktug Kalayci 9:45 a.m.- 10:15 p.m.
Study of YPL Fluids Transition Flow Regime in Pipes

Coffee Break 10:15 a.m.- 10:35 a.m.

Fei Fei Zhang 10:35 a.m.- 11:00 a.m.
Investigation of Cuttings Transport in 30~60 Degree Inclined Wells

Mehmet Arslan 11:00 a.m.- 11:35 a.m.
Buckling and Axial Force Transfer of Buoyancy Assisted Casing-Final Presentation

Ali Karimivajargah 11:35 a.m.- 12:00 a.m.
Pressure Signature of Gas Influx

LUNCH 12:00 p.m. - 1:15 p.m.
Parkview Ballroom
INDUSTRY PRESENTATIONS

NOV ...........................................................1:15 p.m. – 1:45 p.m.
Hege Kverneland - The New Drillers Role with Automated Systems

PROGRESS REPORTS

Binh Bui ...........................................................1:45 p.m.- 2:10 p.m.
Determination of Visco-Elastic Properties of Drilling Fluids

RESEARCH PROPOSALS

Babak Akbari ...........................................................2:10 p.m.- 2:30 p.m.
PDC Drillbit Modeling and Experiments

Oney Erge ...........................................................2:30 p.m.-2:50 p.m.
Effect of Free Drillstring Rotation on Pressure Losses

Bahri Kutlu ...........................................................2:50 p.m. - 3:10 p.m.
Light Weight Drilling Fluids

Coffee Break ...........................................................3:10 p.m. - 3:30 p.m.

Mojtaba Pordel Shahri ...................................................3:30 p.m. -3:50 p.m.
Stress Path Analysis in Depleted Sands

Zhaoyang Wang .......................................................3:50 p.m -4:10 p.m.
Automatic Control of Drawworks

Hao Zeng ...........................................................4:10 p.m - 4:25 p.m.
Study of Effectiveness of LCM Materials

PROGRESS REPORTS

Lu Huang ...........................................................4:25 p.m. – 4:40 p.m.
Shale Stability at Simulated Wellbore Conditions

Mengjiao Yu ...........................................................4:40 p.m.- 4:50 p.m.
Update on Current Research Projects

Budget and Closing Comments ........................................4:50 p.m. – 5:00 p.m.

RECEPTION

The DoubleTree Hotel at Warren Place – Parkview Ballroom
6110 S. Yale Avenue
Tulsa, OK  74136
THE UNIVERSITY OF TULSA
Advisory Board Meeting

University of Tulsa
2450 E Marshall
Tulsa, OK  74110

AGENDA

Tuesday, November 8th, 2011  NORTH CAMPUS

All Visitors Assemble in Drill Building Conference Room.................................9:00 a.m.

Nicholas Takach/ Rahul Gajbhiye.................................................................9:05 a.m. - 9:20 a.m.
Tour Schedule & Facility Improvements

FACILITY TOUR of NORTH CAMPUS.........................................................9:20 a.m. – 11:00 a.m.

ROUND TABLE DISCUSSION.................................................................11:00 a.m. – 11:30 a.m.

LUNCH.................................................................................................11:45 a.m.-1:00 p.m.
The University of Tulsa South Campus- Gallery

INDIVIDUAL MEETINGS (upon request).................................................1:30 p.m. – 5:00 p.m.

*********Next Advisory Board Meeting- May 14th and 15th, 2012**********
Doubletree Warren Place Hotel- Tulsa
MEMBER COMPANIES
BP Exploration 1977
Petrobras/Cenpes 1984
Statoil 1985
Halliburton Energy Services 1996
Baker-Hughes 1997
Schlumberger 1997
Weatherford 2000
ExxonMobil 2002
ConocoPhillips 2003
Shell E&P 2007
VAM Drilling France 2007
National Oilwell Varco 2007
Bureau of Ocean Energy Management, Regulation and Enforcement (Formerly MMS) 2008
ENI 2008
Det norske oljeselskap ASA 2009
Tesco 2010
Hess 2011
SINOPEC (In Progress) 2011
TUDRP PERSONNEL
TUDRP PERSONNEL

EXECUTIVE DIRECTOR/ PRINCIPAL INVESTIGATOR:
Stefan Miska

SENIOR ASSOCIATE DIRECTOR:
Nicholas Takach

ASSOCIATE DIRECTORS:
Mengjiao Yu
Evren Ozbayoglu

RESEARCH ASSOCIATE:
Rahul Gajbhiye

PROJECT ASSISTANT:
Paula Udwin

PROJECT TECHNICIAN:
Randy Darden
Don Harris

RESEARCH CONSULTANTS:
Charles Alworth
JJ Azar
Jeremy Daily
Siamack Shirazi
Jim Sorem
Steven Tipton

RESEARCH ASSISTANTS:
Yuanhang Chen, Ph.D. Student
Vusal Rajabov, M.S. Candidate
Duc Nguyen, Ph.D. Candidate
Mojtaba Pordel Shahri, Ph.D. Student
Goktug Kalayci, M.S. Candidate
Ali Karimivajargah, Ph.D. Candidate
Onel Erge, M.S. Candidate
Hao Zeng, M.S. Candidate

Binh Bui, M.S. Candidate
Mehmet Arslan, M.S. Candidate
FeiFei Zhang, Ph.D. Student
Lu Huang, Ph.D. Candidate
Yahya Adariani, Ph.D. Candidate
Bahri Kutlu, M.S. Candidate
Zhaoyang Wang, M.S. Candidate
Babak Akbari, Ph.D. Student

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Drilling Research Projects
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Tulsa, Oklahoma 74104

FAX: (918) 631-5009
Executive Summaries
Table of Contents
TUDRP EXECUTIVE SUMMARIES

Research Projects

Yahya Hashemian Adariani
*Experimental Study and Modeling of Barite Sag in Annular Flow*

Duc Nguyen
*Smear Effect in Casing Drilling- The Effect of Casing Dynamics*

Goktug Kalayci
*Study of YPL Fluids Transition Flow Regime in Pipes*

FeiFei Zhang
*Investigation of Cuttings Transport in 30~60 Degree Inclined Wells*

Mehmet Arslan
*Buckling and Axial Force Transfer of Buoyancy Assisted Casing*

Ali Karimivajargah
*Pressure Signature of Gas Influx*

Binh Bui
*Determination of Visco-Elastic Properties of Drilling Fluids*

Research Proposals

Babak Akbari- **RESEARCH PROPOSAL**
PDC Drillbit Modeling and Experiments

Oney Erge- **RESEARCH PROPOSAL**
Effect of Free Drillstring Rotation on Pressure Losses

Bahri Kutlu- **RESEARCH PROPOSAL**
Light Weight Drilling Fluids

Mojtaba Pordel Shahri- **RESEARCH PROPOSAL**
Stress Path Analysis in Depleted Sands

Zhaoyang Wang- **RESEARCH PROPOSAL**
Automatic Control of Drawworks

Hao Zeng- **RESEARCH PROPOSAL**
Study of Effectiveness of LCM Materials
Experimental Study and Modeling of Barite Sag in Annular Flow

Yahya Hashemian
INVESTIGATOR: Yahya Hashemian, TUDRP

OBJECTIVE:

- Mathematical modeling and experimental study of barite sag in annular flow considering effects of annular velocity, eccentricity, pipe rotation and inclination angle on barite sag.

SCOPE OF WORK:

- Modeling: Velocity profile of laminar flow for a non-Newtonian fluid in eccentric annulus with stationary inner pipe was obtained numerically. The calculated velocity was assigned to solid particles in axial direction considering momentum time response of particles. Falling velocity correlation in the literature for a cloud of particles in power law fluid was assigned to each particle. Having two components of velocity, the time needed for particles to settle at the bottom of the casing was obtained and a corresponding new density was calculated after that time period.

- Experimental study: A large indoor flow loop was modified to conduct flow tests on an oil base mud in annulus. Flow rate, inner pipe rotation, eccentricity and inclination angle is varied to investigate their effects on change of the flowing fluid density.

RECENT PROGRESS:

- Mathematical modeling: particle concentration, momentum time response of particles and eccentricity was added to the model which resulted in a good match with experimental results in low flow rates.
- New data set of experimental work regarding effects of eccentricity.

FUTURE WORK:

- Continue mathematical modeling development considering:
  - Effects of barite particle shapes on drag and lift
  - Development of practical correlations for barite sag
- Continuation of experimental work on large indoor flow loop.

DELIVERABLES

- Semi-annual advisory board meeting Progress Reports
- Experimental data set
- Modeling
- Final Report

TIME TABLE:

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Smear Effect in Casing Drilling- The Effect of Casing Dynamics

Duc Nguyen
EXECUTIVE SUMMARY

Smear Effect in Casing Drilling – The Effect of Casing Dynamics

Investigator: Duc Nguyen, TUDRP

Introduction:
Casing Drilling is an emerging technology that helps with reducing drilling cost as well as issues associated with conventional drilling such as lost circulation, well control and borehole stability problems. Among various advantages, lost circulation reduction is one of the most beneficial phenomena of casing drilling. However, this effect has not been fully explained nor thoroughly studied. The purpose of this project is to investigate the effect of casing dynamics on the plastering mechanism of drilled solids into the borehole wall, and the relationship of this phenomenon with the reduction of lost circulation problems.

Objectives:
• Provide more thorough understanding of the smear effect and its connection to lost circulation mitigation.
• Create a dynamic model for casing drilling / narrow annulus drilling application.
• Develop a model for particle mechanics of drilled solids in the wellbore, taking into account the effect of casing dynamics.
• Verify models with field data.

Project Status:

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Recent Progress:
• Improved numerical model with consideration of coupled effects between axial-bending and axial-torsion to describe a beam column element more accurately.
• Particles transport model considering PSD that can predict concentration profile changes along the casing.

Future Work:
• Relationship between PSD and casing dynamics.
• Verification of models with field data.
Study of YPL Fluids Transition Flow Regime in Pipes

Goktug Kalayci
Study of Yield Power Law Fluids Transitional Flow Regime in Pipes

Investigator: Göktuğ Kalaycı TUDRP

Statement of Problem

Transition between laminar and turbulent flow regimes result in discontinuity in friction factor which could lead to exceeding the fracture gradient. Although it is mostly accepted that the critical Reynolds Number is above 2100 for onset of turbulent flow regime, this may lead to major errors in estimating friction pressure drop, especially for non-Newtonian fluids with significant yield stresses. Inaccurate friction pressure loss estimation might cause either lost circulation problems or influx of formation fluids into the wellbore.

Objectives:

• Better understanding of behavior of YPL fluids in the transitional flow regime between laminar and turbulent flow in pipes, considering rotation and temperature effects.
• Determine friction factors in the transitional flow regime and validate with experimental results.
• Develop a mathematical model for pressure drop prediction under transition flow conditions used in drilling applications.

Scope of Work:

The project includes both theoretical and experimental work to understand the transitional flow between laminar and turbulent flow regimes for Yield Power Law fluids. This work can be done in two stages: the first will include flow in pipes and the second will consider pipe rotation. In both stages temperature effects will be considered.

Recent Progress:

• Modification of the data acquisition system (Self-Authorized Flow Control)
• Calibration of DAQ system and preliminary experiments with water and no rotation
• Developing mathematical model (modification of Ryan and Johnson Criteria for YPL fluids)
• Conducting experiments with Xanthan Gum without rotation

Deliverables:

• Rheological parameters for Yield Power Law fluids used in this study.
• Experimental results of pressure distributions and friction pressure losses measured for different Yield Power Law fluids at different flow velocities and temperatures.
• A mathematical model to predict friction pressure losses during transition from laminar to turbulent flow.
• Friction factor correlations as a function of Reynolds Number for transitional flow.
• Onset point of transitional and turbulent flow of Yield Power Law fluids.
• Semi-annual Advisory Board Meeting (ABM) Progress Reports and the Final Report.

Project status (completed)

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Investigation of Cuttings Transport in 30-60 Degree Inclined Wells

Feifei Zhang
EXECUTIVE SUMMARY

Investigation of Cuttings Transport in 30~60 Degrees Inclined Wells

Investigator: Feifei Zhang, TUDRP

Problem Statement:

- The cuttings motion in 30–60 degrees inclined wells is complex, cuttings behavior change dramatically in this inclination angle range.
- Unstable cuttings dune or bed begin to appear in this section. The cuttings dune or bed may slide downward upon decreasing flow rate, which can lead to a series of drilling problems.
- The cuttings flow pattern in this inclination angle range varies significantly. Prediction of cuttings behavior by using mechanistic model is difficult.

Objectives:

- Conduct a series of cuttings transport experiments to study cuttings behavior at a set of given parameters.
- Develop models to predict flow pattern, change of cuttings concentration and pressure drop with changes of given drilling parameters.
- Compare the experimental results and the simulation results to examine the reliability of the model.

Experiment:

A total of seventy-two cuttings transport tests and twelve repeat tests were conducted. The following conclusions have been obtained thus far:

- The cuttings move forward in different patterns dependent on the flow rate, inclination angle, drill pipe rotation and ROP.
- The dramatic change of cuttings concentration and pressure loss at the critical angle is caused by the change of flow patterns.
- At low inclination angles, the effect of drill pipe rotation on cuttings concentration is not important. At highly inclined angles, the cuttings concentration decreases as the drill pipe begins to rotate.
- The pressure loss along the wellbore is directly related to the cuttings concentration. At low flow rates, the effect of cuttings on pressure loss is important, and at high flow rates, the effect is insignificant.

Model:

The models are based on the observed flow patterns. Firstly, a flow pattern prediction model will be developed, then different cuttings concentration and pressure loss prediction models will be developed for each flow pattern.

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Buckling and Axial Force
Transfer of Buoyancy
Assisted Casing

Mehmet Arslan
Buckling & Axial Force Transfer of Buoyancy Assisted Casing

INVESTIGATOR: Mehmet Arslan, TUDRP

STATEMENT of PROBLEM

In extended or mega reach wells, running long casing strings is crucial in order to access reserves. However, for such wells that have shallow and high step out profiles, it is one of the most critical of all well operations due to the excessive level of drag between casing and the wellbore. In shallow, highly deviated or horizontal wells, there can be insufficient casing weight in the vertical section to overcome the drag.

Buoyancy assistance allows successful completion for cases where significant reduction in drag is required. However, floatation methodologies also result in a dramatic reduction in the effective weight of tubular and increase the susceptibility of the string to be buckled by lower axial loads than those expected in conventional runs.

OBJECTIVES

- Better understanding of buckling behavior and axial force transfer of nearly weightless tubulars inside horizontal wellbores
- To investigate the effect of buoyancy on the behavior and axial force transfer of tubulars in horizontal wellbores through the transition from both straight to sinusoidal and sinusoidal and helical configurations
- To observe the effect of rotation on buckling behavior and axial force transfer of buoyancy assisted tubulars in horizontal wellbores

PROJECT STATUS

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RECENT PROGRESS & CONCLUSIONS

Four out of five different pipes under consideration have been tested both statically and dynamically, at different buoyancy conditions.

- In terms of static stability,
  - it can be concluded that as the effective weight approaches zero, tubulars still resist buckling with the bending stiffness they have, so certain amount of axial load is still required for both buckling initiation and formation of first helix even for weightless pipes,
  - a model that takes the influence of buoyancy into account to predict buckling loads has been developed.
- Dynamic experiments,
  - simulated the strong effect of rotation on buckling initiation,
  - showed that rotating speed does not influence the onset of snaking motion,
  - also showed that axial force transfer efficiency is well improved by rotation.

DELIVERABLES

- Experimental observation and analytical analysis of buckling behavior and axial force transfer of tubulars inside a constraining cylinder with emphasis on buoyancy
- Semi-annual ABM Reports & A Final Report
Pressure Signature of Gas Influx

Ali Karimivajargah
Pressure Signature of Gas Influx

Investigator: Ali Karimi

Sponsor: TUDRP

Problem statement:
Managed Pressure Drilling (MPD) techniques are used with relying on precisely control annular pressure profile in wellbore and hence enabling us to drill in narrow mud window (between pore and fracture pressure). The need for more information from the well is provided by wired drill pipe telemetry system. Combination of MPD and Wired Drill String Technology offers new ways to achieve safe well control and successful drilling of wells that would otherwise be un-drillable and/or present unacceptably high risk. Therefore, developing methods for accurate signature of annular pressure and early detection of gas kicks and accordingly its location by using wired drill pipe technology can be very helpful in preventing and curing well problems and alleviate associated risks in harsh drilling conditions.

Objectives:
Developing a gas kick simulator for:
- Early detection of gas influx and its location in the wellbore by using Wired Drill String Technology during MPD and conventional operations
- Predicting annular pressure profile when gas influx enters the wellbore, both before and after shut-in
- Predicting bottom-hole pressure, SIDPP, SICP
- Predicting the gas migration velocity after shut-in
- Predicting gas and liquid fractions along the wellbore and pit gain vs. time
- Obtaining gas and liquid velocity distribution in the annular space

Current Work
- Applying Drift-Flux model in two-phase region after shut-in
- Introducing a solution procedure for after shut-in period to predict desired parameters
- Predicting annular pressure profile, pressure profile and its derivatives at desired locations, pit gain, velocity distributions flow patterns, SIDPP, SICP
- Performing sensitivity analysis to investigate effects of mud compressibility and early gas detection after shut-in
- Introducing a method to predict gas migration velocity according to gas void fraction

Deliverables
- Advanced gas influx simulator to observe pressure profiles, detect gas influx, and determine its location, volume, and movement in the wellbore (before and after shut in) with using Wired Drill String Technology
- Matching the model with field data (if available) obtained from Wired Drill String Technology
- Semi-annual Advisory Board Meeting (ABM) reports and the Final Report

Project Status

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Determination of Viscoelastic Properties of Drilling FLuids

Binh Bui
DETERMINATION OF VISCOELASTIC PROPERTIES OF DRILLING FLUIDS

INVESTIGATOR: BINH BUI

INTRODUCTION:
Drilling fluids exhibit viscoelastic properties at various levels. However those properties are not fully investigated. Viscoelastic properties of drilling fluids are very important in constitutive modeling and are used for predicting many phenomena, including pressure peak and dynamic barite sag. Viscoelastic tests are also the standard method to investigate low shear viscosity, gel structure, gelling time, dynamic yield point and the structural stability of drilling fluids. This report summarizes the theoretical study and experimental work conducted thus far to determine viscoelastic properties of drilling fluids, with a focus on oil-based fluids.

OBJECTIVES:
1. To enhance our understanding of the viscoelastic properties of drilling fluids and the applications of viscoelastic data in drilling fluid applications.
2. To investigate and evaluate experimentally the linear viscoelastic range of different drilling fluids using dynamic tests.
3. To validate and extend some rheological correlations for drilling fluids, such as the Cox-Merz rule and superposition principles.

CURRENT WORK:
1. Experimentally investigate the viscoelastic properties and linear viscoelastic range of ten oil-based fluids and other fluids, including polymeric and Bentonite samples.
2. Extend the Cox-Merz rule for the tested samples.
3. Investigate the applicability of time-temperature superposition, and strain-rate and frequency superposition principle for polymeric samples.

FUTURE WORK:
1. Extend the current experiments to water-based fluids.
2. Investigate the applicability of the time-temperature superposition, and strain-rate and frequency superposition principle for each fluid.
3. Validate and extend the Cox-Merz rule for other drilling fluids.
4. Obtain the first normal stress difference and damping function for each sample.

DELIVERABLES:
1. Semi-annual Advisory Board Meeting progress reports.
2. Experimental data.
3. Correlations involving selected rheological parameters of drilling fluids.

PROJECT STATUS:

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PDC Drillbit Modeling and Experiments
RESEARCH PROPOSAL

Babak Akbari
EXECUTIVE SUMMARY

PDC Drillbit Modeling and Experiments

Investigator: Babak Akbari, TUDRP

Problem Statement:

Even though drag bits have been used for a long time in the drilling industry and significant developments in terms of their design have been achieved, knowledge of the cutting mechanism of these bits is still limited. Past research on this subject typically starts with modeling the cutting mechanism of a single PDC cutter. This is part of a reasonable stepwise plan to tackle the main problem, which is full PDC bit modeling. This research proposal describes a continuation and expansion of the earlier studies and mainly focuses on the effects of pore pressure and cutter size, with the eventual goal of a full PDC bit model.

Objectives:

- Cutting response of a single PDC cutter under simulated borehole and pore pressure conditions.
- Cutting response of a single PDC cutter with respect to cutter size.
- A correlation relating the cutting response of a single cutter to all the operational parameters including the previously studied parameters as well as the two new proposed ones.
- A full PDC bit model that integrates the correlation for a single cutter and predicts rate of penetration, mechanical specific energy and bit whirl.

Scope of Work:

The first two tasks will be done using the single cutter facility in TUDRP. To account for the pore pressure, a new design of the bottom sample holder and the top clamp sample holder is needed. For the cutter size experiments, some modifications in the facility to deliver higher torques are needed. The modifications are in progress and the facility will soon be ready to conduct experiments. The full PDC bit model will use FEM methods to find individual forces on the cutters for a given bit design and will then input the results into the simulator.

Deliverables:

- Correlations relating the single PDC cutting response to pressure differential.
- Correlations relating the single PDC cutting response to cutter size.
- An ultimate correlation relating the cutting response to 7 different operational parameters for three different rock types.
- Full PDC bit simulator predicting the full bit drilling response, given operational conditions and bit design parameters.

Tentative Time Table:

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Effect of Free Drillstring Rotation on Pressure Losses
RESEARCH PROPOSAL

Oney Erge
Effect of Free Drillstring Rotation on Frictional Pressure Losses

INVESTIGATOR: Oney Erge

STATEMENT OF THE PROBLEM:
Accurate calculation of pressure loss in wellbores is necessary to control the well, optimize bit hydraulics, prepare a proper drilling fluid program and select the appropriate pump. As known, the pressure loss is strongly affected by pipe rotation. Models corresponding to concentric annuli or stable flow conditions are no longer satisfactorily accurate for actual drilling operations. In an actual wellbore, laminar flow most likely will not be observed due to drillstring rotation and varying eccentricity. There is a substantial need for a reliable model that accurately estimates the effect of free drillstring rotation on frictional pressure losses.

OBJECTIVES:
1. To develop a comprehensive mathematical model that accurately accounts for the effect of pipe rotation in frictional pressure loss calculations of Yield Power Law fluids.
2. To develop a better understanding for the transition from laminar to turbulent region in annular geometries.
3. To conduct experiments using YPL fluids in an annular geometry including rotation of a free drillpipe and collect high quality data

SCOPE OF WORK:
1. In this research, effect of a freely rotating drillstring will be studied. The focus of this project is on a horizontal well setup with drillpipe in compression.
2. The test setup will provide free drillstring rotation through no preset configuration on eccentricity. As the inner pipe rotates, orbital motion, wobbling and lateral motion of the drillstring will be observed. Therefore, unstable flow will occur.
3. Comparisons will be made between the developed model and the test measurements. The aim is for the measurements and developed model to precisely reflect field operations. The mathematical model developed via this research, has the potential to lead to safer, deeper and more precisely controlled oil/gas well drilling operations.

APPROACH:
1. Theoretical work
   - Mathematical model construction for estimating the frictional pressure losses considering pipe eccentricity and rotation based on fundamental conservation principles.
   - Determination of a reasonable laminar/turbulent transition criterion.
2. Experiments
   - Free drillstring rotation
   - Varying RPM
   - Varying flow rate
   - A YPL fluid and water as drilling fluids

DELIVERABLES:
1. High quality data for YPL fluids including effect of drillstring rotation
2. A reliable mathematical model that includes free drillstring rotation effects on the annular frictional pressure losses.
3. Semi-annual Advisory Board Meeting Progress Reports
4. Final Report
Light Weight Drilling Fluids
RESEARCH PROPOSAL

Bahri Kutlu
EXECUTIVE SUMMARY

Lightweight Drilling Fluids

Investigator: Bahri Kutlu, TUDRP

Introduction:
In recent years, there has been an increasing necessity to drill formations which have entered a partially depleted stage because of extended time period of production. More and more horizontal wells have been drilled and completed with open hole in low pressure deposits. This need of redevelopment of old fields and penetrating low pressure zones emerges necessity of lightweight drilling fluids. In low pressure reservoirs with low-permeability, operating with a density out of the required range could result in loss of fluid into the formation. In addition, excess overbalance could result in increased drilling costs, fracturing the formation or potential formation damage. Problems are encountered also in deep water wells. Conventional drilling fluids with specific gravities greater than one exceed pore and fracture gradients in short vertical distance and emerge the need to set casing. If annular pressure can be reduced, the need for casing strings and the time and cost spent can be reduced respectively.

Objectives:
- Evaluating drilling fluids having densities less than that of the base fluids, which are developed by mixing hollow glass spheres.
- Conducting a study on rheological properties and flow characteristics of an incompressible lightweight drilling fluids generated by using hollow glass spheres.

Scope of Work:
The following research activities will be involved in this study: i) literature review; ii) conducting experiments to determine the rheological parameters of hollow glass spheres with different type of base fluids at different temperatures and pressures, iii) flow experiments using the lightweight drilling fluid generated by using hollow glass spheres through an annular geometry, using a flow loop; iv) determining flow characteristics of generated lightweight drilling fluids as a function of rheology, density, fluid composition, concentration and size of hollow glass spheres.

Deliverables:
- Experimental data from viscometer and/or rheometer tests for Hollow Glass Spheres mixed in drilling fluid.
- Experimental data, including the frictional pressure losses at various flow rates, from flow loop tests using fluids mixed with different concentrations of hollow gas spheres.
- Rheological characterization of fluids mixed with hollow gas spheres under different temperature conditions with different concentrations.
- Semi-annual Advisory Board Meeting (ABM) progress reports and the Final Report.

Tentative Time Table:

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Stress Path Analysis in Depleted Sands
RESEARCH PROPOSAL

Mojtaba Pordel Shahri
EXECUTIVE SUMMARY

Stress Path Analysis in Depleted Sands

Investigator: Mojtaba Pordel Shahri, TUDRP

Problem Statement:

Without detailed knowledge of reservoir stress path, i.e., change in fracture gradient with pore pressure variation, geomechanical modeling of depleted reservoir is less quantitative and different problems such as wellbore stability and sand production become more severe in existing and new wells. Ability to design wells with lowest non-productive time (NPT) rely on the ability to predict the stress changes likely to occur in a reservoir undergoing depletion with greater accuracy.

Objectives:

- To develop an understanding of theory of poroelasticity and reservoir stress path in depleted sands
- To develop a new model for predicting reservoir stress path during production/injection in depleted reservoirs with compressible multiphase fluid flow
- To develop a computer simulator to predict the reservoir stress path
- To verify the model with field data (Laboratory data will be used to determine the geomechanical deformation model’s parameters)

Scope of Work:

In this project, the stress depletion response of reservoir will be investigated by advanced modeling approaches. This model will be able to predict the change of minimum horizontal stress within the reservoir due to pore pressure variation. The scope of the works includes:

- Mathematical modeling of reservoir stress path with multiphase fluid flow and deformable reservoir rock
- Develop a computer simulator to predict the reservoir stress path
- To determine the geomechanical deformation model’s parameters by corresponding laboratory data that will be provided by industry
- Validating model by available field data

Deliverables:

- Mathematical model for predicting reservoir stress path
- Computer simulator for predicting reservoir stress path
- Matching the model with field data
- Semi-annual Advisory Board Meeting (ABM) reports and the Final Report
- PhD dissertation

Proposed Time Table:

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Automatic Control of Drawworks
RESEARCH PROPOSAL

Zhaoyang Wang
EXECUTIVE SUMMARY

Automatic Control of Drawworks

Investigator: Zhaoyang Wang, TUDRP

Introduction:

Drilling automation is the ability of drilling machines to work together on their own. The automated drilling program is expected to lower costs of drilling wells, and allows faster drilling with fewer people on site, which makes it safer as well. Essentially, drilling automation aims to turn the knowledge of drilling into working programs. In order to make drilling automation more reliable, it is necessary to make every part of the drilling system effectively automated. The automation of drawworks is one of the major issues. Tripping event is becoming more and more expensive, especially for offshore drilling. Minimizing tripping time is one of the most important parts of controlling drawworks.

Objectives:

- Find or build a model to better calculate the load on the drill pipe during tripping for vertical wells, especially considering dynamic forces in the drill pipe.
- Find or build a model to calculate the bottomhole pressure corresponding to the tripping velocity profile, which takes transient pressure surge into consideration.
- Simulate the whole progress of tripping, and find the most proper tripping velocity profile, which consider the strength of drill pipe and drilling operating pressure window, to minimize tripping time.
- Develop a closed-loop system to automatic control the drawworks.

Scope of Work:

The proposal project includes both calculations and a simulation model to make the automation of drawworks more reliable and practical. The work can be done into three stages: 1. Build a model to calculate the load on the drill pipe that corresponds to the tripping velocity, which takes dynamic force into consideration; 2. Build a model to calculate bottom pressure surge corresponding to the tripping velocity, which considers short term transient pressure surges; 3. Conduct a series of simulated tripping velocity profiles and find the optimum profile which can minimize tripping time in a safe manner. 4. Using the optimization program and control theory to control the drawworks automatically.

Deliverables:

- A mathematical model to minimize tripping time through the control of drawworks. The model will consider bottom hole transient pressure surges and axial dynamic forces.
- A computer program to simulate the mathematical model.
- A simulating system that can perform the whole process of automatic control of drawworks.
- Semi-annual Advisory Board Meeting (ABM) progress reports and a Final Report.

Tentative Time Table:

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Study of Effectiveness of LCM Materials
RESEARCH PROPOSAL

Hao Zeng
Study of Effectiveness of LCM Materials

Investigator: Hao Zeng, TUDRP

Introduction: Lost circulation is one of the most common well control problems encountered in drilling, cementing and completion operations. Large amounts of time and money are spent to control lost circulation. The use of lost circulation materials (LCM) is the most common method to treat lost circulation. However, the use of LCM is poorly understood and has achieved no significant breakthroughs in the past 40 years. As a result, maximizing the effectiveness of LCM is now most important to minimize the cost in lost circulation. Thus, the main aim of this study is to find a way maximizing the effectiveness of LCM under different lost circulation conditions.

Objectives:

• Provide more thorough understanding of existing PSD selection theories and rheological issues that occur in fractured wellbores.
• To observe LCM behavior in both uniform and nonuniform sized fractures under different flow rate.
• To determine the effectiveness of different LCM materials.
• To develop an optimized LCM selection model.

Scope of Work:

The proposed project includes both theoretical and experimental work to obtain the effectiveness of LCM. Experimental facility will be modified first. The experiments will be done for both uniform sized and nonuniform sized fractures. Based on the experimental data, exiting methods and theories can be verified. A LCM selection model will be developed at last.

Deliverables:

• Advanced LCM effectiveness testing facility.
• Experimental observation and analytical analysis of LCM bridging behavior.
• Optimized LCM selection model.
• Semi-Annual Advisory Board Meeting (ABM) reports and the final report.

Preliminary Time Table

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