Baker Hughes INTEQ

Drilling Engineering Workbook

A Distributed Learning Course

80270H Rev. B December 1995

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Drilling Engineering - A Distributed Learning Course

FORWARD

The *Drilling Engineering Workbook* is a correspondence (distributed learning) course which covers the important elements of drilling a well. The emphasis is on the theory behind these drilling elements in order to develop a greater understanding of the principles involved in drilling a well.

This is a lesson-by-lesson distributed learning course. Individuals should study each section and then answer the related questions at the end of the section. Supplementary reading is suggested throughout the text. This workbook, along with the related supplementary reading, should provide a sound basis for anyone involved in those services involved in drilling a well.

Comments or questions, regarding any of the course material, should be directed to the technical training department, either in Houston or Aberdeen.

PREFACE

At Baker Hughes INTEQ, we pride ourselves on our people and their level of professionalism, experience, responsiveness and adaptability at the wellsite, where time, money and effective operations depends on rapid, reliable information management. The INTEQ Field Advancement and Career Training System (IN-FACTS), is a system for training, developing and providing professional advancement for field operations personnel. It is the method behind these applications.

The IN-FACTS program provides a standardized career development path which utilizes a progression of both formal and hands-on learning, to turn potential into fully developed expertise. IN-FACTS is the tool that enables Baker Hughes INTEQ personnel to embark on, and develop successful careers within INTEQ, Baker Hughes, and the oil industry.

IN-FACTS is structured to provide an easily understood, orderly flow of learning experiences. These may or may not be in the same specialty, and allow our personnel to concentrate in one area, or to branch out into other disciplines. Movement through the IN-FACTS career progression is determined by industry experience, skills, and knowledge acquired through rigsite work and a variety of formal and informal training programs.

The training programs are modular, and are composed of formal course work, self-paced distributed learning packages, and on-the-job training.

Requirements for further advancement in our wellsite services includes increased knowledge and understanding of the various subjects involved in “wellbore construction and maintenance”. This distributive learning package will focus on these topics.

INSTRUCTIONS ON COMPLETING THIS WORKBOOK

The aim of this distributive learning workbook is to provide you with the information on various drilling engineering topics that can best be studied outside a classroom. It is not the intention of the Training Department that you complete all the assignments as soon as possible. This workbook project should allow you to spend enough time on each particular subject in order to thoroughly understand those aspects of drilling engineering as they apply to every day wellsite operations. This workbook includes:

- Drilling Fluids and Hydraulics
- Casing and Cementing
- Bit Technology
- Drillstring Basics
- Directional Drilling
- Horizontal Wells
- Stuck Pipe
- Well Control
- Cost Analysis
- Technical Writing

At the end of each chapter there will be “Self-Check” exercises, which are designed to assist you in understanding the information covered in the chapter. It is recommended that you do not proceed until you are confident that you fully understand the concepts, calculations, and applications of the chapter's subject matter. Direct any questions you may have to the Technical Training Department or a local technical expert.

When you have completed the workbook, there will be a “Return” assignment (Appendix A). This is to be completed and returned to the regional/area Training Department or local administrator. Using this assignment, the training administrators will be able to assist you in the next step.

Upon satisfactory completion of the “Return” assignment, an “End-of-Project” test will be necessary to comply with IN-FACTS requirements. Passing requirement for this test is 70%. This test can be provided and administrated by the training department or the local administrator.

Summary

This workbook is designed to review those engineering principles that are unique to drilling a well and to increase your knowledge and understanding of how those principles apply to wellsite operations.

There is a lot to learn, and remember, the learning process will never end. There are no real shortcuts. You will be required to learn for yourself, with guidance and assistance from experienced field personnel, local experts and the Technical Training Department.

The aim of the training you receive at Baker Hughes INTEQ is to develop your individual skills and knowledge to make you a fully competent, reliable professional within the oil industry. IN-FACTS is designed to assist you in this.

Comments

The Technical Training staff at Baker Hughes INTEQ is interested in your comments and suggestions concerning this distributed learning workbook. We want to constantly improve our products and with your help, the improvements will be even better. Please take the time to contact us with your comments.

If possible, use the electronic mail system, E-Mail, to contact us. This way we can route the E-Mail to the appropriate department and get back to you more quickly. However, we will accept any type of communications.

We have enclosed a Comment form. If E-Mail is not available to you, please make copies of this form, add your comments and mail or fax it to us.

When you send us your comments, please ensure the page and paragraph references and the following information is included in your transmittal.

Product Name.

Drilling Engineering Workbook

Product Part Number.

P/N 80270 Rev B

When using the mail-in form, send or fax the form to:

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Scotland
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Attn.: Training & Development Department

Drilling Engineering Workbook

P/N 80270H

Manual Date:_____ Today's Date: _____

Your Name: _____

District Office:_____ E-Mail Address: _____

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City: _____ State: _____ Zip Code: _____

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Comments:

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Cost Analysis

Chapter 10

Technical Writing

Appendix A

End Of Manual Return Exercises

Appendix B

Answers to Self-Help Exercises

Chapter 1

Drilling Fluids And Hydraulics

Upon completion of this chapter, you should be able to:

- Recognize the components in the various types of drilling fluids.
- Explain the advantages and disadvantages of the most common types of drilling fluids.
- Provide an explanation of mud properties as they are reported on a “morning report”.
- Calculate barite and water volumes when changes are made to a pre-existing mud system.
- Calculate PV and YP from Fann viscometer readings.
- Perform hydraulic optimization using the Power Law Model.

Additional Review/Reading Material

EXLOG, *MS-3026 Theory And Applications Of Drilling Fluid Hydraulics*

Baker Hughes INTEQ, *Drilling Fluids Manual,* 1991

API, *The Rheology of Oil-Well Drilling Fluids*, Bulletin 13D,2nd Edition, May 1985

API, *Recommended Practice for Drilling Mud Report Form*, Report 13G, 2nd Edition, May 1982

Chilingarian, G.V. and Vorabutr, P., *Drilling and Drilling Fluids*, Elsevier Science Publishers, 1983

Bourgoyne Jr., Adam, et al; *Applied Drilling Engineering*, SPE Textbook Series, Vol. 2, 1986

Moore, Preston; *Drilling Practices Manual*, 2nd Edition, PennWell Publishing Co.; Tulsa; 1986

Rogers, Walter F., *Composition and Properties of Oil Well Drilling Fluids*, Gulf Publishing Company, 1963

Drilling Fluids

A drilling fluid is any fluid which is circulated through a well in order to remove cuttings from a wellbore. This section will discuss fluids which have water or oil as their continuous phase. Air, mist and foam, which can be used as drilling fluids, will not be discussed at this time.

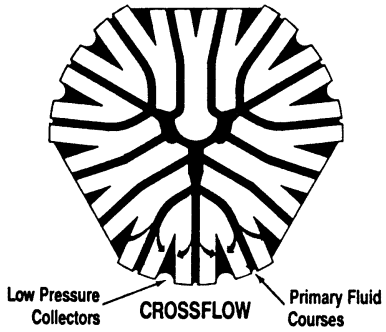
A drilling fluid must fulfill many functions in order for a well to be drilled successfully, safely, and economically. The most important functions are:

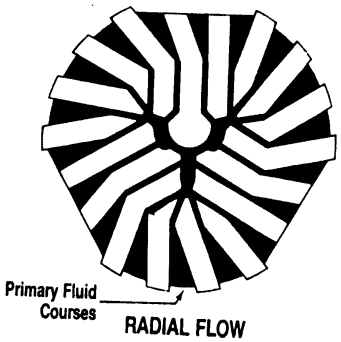
1. Remove drilled cuttings from under the bit
2. Carry those cuttings out of the hole
3. Suspend cuttings in the fluid when circulation is stopped
4. Release cuttings when processed by surface equipment
5. Allow cuttings to settle out at the surface
6. Provide enough hydrostatic pressure to balance formation pore pressures
7. Prevent the bore hole from collapsing or caving in
8. Protect producing formations from damage which could impair production
9. Clean, cool, and lubricate the drill bit

Occasionally, these functions require the drilling fluid to act in conflicting ways. It can be seen that items #1-3 are best served if the drilling fluid has a high viscosity, whereas items #4-5 are best accomplished with a low viscosity. Items #6 & 8 are often mutually exclusive because drilled solids will tend to pack into the pore spaces of a producing formation.

Make-up of a Drilling Fluid

In its most basic form a drilling fluid is composed of a liquid (either water or oil) and some sort of viscosifying agent. If nothing else is added, whenever the hydrostatic pressure is greater than the formation pore pressure (and the formation is porous and permeable) a portion of the fluid will be flushed into the formation. Since excessive filtrate can cause borehole problems, some sort of filtration control additive is generally added. In order to provide enough hydrostatic pressure to balance abnormal pore pressures, the density of the drilling fluid is increased by adding a weight material (generally barite).


Low Pressure Collectors
CROSSFLOW
Primary Fluid Courses


Primary Fluid Courses
RADIAL FLOW

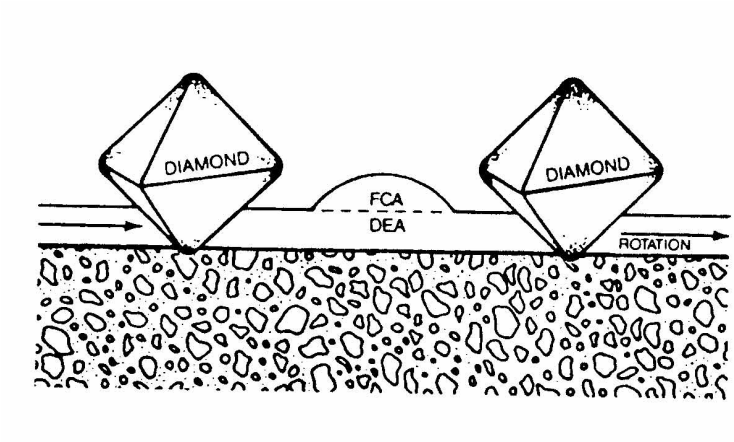

DIAMOND
DIAMOND
FCA
DEA
ROTATION

Figure 1-2