Coiled-tubing Drilling and Fishing Operations

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Lecture 1

(An Introduction to Coiled-tubing Drilling – 1)

Strongly advised to Register

Basics of Drilling Engineering I (Module 1 – 4)

Drilling Engineering II (Module 1 – 4)

Horizontal and Multilateral Drilling

By Prof. Dr. M. Enamul Hossain's Course

at

NSRIC Online Platform

Self Reading Class Schedule

Class Schedule and Hours (Self-Study):

Saturday: 09:00 AM – 10:30 AM (Online – Self-study)

Sunday : 09:00 AM – 10:30 AM (Online – Self-study)

Instructor's Information

Instructor	: Prof. Dr. M. Enamul Hossain NSRIC Chair Professor in Sustainable Energy and CEO & President
Office	: Online
Office Hours	: Virtual (appointment only through Email)
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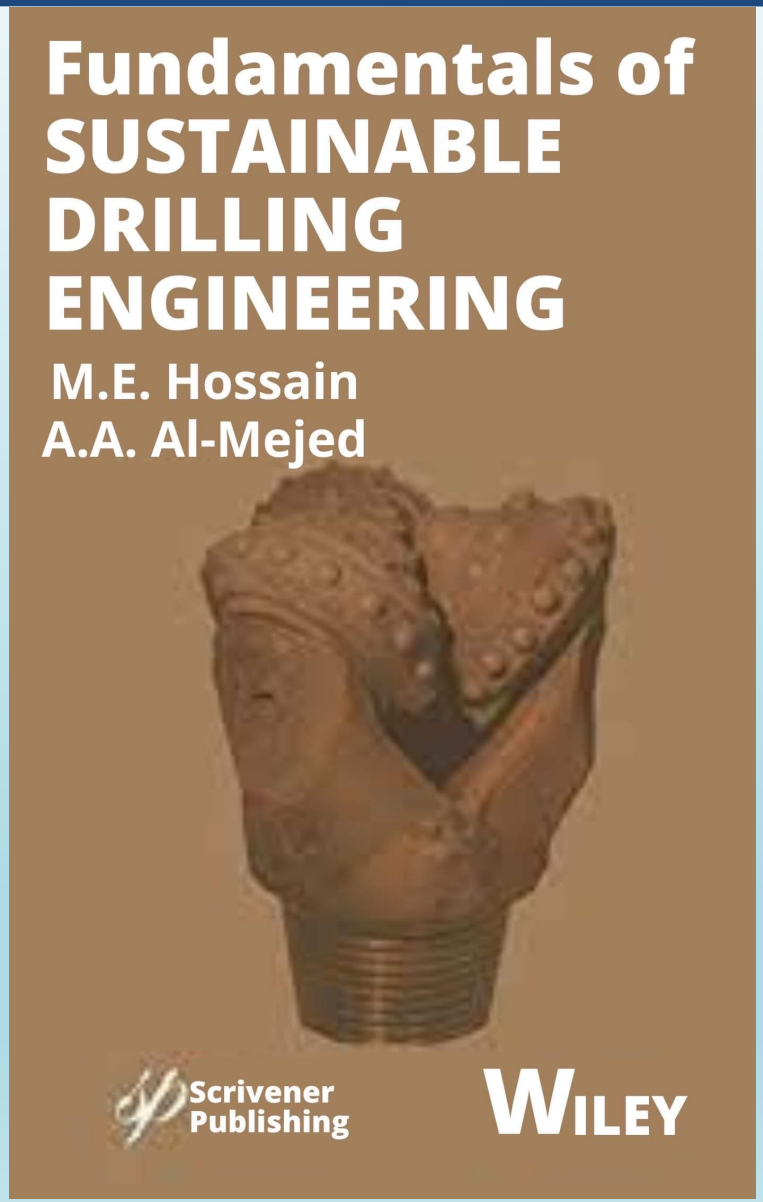
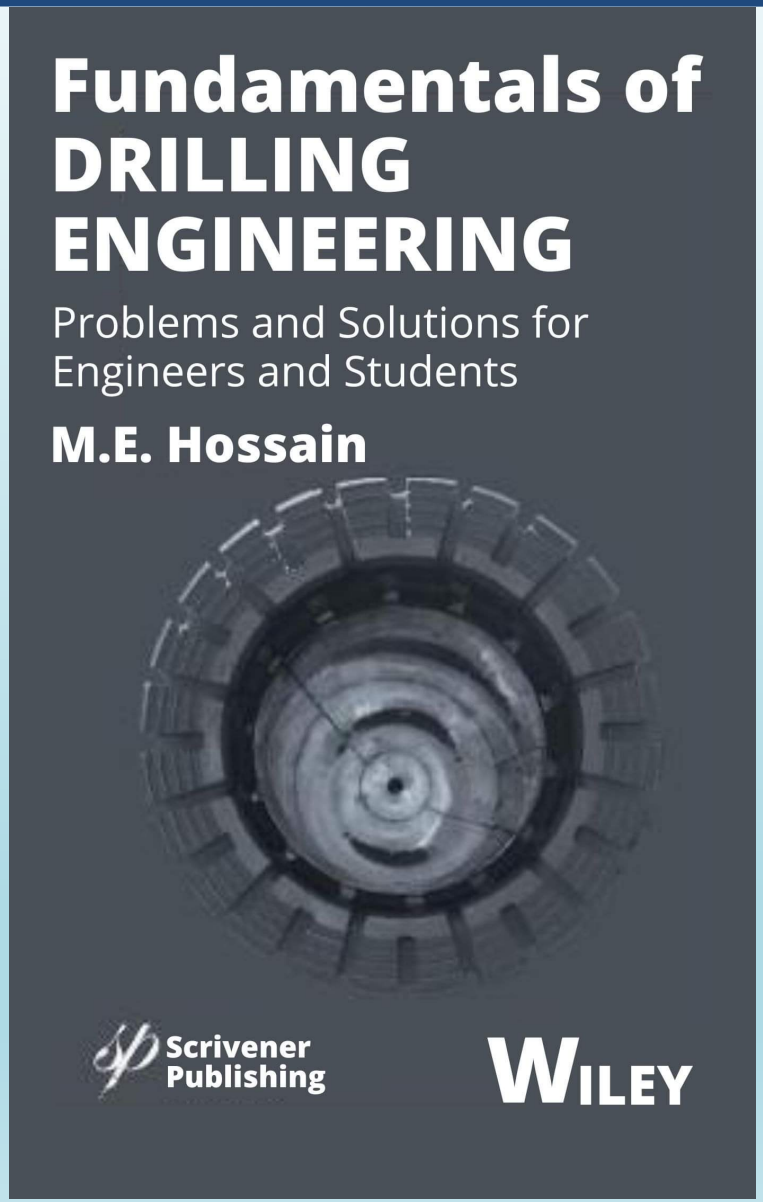
Course Description

This course is designed for audiences and students who are interested to learn about the basics and in-depth of drilling engineering related to coiled-tubing drilling (CTD) and fishing jobs during oil and gas operations. The course content is designed for students who are enrolled in diploma or undergraduate/graduate program(s), early career professionals, professionals and interested in learning coiled-tubing (CT) and fishing operations while drilling. The course covers an overview of coiled-tubing engineering, key elements of a CT unit, applications, benefits, advantages and disadvantages, CT safety, and a detailed overview of equipment related to CTD and fishing jobs. The different CTD models such as sinusoidal and helical buckling, buckling in horizontal and inclined sections, buckling in vertical section and buckling in curved wellbores covered in detail. The critical selection criteria for designing the CT unit along with locked-up situations are described. When it comes to the fishing operations, critical buckling criteria and locked-up, background of fishing jobs, backing off the string, and stuck pipe, how to avoid fishing operations and hazards while drilling, a guideline on preparation of fishing jobs and finally economics of fishing are extensively discussed in this course. In addition, an in-depth calculations related to bucking of CT are highlighted for well planning and design. Further, numbers of workout examples related to CTD field operations are covered. The course contains only one module with nine lectures. Students are strongly advised to complete the courses titled “Basics of Drilling Engineering I”, “Drilling Engineering II” and “Horizontal and Multilateral Drilling” by Prof. M. Enamul Hossain at NSRIC Platform to understand more about the course content.

Textbook and References





Course Contents and Schedule

Lec. No.	Module	Topics	Remarks
Coiled-tubing Drilling and Fishing Operations – One Module			
01	Introduction	Course overview, basics of coiled-tubing (CT) drilling – 1	
02	CT drilling	Basics of CT drilling – 2	
03	CT Equipment	CT Equipment – 1	Quiz 1
04	CT Equipment	CT Equipment – 2	Assignment 1
05	CT bucking models	CT buckling models and workout examples – 1	
06	CT bucking models	CT buckling models and workout examples – 2	
07	CT bucking models	CT buckling models and workout examples – 3	
08	Fishing job	Fishing operations – 1	Quiz 2
09	Fishing job	Fishing operations and equipment – 2	Assignment 2

Coiled-tubing Drilling (CTD)

An Introduction to Coiled-tubing Drilling Cont.

Definition

Coiled-tubing Drilling (CTD) has evolved rapidly since its first operations in 1992. The main motivation for drilling with coiled tubing was the presence of large diameter CT which makes it easy to deliver the required hydraulic horsepower to the downhole. This horsepower is mandatory for **hole cleaning**, **transferring cuttings in the annulus**, and **providing power to downhole mud motors**.

In addition, utilizing heavier and more sustainable tubings helped in providing the necessary weight on bit for drilling and withstand torque (Torque and Drag in Drilling) resulting from drilling operations.

An Introduction to Coiled-tubing Drilling Cont.

Definition Cont.

In the oil and gas industries, **Coiled Tubing (CT)** refers to metal piping, normally 1" to 3.25" in diameter, used for interventions in oil and gas wells and sometimes as production tubing in depleted gas wells, which comes spooled on a large reel.

CT refers to a continuous length of small-diameter steel pipe and related surface equipment as well as associated drilling, completion and workover, or remediation, techniques.

Coiled-tubing Drilling (CTD) is mainly a reentry drilling service that enables operators to more effectively find hydrocarbon pockets still untapped in the reservoir.

Based on the tubing diameter and single reel tubing lengths in excess of 30,000 ft., common CT steels have yield strengths ranging from 55,000 PSI to 120,000 PSI.

An Introduction to Coiled-tubing Drilling Cont.

Introduction

Figure (1a – 1c) shows the CT unit which has continuously-milled tubular product manufactured in lengths that require spooling onto a take-up reel, during the primary milling or manufacturing process. The tube is nominally straightened prior to being inserted into the wellbore and is recoiled for spooling back onto the reel.

Here a long, continuous length of pipe wound on a spool (Figure 1). The pipe is straightened prior to pushing into a wellbore and rewound to coil the pipe back onto the transport and storage spool.

Sometime, depending on the pipe diameter (**1 in. to 4-1/2 in.**) and the spool size, coiled tubing can range from **2,000 ft to 15,000** ft or greater length.

An Introduction to Coiled-tubing Drilling Cont.

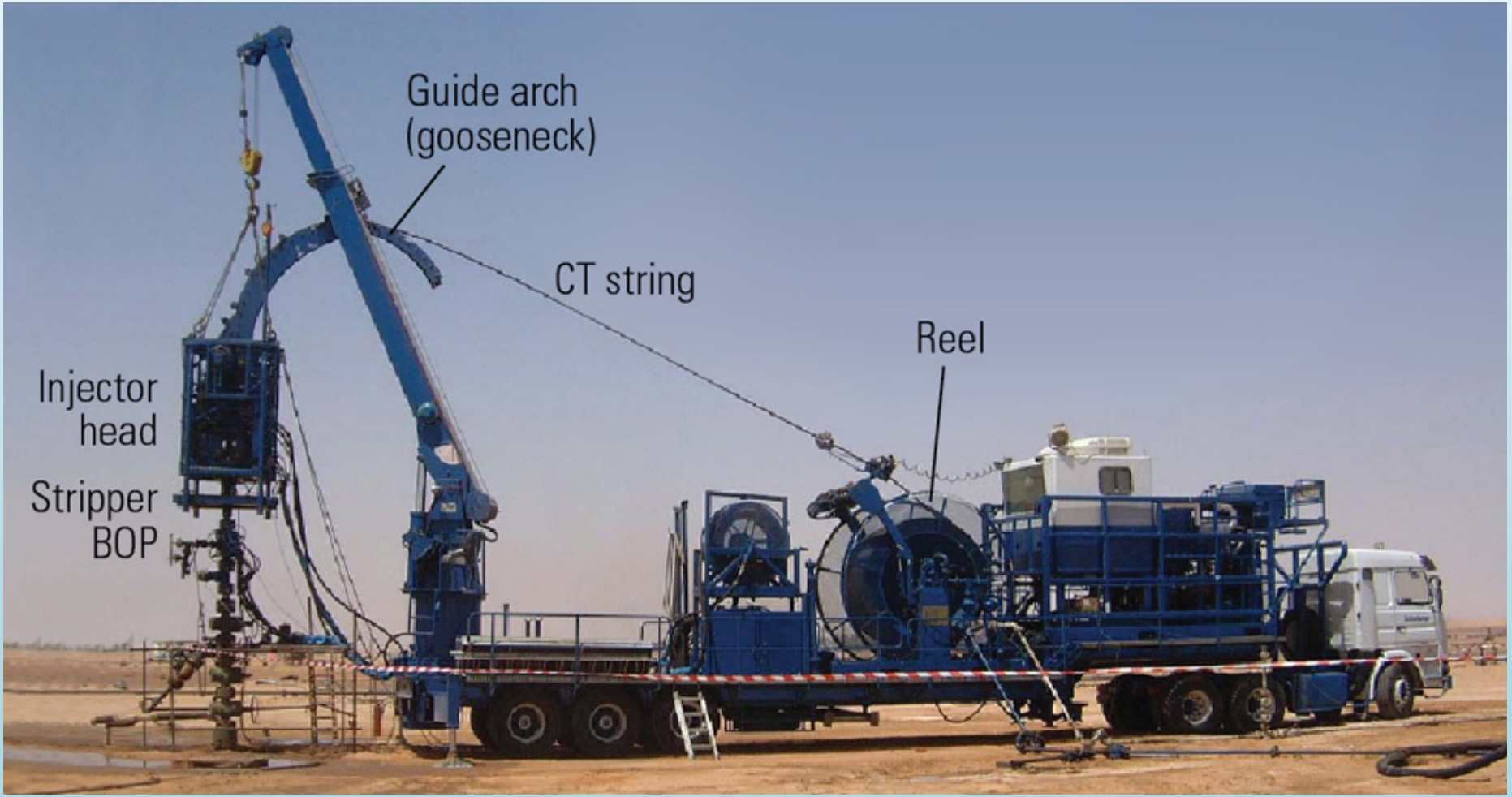
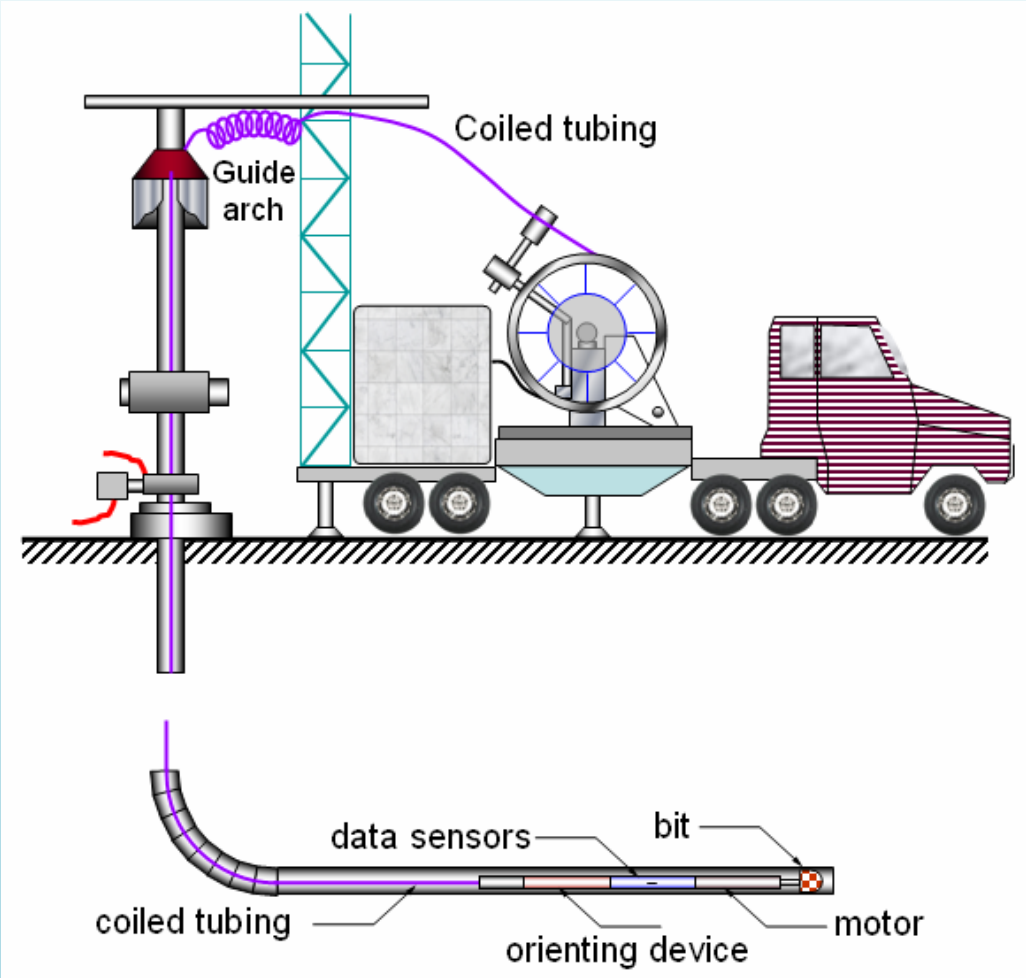
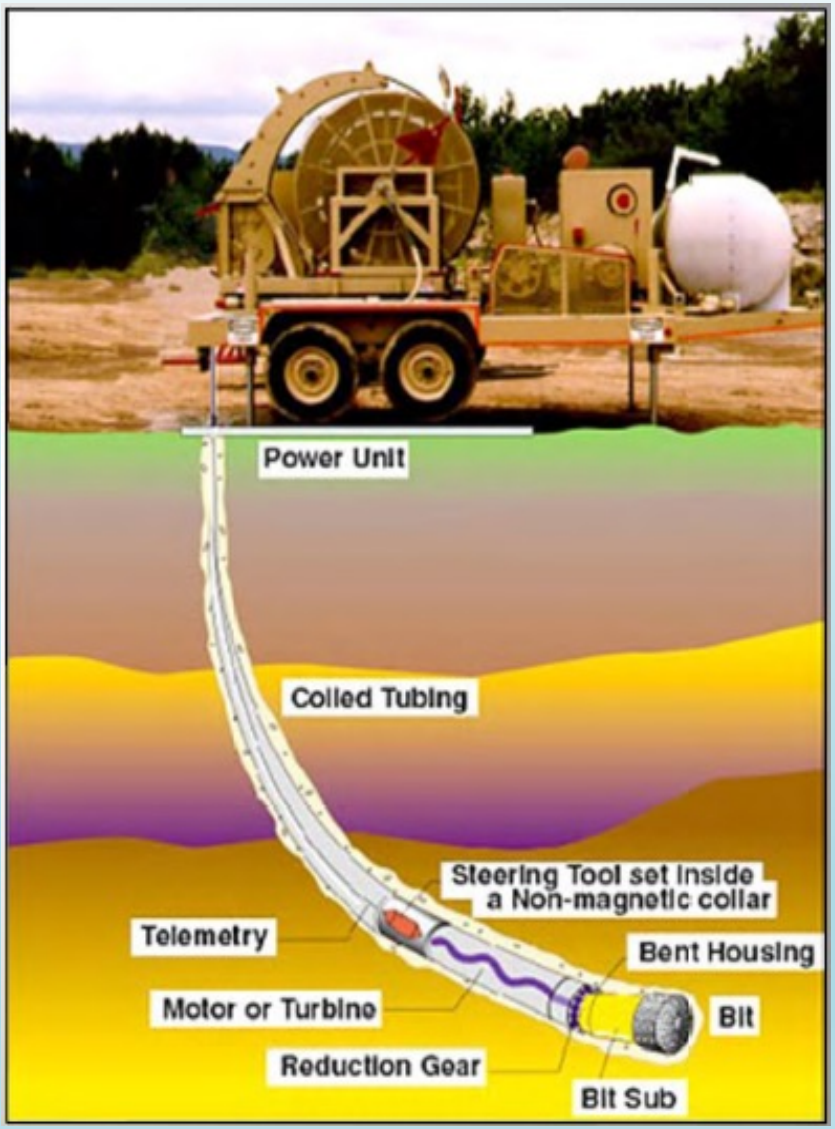


Figure 1a Coiled tubing unit

An Introduction to Coiled-tubing Drilling Cont.



(b)



(c)

Figure 1b and 1c Coiled tubing drilling

Description of CTD

A coiled tubing operation is normally performed through the drilling derrick on the oil platform, which is used to support the surface equipment, although on platforms with no drilling facilities a self-supporting tower can be used instead. For coiled tubing operations on sub-sea wells a Mobile Offshore Drilling Unit (MODU) e.g., semi-submersible, Drillship etc. has to be utilized to support all the surface equipment and personnel. Onshore, they can be run using smaller service rigs, and for light operations a mobile self-contained coiled tubing rig can be used.

The tool string at the bottom of the coil is often called the bottom hole assembly (BHA). It can range from something as simple as a jetting nozzle, for jobs involving pumping chemicals or cement through the coil, to a larger string of logging tools, depending on the operations. Coil tubing has also been used as a cheaper version of work-over operations. It is used to perform open hole drilling and milling operations. It can also be used to fracture the reservoir, a process where fluid is pressurized to thousands of psi on a specific point in a well to break the rock apart and allow the flow of product. Coil tubing can perform almost any operation for oil well operations if used correctly.

Description of CTD Cont..

Coiled tubing drilling is normally a re-entry drilling technique whereby an already drilled well is used to drill new wells at the bottom of an old well as in the case of multilateral wells or use in wells requiring very high build up rates as in horizontal drilling. Because, coiled tubing is flexible, it enhances drilling laterals from existing wells. A whip-stock is set in a casing below the window where another wellbore (lateral) will be drilled. Coiled tubing with a water jet drill head is then positioned above the whip-stock. The coiled tubing is hydraulically controlled from the surface and then produces powerful high velocity water jets capable of fracture the casing and formation rock in a continuous fashion deep into the formation. The size of hole to be drilled depends on the size of the jet head.

CTD utilizes a small rig and less voluminous surface equipment (Figure 2a and 2b). Unlike conventional techniques that use standard drill pipes, CTD reduces the number of steel pipes, volume of drill mud, volume of drill cuttings, and volume of cements used. It also reduces environmental impact. Also in coiled tubing techniques, drilling is not interrupted for pipe connections. Figure 10.20 explains the setup of coiled tubing.

Coiled-tubing Drilling Cont.

Coiled-tubing services

CT services are categorized based on the diameter of the tube as listed below:

Specialized large diameter: 2-3/8 in. to 3-1/2 in.

a) Directional drilling
b) Fracturing
c) Underbalanced drilling
d) Production ESP

Conventional small diameter: 1-1/4 in. to 2 in.

a) Cleanouts
b) Gas lifts
c) Acidizing
d) Velocity strings
e) Well kill
f) Wellbore cleaning
g) Drilling/milling
h) Fishing (We shall cover this operation in this course)
i) E-line logging
j) Sand jetting
k) Thru-tubing packers
l) Underbalanced vertical deepening

Key Elements of A CT Unit

The coiled tubing unit is comprised of the complete set of equipment necessary to perform standard continuous-length tubing operations in the field (Figure 2a and 2b)

The unit consists of **four basic elements**:

- **Injector Head -** to provide the surface drive force to run and retrieve the CT (Figure 3)
- **Reel -** for storage and transport of the CT (Figure 4)
- **Control Cabin -** from which the equipment operator monitors and controls the CT (Figure 5)
- **Power Pack -** to generate hydraulic and pneumatic power required to operate the CT unit (Figure 6)

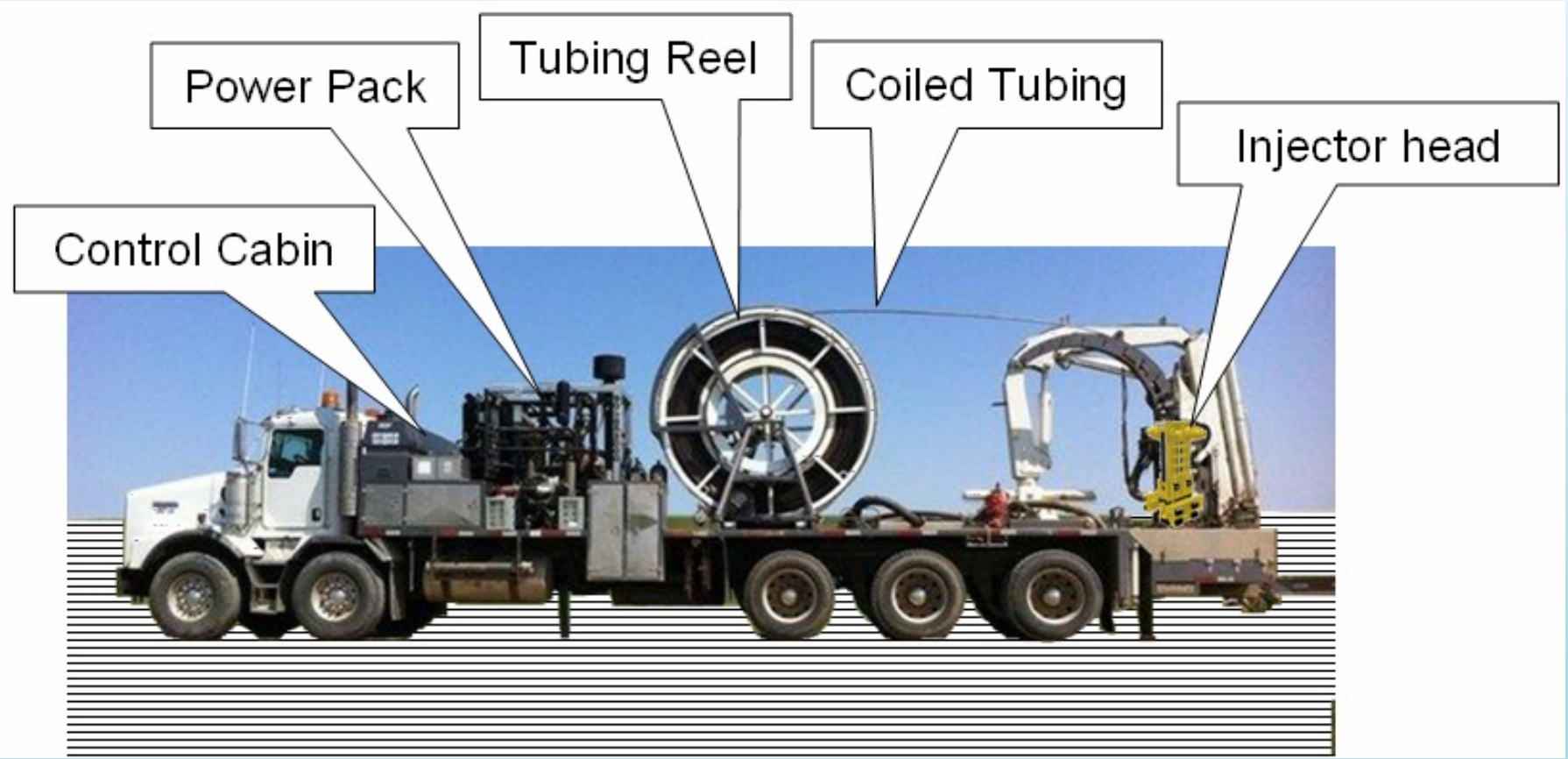
Key Elements of A CT Unit

Figure 7 shows the center of any CT surface operation which is a coiled-tubing unit (CTU), the most prominent feature being a reel from which a continuous length of flexible steel pipe is spooled. To deploy tubing downhole, the CT operator spools the tubing of the reel and leads it through a gooseneck, which directs the CT downward to an injector head, where it is straightened just before it enters the borehole.

At the end of the operation, the flexible tubing is pulled out of the well and spooled back onto the reel. On the hub of the storage reel, a high-pressure swivel joint enables pumping of fluids through the tubing while the reel rotates to spool pipe on or off the reel.

Coiled-tubing Drilling Cont.

Key Elements of A CT Unit



(b)

Figure 2b Trailer Mounted CT Unit and Crane

Coiled-tubing Drilling Cont.

Figure 3 Injector Head

Figure 4 Reel

Coiled-tubing Drilling Cont.

Figure 5 Control Cabin

Figure 6 Power Pack

Coiled-tubing Drilling Cont.

Figure 7 CT surface operation unit

Key Benefit

Figure 8 shows a generic term relating to the use of a CT string and associated equipment. As a well-intervention method, coiled tubing techniques offer several key benefits over alternative well-intervention technologies.

The ability to work safely under live well conditions, with a continuous string, enables fluids to be pumped at any time regardless of the position or direction of travel. This is a significant advantage in many applications. Installing an electrical conductor or hydraulic conduit further enhances the capability of a coiled tubing string and enables relatively complex intervention techniques to be applied safely.

An Introduction to Coiled-tubing Drilling Cont.

Figure 8 CT surface operation unit - string and associated equipment

CT Benefits

- While the initial development of coiled tubing was spurred by the desire to work on live wellbores, **speed and economy** have emerged as key advantages for application of CT.
- In addition, the relatively small footprint and short rig-up time make CT even more attractive for drilling and workover applications.
- Coiled tubing can also be fitted with internal electrical conductors or hydraulic conduits, which enables downhole communication and power functions to be established between the BHA and surface.
- In addition, modern CT strings provide sufficient rigidity and strength to be pushed/pulled through highly deviated or horizontal wellbores. This enables successful execution of downhole operations that would be impossible to perform with conventional wireline approaches or would be cost prohibitive if performed by jointed-pipe.

CT Benefits Cont.

Some of the key benefits associated with the use of CT technology are as follows:

- Coiled tubing drilling will permit cheaper, faster and safer drilling of more stable holes because pipe connections are not required
- Efficient live well intervention
- Rapid mobilization and rig-up
- Ability to circulate while run-in-hole (RIH) or pulling out open hole (POOH)
- Reduced trip time, resulting in less production downtime
- Reduced crew/personnel requirements
- Cost may be significantly reduced
- Compared with conventional techniques using full-scale rigs and standard drill pipe, CTD can significantly reduce environmental impact

Importance

- Coiled-tubing drilling (CTD) operations proceed quickly compared to using a jointed pipe drilling rig because connection time is eliminated during tripping.
- The use of coiled tubing with downhole mud motors to turn the bit to deepen a wellbore.
- Coiled tubing drilling is economical in several applications of drilling
- CTD offers improved cost, safety, environmental impact and hole stability in mineral exploration
- Coiled tubing is often used to carry out operations similar to wirelining.

Coiled-tubing Drilling Cont.

Limitations and Disadvantages Cont.

1. From a financial point of view:

a) CTD is uneconomic in many areas where the abundance of low-cost conventional rigs are available. In such areas, only specialized CTD techniques which cannot be completed by conventional equipment will be viable.

b) The cost per foot of CT is more expensive than that of Oil Country Tubular Goods (OCTG). in addition, there will be a need to junk the used tubing of CT after 6 or more trips depending on the drilling operations. On the contrary, the drill pipes have a longer life than such tubings.

Limitations and Disadvantages Cont.

2. From a technical point of view:

a) In some applications, the advantage of being able to drill slim hole is the inability to use a higher pump rate, WOB, or torque in addition to the limitation in drilling larger hole sizes.

b) Currently, CTD can't be used in drilling the reach and horizontal sections of horizontal and high-angle holes.

c) Since the CT string cannot be rotated, it is mandatory to use downhole tools such as rotary steerable system (RSS) drilling.

d) The tubing life is difficult to be predicted and a failure can suddenly occur.

Limitations and Disadvantages Cont.

2. From a technical point of view:

e) Limited drilling-fluids life: In CTD, it is not recommended to increase solids in mud as it may cause erosion of string.

f) Due to the limited spread of such technology except in certain areas, there will be a limited experience and equipment.

g) In overbalance drilling, differential pressure can increase the chance of differential sticking of bottom hole assembly. This also can happen while drilling with coiled tubing as CT is run while there are residual stresses in CT.

Good Luck

and

Thanks for Being with my Couse

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