MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

UNIVERSITY OF KASDI MERBAH _OUARGLA

INSTITUTE OF SCIENCE AND APPLIED TECHNIQUES

Department of Applied Engineering

THE END-OF-STUDY PROJECT

In view of obtaining a professional bachelor's degree

Speciality : Measurement, Metrology and Quality

Division : Optics and Precision Mechanics

Field : Science and Technology

Realized by:

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Theme :

DRILL STEM TESTES (DST) MEASUREMENT

Defended on 15/06/2022 in front of the jury composed of :

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Before starting the development of this work, it seems natural to thank all person who helped us.
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Thanks also given to Sonatrach company especially Mr.M. Fortas,Mr.H.Radjdal Mr.H.Bensaid for all helps they have given to us during the internship.

Dedication

I dedicate this work as a sign of respect and gratitude to my dear parents:

To my dear father:

the strong shoulder, the watchful, understanding eye, the person worthy of my appreciation and respect. May god protect you and give you the health and a long life.

To my dear mother:

for all the support and love you always have for me, and I hope that your prayers always accompany me and this work is a little thanks for your sacrifices.

May god bless you and give you the health, happiness and a long life.

To my two sisters:

May God protect you and give you the success in your life.

To my grandparents and grandmas, uncles, antes, who encouraged and supported me enormously.

To my second family “Aoun “thank you for being by my side in my difficult times.

To my real best friend who was always in my side all times.

In the end, to all who wish me success.

Dedication

To the pure soul of my mother, who was my companion in my path and the reason for my existence.

To my father, who was my companion, encouragement and supporter.

To my brothers and sisters for every encouragement and all they did for me.

To my fiancé for patience and endurance of my mood swings.

To my friends, to everyone who has an iota of love for me thank you.

Figures list

Abbreviations list

HBK: Haoud Berkaoui

DST: Drill stem testing

MCS: Motion Compensation System

BOP: Blow out Prevention System

MWD: Measurement while drilling

LWD: Logging while drilling

SP: The spontaneous potential

EM: Electromagnetic

Ph: Hydrostatic pressure.

Pc: Cushion pressure

Pf: Formation pressure.

RIH: Run in Hole.

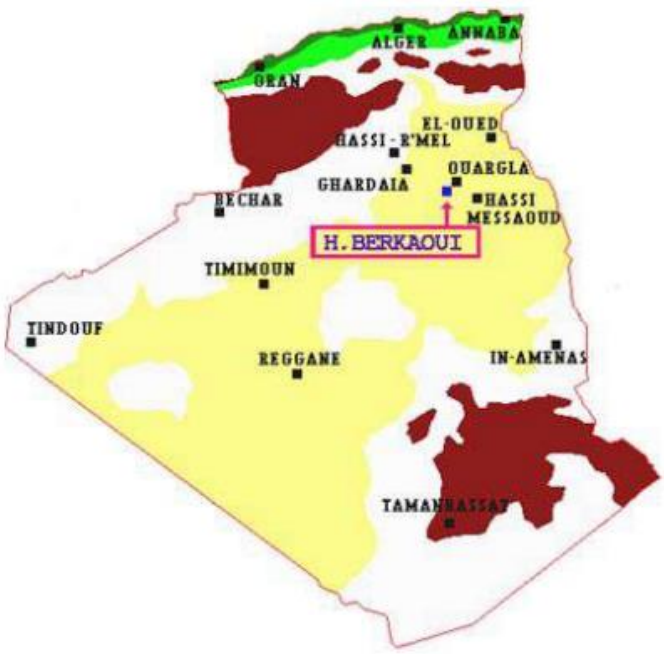
NMR: Nuclear magnetic resonance.

ESD: Emergency shutdown.

TCP: Tubing Conveyed Perforator

1. Presentation of SONATRACH HBK company

The Haoud Berkaoui Regional Directorate (Wilaya of Ouargla), located 700 km south-east of Algeria, and 100 km west of Hassi-Messaoud, with an area of 6300 km², consists of 04 main fields, Berkaoui, Benkahla, Guellala, Benkahla-Est, and 22 peripheral fields.



-Location of HBK company-

2. Regional management history

1965: Discovery of the Haoud Berkaoui field by the OK 101 borehole

1966: Discovery of the Benkahla field by the OKP 24 survey

1967: Commissioning of the HBK oil treatment center

1969: Discovery of the Guellala field by the GLA 2 survey

1971: Start of the oil treatment center in BKH

1976: Creation of the region and commissioning of the GLA processing center

1978: Start of the oil treatment center in GLANE

3. Main activities

The first HBK Oil Treatment Center was commissioned in 1967; Currently there are five (05) oil treatment centers and a gas treatment unit.

- Each Production Center receives crude oil from various wells, stabilizes it, stores it in tanks before shipping it (to the TRC lines).
- The gas recovered from the stabilization is compressed and sent to the Guellala gas treatment plant
- which extracts LPG, sales gas and gas-lift from it.
- Injection of water to maintain pressure in the reservoir.
- Currently the production of oils is around 5500 tons/d, LPG is around160 tons/d.

General Introduction

The term energy source refers to all physical and chemical phenomena.
There are many energy sources that can be exploited, they are used for a variety of purposes, and in different areas of daily life, some exists forever. The energy source is used to produce another type of energy, these energy sources are then classified into two main categories:
renewable energy: solar energy, wind power.
fossil energy sources: Diesel, Kerosene, **oil and gas** which are the fossil energies that are extracted from reservoir. The Hydrocarbons results from the long term of degradation of the bacteria of organic matter trapped in sediments which becomes mature through the processes of Biogenic degradation (Biolysis), and thermal degradation (pyrolysis).
This transformation takes place during the burial of the rocks in the sedimentary basin under the effect of the increase in temperature and pressure, the rock containing the organic matter is called parent rock.
At shallow depths, bacterial degradation can cause gas formation. At medium depth, therefore at medium temperature, thermal degradation produces fluid hydrocarbons (petroleum).
For great depths and temperatures (temperatures above 1000C, which implies a depth greater than 3000m with a usual geothermal gradient of 300 C/km), thermal degradation makes it possible to obtain the gas.
Mobile hydrocarbons, under the influence of pressure, it tends to leave the parent rock, if the latter is permeable (interconnecting pores, natural fractures), and to migrate upwards. When it rises to the surface, it can accumulate in geological structures called traps. So, it becoming mature and ready to be exploited.
to exploit hydrocarbons, we have to drill. In general, drilling is (making a hole), either in the industry the drilling is one of the best methods available to obtain crude oil and gas from sedimentation.

Chapiter 1:

Oil filed familiarization

Introduction

Drilling is used extensively in a variety of applications to investigate the subsurface rock mass conditions, including geotechnical surveys, civil and construction projects, underground and open-pit mining as well as in all aspects of the oil and gas industry.

There are several types of drilling which are commonly used: Vertical/Directional/Horizontal.

We can say that Algerian economy depends on gas and oil.

1. Types of rigs

Rigs are generally divided into two categories:

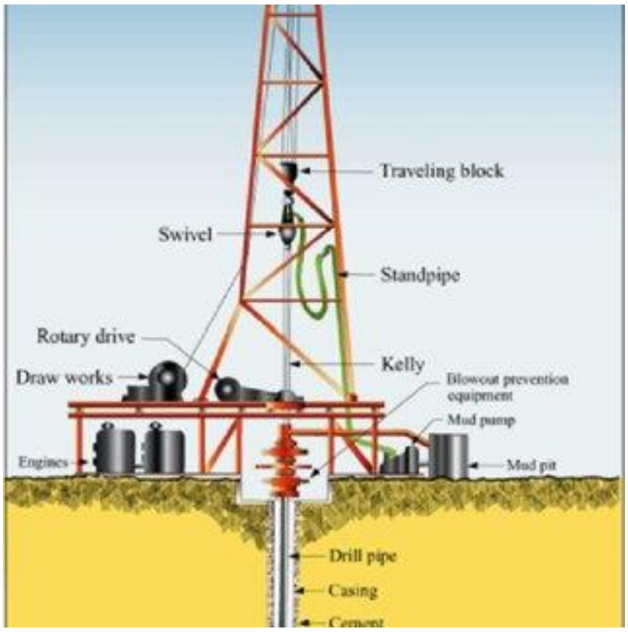
- Onshore (land)
- Offshore

Land rigs are similar, but offshore rigs are of five basic types, each of which is designed to suit a specific offshore environment.

1.1 Land rigs:

Before bringing rig equipment, we must choose a convenient location to reach a suitable way for a well by his duration, and it is important to weigh the advantages and disadvantages of each drilling method since this may differ according to the drilling site.

The most common arrangement for a land drilling rig is the cantilever mast (often called a jack-knife derrick) which is assembled on the ground, then raised to the vertical position using power from the draw works (hoisting system). These structures are made up of prefabricated sections which are fastened together by large pins. First, the engine and derrick substructures are placed in proper position and pinned together by the drilling crew, then the draw works and engines are made operational. The derrick sections are then laid out horizontally, pinned together, and the mast is raised as a unit by the drill line, traveling block and draw works.



F.1.1- (Land rig)

1.2 Offshore Rigs:

1- Barge.

2-Jack-Up.

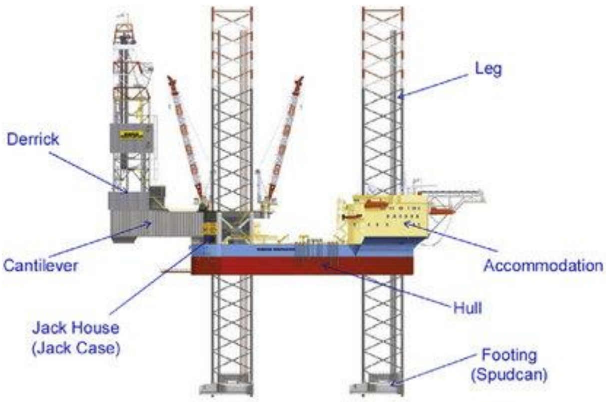
3-Fixed Platform.

4-Piled Steel Platforms.

5-Gravity Structures.

6-Semi-Submersible.

7-Drillship.



F.1.2/ F.1.3- (Offshore rigs)

2. Principal work of a drilling rig:

The drilling rigs used for rotary drilling of deep wells represent a collection of different machines, mechanisms and buildings.

During rotary drilling of a deep well, using a drilling rig, the following operations are carried out:

1. Descent of the drill pipe column into the well.

2- Rotation of a drilling tool.

3- Injection of the drilling fluids into the well in order to raise the cut soil cuttings, cool the bit and consolidate the walls of the well.

4- Lengthening of the drill pipe column by measuring the increase in the depth of the well.

5- Raising the column of rods to replace a worn drilling tool.

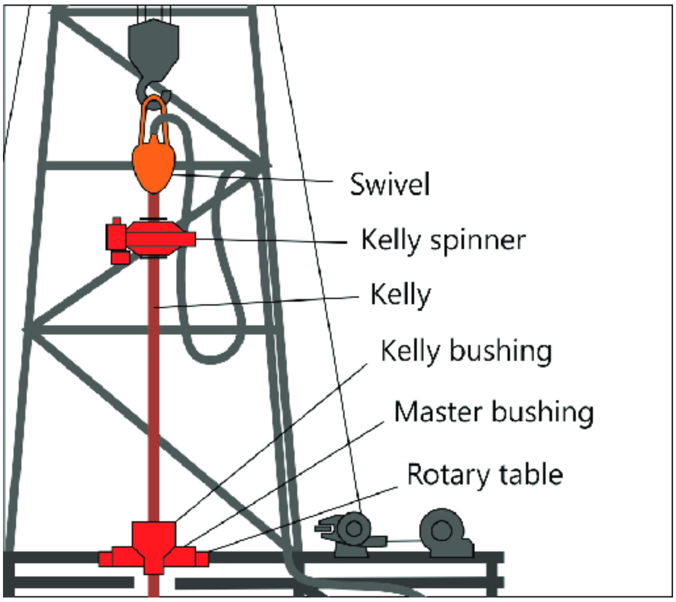
6- Evacuation of cuttings from the ground by drilling liquid and preparation of a new liquid.

7-Descent of the casing columns.

All of this equipment that works above the surface provides three main functions or systems:

2.1 Rotation system:

To turn the tool, we screw at the top of the rods, cylindrical in shape, another square or hexagonal section rod, called drive rod [Kelly], and we introduce it into a hub called rotary table.

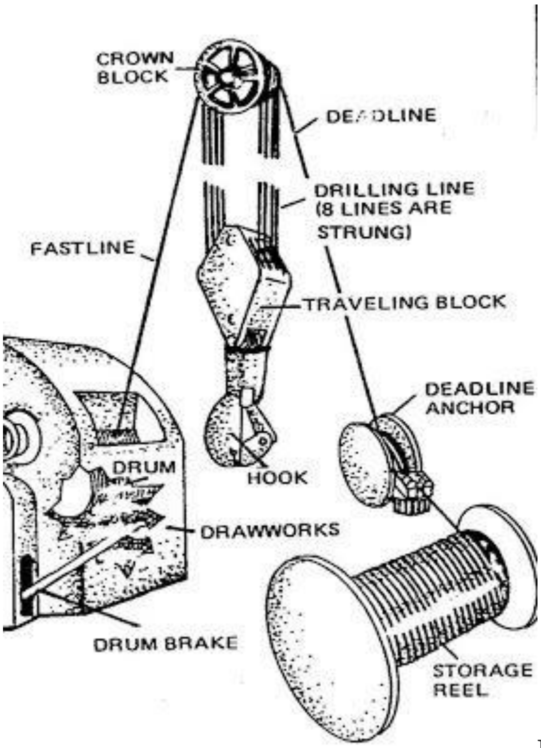


F.1.4 - (Rotation system tools)

2.2 Hoisting system:

To lift the drill string (set of rods - heavy rods - drill hammer), a high-capacity crane must be used, as the drill string can weigh more than 150 tons or more. This crane is made up of:

- a mast
- a draw works
- a hoist comprising the fixed and mobile blocks and the cable.



F.1.5- (Hoisting system tools)

2.3 Pumping function:

The pumping function ensures the routing of the drilling fluid from the suction of the pump to the return to the basins.

Mud is made in large capacity basins. It is then sucked up by mud pumps and pushed back into the hollow rods. It descends along the drill string exits through the tool holes, up through the annulus between the drill string and the well to the surface. There, it is collected in a vertical tube (fountain tube), then conveyed by another horizontal (chute) to vibrating screens, to be cleared of the cuttings, before being reinjected into the well.

Two other systems, although not associated with the drilling process but a security system, must be mentioned when considering rig components:

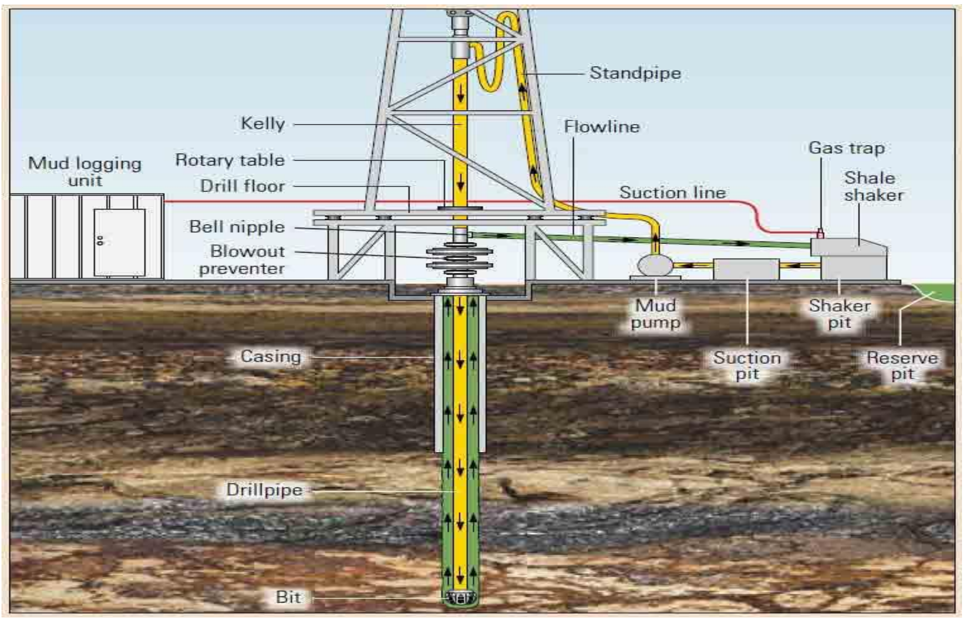
•Motion Compensation System. • Blow out Prevention System.

3. . Mud logging

Mud logging is a service that obtains qualitatively and quantitatively data, drilling fluids and drilling parameters and the creation of a detailed record (well log) of a borehole by examining the cuttings of rock brought to the surface by the circulating drilling medium (most commonly drilling mud). Its unit is feet per minute.

The mud logging unit is the information center on the rig site to serve the exploration and drilling, its major components:

1.Mud pump 2. Pump manifold 3. Stand pipe 4. Swivel 5. Drill string 6. Annulus 7. Return line 8. Shale shaker 9. Desander 10. Desilter 11. Degasser 12. Mud pit



F.1.6 - (Mud logging tools)

3.1 Mud logging’s process circulation

Mud logging totally depends upon the mud circulation principle in well which is going to drill.

Mud pumped by the mud pump via drill string into the bottom of the hole at a specific pressure and this pressure turn the mud fluid back through the annular into the shale shaker.

From the shale shaker, cuttings from the well collected to examine them.

Shale shaker again connected to the mud pit.

As during this circulation process, properties of the out coming mud change.

To overcome this, change a mud logger or chemical engineer makes the properties of the mud same as the formation by mixing something according to the requirements.

4. Casing

When the crew drills the well to depth, it usually has several strings of casing in it.

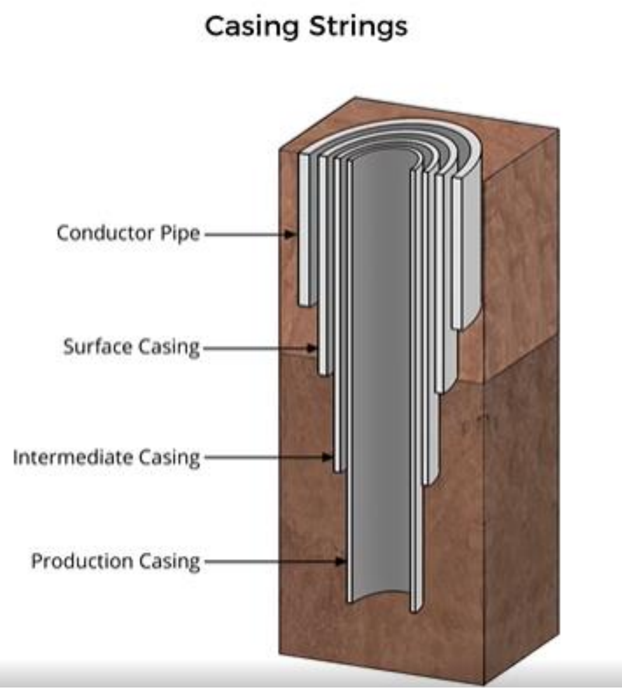
These strings are called: conductor casing, surface casing, intermediate casing and production casing.

First, formations near the surface tend to crumble and cave in easily so conductor casing prevents cave ins. Second, formations near the surface may also hold freshwater that the well can't contaminate. So, surface casing prevents freshwater zones. For another thing, deep formations are sometimes called troublesome formations. That is, they can be drilled by modifying the properties of the drilling mud but once drilled, need to be closed to prevent problems in drilling the deeper portions of the well. So, intermediate casing seals of troublesome zones. Sometimes, deep wells required more than one intermediate casing string.

To conclude, once the zone of production is drilled, it needs to be protected and sealed; so, production casing isolates the producing zone. So, the first string of casing is: the conductor casing. The hole drill first is pretty big.

Usually, crew members connect the BOP system to the surface casing at the well head.

So, this casing has to be strong enough to support the BOP stack and it has to withstand the gas or fluid pressures the well may encounter. Surface casing, also has to be strong enough to support the addition of casing strings hung inside of it.



F.1.7- (Different strings of the casing)

5. *Cementation*

Oil Well cementing is the process of mixing a slurry of cement and water and displacing it down the casing, tubing or drill pipe to hold casing in place and to prevent fluid migration between subsurface formations.

Cementation is an operation of "one shot "process with no second chance unlike mud is run as dynamic, continuously changing process.

There are main functions of Cementing operation like:

-Bond, support the casing and protect it from corrosion.

-Protect the casing from shock loads.

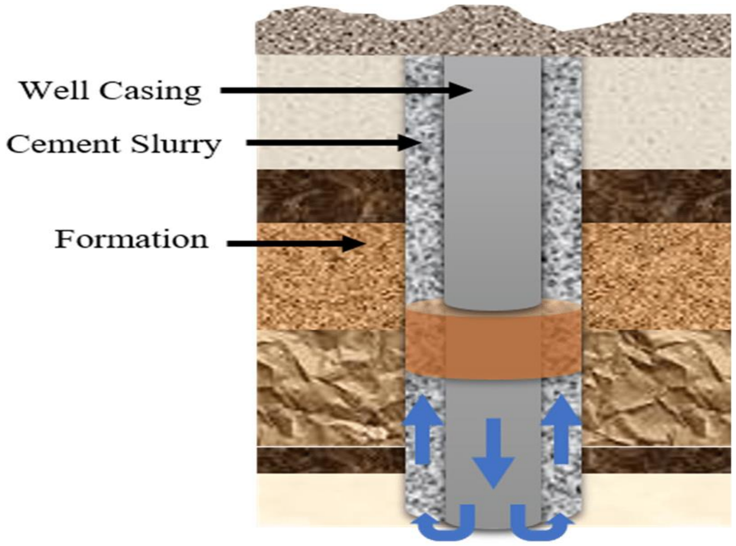
-Sealing-off problematic zones.

-Restrict fluid movement between formations.

It can be divided into two broad categories: primary cementing and second cementing.

5.1 Primary cementing (Casing Cementation)

The cementing takes place soon after the lowering of casing.



F.1.8- (Primary cementation)

it depends on three techniques which are:

5.1.1 Single stage Cementation:

It is the Most common technique.

1.Generally accomplished by pumping one batch of cement down the casing between two rubber plugs.

2.The bottom plug is placed in the casing, followed by cement slurry.

3.When the batch of cement has been pumped into the casing, a top plug is released.

4.The top plug is pumped down until it lands on the top of float collar, then completing the cement job.

5.1.2 Multi stage Cementation:

With the employ of stage cementing tools, or differential valve (DV) tools, this operation used to cement upper sections of the casing string after displacing cement around the lower section.

For another thing, it provides a means of opening and closing port holes for cement displacement and positive containment of the cement after displacement.

All parts of the tool can drill, so it prevents from rotating during drilling.

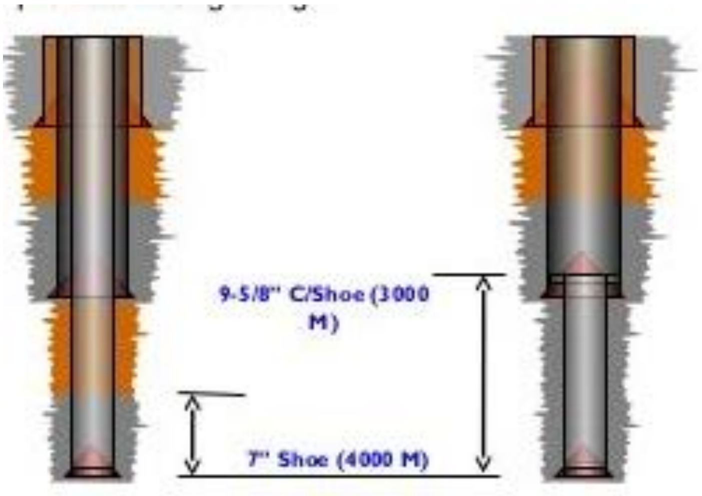
5.1.3 Liner Cementation:

A liner is a standard string of casing, which doesn't extend all the way to surface, but is hung off inside the previous casing string it's basic procedure:

1. Pump water spacer

2.Pump slurry

3.Pumping until pump down plug reaches liner wiper plug



F.1.9- (Primary cementation: liner cementing)

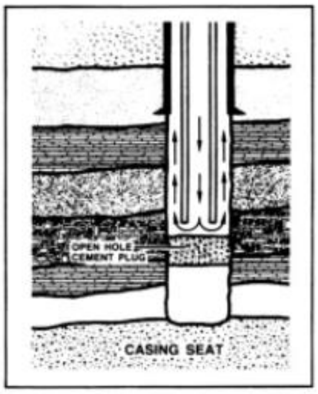
5.2 Secondary cementing

Any other operations other than Primary Cementing Operation (Casing/ Liner Cementation) is referred to as "Secondary Cementation" where cement is pumped in a well either during drilling operation or in production phase, are called also remedial operations.

This operation has two types:

5.2.1 <u>**Plug Cementing**</u>

A cement plug of a specified length in well is placed across a selected interval in an open or a cased hole. The cement is normally pumped through open-ended drill pipe or tubing.



F.1.10- (Plug cementation)

5.2.2 Squeeze Cementing

Squeeze cementing is a process of “correction”

that’s normally used for correct a problem in the wellbore. Before using a squeeze application, a series of decisions and questions must be made to define:

1. If a problem exists
2. The magnitude of the problem
3. If squeeze cementing will correct it
4. The risk factors present
5. If economics will support it.

The Reasons for doing these operations and setting a cement are:

1. To stop lost circulation during drilling.

2. Directional drilling and side tracking.

3. To plug back a depleted zone.

4. Abandonment.

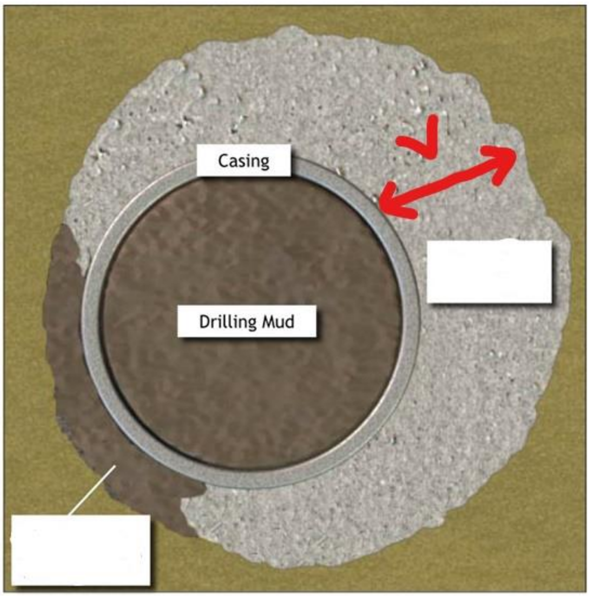
6. Calculating cement volume

To calculate the volume of cement that should be pumped the following data must be available:

1.outside diameter of the casing. 2.the diameter of the well. 3.depth of the downhole. 4.type of the mud. 5.temperature of the bottom.

First calculate the volume of the space between the well diameter and the outside diameter of the casing.

Like the geometric shape it is cylindrical so the volume can be calculated by the following formula: (Well diameter - Outside diameter of the casing) × the depth drilled)



F.1.11- (Well diameter)

7. *Formation evaluation*

It is the science of taking multiple wellbore measurements (all of which are indirect) and constructing an integrated description of formation properties.

7.1 Primary problems in formation evaluation

1- estimating Hydrocarbons in place
2- Estimating Recoverable Hydrocarbons
3- Rock Typing
4- Abnormal Pressure
5- Locating Reservoir
6- Geologic Environments Well logging

8. *Well logging*

also known as borehole logging is the practice of making a detailed record (a well log) of the geologic formations penetrated by a borehole. The log may be based either on visual inspection of samples brought to the surface (Geological logs) or on physical measurements made by instruments lowered into the hole (geophysical logs). Some types of geophysical well logs can be done during any phase of a well's history: drilling, completing, producing, or abandoning. Well logging is performed in boreholes drilled for the oil and
gas, groundwater, mineral and geothermal exploration, as well as part of environmental and geotechnical studies.

8.1 Well logging types

open hole (before run casing)

when wellbore has been cased and cemented.

In other words, the logging is done through the bare rock sides of the formation. This is the most common type of logging method because the measurements are not obstructed and it's done during or after the well has been drilled.

cased hole (after run casing)

On the other hand, cased-hole logging involves retrieving logging measurements through the well casing, or the metal piping that is inserted into the well during completion operations. Cased-hole logging is performed more rarely but still provides valuable information about the well. Cased hole logging is used to help operators obtain additional information from a well or reservoir that has already been completed. For example, the well may have already started production and a cased-hole log could help determine what has hampered flow. In some cases, the decision must be made to plug and abandon the well or recomplete it, and the cased-hole log will help identify what lies beyond the casing of the well.

Cased hole logging can be used to evaluate the formation and completion of the well, as well as determine the state of the cement, corrosion and perforation. Both gamma ray and neutron porosity logs can be run through the casing of a well, and better ideas of thermal decay and interval transit time can be achieved through porosity, hydrocarbon saturation and producibility measurements.

F.1.12- (Types of the hole)

9. Well logging methods

The Spontaneous Potential (SP)

The Spontaneous Potential (SP) log measures the natural or spontaneous potential difference between the borehole and the surface, without any applied current.

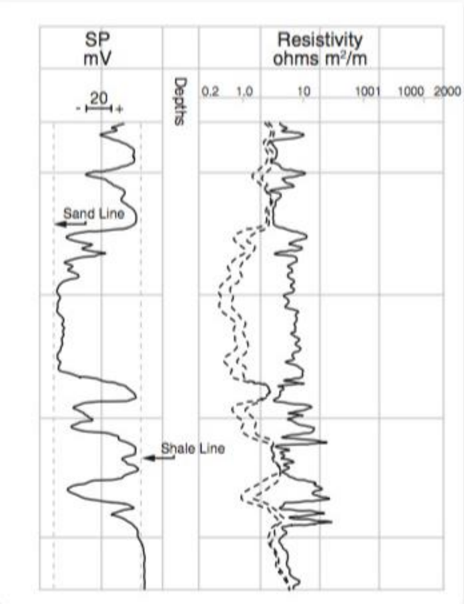
It was one of the first wireline logs to be developed,

found when a single potential electrode was lowered into a well and a potential was measured relative to a fixed reference electrode at the surface.

The most useful component of this potential difference is

the electrochemical potential because it can cause a significant deflection in the SP response opposite permeable beds. The magnitude of this deflection depends mainly on

the salinity contrast between the drilling mud and the formation water, and the clay content of the permeable bed. Therefore, the SP log is commonly used to detect permeable beds and to estimate clay content and formation water salinity. The SP log can be used to distinguish between impermeable shale and permeable shale and porous sands.



F.1.13- (The Spontaneous Potential technique)

logging while drilling (LWD)

it is a technique of conveying well logging tools into the well borehole down hole as part of the bottom hole assembly (BHA).

LWD refers to the addition of wireline-quality formation measurements to the directional data of a Measurement While Drilling (MWD) service. Although attempts to deliver LWD services date back to the 1920's, the first viable tools were by J.J. Arps in the 1960's, but these did not become a commercial service. The growth of MWD in the late 1970's and early 1980's delivered the first commercial LWD services by the major service providers. The initial tools were natural gamma and resistivity, and these made geosteering possible, as horizontal drilling grew. Information is returned to the surface using the same methods as MWD telemetry options.

F.1.14- (LWD tool)

LWD types

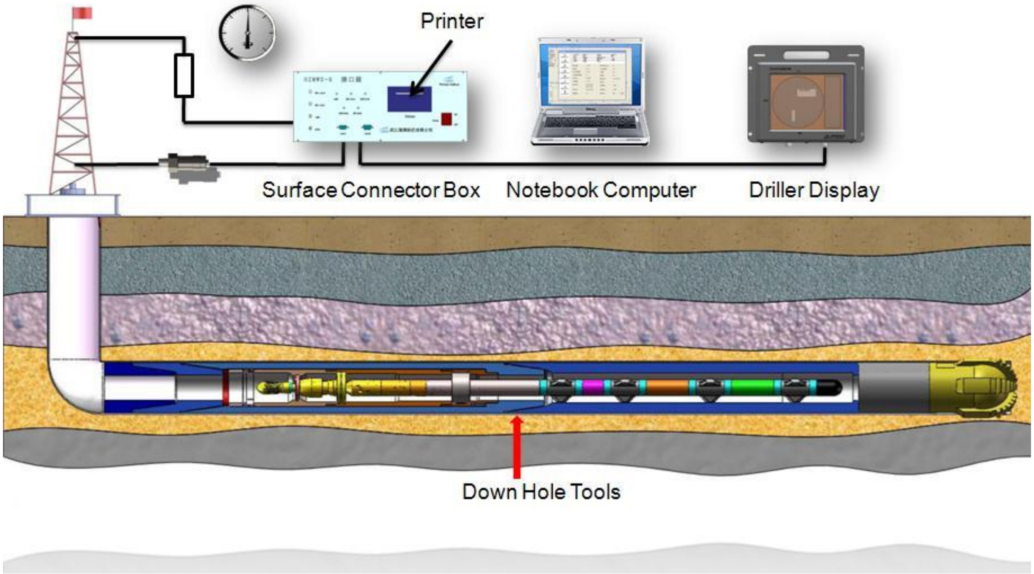
• Electromagnetic logging
• Logging while drilling induction tools
• Acoustic logging
• Nuclear magnetic resonance (NMR) logging
• Nuclear logging

Depth measurement

Good consistent knowledge of the absolute depth of critical bed boundaries is important for geological models. Knowledge of the relative depth from the top of a reservoir to the oil/water contact is vital for reserves estimates. Nevertheless, of all the measurements made by wireline and LWD, depth is the one most taken for granted (despite being one of the most critical). Depth discrepancies between LWD and wireline have plagued the industry. LWD depth measurements have evolved from mud-logging methods. Depth readings are tied, on a daily basis, to the driller's depth. Driller's depths are based on measurements of the length of drill pipe going in the hole, and are referenced to a device for measuring the height of the Kelly or top drive with respect to a fixed point. These instantaneous measurements of depth are stored with respect to time for later merging with LWD downhole-memory data. The final log is constructed from this depth merge. On fixed installations, such as land rigs or jack up rigs, a number of well-documented sources exist that describe environmental error being introduced in the driller's depth method.

Measurement while drilling (MWD)

system of surveying hole conditions, inclination and direction as part of the control of directional drilling operations. Operators use either EM (electro- magnetic), negative or positive pulse technology to transmit information to the surface for recording and analyzing in real time.



F.1.15- (MWD tools)

The type of information may be:

1.directionnal data (inclination, azimuth, tool face)

2.formation characteristics.

3.drilling parameters.

Although the terms Measurement while drilling (MWD) and LWD are related, within the context of this section, the term MWD refers to directional-drilling measurements, while LWD refers to measurements concerning the geological formation made while drilling. LWD tools work with its measurement while drilling (MWD) system to transmit partial or complete measurement results to the surface via typically a drilling mud pulser or other improved techniques, while LWD tools are still in the borehole, which is called "real- time data".

Complete measurement results can be downloaded from LWD tools after they are pulled out of hole, which is called "memory data".

LWD, while sometimes risky and expensive, has the advantage of measuring properties of a formation before drilling fluids invade deeply. Further, many wellbores prove to be difficult or even impossible to measure with conventional wireline tools, especially highly deviated wells. In these situations, the LWD measurement ensures that some measurement of the subsurface is captured in the event that wireline operations are not possible. Timely LWD data can also be used to guide well placement so that the wellbore remains within the zone of interest or in the most productive portion of a reservoir, such as in highly variable shale reservoirs.

LWD technology was developed originally as an enhancement to the earlier MWD technology to completely or partially replace wireline logging operation. With the improvement of the technology in the past decades, LWD is now widely used for drilling (including geosteering), and formation
evaluation (especially for real time and high angle wells).

10. Logging unit

Logging service companies utilize a variety of logging unites, depending on the location (onshore or offshore) and requirements of the logging run each unit will contain the following components:

1. Logging cable
2. self-contained 120-volt AC generator *set of down hole tools
3. Digital recording system

11. Wireline Logging

The oil and gas industry uses wireline logging to obtain a continuous record of a formation's rock properties. Wireline logging can be defined as being "The acquisition and analysis of geophysical data performed as a function of well bore depth, together with the provision of related services. Wireline logging is performed by lowering a 'logging tool' or a string of one or more instruments on the end of a wireline into an oil well (or borehole) and recording petrophysical properties using a variety of sensors.

Logging tools developed over the years measure the natural gamma ray, electrical, acoustic, stimulated radioactive responses, electromagnetic, nuclear magnetic resonance, pressure and other properties of the rocks and their contained fluids.

The data itself is recorded either at surface (real-time mode), or in the hole (memory mode) to an electronic data format and then either a printed record or electronic presentation called a "well log" is provided to the client, along with an electronic copy of the raw data. Well logging operations can either be performed during the drilling process, to provide real-time information about the formations being penetrated by the borehole, or once the well has reached Total Depth and the whole depth of the borehole can be logged.

Real-time data is recorded directly against measured cable depth. Memory data is recorded against time, and then depth data is simultaneously measured against time. The two data sets are then merged using the common time base to create an instrument response versus depth log. Memory recorded depth can also be corrected in exactly the same way as real-time corrections are made, so there should be no difference in the attainable TAH accuracy.

The measured cable depth can be derived from a number of different measurements, but is usually either recorded based on a calibrated wheel counter, or (more accurately) using magnetic marks which provide calibrated increments of cable length. The measurements made must then be corrected for elastic stretch and temperature.

There are many types of wireline logs and they can be categorized either by their function or by the technology that they use. "Open hole logs" are run before the oil or gas well is lined with pipe or cased. "Cased hole logs" are run after the well is lined with casing or production pipe.

Wireline logs can be divided into broad categories based on the physical properties measured.

Conclusion:

The drilling in general is a same principle in all companies, the only thing changes is the different tools and different using of them.

Chapiter 2:

DST Downhole equipment

Introduction

The DST tool has four basic or compulsory components that should exist in every tool assembly made by any service company. These four components are: Drill pipe, Packers, Gauges, Valves.

1. Drill stem testing (DST)

The DST can be defined as a provisional production by using temporary completions which make it possible to convey the fluids contained in the reservoir rocks through downhole pipe towards the surface, to estimate their flow rate and to measure some parameters related to reservoir characterization.

The primary subject of DST Operation in open or cased hole are:

• Isolate the target zone.

• Control well flow.

• Convey fluid to surface.

• Acquire downhole data.

2. Down hole DST equipment

downhole Tools are pieces of oilfield equipment that are used during well drilling, completion and intervention or well work over activities and give us a support to optimize the production and maintain a continuous flow from a reservoir.

The basic equipment for a drill stem test consists of **a string (tubing or drill pipe),** a packer and a valve and gauge as well as slip joint and safety joint.

1.**The string:** channels the flow to surface.

2.**The packer**: is a rubber element to isolate the zone to be tested.

It is designed to isolate the perforated interval from the mud column.

Three main types of Packers: Flex Pac/ Posi Test /Posi thieve.

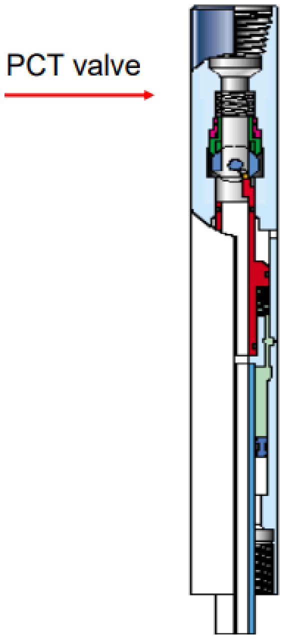
F.2.1- (Packers)

The weight applied on the packer compress its rubber elements against the casing and creates a seal between the annulus and tubing and isolates the formation from the annulus, the two pressures (Ph and Pf) must be isolated from one another.

The 3 basic pressures here are: (Ph): Hydrostatic pressure/ (Pf): formation pressure/(Pc): Cushion pressure.

Generally, the relationship among these pressures is: Ph > Pf > Pc

3.**The valve:** provides a method of controlling the well near the reservoir.



F.2.2- (PCT valve)

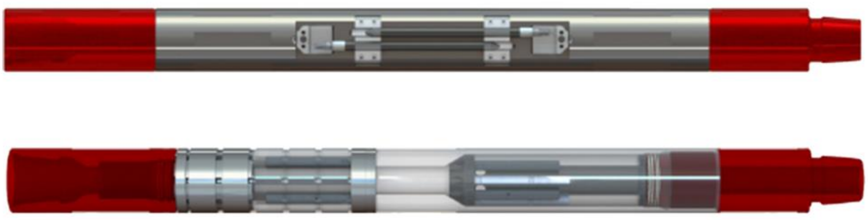
The Tester valve controls the formation by:

- shuts the well downhole to minimize wellbore storage effect.
- isolates annular fluid from cushion while RIH, preventing U-tubing.
- provides a seal for pressure test the string controls the formation.

4.Gauge: is a pressure and/or temperature gauge permanently installed in the drill steam tester.

Typically, they are installed in tubing in the well and can measure the tubing pressure or annulus pressure or both. Systems installed in well casing to read formation pressure directly, suspended systems, and systems built in coil (continuous) tubing are also available.

Permanent downhole gauges are installed in oil and gas wells for the purposes of observation and optimization. The most prolific function of a downhole gauge is to monitor pressure at a single point or multiple points in a well. Temperature is the second most monitored factor. Permanent downhole gauges continue to evolve into many different types of sensors, pressure, temperature, distributive temperature, noise, strain and flow.



F.2.3- (Gauges)

3. DST Types

Open hole Drill Stem Tests

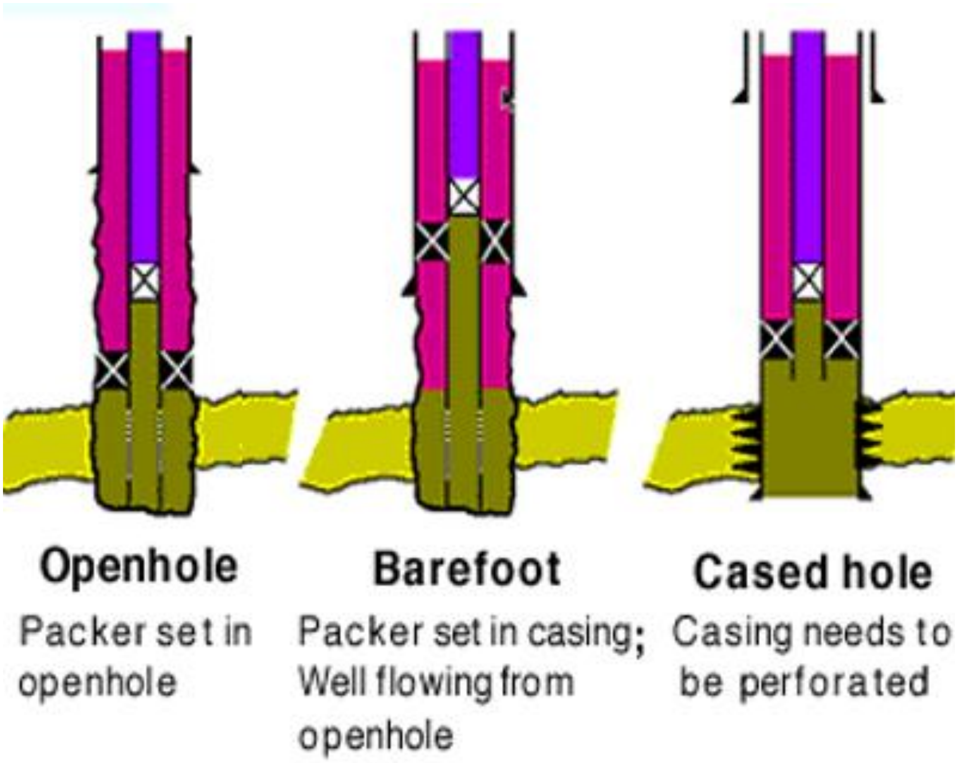
it's performed before casing is run, open hole DST can be the most economical way to determine productive capacity, pressure, permeability or the extent of an oil or gas reservoir. The testing equipment is run into the well and the zone of interest is isolated using inflate or compression-set packers, depending on requirements and drilling conditions.

Barefoot Drill Stem Tests

- In this test the well flow from open hole, and the packer set in casing.
- It’s least expensive completion technique.
- There are no perforating expenses.
- It’s adaptable to special drilling techniques that minimize reservoir damage (wells can be drilled to the top of the reservoir.
- the well can be easily deepened if desired.

Cased hole Drill Stem Tests

It’s Performed after the well is cased; cased hole DST uses a retrievable production packer that is set above the zone of interest. The well is then flow tested through perforations in the casing. One of its advantages is to produce reliable collected data (stable flows and pressures).



F.2.4- (Drill stem test types)

Conclusion:

When the goal is to identify the full productive and economic potential of the formation, drill stem testing (DST) services are a proven means

Chapter 3:

Surface DST equipment

Introduction

The surface equipment needed to perform a well differs significantly depending on the type of environment, well conditions.

The Standard surface test equipment usually consists of:

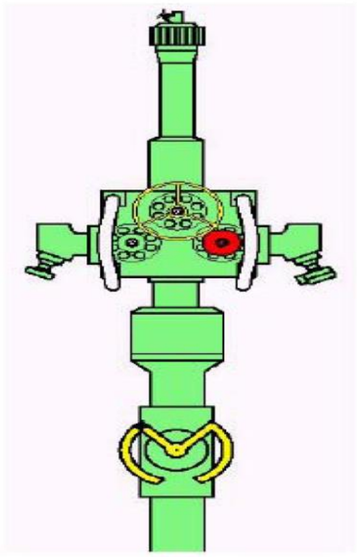
1. Surface test tree

A control head called a flow head or surface test tree, is located directly on the top of the well.

It's is the first piece of the equipment that fluids from well flows through. Its principal function is to control the fluid in and out of the well, in particular, it makes it possible to direct the effluent towards the surface installations and close the well at the head if necessary.

It is equipped with a four gate valves as well as safety valve.

One of its benefits is to support the weight of the test string.



F.3.1- (Flow head)

2. Choke manifold

It's used for a number of reasons, primarily it controls flow. It makes it possible to adjust the flow rate of the well and to lower the pressure of the effluent so as to be below the service pressure of the equipment downstream.

It consists of a set of valves and connections arranged that flow can directed in one or two directions.

F.3.2- (Choke manifold)

3. Heat exchanger

Heaters are used to raise the temperature of the well effluent to prevent the formation of hydrates, reduce viscosity, and break down emulsions.

In the case of an oil, and very particularly of a viscous oil, it promotes the flow of the oil and the oil-water separation by reducing the viscosity of the oil.

In the case of a gas, it makes it possible to heat the gas in order to avoid the formation of hydrates.

In this case, the gas is not expanded all at once at the level of the choke manifold, but several times. In particular, there is a mid-coil choke in the heater or the exchanger.

F.3.3- (Heat exchanger)

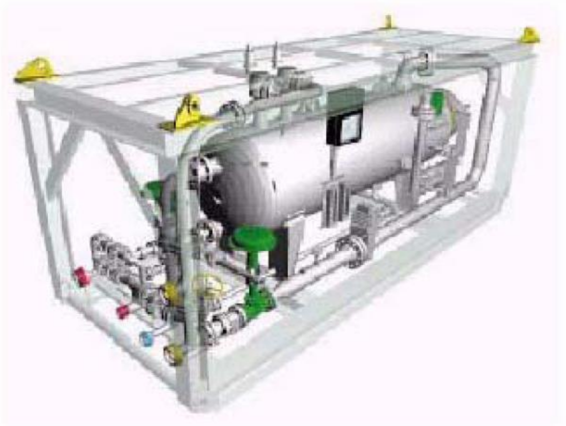
4. Separator

Basic equipment for well testing.

1. It makes it possible to separate the various fluids (gas, oil and possibly water) and thereby it makes it possible to count and sample each of these fluids separately for obtaining more pure liquid and gas products.
2. Isolate the downstream equipment and processes from the field.

Types of Separators :

1. Horizontal Separators
2. Vertical Separators.
3. Cartridge Separators.
4. Electronic Oil Desalter
5. Slug Catcher



F.3.4- (Separator)

6. *Storage tank and surge tank*

certain times during the test, the oil coming out of the separator is sent there. This makes it possible to calibrate the oil meter, to take account of certain phenomena such as the degassing of the oil downstream of the separator or the additional settling of water which is still dispersed (in emulsion) in the oil at the oil outlet of the separator.

If the oil contains hydrogen sulphide in particular, the storage tank must be replaced by a closed tank maintained at very low pressure which is **Surge Tank.**

7. *Basin and a gas torch or burners*

They make it possible to evacuate the fluids produced.

8. *Emergency shutdown system (ESD system)*

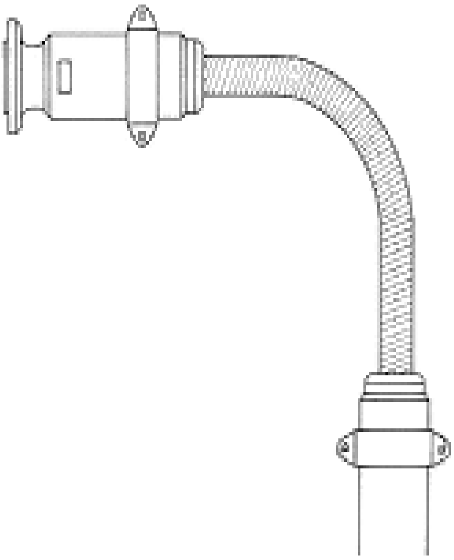
The ESD system controls the production head valve and /or an additional surface safety valve located upstream of the choke. The ESD stations are installed on the separator, the heater, gauging tank.

It allows the well to be closed and the surface equipment to be secured if something happened and necessary, ESD can supplemented with high/low level alarms or high/low pressure detectors.

F.3.5- (Emergency shutdown system)

9. *Flexible pipes (Coflexip)*

They make it possible to connect many equipment to each other. They must be carefully fixed by the restraining cables to avoid any ramming during the test or in the event of breakage.



F.3.6- (Flexible pipe)

Conclusion:

The surface equipment are very important in DST operation for controlling the fluids coming from downhole.

Chapter 4:

DST Operation

Introduction

The drill stem testing is a type of temporary completion that is used to evaluate the characteristics of formation and inspect reservoir's properties.

1. *Principle of test operation*

The aim pursued during a well test is, in general, to obtain information on a well and on a reservoir.
To do this, an instantaneous variation in flow rate is imposed at the head of the well and the corresponding evolution of the pressure at the bottom of the well is measured as a function of time.
The interpretation of a well test always relates to a period where, just after varying, the flow rate is kept constant and the pressure is measured:

- "If this constant flow rate is not zero, it is a flow rate test which causes a pressure drop at the bottom of the well (draw down).
- "If this constant flow is zero, it is a closed well test which causes a rise in pressure at the bottom of the well (build-up)

2. *Different types of test operation*

2.1 Case of tests on exploration wells (in the strict sense)

the first well drilled. For this type of well, the tests are carried out while drilling.

A virgin zone has just been drilled where there is little information on the pressures, the fluids in place and the qualities of reservoir.

The objective of the test is therefore by priority to prove the presence of hydrocarbon and to define the nature and the characteristics of the fluids and the characteristics of the layer and more particularly the initial pressure, the temperature as well as a permeability and an approximate productivity.

2.2 Case of confirmation well tests

These wells, also made during the exploration phase, are also called appraisal wells or, depending on the primary objective, delineation wells.

The approach is not the same, the first information has been obtained on the exploration well. We seek more to prove a discovery but to collect enough data to be able to build or finalize a preliminary project.

2.3 Case of initial tests on development wells

fluids are generally well known. Sampling is an important objective for such a test only in the case of a well that is structurally distant or isolated from the zone already developed.

The effort therefore mainly concerns the determination of the characteristics of the reservoir by means of the analysis of the pressure and flow measurements.

The first objective of the test on a development well is to evaluate the state of the well.

2.4 Case of periodic tests on development wells

These tests are of course carried out with the completion equipment then in place in the well.

the first concern is to monitor the state of health of the well and the objectives are numerous and fall within the framework of a well monitoring policy developed for the entire deposit.

3. *Basic stages of test operation*

3.1 The primary flow

in which the well is cleaned to remove the existing supercharges due to the infiltrating of the mud that formed during the drilling process.

3.2 The initial shut in

this period is longer to allow the high pressure drop that occurred during the first flow and is called closed due to the accumulation of pressure in it.

3.3 Main flow

a longer production period to test the flow characteristics of the formations more accurately, in which samples of fluids are checked for water content using a throttle assembly or variable chokes. In addition to measuring the sample upon reaching the surface in terms of volume and samples of any fluids in the drilling series and collecting them for analysis in the laboratory and finally recording the flow pressures and temperatures.

3.4 Final shut in

We get a shape of curve containing the pressure build-up with the formation permeability and the degree of formation damage likely to occur during the drilling process. And it will tell us if there is only a small reservoir.

Conclusion

The perfect completion and performance of each stage ensures a smooth flow of the drill stem test and accurate results.

Cas Study

Company: Sonatrach

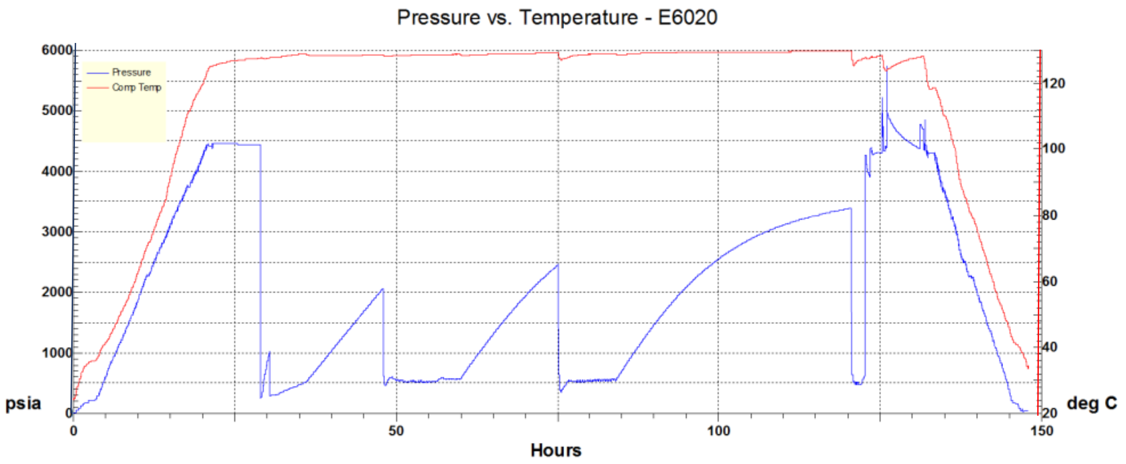
Field area: ALRAR

Well: ESRO#01

Rig: TP#200

Données du puits

Fond (TD)	3565m	X	582 401.945
Sabot 7"	3467	Y	3 219 504.174
Densité boue	0.90	Zt	632.56
Viscosité boue	44	Zs	625.56
Type boue	OBM		



1. Graph analysis (PRESSURE)

1/From the moment [0/15h]: we notice a continuous increase in pressure, as it was between [0psi/4040psi].

2/From the moment [15\30h]: we notice the stability of the pressure as it was [4040psi]

3/From the moment [30h]: we notice a free decrease in pressure where it was between [4040psi/250psi]

4/From the moment [30/45h]: we notice a continuous increase in pressure, as it was between [250psi/2000psi].

5/From the moment [45h]: we notice a free decrease in pressure where it was between [2000psi/500psi]

6/From the moment [50h/60h]: we notice the stability of the pressure as it was [500psi]

7/From the moment [60h/80h]: we notice a continuous increase in pressure, as it was between [500psi/2050psi].

8/From the moment [80h]: we notice a free decrease in pressure where it was between [2050psi/240psi]

9/From the moment [80h/90h]: we notice the stability of the pressure as it was [500psi]

10/From the moment [90h/120h]: we notice a continuous increase in pressure, as it was between [500psi/3040psi]

11/From the moment [120h]: we notice a free decrease in pressure where it was between [3040psi/500psi]

12/From the moment [120h/123h]: we notice a continuous increase in pressure, as it was between [500psi/5050psi]

13/From the moment [123h/135h]: we notice the stability of the pressure as it was [5000psi]

2. Analysis results (PRESSURE)

1. The pressure increases, because of the operation of (**Clean up**), after that the descent of the drill pipe and the anchorage of the packer.
2. Stability of the pressure, because the well is get used to the conditions.
3. The pressure decreases a little, because of the opening of the tester valve. Then it keeps decreasing because the impurities were removed with the added water and the well in flow opening.
4. **Primary flow stage:** The pressure increases and decreases a little because of the pre flow.
5. **Initial shut-in stage**: The pressure increases because of the first buildup of the tester valve
6. The pressure decreases because of the opening of tester valve.
7. **Main flow stage:** The tester valve closes and pressure increases again.
8. **Final shut-in stage:** Final buildup of the valve.
9. Reverse circulation
10. The pressure decreases gradually because of anchoring the packer and reassemble all the tools.
11. The closing and opening process continues for (3 opening and 4 buildups, this is according to the customer's request and desire for accurate measurements).

3. Graph analysis (TEMPERATURE)

[0;15h]: The temperature increases: [20;130°C]
[15;120h]: The temperature stabilizes: [130°C]
[120;150h]: The temperature decreases: [130;35°C]

4. Analysis results (TEMPERATURE)

The temperature increases because of the decent of the tools and starting the operations.
The temperature stabilizes because of the well get used to the conditions.
The temperature decreases because of the end of the operations and reassemble drill pipe.

General Conclusion

Drill stem testing is an oil and gas exploration procedure to isolate, stimulate and flow a downhole formation to determine the fluids present and the rate at which they can be produced. The main objective of a DST is to evaluate the commercial viability of a zone's economic potential by identifying productive capacity, pressure, permeability or extent of an oil or gas reservoir. These tests can be performed in both open and cased hole environments and provide exploration teams with valuable information about the nature of the reservoir. Drill stem testing involves deploying a series of tools known as a test bottomhole assembly (BHA). A basic drill stem test BHA consist of a packer or packers, which act as an expanding plug to be used to isolate sections of the well for the testing process, valves that may be opened or closed from the surface during the test, and recorders used to document pressure during the test. In addition to packers a downhole valve is used to open and close the formation to measure reservoir characteristics such as pressure and temperature which are charted on downhole recorders within the BHA. Below are two types of BHA DST, Cased Hole which can be applied after the well has been cased, and Open Hole which may be performed before casing.

In a low permeability or low pressure formation, surface production may not be achieved but the volume and flow rate of fluid can still be analyzed within the drill stem.

integration between tests results and data are compulsory for completing a well.

Going blindly into completion of a well without performing the drill-stem testing is a great loss. This report has discussed the importance of the DST.

It highlighted the main components that makes up the DST tool each with their own particular function.

It also discussed the best design for the DST and how it is executed. The report came up to conclude that the ability of a well to be completed successfully is to correctly interpret the DST pressure chart, where by the most important parameter is obtained from it, the static reservoir pressure, knowing this value and other parameters will aid in further development of the well.

Abstract:

The main objective of a DST is to evaluate the commercial viability of a zone's economic potential by identifying productive capacity, pressure, permeability or extent of an oil or gas reservoir.
And it is a process that is not easy, and its implementation requires multiple stages and processes in which we use certain equipment to facilitate this process that does not accept complacency and requires great accuracy by a competent person to ensure a good, undoubted result.
And because it depends on it in the case of completing production in this well or stopping it, through it we can know the quantity of production in this well, the life of the well and many of the characteristics that benefit us in the process of extracting oil.

Résumé:

L'objectif principal d'un DST est d'évaluer la viabilité commerciale du potentiel économique d'une zone en identifiant la capacité de production, la pression, la perméabilité ou l'étendue d'un réservoir de pétrole ou de gaz. Et c'est un processus qui n'est pas facile, et sa mise en œuvre nécessite de multiples étapes et processus dans lesquels nous utilisons certains équipements pour faciliter ce processus qui n'accepte pas la complaisance et nécessite une grande précision par une personne compétente pour assurer un bon résultat incontestable. Et car cela en dépend en cas d'achèvement de la production dans ce puits ou de son arrêt, grâce à lui, nous pouvons connaître la quantité de production dans ce puits, la durée de vie du puits et de nombreuses caractéristiques qui nous profitent dans le processus d'extraction du pétrole

ملخص

الهدف الرئيسي من اختبار جذع الحفر هو تقييم الجدوى التجارية للإمكانات الاقتصادية للمنطقة من خلال تحديد القدرة الإنتاجية أو الضغط أو النفاذية أو مدى خزان النفط أو الغاز.
وهي عملية ليست سهلة، وتنفيذها يتطلب مراحل وعمليات متعددة نستخدم فيها معدات معينة لتسهيل هذه العملية التي لا تقبل التراخي وتتطلب دقة كبيرة من قبل شخص مختص لضمان نتيجة جيدة لا شك فيها.
ولأنه يعتمد عليه في حالة استكمال الإنتاج في هذه البئر أو إيقافه، فمن خلاله نستطيع معرفة كمية الإنتاج في هذه البئر، وعمره والعديد من الخصائص التي تفيدنا في عملية الاستخراج النفط.

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