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Dnipro University of Technology
Faculty of Natural Sciences and Technologies
(faculty)
Oil-and-Gas Engineering and Drilling Department
(full name)

EXPLANATORY NOTE

Qualification paper, degree __________bachelor____
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academic group 185-18-2 IC______________________________________
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specialty 185 Oil and Gas Engineering and Technology_____________________
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title Technical project for drilling a production well in terms of Bakr oil field (Egypt)

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TASK

for the qualifying paper for the degree of bachelor

(bachelor, master)

student Omar Asaad Mohamed Khalil **academic group** 185-18-2 IC

(full name) (code)

specialties 185 Oil-and-Gas Engineering and Technology

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title Technical project for drilling a production well in terms of Bakr oil field (Egypt)

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Section	Content	Deadline
Technologic	1. Geological and technical conditions of drilling 2 Geological and technical part	07/05/2022
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Task issued ________________ Khomenko V.L.

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Accepted for execution ____________ Omar .A.M .K

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ABSTRACT

Explanatory note: 76 pages, 16 figures, 10 tables, 17 references.

PRODUCTION WELL, WELL, DRILL BITS, DRILLING FLUID, DRILLING TECHNOLOGY

The object of the study is drilling a well in terms of the Bakr gas condensate field with the development of measures to improve the quality of drilling fluids.

The purpose of the study is to design a well at the Bakr field.

Research tools are literature analysis and theoretical research. The paper is compiled in accordance with the requirements of the guidelines. It contains information about the area of drilling, geological structure and characteristics of productive horizons. In the design part, the issues of well construction are resolved: the well structure has been designed, the equipment for the drilling rig, the rock cutting tool, the drilling and cementing technology have been selected. Measures have been developed to improve the quality of drilling fluids during preparation. Safety precautions are given when drilling wells. The issues of subsoil and environmental protection are highlighted. The estimate of well drilling has been substantiated.

CONTENT

INTRODUCTION

Bakr Oil Field is located at the western coast of the Gulf of Suez. The Middle Miocene Hammam Faraun Member of Belayim Formation is considered to be a good reservoir in the study area. The present work mainly deals with the interpretation of geological and geophysical data to evaluate the hydrocarbon potentials of Belayim reefal limestone reservoir in Bakr Oil Field.

Bakr Oil Field was one of the first commercials oil fields and the most prolific in the Gulf of Suez. The Bakr Oil Field is located at the western coast of the Gulf of Suez, betweenlatitudes 28° 47̀- 28° 40̀N and longitudes 32° 91̀- 33° 00̀. It is located about 10 km north of Gharib Oil Field, and about 40 km north of Ras Shukheir Oil and Gas Field.

1 GEOLOGICAL AND TECHNICAL CONDITIONS OF DRILLING

1.1 Introduction

Geology is the science that makes us know how to read the story told by the very earth beneath our feet in order to find oil and natural gas, which are vital resources in our lives.

Petroleum geology is the study of origin, occurrence, movement, accumulation, and exploration of hydrocarbon fuels. It refers to the specific set of geological disciplines that are applied to the search for hydrocarbons, oil exploration and much more appropriate than random drilling. Petroleum geol ogy and economic evaluation are critical pieces of prospect evaluation.

Key geologic parameters in prospect appraisal are presence of:

a. source rock
b. reservoir
c. trap
d. cap rock
e. adequate and non-destructive thermal history.

The probability of each condition being fulfilled must be addressed. Four economic aspects are:

a. potential profitability of venture.
b. available risk investment.
c. total risk investment.
d. aversion to risk.

Computer simulation techniques may be used to aid the decision of whether or not to embark on anexploration venture.

Resources may be defined by two criteria: economic feasibility of extraction and geological know - edge. Reserves are resources that can be economically extracted from a resource base. Reserve categories can be subdivided into proved, probable, and possible.

Many estimates of global petroleum resources and remaining resources have been attempted and estimates differ widely. Most resources and reserves are contained in giant fields. The world consumes about 99 million barrels per day. Most estimates of world oil reserves indicate that this is about a 50-year supply of oil. Reserve numbers are always changing, however. In addition, the un-conventional oil numbers have not been rigorously assessed.

Petroleum is a finite resource and is only one contributor to the world's total energy needs. Fossil fuels (coal, liquid fuels, and natural gas) are projected to supply much of the total world energy con-sumption for the next several decades. Water sustains life; energy sustains civilization

1.2 Location

Suez gulf occupies the northwestern arm of the Red Sea between Africa and the Sinai Peninsula. Itis the third arm of the triple junction rift system, the second arm being the Gulf of Aqaba

The length of the gulf, from its mouth at the Strait of Gubal to its head at the city of Suez, is 195 miles(314 km), and it varies in width from 12 to 20 miles (19 to 32 km).

The gulf is linked to the Mediterranean Sea by the Suez Canal (north) and is an important shippingroute.

1.3 Company Foundation

General Petroleum Company (GPC) was founded in 1957 as a state-owned company "public sector" with a paid up capital of LE 498 million, wholly owned by the Egyptian General Petroleum Corporation, to be the first national company engaged in the re- search, exploration and production of oil in the Arab Republic of Egypt.

The company owns a number of fields estimated at 22 fields lo- cated in the vicinity of the company's concession areas, which is estimated at 17725 square kilometers as follows :

- 16 field in the eastern desert length of 200 km
- 3 fields in the Western Desert

- 3 fields in Sinai
- In addition to the concession areas of

the company in the Gulfof Suez.

The Company’s contributions to the petroleum sector

- Osuko-Shukir Marine Oil: 49.5%
- Amptco - Amal Petroleum: 50%
- Southern Ramadan Petroleum: 77%
- Petroram - Al-Shawish Petroleum: 44.58%
- The company is acting on behalf of the Egyptian General Petroleum Corporation and the partnersmanaging these companies.

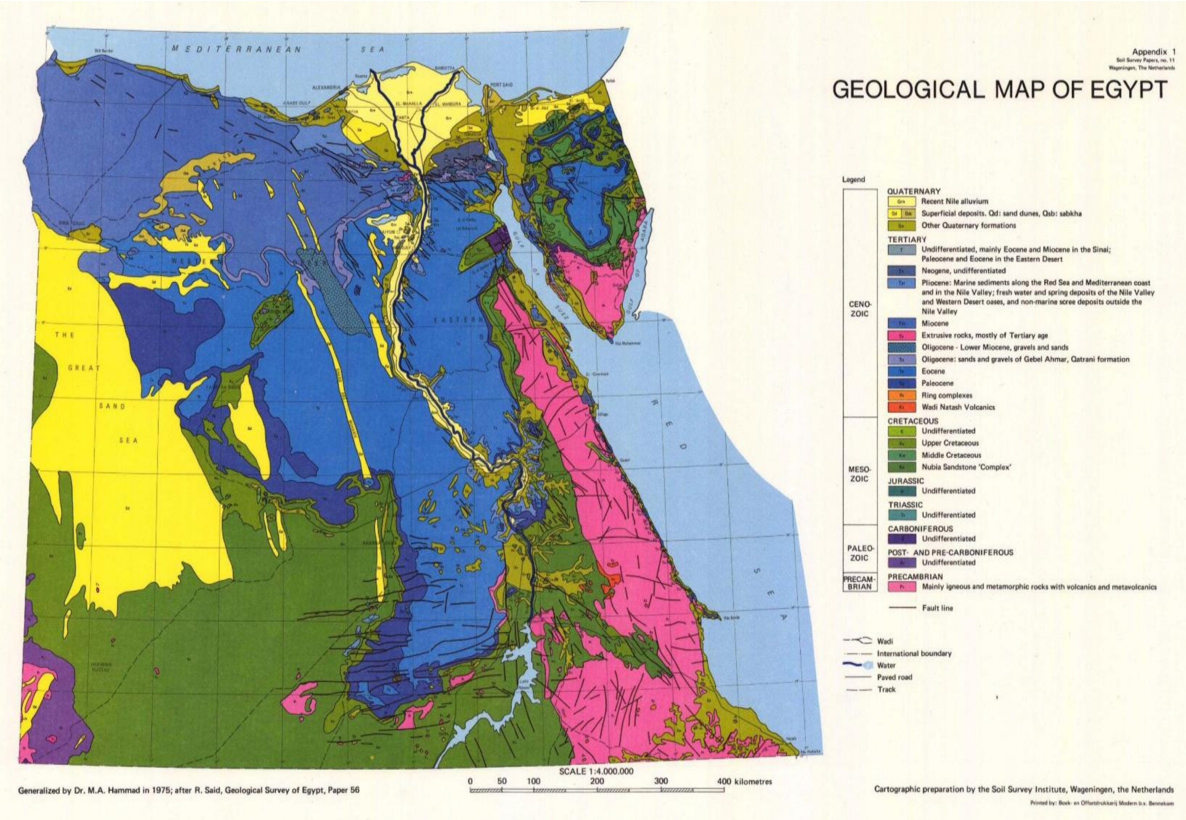


Figure 1.1 – Geological Map of Egypt

1.4 The Geology Of Bakr Field

Bakr Oil Field is located at the western coast of the Gulf of Suez. The Middle Miocene Hammam Faraun Member of Belayim Formation is considered to be a good reservoir in the study area. The present work mainly deals with the interpretation of geological and geophysical data to evaluate the hydrocarbon potentials of Belayim reefal limestone reservoir in Bakr Oil Field.

Bakr Oil Field was one of the first commercials oil fields and the most prolific in the Gulf of Suez. Figure 1.2 shows that the Bakr Oil Field is located at the western coast of the Gulf of Suez, betweenlatitudes 28° 47̀- 28° 40̀N and longitudes 32° 91̀- 33° 00̀. It is located about 10 km north of Gharib Oil Field, and about 40 km north of Ras Shukheir Oil and Gas Field.

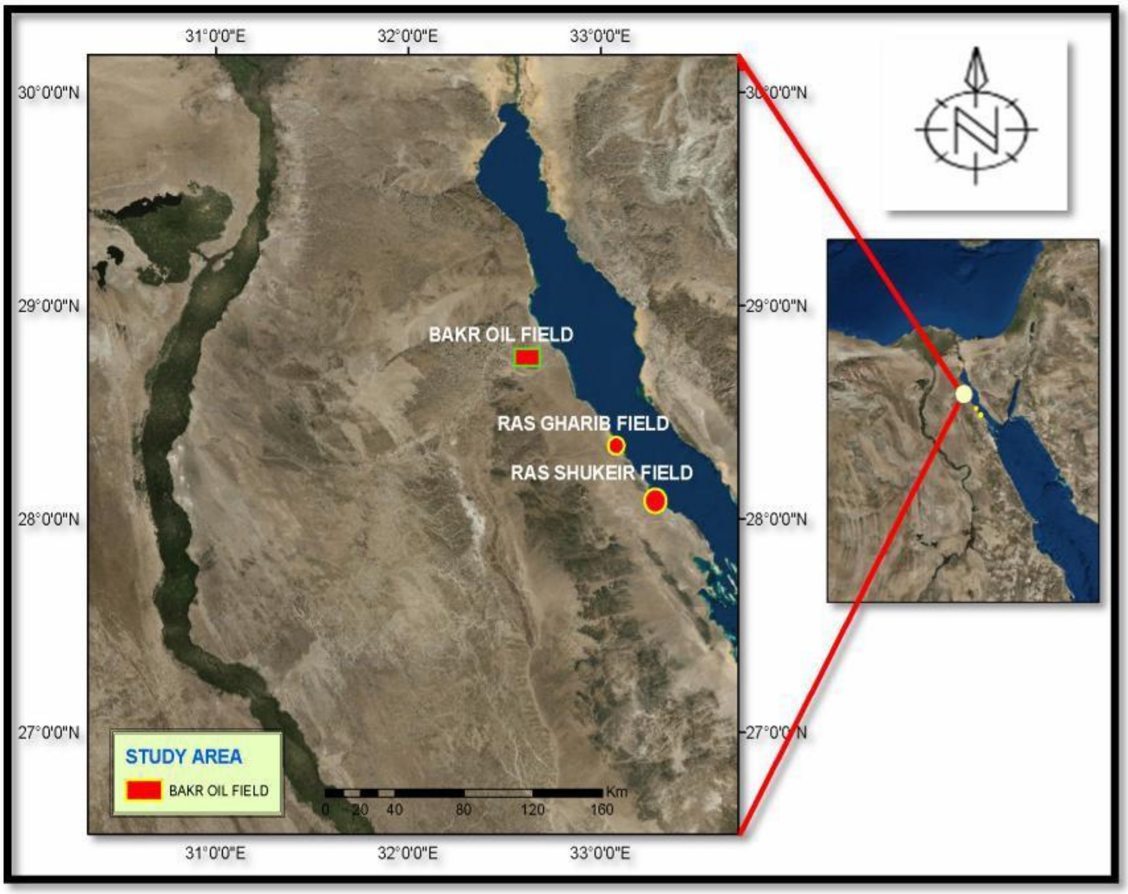


Figure 1.2 – Location map of Bakr Oil Field.

Figure 1.3 – Bakr Field Index Map

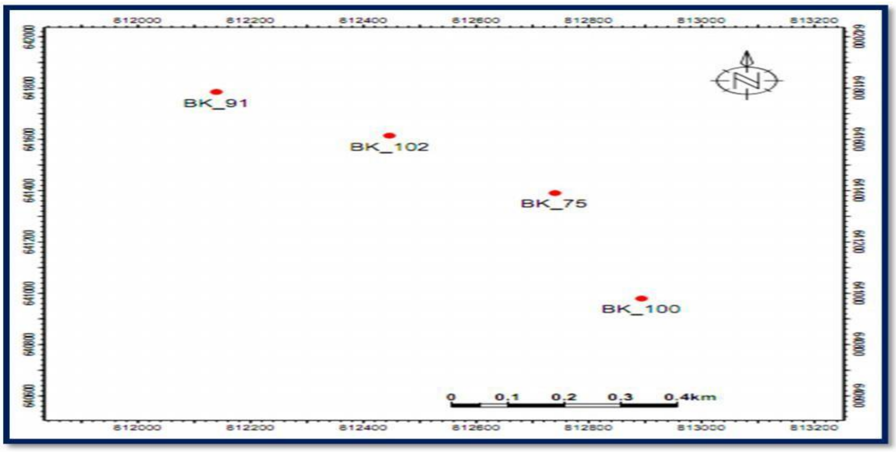


Figure 1.4 – The distribution of the available seismic lines and wells in the study area

In the study area, Belayim Formation consists mainly of reefal limestone with some shale streaks, but in some wells, it is distinguished into four members that have different identities. Feiran and Baba members consist of anhydrite and shale embedded by Sidri Member of shale with limestone interbeds and overlain by Hammam Faraun Member of reefal limestone and shale.

Baba Member is composed of anhydrite and shale interbeds (mostly one bed). It is the lower mem- ber of Belayim Formation, which is conformably, overlies the Kareem Formation.

Sidri Member is the lower clastic member of Belayim Formation, which is composed of calcareousshale intercalated with limestone.

Feiran Member is composed of thick bed of anhydrite with minor shale streaks. It is the thickest member of Belayim Formation in the study area.

Hammam Faraun Member is the youngest member of Belayim Formation, mainly composed of reefal limestone with shale at few wells. Its type section is selected at Wadi Ghrandal, north of Gebel Hammam Faraun. This member is affected by facies changes and remarkable lithological variationall over the Gulf of Suez. It consists of sandstone, shale, and limestone.

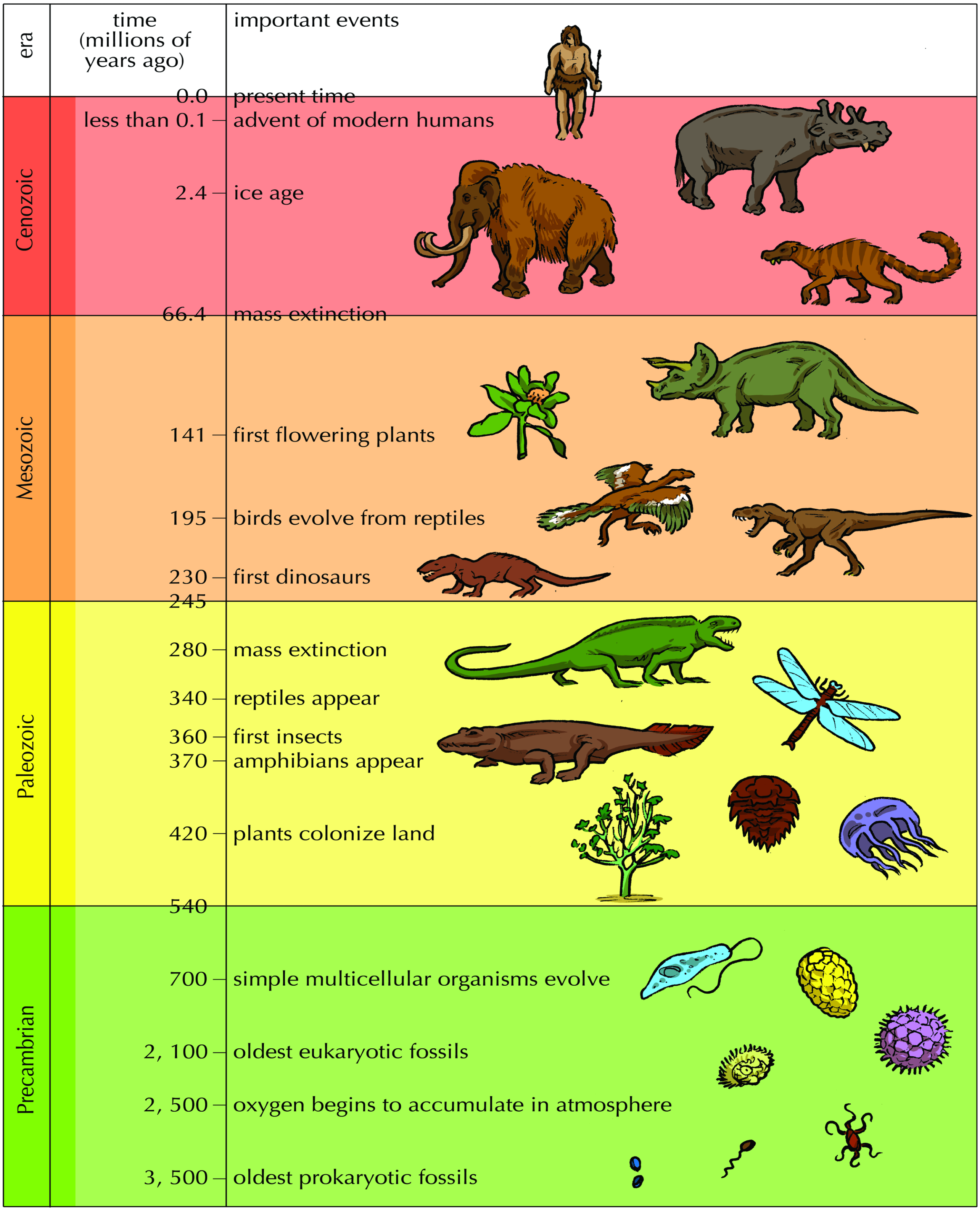


Figure1.5 – The Geologic Time Scale divides the past of Earth, into intervals marked by a distinctive set of fossils recorded in the stratigraphic units

1.5 The Geology Of Nubian Formation

Age:

- The Paleozoic- lower Cretaceous

Lithology:

- Nubian Sandstone is a thick sequence of up to 1200 meters of classic and thin carbonate sedi-ments in ascending order.
- It's classified into the following groups and formations: Qebilat (C) Group, Umm Bogma Formation,Ataqa Group and El-Tih Group.
- Formation is composed mainly of sandstones with shale and minor car-bonate interbeds.
- Petrographically, two main facies of Nubian Sandstone can be recog-nized in the Gulf of Suez:quartzarenite and quartzwackes.

Thickness and Rock Properties:

- Nubian Sandstone is a thick sequence of up to 1200 meters. The pre-Cenomanian Nubian NubianSandstone is one of the most prolific reservoirs in the Gulf of Suez oil province.
- Net pay thickness of up to 450 meters.
- Net sand ratios ranging from 60% to 90%.
- Porosity varies from 10% to 30%.
- Permeability varies from 70-850 md.
- The quality of the reservoir depends on its shaliness, diagenetic histo-ry and the depth of burial(compaction).
- The Nubian Sandstone still a high potential as a reservoir, particularly in the northern sector of theGulf of Suez where few wells have specifically targeted this interval

Geological Map:

The main reason of gathering information in Petroleum Geology is to gener-ate many kinds of geo- logic maps. This information comes from sources like di-rect indications, geological methods (well logs, core drilling and Start tests), geo-physical methods (gravitational, magnetic and Seismic) and geochemical methods to show various underground conditions.

Geologic maps are used to:

- Show the geologic history of the region.
- Predict the location of petroleum pools of the new geologic data uncovered.
- Determine the location of source rock and the reservoir rock.
- Determine the kind of trap.
- Estimate the initial hydrocarbon in place.

Contour lines: which is a line that passes through points having the same elevation.

- Contour lines are continuous.
- Contour lines are relatively parallel unless one of two conditions exists.
- A series of V-shape indicates a valley and the V's point to higher elevation.

Types of Subsurface Maps:

- Structure contour maps.
- Cross sections.
- Panel (fence diagram).
- Isofacies maps.
- Paleogeologic and subcrop maps.
- Internal property maps (Miscellaneous maps).
- Hydrodynamic maps.
- Geophysical maps.
- Geochemical maps.
- Isohydrocarbon map.
- Isopach map.

Structure contour maps

Subsurface structure may mapped on any formation boundary,unconformity, or producing formationthat can be identified and correlated by well data. Structure may be shown by contour elevation maps or by cross sections.

Structure contour maps	Topographic [surface] maps
Consist of contour lines displaying the:	
Depth of subsurface structure	Elevation of surface topography
With respect to datum plane [sea level-KBL]	
Used in mineral and petroleum explora-tion	Different uses and types depending on the data givenon it: political-climatic-economic-physical-geologic
Data obtained from:	
Geophysical survey –Logging & coring fromexploratory/offset wells	Topographic survey [theodolite –leveling –total station] Aerial survey

Cross Section

To clearly display some details about structures, Types:

Correlation [C.S]	Structural [C.S]	Stratigraphic [C.S]
1st geologic feature in wellsto enable geologists decideStratigraphy	Vertical section show-ing the struc-turalatti-tudes	Represent forma-tion Bound-aries, unconformi-ties asa datum level

Panel (fence diagram)

- Isometric projection of structural/stratigraphic section.

Isofacies map

- Facies maps are of several kinds, but those most used in the geology of petroleum are lithofaciesmaps.

They can be divided into:

- These maps distinguish the various lithologic types rather than formations.
- It shows the net thickness of certain lithology specially Sandstone.

Paleogeologic and subcrop maps

Paleogeology may be defined as the science that treats the geology as it was during various geo- logic periods

A paleogeologic map.

. Is defined as a map that shows the paleogeology of an ancient surface.

A subcrop map.

is a paleogeologic map in which the overlying formation is still present where as a paleogeologic map shows the formation boundaries projected in part into the area from which the overlying forma-tion has been eroded.

Internal property maps (Miscellaneous maps)

These maps are prepared to show and illustrate specific phenomena**.**

Isoporosity maps:

- Which show by contours the reservoir pressure in a pool.

Isobar maps:

- Which show the initial or calculated daily rate production of wells in a pool.

Isopotential maps:

- Which show the concentration of salts in oil-field waters by contours.

Iso concentration maps:

- Which show the position of wells from which water is produced along with the **oil.**

Isochore maps:

The Maps which are lines joining points of equal vertical thickness. So isochore maps record the vertical thickness of geological units. These maps illustrate such features as the depth of overbur- den above some deposits, or the real variations in the vertical thickness of some concerted unit.

Isovolume maps:

The Maps which show the contours of equal porosity porosity-ft. (net thickness X porosity)

Water encroachment maps:

- Which are lines joining points of equal vertical thickness.

So isochors maps record the vertical thickness of geological unit's. These map illustrate such fea-tures as the depth of overburden above some deposits

Hydrodynamic maps.

- These maps represent the relation between equipotential surface of oil and Water in the reservoir.
- Theyrepresent the surface normal to which the movement of two fluids takes place.
- It gives information about the direction of fluid movement, density of water and density of oil.

Geophysical maps.

These maps depend on geophysical anomaly (such as local variations or irregu- larity in the normal pattern) which after correction may be attributed to some geolog- ic phenomena.

Geochemical maps.

These maps are used for mapping various kinds of chemical analysis of rocks and their fluid con- tents. It may show the surface distribution of hydrocarbons where those hydrocarbons are found at the surface in large amounts than normal indicating that there is a seepage of oil or gas

Isohydrocarbon map: **$H.P = h * \varphi * (1- Swi)$**

Hydrocarbon potential = net pay thickness * porosity * hydrocarbon saturation.

Isopach V.S Isochore map.

Isopach	Isochore
Consist of contour lines connecting points of equal:	
TST: true stratigraphic thickness	TVT: true vertical thickness
This thickness is meas-ured perpendicularto formation boundary	**This thickness is measured vertically**
Show the thickness variation of rock between 2 surfaces [bed-ding planes or unconformity surface] by contours over area	

1.6 Calculation of OHIP

There are three methods; Volumetric, Material Balance and Decline curve analysis. Only the first

two will be mentioned here

Volumetric Method

This method is based on the use of geological maps, usually derived from log and core data. In thismethod, we, at first, calculate the bulk volume from one of the following methods:

Trapezoidal method

- Applicable only when An/An-1 > 0.5

$$V_B = \frac{h}{2}[A_o + A_n + 2 \times (A_1 + A_2 + A_3 + \cdots + A_{n-1})]$$

- The bulk volume is calculated by the following equation.

- Where

A= area enclosed by every two contour lines. h=thickness between every two contour lines.

V_B= bulk volume.

Pyramid Method

- Applicable only when An/An-1 < or = 0.5
- The following equation is used

$$V_B = \frac{h}{3}[A_o + A_1 + \sqrt{A_o.A_1} + A_1 + A_2 + \sqrt{A_1.A_2} + \cdots + A_{n+1} + A_n + \sqrt{A_{n+1}.A_n}]$$

Simpson Method

- This method is used with an odd number of areas by the following equation:-

$$V_B = \frac{h}{3}[A_o + 4 \times (A_1 + A_3 + \cdots + A_{n+1}) + 2 \times (A_2 + A_4 + \cdots + A_n)]$$

Material Balance Equation (MBE) Method

This method assumes that the reservoir volume remains constant over the life of the reservoir and the fluids present will expand to fill the same reservoir volume so that it can accurately be called volumetric balance.

Calculation of Original Oil in Place in Nubia"C"

Using Isopach Method:

Contur Line	H(m)	Area(m^2)	Area Ratio	Method	
1250	0	1102025.414			
1230	20	961121.7608	0.872141112	Trapezoidal	Simpson
1210	40	811688.8672	0.844522492	Trapezoidal	Simpson
1190	60	666983.2018	0.821722742	Trapezoidal	Simpson
1170	80	522949.9101	0.784052595	Trapezoidal	Simpson
1150	100	382036.4148	0.730541124	Trapezoidal	Simpson
1130	120	242615.1207	0.635057579	Trapezoidal	Simpson
1110	140	133788.622	0.551443874	Trapezoidal	Simpson
1090	160	47967.70009	0.358533479	Pyramidal	Simpson
1070	180	706.0319603	0.014718904	Pyramidal	Pyramidal
1061	189	0	0	Pyramidal	Pyramidal

Trapezoidal Method (m^3)	87226825.88
Simpson's Method (m^3)	**85106888.24**
Average (m^3)	**86166857.06**

Calculation of the Bulk Volume from Surfer™ Program

- Trapezoidal Rule: B = 95578008.457215 m^3
- v Simpson's Rule: B = 95091631.673376 m^3
- v Simpson's Rule: B = 95789095.424085 m^3

Net/Gross	0.59592409
Porosity	0.2128776
S_{wi}	0.1868358
B_o	1.08096771

$$N = \frac{B_v \times \frac{Net}{Gross} \times \emptyset \times (1 - S_{wi})}{Boi} = \frac{95486245.18 \times 0.2128776 \times (1 - 0.1868)}{0.159 \times 1.08096771} = 57.6\ MMSTB$$

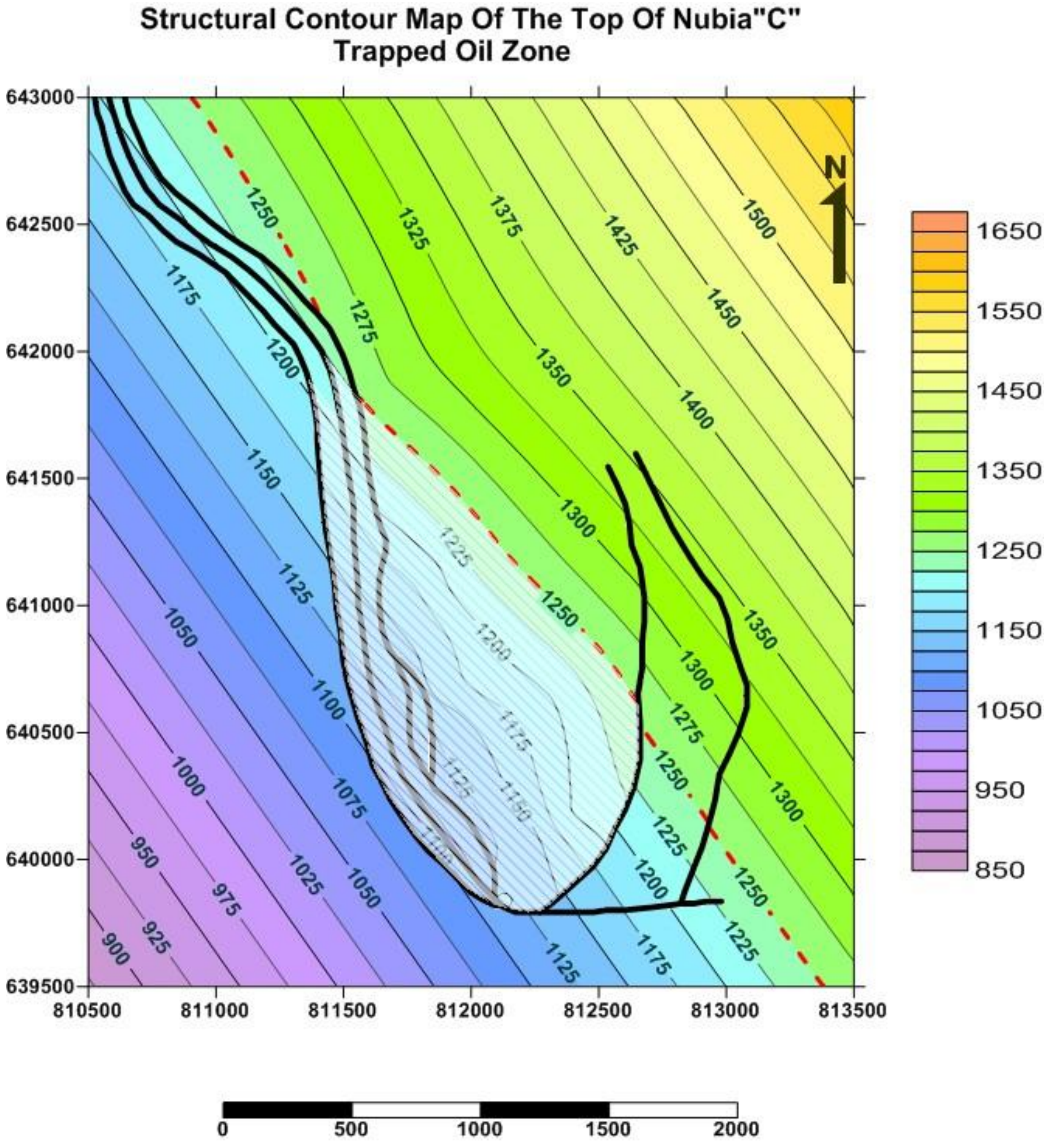


Figure 1.6 – Trapped oil zone

2 GEOLOGICAL AND TECHNICAL PART

2.1 Selection and substantiation of the well design

A well design is understood as a totality of data on the number and size of casing strings, well diameters for each-casing, cementing intervals, as well as methods and intervals for connecting the well to the producing formation.

Well planning is perhaps the most demanding aspect of drilling engineering.

It requires the integration of:

- Engineering Principles
- Corporate or Personal philosophies
- Experience-Factors.

The final objective for any well planner is to design a safely drilled minimum cost hole that satisfies the reservoir engineer's requirements for oil and gas production.

The skilled well planners normally have three common traits. They are experienced drilling: personnel who understand how all aspects of the drilling operation must be integrated smoothly. They utilize available engineering tools, such as .computers and third party recommendations, to guide the development of the well plan And they usually have an investigative characteristic that drives them to research and review every aspect of the plan in an effort to isolate and remove potential problem areas.

To establish the number of casing strings and the depth of their running, we build a combined graph of the change in the gradients of reservoir pressure and hydraulic fracturing pressure along the depth of the boreholeOn its basis we have designed the first rough design of a borehole. The final decision on the number of casing-strings and the depth of their running is made after analyzing the geological and technical conditions of drilling, taking into account possible -complications. Below-is a combined pressure plot and projected well design.

Types of casing.

- Conductor casing
- surface casing
- intermediate casing
- production casing
- liner casing

Conductor casing is the first string set below the structural casing (i.e., drive pipe or marine conductor run to protect loose near-surface formations and to enable circulation of drilling fluid). The conductor isolates unconsolidated formations and water sands and protects against shallow gas

A Surface Casing is a pipe string with a large diameter that is the first one to be set in a well. It is a low-pressure pipe which is cemented first in the well to act as a protective shield to preserve the water aquifers in the region

Intermediate Casing is the casing which is generally set in place before production casing and after surface casing to provide protection against the abnormally pressured or weak formations. The casing enables the use of drilling fluids with different density crucial for controlling the lower formations

Production Casing refers to the casing that is run across the reservoir in sections through which the well will be drilling. It is one of the final intervals of the casing which is performed during the casing of a well

Liner is a casing string that does not extend back to the wellhead, but is hung from another casing string. Liners are used instead of full casing strings to: Reduce cost. Improve hydraulic performance when drilling deeper

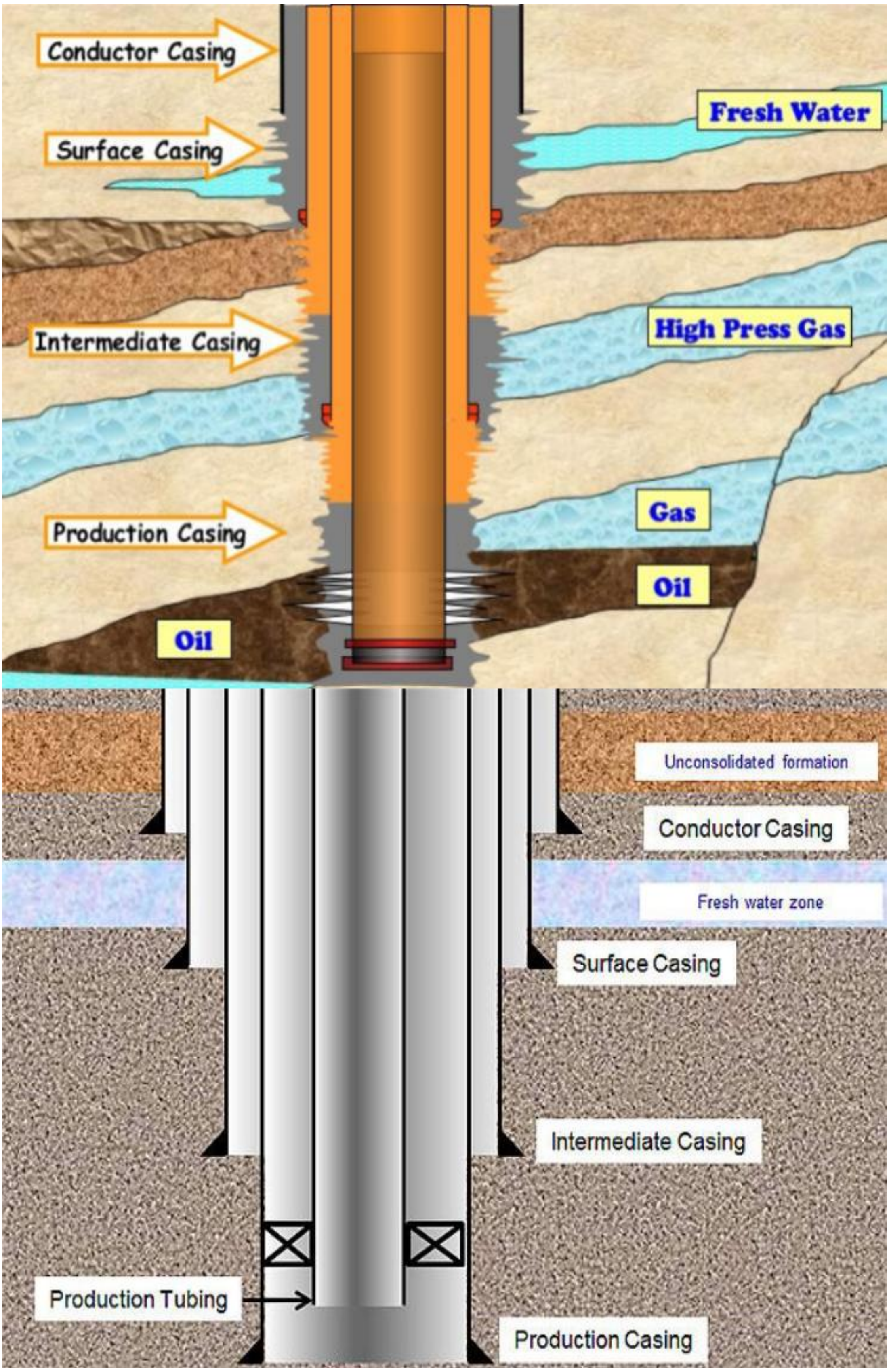


Figure 2.1 – Types of casing

Table 2.1 – Project geological section along the well

Interval of occurrences, m	Lithological characteristics of sediments	Category		Pressure gradient, MPa/m		Petroleum system elements
		From hardness	From abrasiveness	Reservoir	Hydraulic fracturing	
0-700	Sandstone, anhydrite, shale	II	II	0.0105	0.0140	
700-1300	Anhydrite, sandstone, shale	IV	IV	0.0126	0.0160	
1300-2150	Anhydrite, shale, salt	IV	V	0.0120	0.0150	Seal rock
2150-2300	Shale, sandstone, anhydrite	VI	IV	0.0130	0.0170	
2300-2900	Sandstone, shale	VI	V	0.0150	0.0190	Reservoir rock

From 0 to 700 m there are sandstone, anhydrite, shale. They have II category from hardness and II category from abrasiveness. Reservoir pressure gradient is 0.0105 MPa/m and hydraulic fracturing pressure gradient is 0.0140.

From 700 to 1300 m there are sandstone, anhydrite, shale. They have IV category from hardness and IV category from abrasiveness. Reservoir pressure gradient is 0.0126 MPa/m and hydraulic fracturing pressure gradient is 0.0160.

From 1300 to 2150 m there are anhydrite, shale. salt . They have IV category from hardness and V category from abrasiveness. Reservoir pressure gradient is 0.0120 MPa/m and hydraulic fracturing pressure gradient is 0.0150.

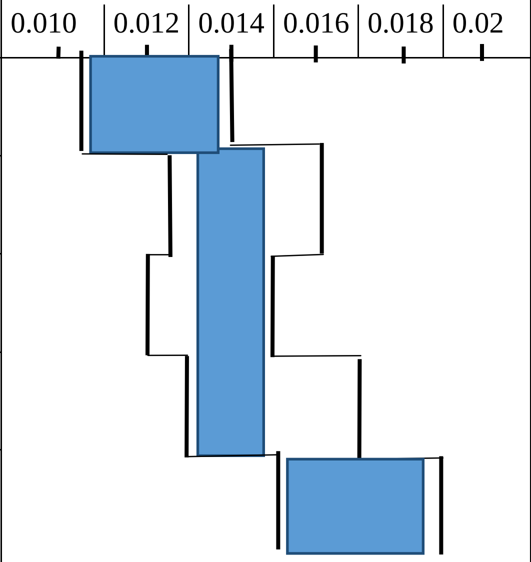
From 2150 to 2300 m there are sandstone, anhydrite, shale. They have VI category from hardness and IV category from abrasiveness. Reservoir pressure gradient is 0.0130 MPa/m and hydraulic fracturing pressure gradient is 0.0170.

From 2300 to 2900 m there are sandstone, shale. They have VI category from hardness and V category from abrasiveness. Reservoir pressure gradient is 0.0150 MPa/m and hydraulic fracturing pressure gradient is 0.0190

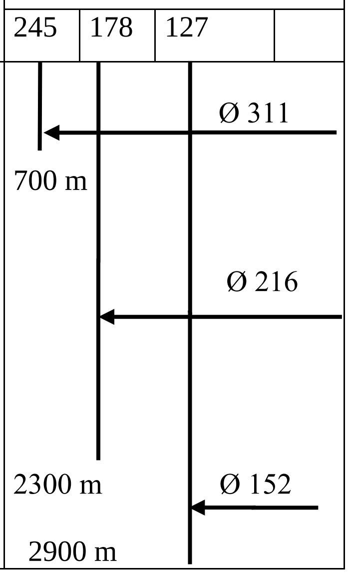
Table 2.2 – Combined pressure graph

Depth of bottom boundary, m	Pressure MPa/m gradient	
	reservoir	hydraulic fracturing
700	0.0105	0.0140
1300	0.0126	0.0160
2150	0.0120	0.0150
2300	0.0130	0.0170
2900	0.0150	0.0190

Combined card of pressure



Well design



1. In accordance with the initial data, the diameter of the production casing

$$d_{pr} = 127 \text{ mm}.$$

2. Diameter of a drill bit for production casing

$$D_b^{pr} = d_j^{pr} + 2\delta,$$

where

d_j^{pr} is the production casing joint diameter; for a given production casing d_j^{pr} = 141 mm;

δ is the size of the gap between the production casing collar and the wellbore wall, since the production casing diameter is d_{pr} = 114 mm, then we accept δ = 5 mm.

$$D_b^{pr} = 141 + 2 \cdot 5 = 151 \text{ mm}.$$

In accordance with State Standard, we accept for drill bits D_b^{pr} = 152 mm.

3. Determine the inner diameter of the intermediate casing

$$d_{in}^{pr} = D_b^{pr} + (6 \div 8),$$

$$d_{in}^{pr} = 152 + 6 = 158 \text{ mm.}$$

We accept in accordance with State Standard for casing pipes

$$d_{out}^{pr} = 178 \text{ mm; } d_{in}^{pr} = 166 \text{ mm; } d_j^{пр} = 194.5 \text{ mm.}$$

4. Determine the diameter of the bit for drilling under the intermediate casing

$$D_b^{int} = 194.5 + 2 \cdot 10 = 214.5 \text{ mm.}$$

Accepted according to Standard for drill bits $D_b^{int} = 216$ mm.

5. Determine the inner diameter of the surface casing

$$d_{in}^{sc} = 216 + 6 = 222 \text{ mm.}$$

We accept in accordance with Standard for casing pipes

$$d_{out}^{sc} = 245 \text{ mm; } d_{in}^{sc} = 228.7 \text{ mm; } d_j^{sc} = 269.9 \text{ mm.}$$

6. Determine the diameter of the drill bit for surface casing

$$D_b^{sc} = 269.9 + 2 \cdot 10 = 289.9 \text{ mm.}$$

Accepted according to State Standard for drill bits $D_b^{sc} = 311$ mm.

7. Determine the outside diameter of the conductor

$$d_c^{out} = D_b^{sc} + (50 \div 100)$$

$$d_c^{out} = 311 + 50 = 361 \text{ mm.}$$

We accept in accordance with State Standard for casing pipes

$$d_c^{out} = 388 \text{ mm; } d_c^{in} = 359 \text{ mm.}$$

The calculation results are summarized in the table 2.3.

Table 2.3 – Well design

Casing	Casing depth, m	Casing diameter, mm	Drill bit diameter, mm	Interval cementing, m
Conductor	20	388	–	0-20
Surface casing	700	245	311	0-700
Intermediate casing	2300	178	216	0-2300
Production casing	2900	127	152	0-2900

2.2 Drilling method

A method of drilling whereby an impact tool or bit, suspended in the well from a steel cable, is dropped repeatedly on the bottom of the hole to crush the rock

- Rotary Drilling
- Electro-Drilling
- Hydraulic Engine Drilling
- Power swivel or Top drive system.

Rotary drilling is used to form a deep observation borehole or for obtaining representative samples of rock. The drilling method involves a powered rotary cutting head on the end of a shaft, driven into the ground as it rotates. The system requires lubrication (air, water or drilling mud) to keep the cutting head cool .In mud rotary drilling, fluid is pumped down the hollow drill pipe, called the kelly, and forced out of jets in the drill bit. That fluid then carries the cuttings, or cut materials, through the hole and up to the surface and the mud is reused either thru a mud containment system or pit

Electro-drilling. In this method, rotary tables, winches and the like are driven by-electric-motors, thus leading to better flexibility in operations along with remote-controlled drilling. These drills are new methods of oil and gas exploration, as they provide more direct power to the drill bit by connecting the motor above the bit, below the hole.The electro drilling system has been successful in complex geological conditions where there is use of weighted mud or mud mixtures. which are keen to implement electro-drilling widely to boos

A top drive is a mechanical device on a drilling rig that provides clockwise torque to the drill string to drill a borehole. It is an alternative to the rotary table and kelly drive. It is located at the swivel's place below the traveling block and moves verticaly up and down the derrick

Hydraulic Engine Drilling

There are two main types of hydraulic- engines: mud motor and turbo drill.

A mud motor (or drilling motor) is a progressive-cavity-positive-displacement pump (PCPD) placed in the drill string to provide additional power to the bit while drilling. The PCPD pump uses drilling fluid (commonly referred to as drilling mud or just mud) to create eccentric motion in the power section of the motor which is transferred as concentric power to the drill bit. The mud motor uses different rotor and stator configurations to provide optimum performance for the desired drilling-operation typically-increasing the number of lobes and length of power assembly- for greater horsepower. In certain applications, compressed air, or other gas, can be used for mud motor-input power. Normal rotation of the bit while using a mud motor can be from 60 to over 100 m.

Based on the design of the well, the geological and technical conditions of drilling and the final diameter, we accept rotary drilling with a rotor.

2.3 Selection of drill bits

The drill bit is an important component in the drill string. The bit drills the rock in many mechanisms. The drilling bit is selected according to the formation to be drilled. The bit performance is related to several operating parameters like: weight on bit, revolution per minute, mud properties and hydraulic efficiency When the bit is pulled out of the hole, the level of damage on the bit must be carefully recorded. The system followed to evaluate the bit is called the IADC dull grading system which is designed to facilitate the damage grading. An accurate grading can contribute effectively in bit selection in future operations. There are two main types of drilling bits: Roller cone bits, fixed cutter bit.

Types of drilling bits

- Roller con bits
- PDC
- diamond bits.

I- Roller Cone Drilling Bits

They are also called tri-cone bits. The cutting structures are mounted on three rolling cones and all these cones are attached to main bit body. There are two main types of tri-cone bits:

Mill tooth bits

These types of bits have steel teeth which are milled on the cones. The size and shape of teeth vary according to the formation to be drilled. In soft formation, the teeth are long and slender, where in hard formation the teeth are short and broad.

Figure 2.2 - Mill Tooth Drilling Bit

Insert bits

In these types of bits, the teeth are not milled into the cones, instead of that, tungsten carbide inserts are pressed into the cones. These technics make the bits much harder and can last longer when drilling through hard formation. The size and shape of teeth also depend on the formation to be drilled, the teeth can be long and chisel shapes in soft formation, and for hard formation can be short and round shapes.

Figure 2.3 – Insert Drilling Bit

II- FIXED CUTTER DRILLING BITS:

Fixed cutter bit has no moving parts; the cutting structures and bit body rotate as one part. The main types of these bits are: PDC (polycrystalline diamond compact), TSP (thermally stable PDC) and diamond bits.

TSP Drilling Bits

It was noticed that the bonding materials are the weakest part of the cutter. Under the high temperature at the bottom while drilling, the bonding materials lose their strength. The TSP bits are composed with same artificial diamond without using the bonding materials.

Figure 2.4 – TSP Drilling Bit

The PDC Drilling Bits

This type of bits can be used for different formations from soft to hard. The PDC bit has cutters which consist of a layer of artificial diamond (polycrystalline diamond). Using a high pressure high temperature technique the polycrystalline diamond is bonded on layer of cementer tungsten carbide.

The cutter is self-sharpening because the sharp crystals are exposed continuously as each layer wears or disappears.

The bit body is forged with same high steel used to make the cones of the tri-cone bits, and in order to reinforce the bit against fluid erosion, the face of the bit is coated by a layer of tungsten carbide.

Figure 2.5 – PDC Drilling Bits

PDC bit design

The PDC bit has an important advantage if it is compared with the tri-cone bit; it has no moving parts like bearings or cones which they have to be fished in case of faiure.

The PDC bit shears the formation rather than crushing or gauging the formation as do the tri-cone bit The PDC bit has longer life and extended gauge with tungsten carbide wears pads which help to maintain gauge.

The concave shape of bit's face permits the cutters to drill the rock simultaneously, and also increasing bit stabilization and decreasing the potential for deviation.

The cleaning action of the bottom of the hole and the cutters are performed by the jet nozzles which vary in number and size. They are located in such manner to increase the quality of cleaning.

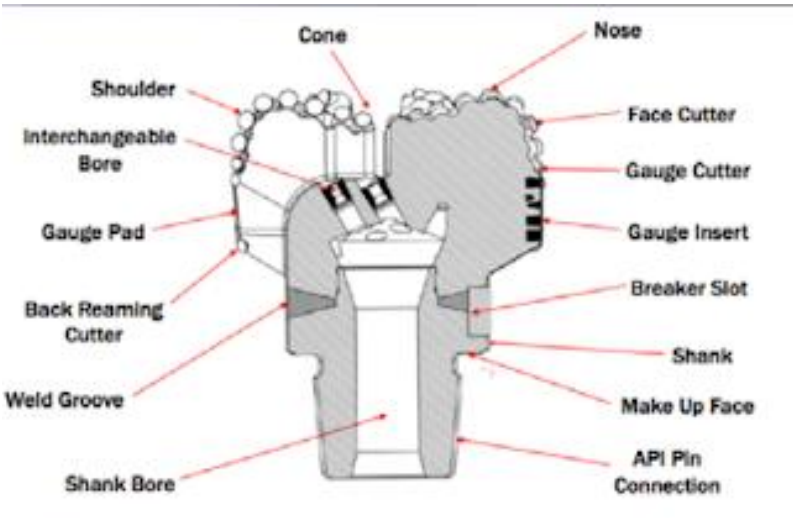


Figure 2.6 – PDC Bit Design

Diamond Drilling Bits:

The natural diamond bits are used to drill through very hard abrasive formation. This type of bits was developed from mining industry. The main advantages of this type of bits are their longevity, reduced number of run bits and tripping time to get to the next casing point.

There are also some drawbacks of using a natural diamonds bits. The slow rate of penetration is one of the main down sides of using this kind of bits. The diamonds are set into a steel body; roughly two thirds of the cutter length is embedded into the bit head which can cause easy balled bits in soft formation, for this reason the natural diamonds bits are used for hard, abrasive formations.

The natural diamond bits require relatively high RPM and moderate WOB. High hydraulic horsepower is not a major requirement, so the jet nozzles are not used.

The drilling fluids flow through orifices then by flow channels cut into the bit head to promote cutter cooling and cleaning.

Figure 2.7 – Diamond Drilling Bits

Table 2.4 – Drill bit characteristics

Depth, m	Characteristic of rocks		Type of bits (manufacturer)	Recommended WOB, lb/in (N/m)	Recom-mended ro-tary speed, rpm
	Category of hardness	Category of abrasives			
0-700	II	II	311D519M122 DB Bits	250-2500 45000-450000	60-350
700-2300	IV – VI	IV-V	216M513M233 Drill Master	200-2,500 36000-450000	60-350
2300-2900	VI	V	152M613M333 Smith Bits	500-4,000 90000-720000	60-400

2.4 Drill string

2.4.1 General information about drill pipes

The drill string means the tubulars and the accessories used to run the drill bit to the bottom. The drill string is composed of drill pipe, heavy weight drill pipe, drill collars and other components like stabilizers and drilling jars.

There are many functions of the drill string among them:

- Suspend the drill bit
- Transmit the rotary motion from the Kelly or top drive to the drill bit
- Provide a flow path to circulate drilling fluids

The bottom hole assembly BHA is the components used above the bit without taking in consideration the drill pipe.

Drill pipe

The drill pipe constitutes the majority of the drill string length. It is seamless with threaded connections. The drill pipe has two tool joints, one female is called a box and the other male is called pin. The outer diameter of the tool joint is larger than the body of the drill pipe to accommodate the threads.

One drill pipe is called a single or a joint. The dimensions of the drill pipe are specified by the API (American petroleum Institute). There are three ranges of length; range 2 is most common on rig sites. The drill pipe must be measured on rig site to get accurate length of drill pipe. The drill pipe is manufactured in verity of weight, diameters and also materiel grades. The specification of drill pipe can appear as: (5" 19.lb/ft Grade S Range2).

Figure 2.8 - Drill Pipe Joints

The drill pipe is characterized by burst, collapse, tensile and torsional strength. These specifications are used to select the appropriate drill pipe for a particular drilling operation.

The weight of the drill pipe mentioned in the manual is called weight in air. When drill pipe is in the well, it has to be taken in consideration the buoyancy force which is related to density of the drilling fluid. The weight of the drill pipe when run in the well can be calculated as follows:

Buoyant weight= weight of pipe in air x buoyancy factor

Drill pipe stress and failure:

The drill pipe can be exposed to many stresses:

- Tension: due to hole problems, an overpull can be exerted causing extra tension on the drill pipe (ex: stuck pipe). This tensile load can lead to drill pipe failing.

- Torsion: Bad hole conditions can increase the twisting force and torque on each joint leading to poor rotation transmission from the surface to the bottom.

- Cyclic fatigue: The wall of the drill pipe while drilling deviated wells is exposed at point of bending to tensile and compressive forces. While rotating the drill string, the same point on a drill pipe sustains a cycle tensile and compressive forces. This cyclic stresses can result in fatigue of the drill pipe.

Also there are other causes of fatigue like abrasive friction, vibration and bit bouncing off bottom.

- Corrosion is also another issue which can affect drill pipe strength; corrosion can be due to presence of dissolved gases and acids. Carbone dioxide can form acid dioxide which can lead to steel corrosion.

- The hydrogen sulfide can be present in the formation. It can cause hydrogen embrittlement or sulfide stress cracking. The surface of the steel absorbs the hydrogen in the presence of the sulfide. When the concentration will be greater than a certain level(less than 13 ppm), cracks can appear on pipe body. The combinations of stress and cracks leads to pipe failure.

Tool joints:

The tool joints provide screw threads in order to connect drill pipes together. The seal is guaranteed by the shoulder/shoulder connections between pin and box. Hard facing material is welded on the surface to protect the tool joint from abrasive wear when rotating drill string in the borehole or when making connection by rig tongs. This layer of hard facing material can be replaced in workshops when it becomes depleted due to excessive wear. The internal diameter of the tool joint is less than the internal diameter of main body. The same stresses applied on the drill pipe during drilling operations are subjected on the tool joint, but also there are other additional issues:

- During operations, frequent engagement of box and pins can be done harshly which can damage the threads.

- When tripping out of the hole, the last tool joint support all the weight of the string beneath it.

Figure 2.9 - Drill Pipe Tool Joints

Heavy weight drill pipe (HWDP)

Heavy weight drill pipe has a greater wall thickness if we compare it with the wall thickness of ordinary drill pipe. It is used instead of drill pipe where the stresses concentration is important. These stresses are due to:

- The sharp difference in cross section between the drill pipe and drill collars.
- The difference in stiffness between the drill pipe and drill collars
- The bouncing caused by the bit while drilling

The main benefit of using the HWDP is absorbing the stresses being transferred from the drill collars to the drill pipe. The use of HWDP between drill collars and drill pipe can minimize the stresses caused by the high level of difference in stiffness.

Figure 2.10 – Heavy Weight Drill Pipe

The heavy weight drill pipe is characterized by many features:

- High wall thickness
- Long tool joint
- More hard facing

For operations, the heavy weight drill pipe should be operated in compression; in order to maintain the compression while drilling highly deviated wells/

Drill collars:

Drill collars have larger outer diameter and smaller inner diameter than drill pipe. The functions of drill collars are:

- Provide the required weight on bit while drilling
- Maintain drill string in tension which reduces bending and fatigue failures.
- Provide stiffness for directional control

The connection thread of a drill collar can be machined directly on the body due to the large wall thickness. In order to prevent failure, correct make up torque has to be applied. It is very important to handle drill collars carefully. Shoulders and threads should be lubricated with lubricant containing 40% to 60% of metallic-zinc powder.

Figure 2.11 – Drill Collars

Similarly to drill pipe, drill collars are subjected to different stresses caused by:

- Bending and buckling forces
- Tension
- Vibration
- Alternate tension and compression

There are other types of drill collars used for special operations:

- Spiral drill collars are used to avoid stuck while drilling through highly porous formation. The stuck can occur when high overbalanced of mud pressure is applied or while drilling high deviated wells. Among the methods used to minimize the risk of differential sticking is reducing the contact area between the collars and wellbore. In order to reduce the surface contact, spiral grooves are cut on collars.

- Nonmagnetic collars: this type of collars is used to isolate survey instruments from magnetic distortion caused by the steel of the drill string. The magnetic distortion can affect the directional instrument functioning.

Other drill string components:

Stabilizers

Stabilizers are piece of pipe with blades machined on the external surface. The blades can be spiral or straight, normally they are 3 blades. They have many functions

- Reducing bending and buckling stresses on drill collars
- Remaining the string in concentric position which allows higher WOB.

- Preventing stuck by differential sticking.

During operations, stabilizers can wear and become under-gauge. If the stabilizers become 3/16" under-gauge, they have to be replaced to operate effectively.

Figure 2.12 – String Stabilizers

1. The diameter of the drill collar is selected taking into account the diameter of the bit based on the following conditions

$$\frac{d_c}{D_b} = 0.75 \div 0.85 \text{ if } D_b \le 295.3 \text{ mm;}$$

Then

$$d_c = (0.75 \div 0.85) \cdot D_b = (0.75 \div 0.85) \cdot 152 = 114 \div 130 \text{ mm.}$$

In accordance with State Standard at the drill collar we accept $d_c =$ 120 mm.

The weight of 1 m of these collars is q_c = 635 N.

The diameter of the drill pipe is chosen from the ratio

$$\frac{d_{dp}}{d_c} = 0,75 \div 0,80,$$

Then

$$d_{dp} = (0.75 \div 0.80) \cdot d_c = (0.75 \div 0.80) \cdot 120 = 90 \div 96 \text{ mm.}$$

In accordance with State Standard, we accept for drill pipes $d_{dp} =$ 89 mm.

TBNK-89.

2. The bottomhole assembly (BHA) is designed taking into account the profile of the wellbore and the tendency of the rocks to bend the well. Since the well is vertical, we use an above-bit calibrator, one drill collar of the maximum possible diameter (UBTS1-146), a stabilizer, and then a drill collar of the calculated diameter.

Since the layout is single-stage, the required length of the drill collar is determined by the formula

$$l_c = \frac{K \cdot WOB}{q_c\left(1 - \frac{\rho_{fl}}{\rho_m}\right)},$$

where

K – safety factor, K=1.20-1.25;

WOB – weight on bit, N;

ρ_{fl} – density of drilling fluid, kg/m^3;

ρ_m – metal density, kg/m^3;

q_c – weight of 1 m of drill collar, N/m.

The resulting length of the drill collar is rounded up to a value that is a multiple of the length of the stand.

$$l_c = \frac{1.25 \cdot 60000}{635 \cdot \left(1 - \frac{1610}{7850}\right)} = 148.5 \text{ m}.$$

We accept a multiple of the length of the stand (25 m) l_c = 150 m.

The weight of the drill collar is

$$G_c = l_c \cdot q_c = 150 \cdot 635 = 95250 \text{ N}.$$

The length of the collar is checked for stability against its own weight. For this, the critical length of the drill collar is determined by the formula

$$l_c^{cr} = 1{,}94\sqrt{\frac{EI}{q_c}},$$

where

E – elastic modulus of material (steel), N/m^2;

I – bending moment of inertia, m^4

$$I = \frac{\pi}{64}\left(d_{out}^4 - d_{in}^4\right),$$

where

d_{out}, d_{in} – outside and inner diameter of the drill collar respectively, m.

$$I = \frac{\pi}{64}(0.120^4 - 0.064^4) = 9.36\cdot10^{-6}\ m^4.$$

Then

$$l_c^{cr} = 1.94\sqrt{\frac{2.1\cdot10^{11}\cdot9.36\cdot10^{-6}}{6.35}} = 107.9\ m.$$

Because $l_c \geq l_c^{cr}$, then, to prevent possible borehole curvature, we include centralizers in the drill collar assembly.

Above the drill collar we place the heavy weight drill pipes. To do this, we select pipes made of steel of strength group "D" with the greatest wall thickness and length 300 m, q_{dp} = 224 N.

Its weight is

$$HWDP = l_{HWDP}\cdot q_{HWDP} = 300\cdot 212 = 63600\ N.$$

2.4.2 Drill string design

First section

When determining the design of the drill string, we assume that the drill string has a single-stage design. For the first section, we accept drill pipes of strength group "D" with a minimum wall thickness (9 mm). TBNK-89×9.

The length of the first section is determined from the condition of permissible tensile stresses by the formula

$$l_1 = \frac{Q_{t1} - K_f\left(G_c + G_{abs}\right)\left(1 - \frac{\rho_{fl}}{\rho_m}\right) - P_b F_p}{Kq_1\left(1 - \frac{\rho_{fl}}{\rho_m}\right)};$$

$$Q_{t1} = \frac{Q_t}{K_1 n},$$

where

Q_{t1} is the permissible tensile load for pipes of the first section, N;

K_f – coefficient of friction (K_f=1.15);

G_c – collar weight, N;

G_{abs} – weight of the above-bit set, N;

P_b – bit pressure loss, Pa;

F_p – drill pipe flow area, m^2;

q_1 – weight of 1 m of drill pipes of the first section, q_1 = 178 N/m;

Q_t – tensile load limit determined from the yield point of the pipe material σ_t, N for steel grade “D” σ_t = 380 MPa;

$$Q_t = \sigma_t \cdot F_{cs}.$$

F_{cs} – cross-sectional area of the drill pipe body, m^2;

n – safety factor (since rotary drilling n = 1.4);

K_1 is the coefficient that takes into account the effect of torque and bending moment (rotary drilling K_1=1.04).

Then

$$Q_{t1} = \frac{380 \cdot 10^6 \cdot 0.785\left(0.089^2 - 0.071^2\right)}{1.04 \cdot 1.4} = 590043 \text{ N}.$$

Then the length of the first section

$$l_1 = \frac{590043 - 1.15 \cdot (952505 + 63600)\left(1 - \frac{1610}{7850}\right) - 12 \cdot 10^6 \cdot 0.785 \cdot 0.071^2}{1.15 \cdot 178 \cdot \left(1 - \frac{1610}{7850}\right)} = 237$$

6 m.

In accordance with the length of the stand, we take l_1 = 2375 m.

Second section

Since the total length of the BHA, drill collar and the first section is less than the depth of the borehole, we install the second, stronger one after the first section. (wall thickness 11 mm, weight 1 m 212 N). TBNK-89×11. The length of the second section is determined by the formula

$$l_2 = \frac{Q_{t2} - Q_{t1}}{kq_2\left(1 - \frac{\rho_f}{\rho_m}\right)}.$$

Where

$$Q_{t2} = \frac{380 \cdot 10^6 \cdot 0.785\left(0.089^2 - 0.067^2\right)}{1.04 \cdot 1.4} = 703135 \text{ N.}$$

Then the length of the second section

$$l_2 = \frac{703135 - 590043}{1.15 \cdot 212 \cdot \left(1 - \frac{1.61}{7.85}\right)} = 583 \text{ m.}$$

In accordance with the length of the stand, we take l_2 = 575 m.

Since while the total length of the sections, drill collars and BHAs exceeds the design depth of the well, the length of the second section will be

$$l_2 = L_w - l_c - l_{HWDP} - l_1 = 2900 - 150 - 300 - 2375 = 75 \text{ m.}$$

The drill string design is given in the summary table.

Table 2.5 – Drill string design

Indicators	Section number			
	Collar	HWDP	1	2
Outside diameter of pipes, mm	120	89	89	89
Wall thickness, mm		11	8	9
Strength group of pipe material		D	D	D
Section length, m	150	300	2375	75
Weight 1 m, N/m	635	212	178	212
Section weight, N	95250	63600	422750	15900
Total weight, N	597500			

2.5 Selecting the drilling mode

I. Drilling mode for in the interval of 0-700 m with a PDC drill bit 311D519M122.

1. Weight on bit WOB

$$WOB = c_s D_b,$$

where

c_s – specific load per unit diameter, specific load for 311M613M122 drill bit is c_s = 250000 N/m;

D_b – bit diameter, m.

Then

$$WOB = 250000 \cdot 0.311 = 77750 \text{ N}.$$

Then we take WOB = 77000 N.

2. Rotary speed

$$n_д = \frac{60 \cdot 3}{3.14 \cdot 0.311} = 184 \text{ min}^{-1}.$$

We accept $n_д = 180$ min^{-1}.

3. The flow rate of the drilling fluid is based on two conditions

a) From the condition of cleaning the bottom of the cuttings

$$Q_1 = q_0 F_b,$$

where

q_0 – specific consumption of drilling fluid, m^3/s per 1 m^2 of bottomhole, since we are drilling rotary, we take q_0=0.4 m^3/s;

F_b – bottomhole area, m^2;

$$Q_1 = 0.4 \cdot 0.785 \cdot 0.311^2 = 0.030 \text{ m}^3/\text{s};$$

b) from the condition of transporting sludge in the annular space

$$Q_2 = V_{min} F_{as}$$

where

V_{min} – the minimum permissible speed of movement of the drilling fluid in the annular space, since the bit is of large diameter, then we take V_{min}=0,4 m/s.

F_{as} – the area of the annular space between the drill pipe and the borehole walls, assuming a vugness factor of 1.2, we have

$$Q_2 = 0.4 \cdot 0.785 \cdot ((1.2 \cdot 0.311)^2 – 0.089^2) = 0.041\ m^3/s.$$

We accept the biggest value

$$Q = 41\ l/s.$$

II. Drilling mode for in the interval of 700-2300 m with a PDC drill bit 216M513M233.

1. Weight on bit WOB

$$WOB = c_s D_b,$$

where

c_s – specific load per unit diameter, specific load for 216M613M233 drill bit is c_s = 250000 N/m;

D_b – bit diameter, m.

Then

$$WOB = 250000 \cdot 0.216 = 54000\ N.$$

Then we take WOB = 54000 N.

2. Rotary speed

$$n_д = \frac{60 \cdot 3}{3.14 \cdot 0.216} = 265\ min^{-1}.$$

We accept $n_д = 270\ min^{-1}$.

3. Drilling fluid consumption

a) from the condition of cleaning the bottom of the cuttings

$$Q_1 = 0.4 \cdot 0.785 \cdot 0.216^2 = 0.014\ m^3/s;$$

b) from the condition of transporting sludge in the annular space

$$Q_2 = V_{min}F_{as}$$

The minimum permissible speed of movement of the drilling fluid in the annular space, since the rocks are of medium hardness, then we take V_{min}=1 m/s.

F_{as} is the area of the annular space between the drill pipe and the borehole walls.

$$Q_2 = 1 \cdot 0.785 \cdot ((1.2 \cdot 0.216)^2 - 0.089^2) = 0.046 \text{ m}^3\text{/s}.$$

We accept Q = 46 l/s.

III. Drilling mode for production casing in the interval of 2300-2900 m with a PDC drill bit 152M613M333.

1. Weight on bit WOB

$$WOB = c_s D_b,$$

where

c_s – specific load per unit diameter, specific load for 152M613M333 drill bit is c_s = 400000 N/m;

D_b – bit diameter, m.

Then

$$WOB = 400000 \cdot 0.152 = 60800 \text{ N}.$$

Then we take WOB = 60000 N.

2. Rotary speed

$$n_д = \frac{60V_p}{\pi D_b},$$

where

V_p – peripheral speed, m/s, for this conditions V_p = 1.5 m/s;

D_b – drill bit diameter, m;

$$n_д = \frac{60 \cdot 3}{3.14 \cdot 0.152} = 378 \text{ rpm}.$$

We accept $n_д = 380$ rpm.

3. Consumption of drilling fluid

a) from the condition of cleaning the bottom of the cuttings

$$Q_1 = 0.4 \cdot 0.785 \cdot 0.1524^2 = 0.007 \text{ m}^3/\text{s};$$

b) from the condition of transporting sludge in the annular space

$$Q_2 = V_{min} F_{as}$$

The minimum permissible speed of movement of the drilling fluid in the annular space, since the rocks are of medium hardness, then we take V_{min}=1 m/s.

F_{as} – the area of the annular space between the drill pipe and the borehole walls.

$$Q_2 = 1 \cdot 0.785 \cdot (0.166^2 - 0.089^2) = 0.015 \text{ m}^3/\text{s}.$$

We accept the biggest value

$$Q = 15 \text{ l/s}.$$

The calculation results are summarized in the table.

Table 2.6 – Drilling mode

Depth	Drill bit	Drilling mode		
		Weight on bit, N	Rotary speed, rpm	Fluid flow, l/s
0-700	311D519M122	77000	180	41
700-2300	216M513M233	54000	270	46
2300-2900	152M613M333	60000	380	15

2.6 Well circulation

Substantiation of the density of the drilling fluid

We select the density of the drilling fluid according to the combined pressure graph and refine it for each interval of compatible drilling conditions using the formula

$$\rho_f = \frac{\alpha P_r}{gH};$$

where

P_r – reservoir pressure in the well interval for which ρ_f, Pa;

g – free fall acceleration, m/s^2;

H – hole top depth, m;

α – standard coefficient, which, in accordance with the requirements of the rules for conducting drilling operations, determines the pressure reserve in the bore-hole above the reservoir.

1. Density in the range 0-700 m (since H <1200 m, we take α = 1.12).

$$\rho_f = \frac{1.12 \cdot 700 \cdot 10500}{9.81 \cdot 700} = 1198 \text{ kg/m}^3.$$

Accept $\rho_f = 1200$ kg/m^3.

2. Density in the interval 700-2300 m (since H = 2500 m, we take α = 1.07).

$$\rho_f = \frac{1.07 \cdot 2300 \cdot 13000}{9.81 \cdot 2300} = 1417 \text{ kg/m}^3.$$

Accept $\rho_f = 1420$ kg/m^3.

3. Density in the interval 2300-2900 m (since H = 2500 m, we take α = 1.05).

$$\rho_f = \frac{1.05 \cdot 2900 \cdot 15000}{9.81 \cdot 2900} = 1607 \text{ kg/m}^3.$$

Accept $\rho_f = 1610$ kg/m^3.

2.7 Selecting a drilling rig

We select the drilling rig according to the rated lifting capacity in accordance with the largest weight of the drill or casing string in the air.

To determine the greatest weight of the string, we will compile a comparative table of the weight of the drill and casing strings.

Table 2.7 – Weight of the strings

Indicators	Drill string	Intermediate casing	Production casing
Column length	2900	2300	2900
Weight 1 m, N		249	167
Column weight, N	597500	577200	484300

Drilling rig drive type is selected depending on regional conditions. Taking into account the experience of work in this area, the drilling of the projected well will be carried out using a drive from an internal combustion engine.

To determine the largest string weight, we will compile a comparative table of the weight of the drill and casing strings.Thus, the intermediate column has the maximum weight.To drill a well, we choose the Uralmash 3D-76 drilling rig.

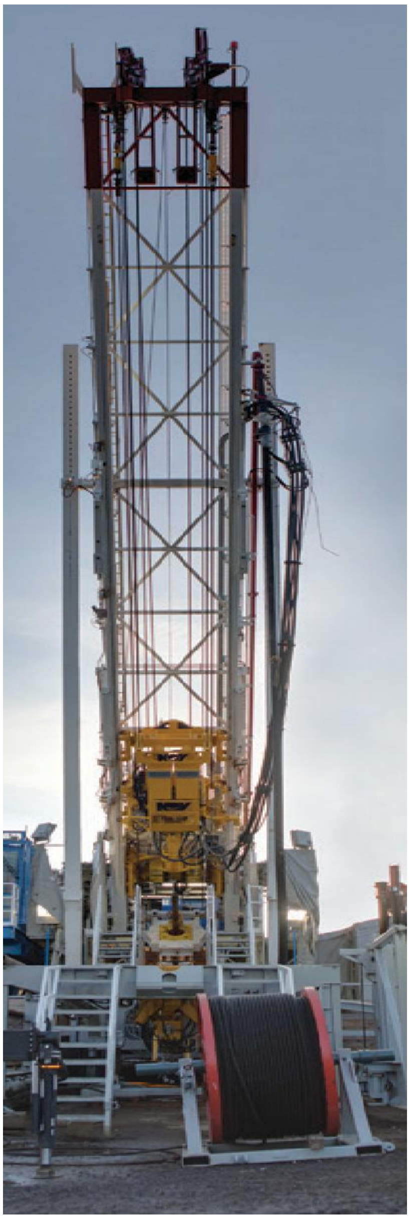
It is designed for drilling production and exploration wells for oil and gas with a nominal depth of 5000 m in a temperate climate, climatic version “U”, category I.

Specifications:

Table 2.8 - Velocity Series

Velocity Series	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Vertical Slant (VSR)	**20 ft 6 in. (6.25 m)**	**19 ft 4 in. (5.89 m)**	**1 ft 2 in. (0.36 m)**	**12 ft 6 in. (3.81 m)**	**14 or 20 ft (4.27 or 6.10 m)**	**76 ft (23.16 m)**	**90 or 96 ft (27.43 or 29.26 m)**

Table 2.9 - Conventional Substructures and Drilling Masts



Rig Model Specifications	Vertical Slant (VSR)
Hook capacity	100 or 150 ton (90.71 or 136.07 mt)
Mast type	Telescopic
Mast height	75 ft 4 in. (23.16 m)
Base width	6 ft 4 in. (1.93 m)
Raising method	Cylinder raised
Applicable drawworks (no. of lines)	D700AC (6)
Substructure type	Swing-up, box-in-box
Casing capacity	280,000 lb | 140 ton (127 mt)
Floor height	14 or 20 ft (4.2 or 6.1 m)
Cellar/clearance height	12 ft 6 in. or 18 ft (3.8 m)
Drill floor opening	27½ in.
Standard crown sheave groove	1⅛ in.

Mast and substructure

• Default is vertical, but capable of slant operation up to 45°

• Small footprint to accommodate small site areas

• Advanced hydraulics system allows mast to be positione perfectly over wellbore at whatever angle is required

• Telescoping mast travels with top drive, torque wrench, and pipe handler to shorten rig-up time

• Substructure quickly loads onto a separate trailer for easy transportation

Amphion and driller's cabin

• Integrated control system for managing, controlling, and monitor ing rig floor equipment for safe and efficient operations

• Configurable control screens and a CCTV screen maximize the driller's operational efficiencies and awareness

• Touch screens are user friendly, respond quickly, and allow simultane ous monitoring of multiple equipment on one screen

• Ergonomic, adjustable, climate-controlled workstation

• Multi-tool controllers, complete with battery back-up, and Redundant power network; protects the system against power loss

Hydraulic torque wrench

• Compact and lightweight

• Capable of operating at an angle

• Simple operation; ideal for quick, repetitive procedures

• 2⅞-to 14⅜-in. tubular connection range

• Makeup/breakout torque up to 0-100,000 ft-lb

Top drive — TDS-150

• Most powerful 150-ton AC top drive on the market

• Pull-down capacity of 80,000 lb

• Slant drilling capability available to run on mast rails with integrated block • 150-ton dynamic and static capacity

• Dual 250-horsepower AC induction motors

• 24,700 ft-lb continuous torque and 36,500 ft-lb intermittent torque

At 100 rpm

D**rawworks — D700 AC**

• Unique AC motor performs main braking; motor in con-junction . with the VFDs is capable of stopping and holding maximum . . hookload at zero speed indefinitely

• No HPU or brake water cooling system require

• 700 horsepower

• 150-ton hoisting capacity

• Two caliper disc brakes

Pipe-handling system

• Pipe brought directly to well center

• Personnel removed from danger area while picking up and laying . down pipe

• Need for manual handling eliminated

BOP — Model 6012 ram 11 in. 3,000/5,000 psi

• Proven performance, rugged, powerful and capable of op-erating in . . harsh environments

• Hydraulically actuated doors for ease of service and ram replacement

• Manufactured from forged materials that meet H2S Service in

accordance with NACE MR0175

• Proven trim package is standard and includes Xylan coat-ing in the

through bore, ram cavities, and all wellbore wetted surfaces

• Hard coatings on dynamic sealing surfaces

• Only two hydraulic connections required per ram

• Optional large-bore shear bonnets and boosters and option-al

Model 6000 shear ram

• BOP hoists transport BOP to well center assembled

Mud pumps — F-1000, Triplex

• Rugged Fabriform construction

•Design engineered for optimum performance under severe drilling conditions

• 1,000-horsepower at 140 spm

• Low weight-to-horsepower ratio

Mud pumps — 8-P-80, Triplex (optional)

• High strength and lightweight for easy portability

• Multiple liner sizes allow pressures and volumes to handle circulation . requirements in deep drilling applications

• 800-horsepower at 160 spm

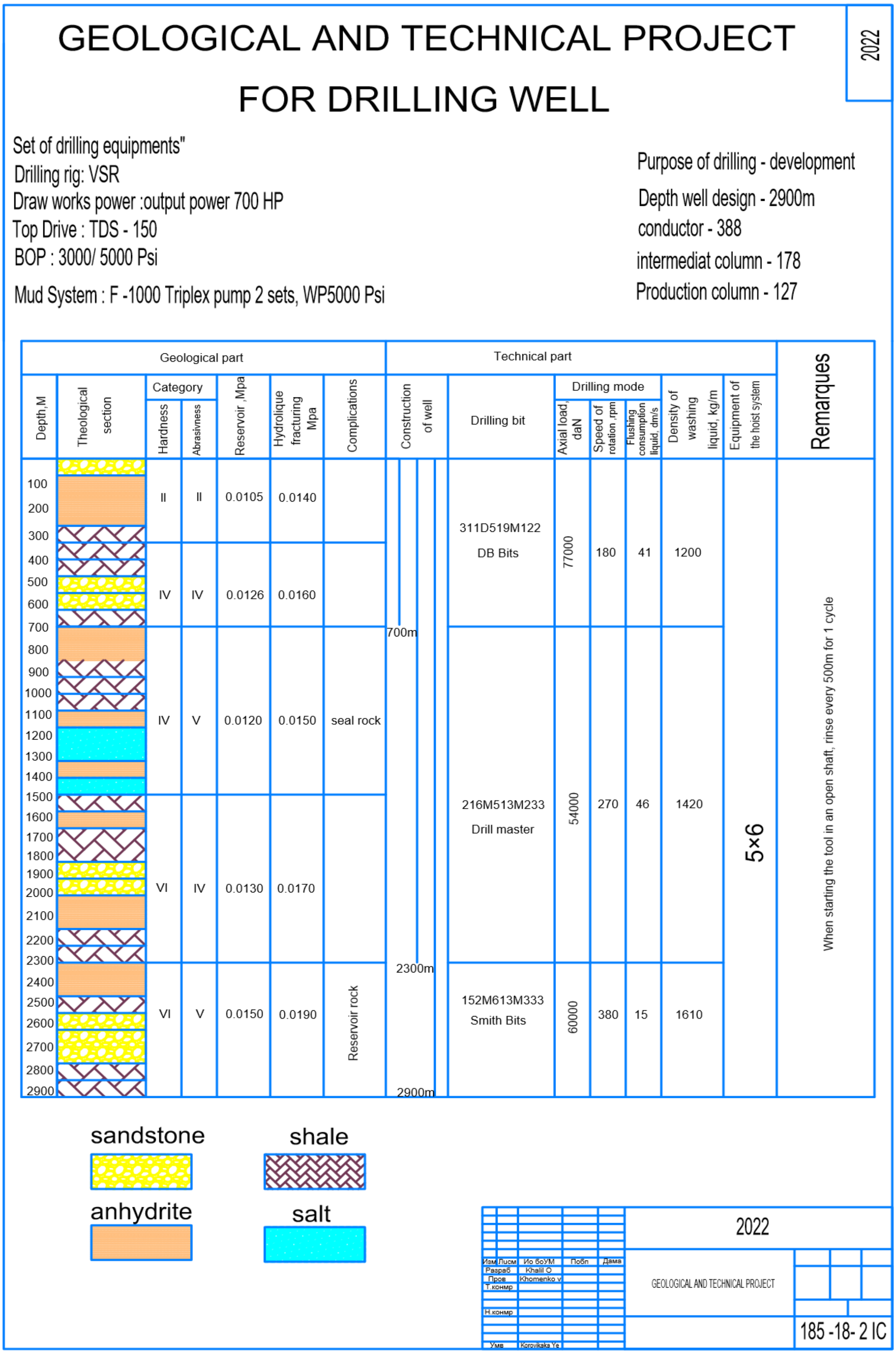


Figure 2.13 – Geological and Technical Project

3 LABOUR PROTECTION

3.1 Training and instruction of workers

The quality of vocational training and education of workers in safe working methods is one of the most important factors in reducing the level of injuries at work.

The training of new skilled workers for the oil and gas industry is carried out both in the production and technical schools (PTS) for vocational education, and directly at the enterprises and organizations of the industry.

3.2 Preparing the rig for drilling

The analysis of drilling accidents suggests that most of them occur as a result of the use of inappropriate working practices.

In order to reduce injuries, a high qualification of workers is required, their knowledge of the technical features of well drilling, the purpose, design and operating rules of equipment and mechanisms, correct and safe work practices, as well as; high level of technical supervision.

Improvement of labor organization, mechanization of heavy and laborintensive work, rationalization of technological processes, implementation of new types of equipment, mechanisms and tools the main directions for increasing labor productivity and creating a healthy and safe working environment at drilling rigs. When drilling oil and gas wells, a significant number of accidents occur during the operation of equipment. Correct installation and timely maintenance of it create conditions for further safe work. Therefore, before putting into operation only the mounted drilling rig, it is necessary to check its equipment with safety devices and devices, elements of small mechanization, control and measuring instruments and spare tanks.

Before starting drilling, the driller must have the following documents:

1. Well placement certificate.
2. Geological and technical outfit.
3. Approved layout of drilling and power equipment.

4. Passport for a drilling rig, drilling and power equipment, hoist line, drill pipes,
instrumentation.
5. The act of pressure testing of the injection line of mud pumps.
6. The act of checking the condition and compliance with the standards of grounding resistance of electrical equipment, starting devices.
7. Test report for the travel block lifting limiter under the crane block.
8. The derrick fastening and cementing certificate.
9. Tower test certificate.

All members of the drilling crew must be familiar with these documents. Preparation of a drilling rig for drilling consists of the following activities: checking of all fastening parts on the drilling rig and drilling equipment, reequipment of the tackle system, borehole drilling, centering the tower with a rotor, cementing the equipment, creating directions.

The well construction cycle includes the following main types of work:

- preparatory and construction works
- drilling and fastening;
- tide test;
- dismantling of equipment.

The safe performance of these stages of work is ensured by compulsory compliance with the safety rules given in the current instructions and other regulatory documents for each type of work.

Each of the above documents contains safety rules for a specific type of work that is performed during the well construction process.

The most dangerous types of work are envisaged to be carried out under the guidance of a person who has the right to carry them out, sufficient work experience, knows well the spinning wheels of such work and the labor protection requirements when performing them.

At the same time, the most dangerous are works on installation, dismantling of the tower and equipment on it and moving it to another well in a vertical position, as well as: installation: (dismantling) of large and heavy drilling equipment using lifting mechanisms.

Installation, dismantling: and transportation of the tower and drilling equipment must be carried out in accordance with the requirements of the manufacturer's instructions, the approved layout of the drilling equipment and foundations, as well as: labor protection. The drilling base and live equipment are connected to the ground loop using metal bars, and the tower is equipped with a lightning rod. Before drilling the well, it is necessary to hold a start-up conference to familiarize with the working project with the participation of the entire drilling crew and the main UBR specialists.

3.3 Safety measures when performing work

The most dangerous types of work during the stage “Drilling and casing the well” are round-trip operations, collection and disassembly of the BHA, pulling the drill collar into the drilling rig and throwing it out onto bridges, work on replacing large-sized equipment that has failed, operation of drilling pumps, liquidation intensive gas showings, gas emissions and fountains, cargo handling and others.

When performing tripping operations, the most dangerous are accidents associated with the tightening of the traveling block under the crown block with the next break of the wireline, the fall of the tackle system into the drilling, and possibly the fall of the derrick. To prevent this type of accidents, work on lowering and lifting the drill string and casing should be carried out only if there is a working anti-tensioner of the traveling block under the crown block and a working brake system of the winch.

According to the operating conditions, the drilling tower belongs to the objects that require special attention, since they are susceptible to significant variable loads from zero to permissible, which necessitates increased control over its operation/

According to paragraphs. 3.2.1 - 3.2.3 “Safety rules in the oil and gas industry” and amendments to them., In order to prevent dangerous operation, the drilling rig, crown block, crown block frame, undercrown block beams are subject to inspection at least once every two months by a mechanic and a drilling foreman, as well as, at least once a year, a thorough inspection by a special team to inspect the drilling rigs; in the manner prescribed by the approved methodology. After 7 calendar years, the rig must be inspected by a special commission with the participation of the chief specialists of drilling and rig-assembly organizations and, if there is a conclusion about its suitability for fur ther operation, it must be tested for carrying capacity. If the test results are positive, the commission sets the term for further operation of the tower, but not more than 5 years.

In the future, in an exceptional manner, the operation of the tower can be extended for another 3 years, but only after its complete disassembly with revision of all units and elements, rejection and replacement of some of them unsuitable for further operation, assembly and subsequent testing.

In all cases of operation of the tower for more than 7 years, it should be annually inspected by a commission with the participation of chief specialists, drawing up an act on its technical condition and a conclusion on the suitability of the tower for further operation. In addition, the tower status is checked:

- before running the casing;
- before the start and after the end of fishing operations, which require the stuck pipe string to be pacing;
- after a strong wind at a speed of 15 m / s for an open area and 21 m / s - for a forest and in a hollow;
- after the end of the installation.

The introduction of lubricating additives and chemicals into the drilling mud is provided through the mud cleaning system in accordance with safety rules and instructions for their safe use, and the maintenance personnel must be provided with personal protective equipment in advance, based on the type of chemicals that are used.

When working with drilling tongs, which are used for screwing and unscrewing drill pipes, the presence of people in the range of these tongs is not allowed, which will eliminate the possibility of injury to the maintenance personnel.

To prevent rupture of the injection and auxiliary service lines during the circulation and pumping of drilling mud and chemicals, mud pumps and pumps for household needs are equipped with safety devices.

Intensive gas shows, gas emissions and fountains are the most dangerous types of complications and accidents. Prevention of gas seepage and gas fountains

in compliance with the "Temporary instruction for the prevention of gas and oil water seepage, emissions and open flowing during well drilling":

- selection of an appropriate well design;
- selection of casing strings of appropriate strength;
- selection of the density of the drilling fluid, which ensures the implementation of the required hydrostatic pressure in the well, exceeding the formation pressure;
- wellhead sealing with blowout preventer equipment;
- availability of reserve drilling mud with a volume of at least one well volume;
- availability of a drilling crew trained in practical actions to prevent and eliminate gas and gas outbursts.

Operation of pressure vessels must be carried out in accordance with the requirements of the “Rules for the installation and safe operation of pressure vessels”.

Operation of electrical equipment, power and lighting lines must be carried out in accordance with the requirements of the “Rules for the safe operation of electrical installations of consumers

Repair work that is carried out in the process of drilling a well using an electric welding machine must be carried out by persons who have permission and work experience in compliance with the rules and instructions for labor protection in accordance with the approved list.

According to the Rules for the Development of Gas and Gas Condensate Fields, well development is envisaged to be carried out only with the appropriate pressure Christmas tree installed at the wellhead and piping the flow manifold of the well, which makes it possible to carry out the necessary sampling, measurement of pressure and temperature.

Fountain fittings should be fixed and pressurized to the pressure allowed for pressurizing the production casing, and the discharge manifolds should be pressurized to 1.5 times the pressure expected at the wellhead.

The most dangerous types of work during well testing are perforation work, when unauthorized shots are possible, as well as possible gas showings when perforating productive horizons. In order to prevent gas emissions during perforation, blowout equipment is installed at the wellhead, and perforation work is planned to be carried out in accordance with the safety requirements specified in section. 12 “Safety Rules”. All work on well testing is planned to be carried out under the supervision of a responsible engineer and technical worker in compliance with the requirements of Section 4.10. “Safety rules in the oil and gas industry”. When conducting research in a well, the measurable line is supposed to be fixed on at least two supports, one of which is installed at the end of the DVKT line. Near the Christmas tree and near the DVKT, to replace the diaphragms, it is planned to install sites of a stationary or mobile type.

Before replacing diaphragms, the tested line must be vented to atmospheric pressure. Ignition of the gas that comes out of the flow lines is provided with the help of a rocket launcher, and at low flow rates of a long-burning hearth, which is bred before opening the valve.

When working with a lubricator at a height, it is planned to install a platform with a flooring made of metal sheets that exclude the possibility of sliding or boards with a thickness of at least 4 cm, a handrail with a height of 125 cm with longitudinal strips located at a distance of 40 cm from the bottom from one and a side height not less than 15 cm, which adheres tightly to the flooring. Well survey work should be carried out in accordance with the “Instructions for the Integrated Study of Gas and Gas Condensate Reservoirs and Wells”.

Drilling of a well using the existing technology is carried out around the clock, and therefore it becomes necessary to provide the workplaces of the drilling crew and other facilities with appropriate lighting.

During the construction of the well, it is envisaged to use personal protective equipment and overalls for workers of the drilling and rig crews. The list of personal protective equipment and overalls that meet the requirements of the current ST and TC.

The drilling crew must be provided with a set of labor protection instructions in force at the enterprise in accordance with the approved list, as well as) plans for the elimination of possible accidents and practical actions in case of oil and gas shows and open fountains.

3.4 Industrial hygiene

The process of drilling a well is accompanied by noise and vibration levels that can reach from 80 to 100 dB at permissible levels. The main sources of noise on the rig are: drawworks, rotor, mud pumps, DVZ, electric motors, vibrating screens and other mechanisms. Since the noise level may have certain deviations from the permissible, the maintenance personnel are expected to provide protective equipment in.

The control of noise and vibration levels is carried out by the labor protection service of the enterprise or by specialized organizations that have the appropriate permission, under contracts with the drilling organization.

In accordance with the requirements of the Occupational Safety Standards System (Occupational Safety Standards System), incoming inspection of equipment, instruments and tools is provided for their compliance with GOSTs and TUs before the start of installation and drilling operations, as well as the availability of passports for all equipment, instruments and tools.

It is planned to plan the drilling site with a slope towards earthen barns, and under the derrick, aggregate and pumping blocks - the construction of sewage trays in order to remove atmospheric precipitation and drilling wastewater.

The well is planned to be drilled by a drilling team of 36 people. Due to the continuous cycle of well construction, the robot of the drilling crew is carried out around the clock, in shifts. The maximum number of people on the rig is 13 people

Delivery of the drilling crew to the drilling site is envisaged by the shift motor transport in 8 hours., in connection with which it is planned to install carriage houses on the drilling site, in which the premises are located:

- for the driller (with permanent radio communication);
- for the rest of the members of the drilling crew;
- for work and leisure of specialists who have arrived on a business trip;
- power supply unit;
- dressing room with wardrobes, one compartment for 1 chol.;
- for drying workwear;
- shower room for 1 mesh;
- washbasin for 2 taps.

Drinking water consumption per person per day add up to 25 liters of jail and 11 liters of hot The average demand for drinking water per day is 0.3-0.5 m^3. Potable water storage areas must meet the requirements of Ch. 13.7 “Safety rules in the NGDP”.

Special waterproof pits or tanks are to be constructed for household wastewater, in which the wastewater is neutralized and transported to the nearest local treatment plant. It is planned to store solid household waste in closed metal containers and, as they accumulate, take it to the landfill. at a distance of 75 m from the working area, carriage houses and outside the sanitary protection zones of a water well, it is planned to build a toilet at two distances with a size of at least 1.6x1.2 m with a waterproof concreted cesspool with a volume of at least 13 household waste ... (The volume of the cesspool is taken from the calculation of the simultaneous maximum number of people at the drilling rig, 13 people, but the frequency of cleaning the hole is 1 time / year).

Meals for the members of the drilling crew are provided with the help of a boiler station for 9-12 seats.

Heating of the wagon houses is provided by water heating from the boiler room, mounted on the drilling rig. It is envisaged to build a pipeline with a diameter of 51 mm from the boiler room to the carriage houses, and on the branches of 32 and 25 mm.

It is planned to provide the drilling room with a first aid kit with a set of medicines and instruments and dressing materials for providing first aid to victims, as well as medical stretchers.

Communication with the management of the drilling organization and the personnel on duty is provided by means of a radio station.

3.5 Fire safety

When drilling a well, it is necessary to adhere to the requirements of the “Fire Safety Rules in the Gas Industry”.

At the drilling site, it is necessary to provide external water supply for fire extinguishing in accordance with the “Protocol of the technical meeting on the issues of external water supply of drilling sites for drilling units

The scheme provides for the installation of fire hydrants on the branches of the water supply from the water storage tank in the pumping room, the towerpower unit, the drilling mud cleaning and degassing unit, near the residential wagon houses, as well as a tap installed between the water well and the water supply tank for connecting the fire department driveway technology.

The placement of wagon houses for housing and amenity needs, storage, production and auxiliary premises, access roads and sites for the placement of special equipment must be performed in accordance with the requirements of the Fire Safety Rules, and the drilling rig is provided with primary fire extinguishing means.

The arrangement of residential wagon houses is provided separately from one another or in pairs to the end to each other. In the latter case, the exits from them should be located in opposite directions.

At a distance of 15 m from the wellhead, it is planned to build a site 12 m wide to accommodate fire fighting equipment in case of extinguishing a fire of gas and oil fountains.

Oil and PMM, which are used in the construction of a well, are fire hazardous. In order to prevent their ignition, appropriate metal containers are provided, which are equipped with level gauges and breathing tubes installed on the concreted sites, the area around which is heaped with an earthen embankment 1 m high.

It is planned to install a tank for storing oil for technological needs at the PMM site. Installation of a tank for oil on gutters is prohibited.

When oil is introduced into the drilling fluid and oil baths are installed, it is necessary to adhere to the requirements of the "Fire safety rules in the gas industry" clause.

The construction of an overhead power line is provided in such a way that a wire break does not create a fire hazard.

The placement of containers with PMM and oil is envisaged at a distance of at least 20 m from the premises of the power and pumping units and other buildings and structures, and the fuel pipeline is planned to be equipped with a shut-off valve, which is installed at a distance of 5 m from the wall of the machine room.

It is planned to equip the discharge pipes of the engines with spark arrestors, and discharge the discharge gases at a distance of at least 15 m from the wellhead when laying the discharge pipeline horizontally and 1.5 m from the roof ridge of the room - when laying it vertically. In places where exhaust pipes pass through a wall or roof that can burn, it is planned to leave a gap between the pipes and the structure of the room at least 15 cm, and wrap the pipe in these places with noncombustible material.

The electrical distribution board of the drilling mud cleaning and degassing unit is planned to be installed in an intensively ventilated place outside the degasser installation block, and ventilation windows are also provided in the roof and cladding of the block walls. Illumination of the unit for cleaning and degassing drilling mud and preventers is provided with explosion-proof lamps.

Conclusions for the section

Table 3.1 – The work provides all the necessary life safety measures

A Potentially dangerous factor	Factr
High pressure	A stream of liquid under pressure
Fire hazard	Ignition of combustible substance
No railing	Fall of workers
Electrical hazard	Electrical and electric shock
Desent – lifiting operations	Injure to moving part
High labor intensity of works	Body fatigue
Leakage of harmful substances	Poisoning and burns of the body

4

4 ENVIRONMENTAL PROTECTION

Environmental protection envisages measures aimed at ensuring the safety of settlements, rational use of land and water, prevention of pollution of surface and ground waters, the air basin, preservation of forests, nature reserves.

The main requirements for environmental protection during the operation of wells are the selection of downhole and surface equipment and the establishment of optimal modes of its operation.

In fulfillment of the specified requirements for the protection of the environment during the drilling of project wells, measures must be taken to ensure:

a) prevention of open flowing, decanter formation, absorption of drilling fluid, collapse of the walls of wells and interstratal flows of oil, water and gases in the process of wiring, development and their further operation;

b) reliable isolation in wells of oil-bearing, gas-bearing and water-bearing strata throughout the section;

c) tightness of all technical and casing strings, lowered into the well, their high-quality cementing;

d) prevention of deterioration of reservoir properties of productive strata, preservation of their natural state during opening, consolidation and development

Perforation and torpedoing of wells must be carried out in strict compliance with the current instructions. After the completion of drilling the well and perforating the string, to prevent a decrease in permeability and the bottomhole zone due to prolonged exposure to water or mud, the well should be developed in the shortest possible time.

If there is a danger of interstratal flows of oil, gas and water, it is not allowed to take measures to intensify the inflows of oil and gas.

When testing wells, development products should be collected in closed containers.

The transportation of auxiliary materials and solutions injected into the oil reservoir should be carried out in closed containers or containers, excluding their leakage.

If oil spills on the surface of the earth or enters a water body as a result of an oil and gas outburst, open flowing of a well or a pipeline accident, it is necessary to inform the authorities exercising state control over the state of water bodies, no later than 3 hours from the moment of detection, stop taking surface and groundwater for drinking water supply and take measures to prevent further spread of pollution.

Oil spilled from the surface of the object must be localized, collected by technical means and methods that are harmless to the inhabitants of water bodies and do not have a harmful effect on the conditions of sanitary water supply, and sent to oil treatment plants or treatment facilities.

On a contaminated plot of land, the collection or neutralization of pollution should be carried out, followed by land reclamation in. If the embankment and waterproofing of the sections are violated, they must be restored.

A significant plot of land is temporarily taken away for the construction of a well. After the completion of drilling and testing of the well, most of the land is to be returned to the land user in a reclaimed form. Therefore, by the beginning of construction and installation work, it is necessary to remove the working layer and store it on a separate site, and after the end of drilling, use the removed working layer to restore the fertility of this area.

The main sources of environmental pollution during drilling are flushing fluid and reagents that are used to regulate properties; particles of rocks or blowouts from the well of formation fluids and drilling mud during gas showings; when mastering and testing; remnants of grouting solutions.

Minimizing environmental pollution while drilling is possible only through complex problem solving. To do this, it is necessary to use metal or concrete vats to provide flushing fluids, reagents, oil and petroleum products, and to collect and temporarily store all cuttings, reservoir and drilling wastewater (BSW), earthen pits with a sufficiently high and reliable embankment, which cannot be destroyed by storm water. The bottom and walls of earthen barns must have good waterproofing so that liquids and chemicals that are stored cannot penetrate into groundwater horizons and natural water bodies. Drainage ditches are to be built around the rig to remove DWW and spilled drilling fluid into a sump.

During drilling operations, a large amount of wastewater is generated. It is recommended that they be cleaned and reused.

Combustible gases that are released during degassing of the drilling fluid or during the development, testing of the well are burned in a special torch, which is installed no closer than 100 m from the well.

If the gas contains H_2S, then simply burning it is not enough, since when H_2S is burned, sulfur oxides that are heavier than the air are formed and form a very toxic sulfuric acid with moisture. Therefore, H_2S and other highly toxic components of formation fluids must be neutralized while in the well or in the cleaning system of the drilling rig

After completing the drilling of the well, the area to be reclaimed must be freed from drilling mud and cuttings that remained in the vats.

To prevent the penetration of drilling waste and well testing waste, household wastewater, and contaminated rainwater from the drilling site into the soil, a system for the accumulation and storage of drilling waste is organized, which includes:

- the formation, through appropriate planning, of technological sites, their waterproofing and the installation of trays for transporting wastewater to the collection point;

- construction of storage pits, which provide separate collection of drilling waste and well test products by type. It is envisaged to clean drilling wastewater from suspended and oil mixtures to the concentration of substances dissolved in them within the permissible limits in accordance with the "Hygienic standards of the Ministry of Health Healthy Me" 1003-72 and discharge to the area after agreement with the authorities of the sanitary and epidemiological service.

Purified BSV must meet the following requirements:

- pH - 5-9

- mech mixtures - up to 30 mg / l
- content of oil products
- up to 50 mg/l.

BSV cleaning is carried out by the method of chemical coagulation using coagulant aluminum sulfate Al_2. A 19% aqueous coagulant solution is prepared at the drilling rig in advance in a 25 m^3 tank. Mixing of the solution is carried out using a TsA-320M unit, or with compressed air. Treatment of contaminated water is carried out using the pump of the TsA-320M unit by spraying the solution onto the surface of the liquid in the barn. The settling time of the coagulated particles is 12- 24 hours, and the compaction time is up to 36 hours. After that, it is necessary to move all the illuminated liquid to the area adjacent to the drilling site with the unit.

The degree of purification for the main contaminating components is equal to:

- on suspended substances - 96%;
- by chemical oxygen demand - 90%;
- for oil and oil products up to 95%.

Conclusions for the section

The measures are represented to prevent accidents and complications as well as to protect mineral resources and the environment.

CONCLUSIONS

In this work, drilling and casing of a production well with a depth of 2900 m at Bakr oil and gas field with the development of measures to prevent violations of the integrity of the walls of the well.

In the general part, the following is given: the geographical location, an overview of previously conducted geological and geophysical studies and the geological characteristics of the area of work. The following is described: stratigraphy, tectonics and physicochemical properties of formation fluids in a given area.

The well will be drilled by a drilling rig Vertical Slant (VSR) in four drilling intervals: surface casing - 245 mm in diameter, intermediate string - 178 mm in diameter and for production casing 127 mm in diameter, using mud. The drilling process is monitored by the GTI station.

The work provides all the necessary life safety measures. It also considers measures to prevent accidents and complications as well as to protect mineral resources and the environment.

For drilling we use PDC drill bits. Drill bit diameter for surface casing is 311 mm, for intermediate casing is 216 mm and for production casing is 152 mm.

Collar diameter is 120 mm, drill string diameter is 89 mm.

For drilling the well we choose Vertical slant drill rig of American company National Oilwell Varco.

Necessary measurements on labor and environment protection were also planned in the work.

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APPENDIX A

List of the qualification materials

№	**Format**	**Designation**	**Name**	**Number of sheets**	**Note**
1					
2			Documentation		
3					
4	A4	OGED.21.02.EN	Explanatory note	73	
5					
6			Overview map of the work area		
7					
8			Overview map of the work area	1	
9			Bakr oil field	1	
10			Characteristics of the geological section	2	
11			Combined pressure schedule and well design	1	
12			Geological and technical project	1	