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НАЦІОНАЛЬНИЙ ГІРНИЧИЙ УНІВЕРСИТЕТ

ФАКУЛЬТЕТ МЕНЕДЖМЕНТУ
Кафедра іноземних мов

ЗБІРНИК ТЕКСТІВ ТА ВПРАВ

до практичних занять та самостійної роботи студентів напряму підготовки «Гірництво», спеціальність «Буріння»

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Відповідальна за випуск зав. кафедри іноземних мов С.І. К;острицька, проф.

Друкується в редакційній обробці упорядників.

Lesson 1

THE DIAMOND DRILL

Task 1. Match the following English words with their Ukrainian equivalents.

Core drill	Кар'єр, розробляти відкритим способом
Blast hole	Штанга
Device	Шпур
Quarry	Долото
Oil well	Колонковий бур
Road	Пристрій
Fit	Нафтова свердловина

Task 2. Fill in the gaps in the following sentences choosing the right words from Task 1.

1) Some sources written in the 1860s mention the design and presumed results of an _________ core-drilling tool called the diamond drill.
2) One rib of a diamond _________ now holds man9y more stones than an entire one of earlier decades.
3) The principal uses of the diamond _________ in the 1800s and early 1900s were in prospecting, mining and guarrying such as for coal in Pennsylvania, copper and iron in the Michigan and Minnesota ranges, gold in the Rand, etc.

Task 3. Before reading the text, discuss with your partner the following questions:

1) When, where and how was the diamond core drill invented?
2) What kinds of drills were used in ancient times?9
3) What is Moh’s scale of hardness?

Task 4. Read the text and check your answers to Task 3.

The diamond core drill was invented and put to practical use in 1863 by Rodolphe Leschot, a French engineer. He used it for drilling blast holes for tunneling Mount Cenis on the France-Italy border. Leschot patented the device in the United States in 1863 and it was reissued in 1869 (Brantly 1971). In 1869 a Leschot diamond drill was shipped to the United States for use in a marble quarry in Vermont (Edson, 1926). It is not known if there is any connection between the 1865 experimental diamond core drilling in the Pennsylvania oil region and the Leschot blast hole drilling in France in 1863. A direct connection does not seem likely.

Most any oil well device has a precursor in antiquity. A type of diamond rotary drilling was used 5000 years ago in Egypt to quarry stone. A hollow wooden rod (later metal) hardened by fire was rotated by hand or bow string on loose, hard mineral grains such as granulated rubies or sapphires which were sifted onto the drill surface. Short holes of about 6 inches, and at least one example of 20 feet were drilled in this way. Ruby and sapphire are species of corundum which is number nine on Moh's scale of hardness. Glass (quartz) is number seven and diamond is number ten which is the hardest mineral and would cut through any hard rock.

The 1865 experimental diamond core drills as well as the earlier one by Leschot consisted of a hollow tube or cylinder having a number of stones set on the bit end. The idea of using jewels or stones as cutting faces came from Leschot's early experience as a watchmaker, a concept which he successfully applied as a tunnel engineer. Leschot's diagram for the reissue of his drill shows that the bit had six stones. Morris (1865) says six stones and Eaton (1866) says fifteen in the tools they described of the experimental oil well(s) in the oil region. Edson (1926) states that the average number used in bits in the 1920's were eight. Setting the stones was the work of a highly skilled expert. The stones are carbonados (black diamonds) or South African borts, the latter being preferred. Leschot may have used cleat diamonds of jewel grade at first.

Task 5. Find in the text the names of minerals. (The total number is 5.)

Task 6. Decide if the statements are true (T) or false (F) in relation to the information in the text. If the statement is false, change it to make it true.

1) The use of diamond core drill started in the 18th century in France.
2) The diamond core drill was used to quarry marble in the USA.
3) The first diamond drills were invented 5,000 years ago.
4) Quarts can cut through any hard rock as it is the hardest material.
5) The first diamond drill invented by a French engineer, Rodolphe Leschot, consisted of a cylinder with 6 stones on the bit end.

Task 7. Read the following paragraph and tell what it says about.

The diamond core drill requires a rotary motion and circulating fluid. The 1860's saw not only the invention of the diamond drill but also numerous patents for pioneer rotary drilling machines although the fluid circulating rotary method could be traced to an 1844 English patent by Robert Beart of Godmanchester. Rotary drilling came into considerable use in the United States via fluid circulating rotary drilling rigs in Corsicana, Texas in 1894-1900 and in 1901 at Spindletop and thereafter.

Task 8. Ask all possible questions to the following passage.

The first commercial use of diamond core drilling for oil happened in 1916 and began to replace other rotary core methods such as the adamantine drag-type coring tool and the calyx toothed coring bit. By the 1920's diamond core bits and drilling bits were in general use in the United States and were being used to drill into the limestone reservoirs of high pressure wells in the Tampico Basin in Mexico.

Petroleum geologists made considerable use of portable diamond core outfits to drill key bed holes, also called strat holes. The recovered core allowed the stratigraphy to be studied in detail. The tops of key beds were used for structural mapping which was part of the process to select a location for oil drilling. This was in the late 1920's and 1930's before electrical well logging services and seismograph methods were generally available.

The Mid-continent, Gulf Coast and California were the main regions employing diamond core operations for oil in the U.S. in those years. In the older eastern fields, such as the Bradford field on the Pennsylvania-New York border, diamond coring was carried out for water-flooding operations.

Lesson 2

THE INFLUENCE OF THE ROCK PROPERTIES ON THE PERFORMANCE OF THERMALLY STABLE PDC CORE BITS

Task 1. Before reading the text, fill in the gaps in the following sentences.

a) drilliability	e) properties
b) rate	f) performance
c) rig	g) design
d) penetrated rock	h) core bits

Drilling[1] ______ is one of the main factors controlling drilling cost. The principal factors which need to be considered in predicting drilling rates are the bit[2] _______, the bit operating parameters and the characteristics of the[3] _____________. A variety of rock types were drilled using thermally stable polycrystalline diamond compact (PDC) and impregnated diamond[4] ______ using a fully instrumented laboratory drilling rig at different rotational speeds and a over range of weights on bit. A wide range of textural, mechanical and intact[5] _______ of the rock were quantitatively determined, many of which were found to have high degree of correlation for a given rock type. The rock properties have a significant influence on the drilling rates and in the prediction of drilling rates, but the complex nature of the failure mechanisms results in no single property being suitable as a[6] _______ criterion for a drilling system. However, Grain shape factor, texture coefficient, quartz content, silica content, uniaxial compressive strength were found to have a significant effect on the[7] ________ of the drill bits.

Task 2. Read the text and decide on a suitable title for it.

Knowledge of rock properties is essential for proper design of the bit, drilling machine, and their operating conditions. Since the choice of drilling method and its economic implementation depend to very large extent on the quality and quantity of rock investigation data that are available to machine manufacturers and contractors at the design or tender stage. In fact, the performance of any drill bit is complex and is affected by numerous factors which include operating parameters of the bit, formation properties, bit designs and type, wear, drilling fluid properties and flow mechanics, capability of drilling machine, operator or crew efficiency. However, the principal factors which require consideration in predicting drilling rates are the rock characteristics and the operating parameters of the drill bits, particularly for mining applications.

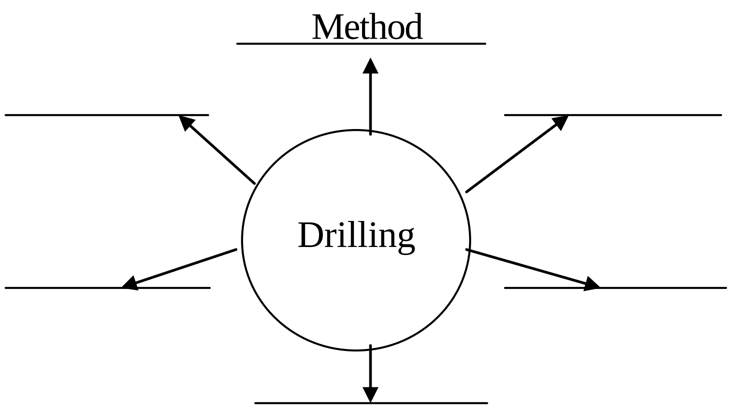
There are many studies relating to the effects of the rock properties on the performance of percussive and diamond drilling (Paone et. al., 1968; White, 1969; Schmidt, 1972; Clark, 1979; Rabia and Brook, 1980; Miller, 1986; Howarth and Rowlands, 1987; Ambrose, 1987; Miller and Ball, 1990; Singh, 1990). Most of these studies have investigated the effects of the standard physical properties of rocks on the drilling performance. However, the standard physical property tests do not measure all of the rock factors that influence fracturing and crushing under the action of a drill bit. Rock textural characteristics (such as grain size, grain shape factor, grain orientation, degree of grain interlocking, grain bonding structure), total silica content and physical structure are also very important and their influence on the drilling rate varies from one rock type to another and even for different samples of the same rock type. Consequently, an ideal test for the prediction of rate of penetration (ROP) would include all the significant factors governing cutting at the bit/rock interface.

Recently, operating characteristics and performan3ce analysis, wear characteristics and mechanism, performance prediction using multi-variable analysis, textural influence of rocks, analysis of drilling detritus and its effects on the performance of polycrystalline diamond compact (PDC) core bits have been examined (Ersoy and Waller, 1994, 1995, 1996; Waller and Ersoy, 1995). No study has been found relating the influence of a wide range of rock characteristics on the rate of PDC drilling.

Task 3. Match the words in the left and right columns as they are used in the text.

1) rock	a) parameters
2) drill	b) drilling
3) operating	c) bit
4) bit	d) properties
5) principal	e) factors
6) percussive	f) design

Task 4. Complete the diagram with appropriate word-combinations.



Task 5. Answer the questions about the text.

1) Why is it important to know the properties of rocks?
2) What does the choice of drilling method depend on?
3) What is a drill bit affected by?
4) What influence the drilling rate?

Lesson 3

Task 1. Match the following English words with their Ukrainian equivalents.

1) drilling trial	a) обертальний момент
2) core bit	b) система розрізу бурової свердловини
3) pin bit	c) пробне буріння
4) rectangular bar	d) колонкове долото, бурова коронка
5) hybrid bit	e) ступінь проникнення
6) cutting material	f) частота обертання
7) rate of penetration	g) пальцевий бур, долото
8) rotational speed	h) прямокутний брусок
9) torque	i) ріжучий матеріал
10) logging system	j) гібридний бур, долото

Task 2. Fill in the gaps in the following sentences choosing the right words from Task 1.

1. _________ had a total of six segments each with eight pins and 2 or 5 carbide strips.
2. _________ is made of polycrystalline diamond pin in the form of _________ of approximately 2 mm section.
3. Each rock was drilled using each bit over a range of WOB and at three _________.
4. _________ is essentially an impregnated bit 9enhanced with PDC pins.
5. _________ reduced over a small range with increasing _________.

Task 3. Read the text and decide on a suitable title for it.

Drilling trials were conducted in limestone, siltstone, sandstone, granite and diorite using PDC and impregnated diamond BQ (ID 36mm, OD 59mm), wireline, core bits. Two types of PDC bits, pin and hybrid, based on the "Syndax3" product were tested. Syndax3 is a solid, unbacked, polycrystalline diamond product, which is thermally stable to 1200° C in a reducing atmosphere (Tomlinson and Clark 19992). The cutting material is made of polycrystalline diamond pin in the form of a rectangular bar of approximately 2 mm section. The pin bit had a total of six segments each with eight pins and 2 or 5 carbide strips symmetrically placed on the outside and inside edges. The hybrid bit is essentially an impregnated bit enhanced with PDC pins. It has six or eight segments and each containing four pins. The impregnated bit had eight segments of a soft matrix material. Matrix impregnation of the hybrid and impregnated bits used synthetic diamonds of 30-40 US-mesh at 40 concentration, and blocky and cubooctahedral in shape.

The rate of penetration (ROP), weight on bit (WOB), rotational speed (RPM), torque and drilling specific energy (SE) were monitored on a computer controlled logging system. Each rock was drilled using each bit over a range of WOB and at three rotational speeds (550 rpm, 1150 rpm and 1650 rpm). However, these speeds reduced over a small range with increasing torque. Therefore, each bit contains a series of drilling data for each rock, at each different RPM and applied WOB. Water was used as flushing medium at 60 1/min. A total of 580 drilling tests have been completed and a total of 220 metres have been drilled.

The optimum data for the bits were extracted from each series of results using a criteria based on maximum ROP at minimum drilling SE or vice versa. SE gives a very good indication of bit performance. This is illustrated in Figure 1 showing the WOB and SE versus ROP for the pin bit in limestone at 1650 RPM. The regions of the SE and WOB curves selected as optimum performance are shown between vertical delimiters. The Figure show clearly that high ROP is produced at low SE. The optimum data were used for performance comparisons of the bits. Figure 1 also show that increasing WOB gave increasing ROP up to some maximum point. Further increase of WOB causes constant or little increases or even decreases ROP.

Task 4. Answer the following questions.

1) How many types of PDC bits were tested? What are they?
2) What does pin bit consist of?
3) What does hybrid bit consist of?

Task 5. Decode the abbreviations.

PDC, ROP, WOB, RPM, SE, ID, OD.

Task 6. Find in the text the names of minerals and learn them by heart.

Task 7. Decide if the statements are true (T) or false (F) in relation to the information in the text. If a statement is false, change it to make it true.

1) Drilling trials were conducted in limestone, siltstone, sandstone, granite and diorite.
2) Three types of PDC bits based on "Syndax 3" product were tested.
3) The hybrid bit has six or eight segments and each containing four pens.
4) The impregnated bit had nine segments of a soft matrix material.
5) Each rock was drilled using each bit over a range of WOB and at five rotational speeds.
6) A total of 580 drilling tests have been completed and a total of 320 meters have been drilled.
7) Further increase of WOB causes constant or little increases or even decreases ROP.

Lesson 4

Task 1. Match the following English words with their Ukrainian equivalents.

1) grain size	a) розташування зерен
2) rock texture	b) ступінь зіплення
3) X-ray machine	c) текстура породи
4) tensile strength	d) розмір зерен
5) rock hardness	e) штучний корунд
6) artificial corundum	f) рентгенівський апарат
7) degree of grain interlocking	g) твердість породи
8) grain orientation	h) межа міцності на розтягування

Task 2. Fill in the gaps in the following sentences choosing the right words from Task 1.

1) _________ "Baux 60US screen size 60" was used as the index standard material.
2) Total silica content was determined by chemical analysis using an automatic _________.
3) _________ is taken as a measure of the bond strength between grains.
4) The textural characteristics are _________, grain shape, _________, _________, relative proportions of grains and matrix.

Task 3. Read the text and answer the following questions:

1) What is the performance of a drill bit influenced by?
2) What does the resistance of rock to drilling depend on?
3) What are the textural characteristics?
4) How were they measured?
5) What was determined by chemical analysis?
6) What does index tests comprise?

The performance of a drill bit for a given duty is considerably influenced by the rock properties which enable the determination of the drilling parameters required to drill a particular hole. Therefore, it is of vital importance to know whether a rock can be drilled by a chosen drill bit and method before problems arise rather than see the costly removal a system which proved to be inadequate.

Drillability or cuttability of rocks cannot be defined in an absolute manner by a single index or measured by a single test, because there is no single rock parameter which can adequately define the breakage characteristics that are predominant in drilling mechanics. The resistance of rock to drilling depends to large extent upon the means used for destruction. Thus, extensive laboratory tests have been carried out on the drilled rocks. These tests include mineralogical, textural, chemical, physical and index properties analysis.

The percentage mineral analysis has been calculated using a point counter with an average of 3000 counts from two thin sections of each rock. The textural characteristics are grain size, grain shape, degree of grain interlocking, grain orientation, relative proportions of grains and matrix. These were quantitatively measured using an automatic image analysis system. These were used to derive a texture coefficient, which models the interaction between the rock texture and the drill bit, as a single number. Total silica content was determined by chemical analysis using an automatic X-ray florescence machine.

Mechanical and deformation properties consist of uniaxial compressive strength (UCS), indirect (Brazilian) tensile strength (BTS) and Young's Modules which were determined according ISRM suggested methods (Brown, 1981). Index tests comprise hardness, such as Mohs hardness (the overall rock hardness has been calculated according to Mohs scale from mineral proportions of the rocks) and Shore Schleroscope hardness number, abrasiveness, such as Cerchar abrasivity index, dynamic impact abrasive index (DIAI) (Al-Ameen and Waller, 1992) and Schimazek's F-abrasivity factor (Schimazek and Knatz, 1970). The DIAI test is based on the weight loss sustained to a shim after being tangentially impacted by 1000 gm. of accurately sized paniculate rock material at a predetermined velocity. The rocks from the drilling core were crushed and sieved in size of > 212 mesh to <

425 mesh. The shim is weighted before and after each test in an accuracy of ± 0.0001 gm. The subsequent weight loss is expressed numerically as a function of the abrasive potential of the whole rock material. An artificial corundum "Baux 60 US. screen size 60" was used as the index standard material. The DIAI is calculated as a percentage at the following equation:

$$DIAI = \frac{\text{Weight loss due to sample} \times K \times 100}{\text{Weight loss due to standard}} \quad (1)$$

K= Density correction factor

$$K = \frac{\text{Specific gravity of the sample}}{\text{Specific gravity of the standard material}} \quad (2)$$

"F" value is defined as:

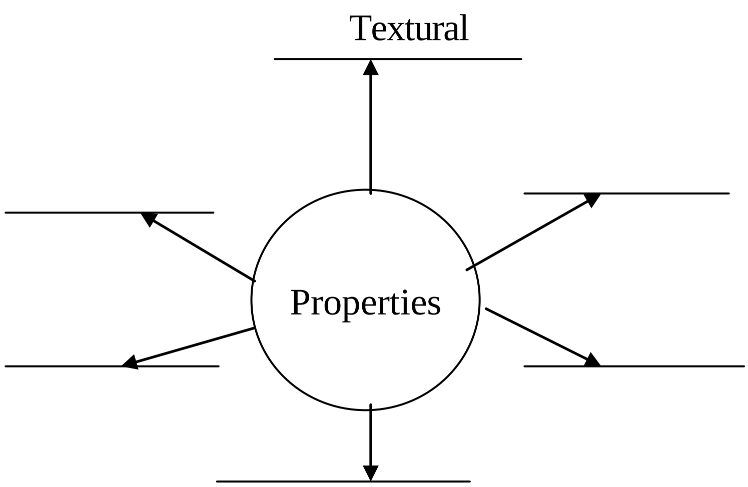
$$F = EqQtz \times \phi \times BTS / 100 \text{ (N/mm)} \quad (3)$$

Where F is the Schimazek's wear factor (N/mm), EqQtz is the equivalent quartz volume percentage, ϕ is the grain size (mm) and BTS is indirect Brazilian tensile strength It has been suggested that if the grain size is less than 0.025 mm, below this diameter grains have little influence on abrasivity. Tensile strength is taken as a measure of the bond strength between grains. Hardness of minerals other than quartz may be accounted for by expressing their hardness relative to that of quartz. Certainly in Europe the F value is used to assess abrasivity of sedimentary rocks, especially in coal mining and tunnelling (Schimazek and Knatz, 1970, Braybrooke, 1988, Verhoef et. al., 1990, Verhoef, 1993).

Task 4. Decide which of these titles best sum up the content of the text.

1) Performance of a Drill Bit
2) Rock Characteristics
3) Different Tips of Analysis

Task 5. Complete the diagram with appropriate word-combinations.



Task 6. Match the words in the left and right columns as they are used in the text.

1) drilling	a) hardness
2) grain	b) index
3) texture	c) rocks
4) silica	d) parameters
5) rock	e) shape
6) sedimentary	f) content
7) abrasivity	g) coefficient

Task 7. Learn the names of the minerals and characterize them.

Limestone, sandstone, siltstone, granite, diorite.

Lesson 5

ROCK FACTORS INFLUENCING PERFORMANCE OF THE BITS

Task 1. Read the text and answer the following questions**.**

a) Why is there little information about the effects of the rock parameters on the performance of the drill bits?
b) How does the grain shape factor influence the drilling rates of the bits?
c) What influences the sandstone behavior?
d) How does drilling cutting process related to an aspect of the rock texture?

Although everyday thousands of holes have been produced, there have been little quantitative productivity data available in the literature concerning the effects of the rock parameters on the performance of the drill bits from which the relationship can be independently evaluated. This may be due to a number of reasons: drilling is generally done by contractors who either do not keep sufficiently detailed records to be able to determine productivity or they regard the information as a commercially sensitive.

Angular, elongated and rough particles of a rock produce lower drilling rate than rounded particles of a rock. The values of grain shape close to zero, for very elongated and angular particles and 1 for a perfect circle or round particles. Grain shape is also known as form factor or circularity factor. The PDC bits reach the highest point in the ROP of sandstone. Although sandstone contained more angular particles than siltstone, the sandstone gives better ROP than the siltstone for the bits. High silica and quartz content, a considerable amount of pores, and weakly bonded of particles are responsible for the behaviour of the sandstone. The PDC bits are resistant to the abrasive minerals in the rock. Therefore, their performance are higher than the performance of the impregnated bit in this rock.

The relationship of texture coefficient with ROP is clearly significant. However, sandstone behaves differently. This change in ROP of the sandstone is basically caused by the quantity of silicate matrix, pore content and weakly bonded particles which produce high drilling rates for the bits. An interlocked texture coefficient simply presents' a physical barrier to crack propagation. It can be concluded that drilling cutting process and fracture mechanisms in the rock are to some extent related to and dependent an aspect of the rock texture.

There is a perfect correlation between UCS, BTS and Young's Modules. Again, sandstone behaves differently. As mentioned above, the polishing of the bits were prevented during drilling process by the high quartz and silica contents of the rock. These minerals in the rock have been weakly bonded and the rock also contains a considerable amount of pores. Therefore, the bits penetrated this rock very well, but a great amount of wear occurred in the impregnated bit.

The relationship of Shore hardness is one of the most important rock factors. A good relation exists between Shore hardness and ROP, because the Shore hardness includes all grain characteristics, degree of cementation, bonding structure and intact characteristics of the rocks. A decrease in ROP is seen as Shore hardness increases except for sandstone. This behavior of the sandstone is responsible from others properties of it.

The relation between Cerchar abrasivity index and ROP is not clear in all types of rocks. But in limestone, siltstone and diorite increasing of Cerchar abrasivity decreases ROP.

Task 2. Say which statements are true and which are false.

1. The effect of the grain size on the drilling performance is not clear.
2. Rounded particles of a rock produce lower drilling rate than angular, elongated and rough particles.
3. A decrease in the grain shape factor increases drilling rates of the bits.
4. The PDC bits reach the highest point in the ROP of sandstone.
5. The performance of the impregnated bits is higher than the performance of PDC bits in the sandstone.
6. When the silica content of the rocks increases ROP also increases.
7. In limestone, siltstone and granite increasing of Cerchar abrasivity decreases ROP.

Task 3. Write a summary to the text.

Lesson 6

DRILLING METHODS AND EQUIPMENT
(PART 1)

CABLE TOOL DRILLING

Task 1. In pairs discuss the folowing questions:

1) What methods of drilling do you know?
2) What are the basic types of drilling rigs?

Task 2. Before reading the text, try to learn new vocabulary:

Cable tool – електробур

Debris [‘deibri:] – уламки породи

Fluid mud –буровий розчин, промивальна рідина
Failer – желонка
Sludge – шлам
Cave – завалюватися
Slough [slaf] – осипатися
Casing – обсадні труби
String of casing – обсадна колонка
Derrick – бурова вишка
Hoisting reel – барабан для піднімального каната
Bull wheel – ведуче колесо ударно-канатного станка
Calf wheel – талеве колесо станка канатного буріння
Sand reel – тартальний барабан
Swab – поршень, сваб
Walking beam – балансир
Pump jack – качалка
Grooved sheave – жолобчатий шків
Stem – штанга, ствол
Jar – бурильна серга
Sinker – ударний шланг
Drilling line – бурильний канат

Task 3. Read the passage and give the characteristics of cable tool drilling.

In drilling a well with a cable tool, it is impractical to either drive the tool down with the hammer or to blow debris from the hole. So the cutting is suspended on a rope and raised and dropped repeatedly to drill the hole. Enough water is used in the hole to mix with the cutting to produce a fluid mud. When this mixture is sufficiently thick, the drilling tool is withdrawn and a bailer is run into the hole. The bailer resembles a slender, bottom-filling water bucket used on bored farm-wells. Sludge is sucked into bailer on bottom and dumped at the surface. This process is repeated until the desired depth is reached or until a soft formation or a water sand is encountered.

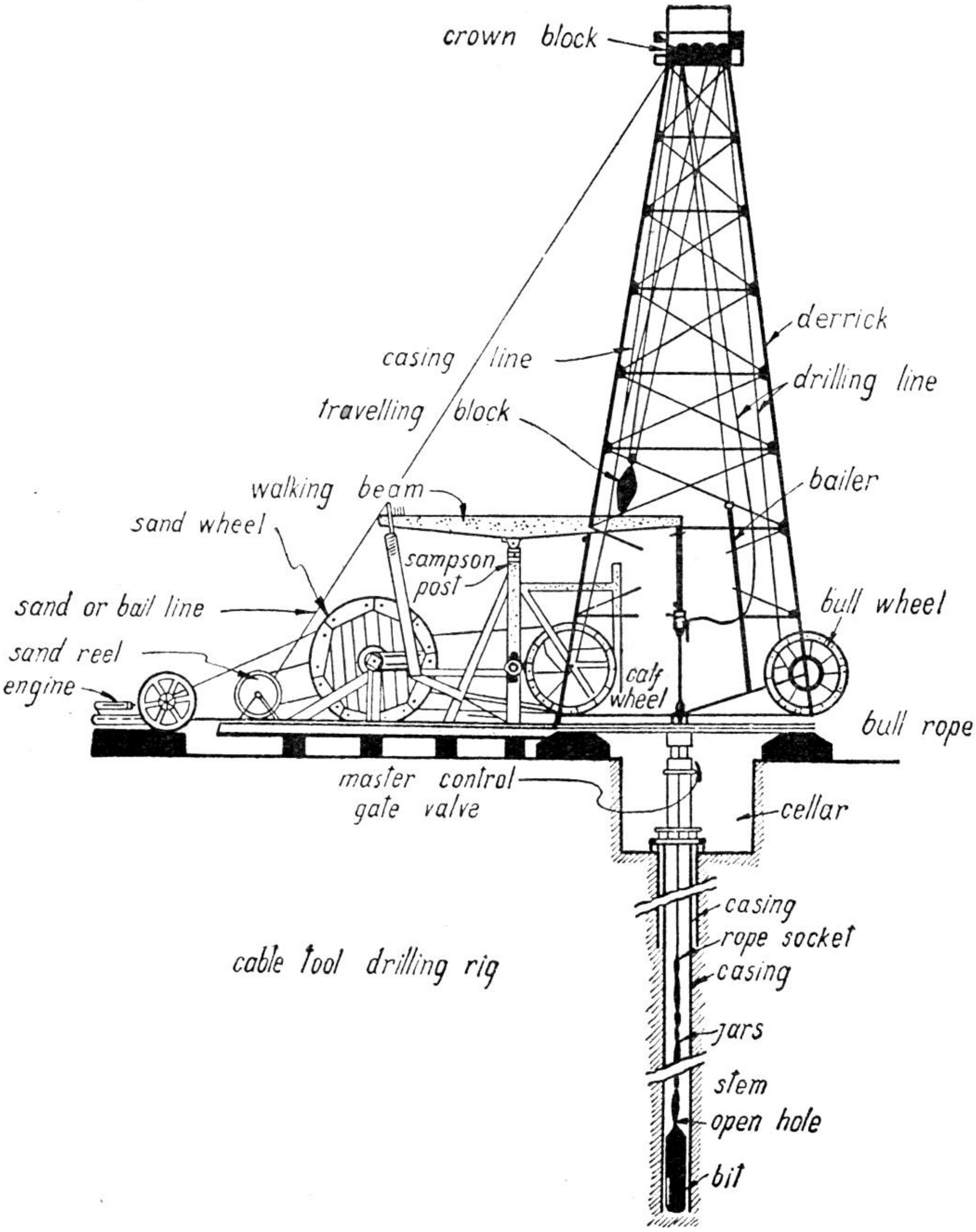
One of the big disadvantages of the cable tool method is the difficulty of penetrating soft formations. Wall of the hole is unsupported and tends to cave in or slough. To overcome this trouble, it is necessary to run casing through such sections to establish a wall to permit drilling to continue. If several soft formations are encountered, a string of casing will be required at each point to protect the hole. Consequently, the cable tool hole starts with a large diameter to have room for nesting the required strings of pipe needed to reach the projected depth.

A derrick is necessary for lifting tools and pipe in and out of the hole. As the maximum length of any single joint of pipe will exceed 40ft. slightly, the derrick does not have to be as high as average rotary derrick.

Three hoisting reels distinguish the cable tool machine. The bull wheel handles the drilling tools going in and out of the hole. The calf wheel is used for hoisting and running of casing. The sand reel carries the small line on which the bailer and, later, the swab is run.

An up and down motion is imparted to the drilling tools by the walking beam or by a spudding arm. The walking beam, used on the standard rig, operates like a pump jack or see-saw in lifting and dropping the drilling string attached to the end over the hole. The8 spudding arm operates by pushing a grooved sheave against the fixed line of the drilling string for raising in the hole and then dropping by suddenly releasing the line.

The bit is screwed into a heavy stem to impart additional weight for cutting. Immediately above this, in the drilling string, are the jars, which permit flexibility in the string and aid in giving a free striking motion. The jars are similar to two huge chain links. This arrangement permits blows to be struck upward so that a stuck bit may be retrieved. The jars may be weighed from above by a sinker, which is a long, cylindrical joint of solid metal. The complete string of drilling tools is surmounted by a rope socket to which is attached the drilling line.



cable tool drilling rig

Importance of Cable Tool Method. While the importance of the cable tool drilling method has declined, there are still many shallow holes drilled by this procedure. Chief advantages of the technique are:

(1) Ability to penetrate very hard formations at relatively low cost;

(2) Full recovery of all cutting from all formations so that no oil possibilities are miss8ed; and,

(3) S2afeguarding the formations from damage (particularly low-pressure sections) that might result from columns of fluid as used in rotary drilling.

This third advantage has made the cable tool method desirable for the completion of wells. Consequently, many portable cable tool units are engaged in well completion of work.

Chief reasons why the rotary method has gradually replaced the cable tool operations are:

(1) Greater speed of penetration (particularly in the softer formations);

(2) Expense of multiple strings of casing required in cable tool practice;

(3) The extreme difficulty of controlling high bottom-hole pressures with cable tools.

Task 4. Match the sentence halves to form complete sentence:

1) The bailer is	a) the drilling tools going in and out of the hole.
2) A derrick is used for	b) a slender, bottom-filling water bucket used on bored farmwells.
3) The bull wheel handles	c) attached to a rope socket.
4) The calf wheel	d) carries the small line on which the bailer is run.
5) The sand reel carries	e) lifting tools and pipe in out of the hole.
6) The drilling line is	f) hoisting and running of casing.

Task 5. Speak about advantages and disadvantages of cable tool drilling.

Lesson 7

DRILLING METHODS AND EQUIPMENT
(PART 2)

ROTARY DRILLING METHOD

Task 1. Discuss the following questions:

1) What is the text you are going to read about?
2) Do you know any characteristics of rotary drilling?

Task 2. Read the text and check your answers to Task 1.

The rotary method derives its name from the fact that a boring, twisting, or rotary motion is employed in cutting the hole. Because of an. ingenious arrangement for circulating fluid, it is not necessary to withdraw the bit to remove cuttings from the hole. The cutting bit is carried on the end of hollow pipe through which fluid is forced downward and out of the openings in the bit. After release, at the bottom of the hole, the fluid is forced upward by pressure and carries with it debris from the bottom of the hole. Minute rock fragments, called cuttings, are removed from the fluid before the fluid makes the cycle again.

Derricks are generally of two types: Standard derricks built on the job and dismantled for removal to the next location, and the jack-knife or portable derricks. The ja8ck-knife derrick can be moved and erected on the job by regular drilling crewmembers. The derrick is hauled to the location in sections by trucks. It is bolted together on the ground, in a horizontal position, and the whole derrick is then raised to a vertical standing position by rig hoisting equipment.

The flowline for the mud returning from the borehole can be located in a better position with reference to the mud tanks.

In the top of the derrick is the crown block containing several sheaves. These are sheaves or pulleys similar to those used in driving the fan or generator on your automobile.

Wire line is spooled on the drum of the draw-works, which does the work of hoisting and lowering tools in the hole. After the line passes over the first sheave in the crown block it is threaded through one sheave of the travelling block and so on back and forth until the line is "strung up". Six or eight lines, meaning the use of three or four sheaves on each block, are most commonly used.

The drum of the draw-works can be operated at several different speeds. The outer edges are equipped with brake drums and flanges. These brakes are often cooled by water jackets and are aided by other devices built into the draw-works.

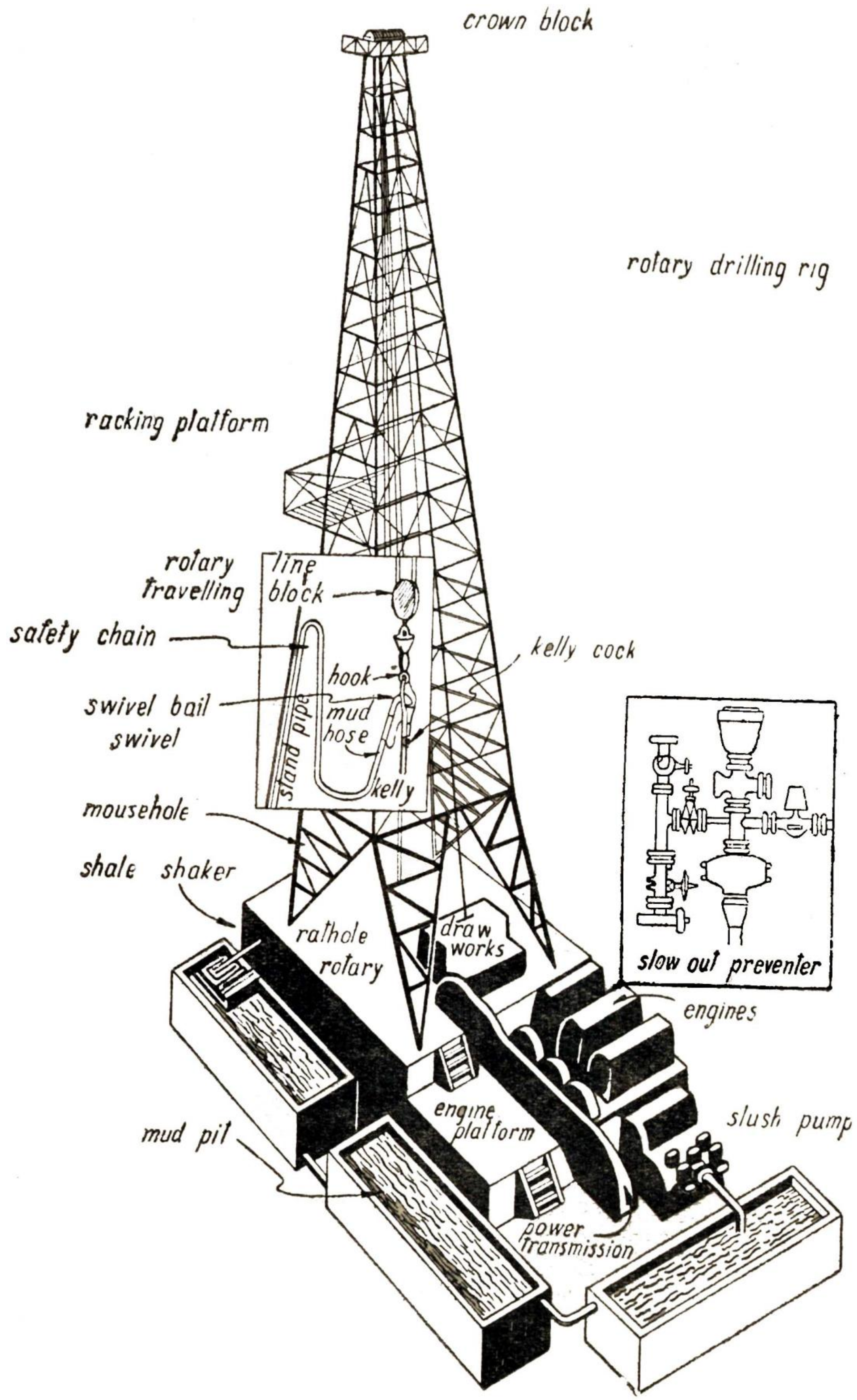
Other integral parts of the draw-works are the catheads. These spool-like reels are used for hoisting or moving small loads with the manilla rope catline or for pulling the tongs (huge wrenches) that tighten or loosen the threaded joints of drill pipe.

The power that drives machinery of the rotary or cable tool rig may be selected from several sources. Most rigs today are "mechanical", meaning that their prime movers are gas, gasoline, or diesel engines.

Since the prime movers also drive slush pumps, the entire amount of power is not usually moving through the draw-works. Slush pumps or mud pumps require considerable power to keep them pulsing. The pumps are the heart of the circulatory system. Through the suction hose is drawn the mud from earthen slush pits or steel mud tanks. Under pressure, this mud is delivered through the discharge of the pump to the standpipe.

Mud leaves the standpipe at the gooseneck to enter the rotary hose. This hose is necessary for making a flexible connection so the drill pipe may move up and down, within a range of 30 to 40 ft., without interfering with the circulation of mud.

Mud flows from the rotary hose through the swivel to the drilling string. Swivel is constructed so that the upper portion, attached to the hose, remains stationary while the lower part, fastened to the kelly, rotates freely. This arrangement permits the entire8 drilling string to be rotated while fluid is coursing through it to the bit.



The kelly or kelly joint or grief stem is the top section of the drilling string.

Each time a bit becomes dull and needs replacement, the entire string of pipe has to be pulled from the hole and re-run. To save time, the pipe is generally pulled in doubles (two joints at a time) or trebles (three joints at a time) and stacked upright in the derrick in rows called stands. Going in or out of the hole with the drill pipe is called a trip. A complete "in and out" job is referred to as a round trip.

The bottom joints of the drill string are frequently made with very thick walls for increased weight. These are drill collars and they serve a similar purpose to the plumb bob on a string. By placing additional weight in the bottom portion of the drill string it is kept in tension, and greater efficiency is achieved. The added weight also permits the driller greater range in the amount of weight that he may carry on the bit. Other advantages are in keeping straight hole and in reducing wear on tool joints (the connections between joints of drill pipe).

Immediately below the drill collars, the bit is attached.

Task 3. Answer the following questions:

1) What are the types of derricks? What is the difference between them?
2) What are the integral parts of the draw-works?

Task 4. Write a summary to the text “Drilling methods and equipment (parts 1,2)”

SUPPLEMENTARY READING

Give the main ideas to the texts below.

Text 1.

Hydraulic tophammer drilling is popular because it is fast, but it is susceptible to hole deviation. This can be a serious problem in quarries and surface mines because it leads to poor—or even dangerous — rock throw, poor fragmentation, and uneven benches, with stumps and boulders which need expensive secondary blasting. (In civil engineering work, accuracy in presplit-ting can also be vital). To compensate, hole spacing and burden can be reduced, but this puts up drilling and explosives costs.

Hole deviation has been found to occur in two ways; innaccuracies in mast alignment and collaring which account for 1 to 1.5% deviation, and deflection in the hole which can account for deviation of over 5% of the hole depth. Compounded, these inaccuracies can therefore total over 7%, whereas no more than half this figure might be generally considered acceptable.

The benefits of straight holes are not realised only in the quality and economy of the blast; straightness of the drill string results in faster and cheaper drilling because of the higher transmission efficiency of percussive energy, and reduced component wear.

Text 2.

The advantages of pneumatic DTH are straight drilling, consistent penetration rate at whatever depth, and versatility; one machine can cope with a variety of rock types and conditions without expensive and lengthy alterations. However, its main disadvantage is slower drilling; this is mainly because compressed air is not a very efficient medium for transmitting power. Higher air pressures give better penetration rates, but a small increase in drilling speed can only be won by a large increase in power input (and noise) to drive the compressor.

Write summaries to the following texts.

Text 1.

Longhole blasting is an important technique, and is the basis for the high production mass mining methods of sublevel caving, sublevel stoping and VCR mining. Drilling long blast holes has developed its own technology with a variety of specialities, with blast holes of different diameter, length and direction etc. The drill pattern design sets the parameters for the longhole drill rig.

Extension drill steel originated in the 1950s. Short sections of drill rods joined together into a long drill string provided the basis for longhole drilling and mining methods like sublevel stoping and sublevel caving.

In those days, longhole drilling was a laborious and cumbersome undertaking. Heavy machine components had to be carried around and rigged up for drilling by the miners themselves, and the driller would be standing in flushing water amid the fog and noise of the drill, handling stacks of extension rods.

The long hole drill rig of 1993 is a fully mechanised tool for efficient long hole drilling in underground mines, and is a complex machine that integrates multiple functions. The operator rarely resorts to physical work as the remote controlled servo system does it for him. The environment is still the underground mine but the atmosphere is clear and the noise of the hydraulic rock drill is bearable. Today's longhole drill rig is often fitted with an operator's cabin, which provides comfort comparable to that in an office.

Selecting the appropriate longhole drill rig for a specific application is a qualified task, which requires careful study and evaluation of all features and options. It is a capital-heavy unit which is expected to serve its owner for many years. When the drill rig is delivered to the mine it is too late for changes; all technical details must be agreed well in advance with the rig manufacturer.

Technical development is a continuous process, so make sure that the drill rig is properly updated to present standards. This applies in particular to the control system and the automatics, which may notably influence the drill rig's output.

Text 2.

Alluvial Mining Co. Ltd. is about to begin a major diamond prospecting project off the coast of South West Africa. The UK company has contracted to the Namibian Mineral Corporation (N AMCO) to carry out a comprehensive minerals survey covering 5600 line km over Luderitz Bay and Hottentots Bay, Namibia, and also a third licence area named 12b, off South Africa. NAMCO is the first company to have been granted major marine diamond concessions off Namibia since the Republic's independence in February 1990.

The survey will probably take around 100 days to complete and will include a geotechnical programme to recover grab samples of potential diamond-bearing sediments and 6 m seabed cores at selected sites, following a detailed geophysical study of the area.

For this geophysical study, the surveyors will collect bathymetric, and also near-seismic data to present N AMCO's prospectors with a picture of the first few metres into the seabed over the whole region. Alluvial Mining's geotechnical team will be working in water depths from less than 10 m, to 200 m.

Alluvial Mining is a subsidiary of Royal Boskalis Westminster, one of the world's largest dredging companies, and has 25 years' experience in the location, mapping and mining of marine deposits of gold, diamonds and rutile in many parts of the world. Alluvial Mining's prospecting services are backed up by a specialist division which designs and builds seabed dredges for lifting sediments from most marine situations, from placer deposits to those at water depths well below 500 m. These include subsea remote-control grabs, vibrocorers and various rotary corers. For more detailed evaluation, drilling and bulk sampling exploration stages, the company operates a number of subsea air lift corers and specialised remotely operated dredge systems. These systems can provide bulk samples ranging from a few hundred kilos to several tonnes.

Translate the texts into your native language.

Text 1.

Exploration spending continued at low levels during 2000 due to the low gold price and the rival attractions oi investing in e-commerce. These factors resulted in a lack of funding for junior companies, in particular, and a reluctance to invest by gold-oriented companies. Two commodities bucked the trend, however - diamonds and platinum group metals, particularly palladium the price of which soared to nearly $1,000 /oz and sparked a frenzied re-examination of many old projects, particularly in South Africa's Bushveld Complex and in eastern Canada.

The multipurpose drill rig, that can both hammer and core efficiently, is now a well-established tool. UDR, for instance, has to date sold 100 of its model 650 rigs. Now the technology has been taken a stage further, underground, with Colorado-based Connors Drilling having developed an underground machine that can drill RC holes (up to 110 mm) to 150 m, and then core drill onwards from H size.

The DTH hammer is well established as an explorationist's tool. However it is limited in its capabilities by the fact that it uses air and has a poor reputation for hole straightness. Now a development from the oil industry offers a fluid hammer that is powered from the regular mud system. SDS Digger claims penetration rates three to five times faster than conventional rotary drilling and has drilled a 220 mm hole to 4,300 m. Whilst the diameters, and depths, are still 'oilfield' the fluid hammer is certain to be of interest to 'Minex' drilling when it is reduced in size. SDS is now talking to Sperry-Sun about the directional drilling capabilities of the fluid hammer.

Text 2.

Wooden pipes were common before the oil booms of the 1860's and served mostly to carry water in farms and to domiciles but iron, lead and tin pipes were also greatly in use in cities and factories at that time. Some liquids in manufacturing or processing plants were carried in wooden pipes and also in wooden troughs on the premises such as was done with brine in the salt industry near Syracuse, New York, from the 1790's into the 1900's. Wooden pipes and gutters were used for some purposes around the oil wells in the earliest years of the first decade of oil (1860's) and at least one pipeline proposal in Oil Creek Valley planned to use wood (1861).

Wood pipe was used at a very early date in the natural gas industry. In 1821, gas from an excavated gas spring on Canadaway Creek in Fredonia, N.Y. was conveyed in a wood pipe to a nearby user and sold on a burner basis (30 burners were supplied). In 1823, gas found bubbling up through joints in the organic shale cropping out along the south shore in Lake Erie was captured and piped to the Barcelona Harbor lighthouse through pine logs. There were other early gas occurrences in the Appalachian basin that were utilized by piping through wood pipes.

An 1862 photo of well Phillips No. 2 on the Tarr Farm, Oil Creek Valley shows crude oil being fed into a large wooden storage tank via a trough made of two boards nailed snuggly together to form a V while the top of the V was covered by a plank. The photograph also shows iron pipe (tubing) in use at the same well.

In the narrow muddy flat along a tributary of Oil Creek the writer found joints of seven foot eight inch (probably variable lengths) wooden pipe that had been milled (to have a male end) and were wound with spirals of loosely spaced iron bands as well as coated on the outside with asphalt or similar bituminous substance. The outside diameter varied from 7-1/2 to 5-1/2 inches due to tapering. These wooden pipes were located in a heavily drilled area and may have been used for oil purposes, but no trace of oil was left in the pipes. They could have served the nearby railroad stations of the day or might have been used by the local lumber plants. No study has been done of this wooden pipeline. It is presumed that the pipes date to the 1860's-70's. One point of view is that they conveyed water (but the stream was doing that anyway).

In 1972 the writer attended an auction of the merchandise of the old Hanna Hardware Store in Townville which is near the NW Pennsylvania oilfields. A large number of square joints of wooden pipe (the round hole was drilled in the center) were among the items sold. These had probably been on the shelf for many years.

Cast iron and wrought iron pipes of various diameters were in use around the producing wells from the start of the industry. The pipes variously served as drive pipe, conductor, casing, tubing and for conveyance of oil in and around the lease. Wooden troughs for passing oil to tanks or flatboats on the nearby creek were common too.

GLOSSARY

Українсько-англійський

Бурові установки

Бурова установка	drilling rig
Стаціонарна бурова установка	stationary rig
Пересувна бурова установка	mobile rig
Самохідна бурова установка	self-propelled drilling rig
Переносна бурова установка	pack-sack rig
Буровий агрегат	drilling rig and accessories
Буровий верстат	drilling rig
Обертач бурового станка	swivel head
Обертач роторного типу	rotor
Обертач шпиндельного типу	spindle-type swivel head
Верстат обертального буріння	rotary drilling rig
Роторний буровий верстат	rotary drill
Шпиндельний буровий верстат	spindle-feed rig
Станок ударного буріння	churn drill
Буровий насос	slush pump, mud pump
Бурова вишка	derrick
Баштова вишка	derrick
Бурова щогла	mast
Бурова будівля	shelter

Бурові вибійні машини

Турбобур	turbodrill
Гідроударник	hydraulic hammer
Пневмоударник	pneumatic hammer
Електробур	electro-drill
Магнітострикційний бур	magnetostrictive drill

Буровий інструмент

Технологічний інструмент	drill string, drill supply
Колонковий набір	core barrel
Породоруйнуючий інструмент	drilling tools
Бурове долото	bit
Ударне долото	wire-line bit
Ріжуче долото	drag bit, fishtail bit
Лопатеве долото	blade bit
Алмазне долото	diamond bit
Шарошка	roller, roll
Шарошкове долото	roller bit, rock bit
Штирьове долото	button bit
Бурова коронка	core bit
Твердосплавна коронка	hard metal bit, tungsten carbide core bit
Алмазна коронка	diamond coring bit

Матриця коронки	matrix
Промивальний канал коронки	waterway, waterhole
Дробова коронка	shot bit
Колонкове долото	core bit
Розширювач	reamer, underreamer
Кернорвальний пристрій, кернорвач	core catcher, core braker
Колонкова труба	core barrel
Подвійна колонкова труба	double tube core barrel
Трубний перехідник	sub
Від'єднувальний перехідник	safty sub
Шламова труба	calyx
Бурильна труба	drill pipe
Обважнена бурильна труба (ОБТ)	drill collar
Бурильна свіча	double, thrible, fourble
Бурильна колона	drill pipe string, drilling string
Колона обважнених бурильних труб	drill collar string
Бурильний замок	tool joint
Ведуча труба	kelly, square kelly
Буровий сальник	swivel
Вертлюг-сальник	eye-bolt swivel
Ударна штанга	drive rod
Розсувна штанга, ножиці, яси	drilling jar
Канатний замок	rope socket
Желонка	bailer
Шнек	core auger

Допоміжний інструмент

Обсадна труба	tube, casing
Обсадна колона	casing string
Башмак обсадних труб	casing shoe
Трубний ніпель	nipple
Направляюча труба	surface casing
Кондуктор	conductor
Потайна колона	liner
Ходова колона	mobile column
Випереджальна колона	advance column
Експлуатаційна колона	production string
Труборозворот	power tong
Труботримач	spider, safety clamp
Трубний хомут	casing clamp
Підкладна вилка	fork

Спускопіднімальний інструмент

Кронблок	crown block
Елеватор	elevator
Фарштуль	lifting sub, hoisting

Вертлюг-амортизатор	hoisting hook, lifting hook
Свічеукладальник	pipe handling equipment
Свічеприймальник	rod hangers
Трубний підсвічник	pipe rack

Аварійний інструмент

Ловильний інструмент	fishing tools
Ловильний дзвін	bell-mouth socket, bell rod tap
Ловильний мітчик	fishing tap, screw-tap, rod tap
Ловильний йорж	wire line grab
Труборіз	pipe cutter
Труболовка	casing spear, pipe dog

Інструмент для буріння направлених свердловин

Відхилювач	deflecting tool
Стаціонарний клин	stationary wedge
Клин, що витягається	retrievable wedge
Відхиляючий снаряд	whipstock
Штучний вибій	artificial bottom plug
Орієнтатор	orientator

English-Ukrainian

Advance column	випереджальна колона
Artificial bottom plug	штучний вибій
Bailer	желонка
Bell-mouth socket, bell rod tap	ловильний дзвін
Bit	бурове долото
Blade bit	лопатеве долото
Button bit	штирьове долото
Calyx	шламова труба
Casing	обсадна труба
Casing clamp	трубний хомут
Casing shoe	башмак обсадних труб
Casing spear	труболовка
Casing string	обсадна колона
Churn drill	станок ударного буріння
Conductor	кондуктор
Core auger	шнек
Core barrel	колонковий набір, колонкова труба
Core bit	бурова коронка, колонкове долото
Core catcher, core braker	кернорвальний пристрій, кернорвач
Crown block	кронблок
Deflecting tool	відхилювач
Derrick	бурова вишка, баштова вишка
Diamond bit	алмазне долото
Diamond coring bit	алмазна коронка

Double	бурильна свіча
Double tube core barrel	подвійна колонкова труба
Drag bit	ріжуче долото
Drill collar	обважнена бурильна труба (ОБТ)
Drill collar string	колона обважнених бурильних труб
Drill pipe	бурильна труба
Drill pipe string, drilling string	бурильна колона
Drill string, drill supply	технологічний інструмент
Drilling jar	розсувна штанга, ножиці, яси
Drilling rig	бурова установка, буровий верстат
Drilling rig and accessories	буровий агрегат
Drilling tools	породоруйнуючий інструмент
Drive rod	ударна шта9нга
Electro-drill	електробур
Elevator	елеватор
Eye-bolt swivel	вертлюг-сальник
Fishing tap, screw-tap, rod tap	ловильний мітчик
Fishing tools	ловильний інструмент
Fishtail bit	ріжуче долото
Fork	підкладна вилка
Fourble	бурильна свіча
Hard metal bit	твердосплавна коронка
Hoisting	фарштуль
Hoisting hook	вертлюг-амортизатор
Hydraulic hammer	гідроударник
Kelly, square kelly	ведуча труба
Lifting hook	вертлюг-амортизатор
Lifting sub	фарштуль
Liner	потайна колона
Magnetostrictive drill	магнітострикційний бур
Mast	бурова щогла
Matrix	матриця коронки
Mobile column	ходова колона
Mobile rig	пересувна бурова установка
Mud pump	буровий насос
Nipple	трубний ніпель
Orientator	орієнтатор
Pack-sack rig	переносна бурова установка
Pipe cutter	труборіз
Pipe dog	труболовка
Pipe handling equipment	свічеукладальник
Pipe rack	трубний підсвічник
Pneumatic hammer	пневмоударник
Power tong	труборозворот
Production string	експлуатаційна колона

Reamer	розширювач
Retrievable wedge	клин, що витягається
Rock bit	шарошкове долото
Rod hangers	свічеприймальник
Roller bit	шарошкове долото
Roller, roll	шарошка
Rope socket	канатний замок
Rotary drill	роторний буровий верстат
Rotary drilling rig	верстат обертального буріння
Rotor	обертач роторного типу
Safety clamp	труботримач
Safty sub	від'єднувальний перехідник
Self-propelled drilling rig	самохідна бурова установка
Shelter	бурова будівля
Shot bit	дробова коронка
Slush pump	буровий насос
Spider	труботримач
Spindle-feed rig	шпиндельний буровий верстат
Spindle-type swivel head	обертач шпиндельного типу
Stationary rig	стаціонарна бурова установка
Stationary wedge	стаціонарний клин
Sub	трубний перехідник
Surface casing	направляюча труба
Swivel	буровий сальник
Swivel head	обертач бурового станка
Thrible	бурильна свіча
Tool joint	бурильний замок
Tube	обсадна труба
Tungsten carbide core bit	твердосплавна коронка
Turbodrill	турбобур
Underreamer	розширювач
Waterhole	промивальний канал коронки
Waterway	промивальний канал коронки
Whipstock	відхиляючий снаряд
Wire line grab	ловильний йорж
Wire-line bit	ударне долото

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