DISPOSAL OF DRILLING WASTE FOR DRILLING IN THE CONDITIONS OF THE KARAYKOZOVSKOYE FIELD

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According to the Law of Ukraine "On Waste Management", "...the waste management hierarchy is implemented by central and local executive authorities, local self-government bodies, enterprises, institutions and organisations in order to (in order of priority)

1) prevention of waste generation;
2) preparation of waste for reuse;
3) recycling;
4) waste recovery (including energy production);
5) waste disposal...".

Drilling waste includes drilled rock or drill cuttings, spent drilling fluids, and drilling wastewater. Drilling also produces other wastes, but their volumes are relatively small. All three of these components of drilling waste contain water, particles of drilled rock, drilling mud components and sometimes oil (or other hydrocarbons) in varying proportions, which may be included in the waste when passing through oil-bearing formations or added as a lubricant to the drilling mud. The composition of drilling waste mainly depends on the geological section (rocks), type of drilling fluids and chemicals used to treat the drilling fluids.

In Ukraine, there are two methods of drilling oil and gas wells: pit and pitless. With pit drilling, drilling waste is collected, stored, neutralised, solidified and disposed of in waterproofed sludge pits directly at the drilling site. In the case of pitless drilling, drilling waste is accumulated in containers and metal tanks and transported to other locations (pits, storage facilities, landfills) for treatment or disposal.

The vast majority of wells are drilled in the Dnipro-Donetsk Basin (Chernihiv, Sumy, Poltava and Kharkiv regions).

Drilling mud in a well performs a number of different functions, including

removal of drilled rock from the well;

cooling the bit while it is working on the bottom hole;

erosion of rock on the bottom hole;

strengthening of well walls, etc.

Thus, the composition of spent drilling fluids also depends on the geological section, water, salts and chemicals used to treat the fluid.

Drilling wastewater can include rain and melt water, especially if the drilling sites are poorly planned, from which this water can flow into the pits. In addition, there may be irrational water use by drilling crew members. It should be noted that pitless drilling produces much less liquid waste, but the cost of transporting drilling waste increases.

Calculate the volume of drilled rock formation

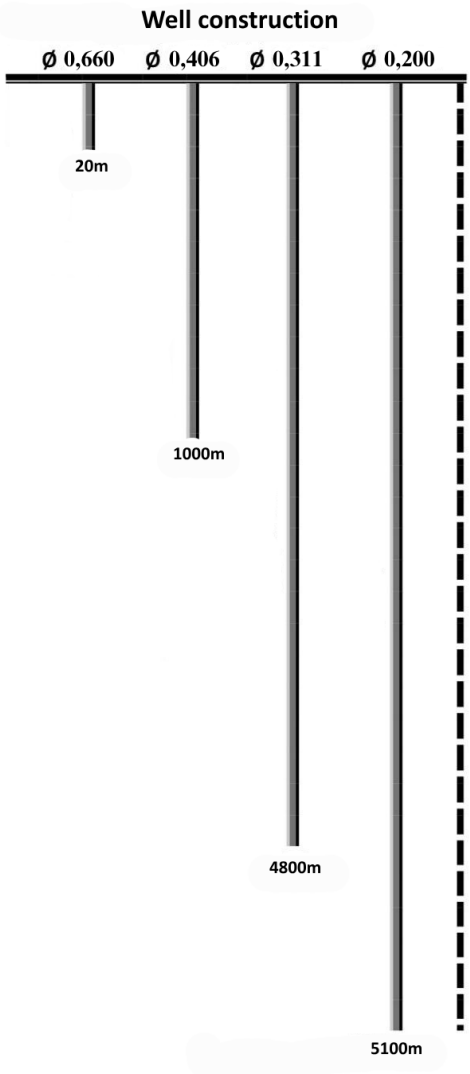

Fig. 1

Consider the (approximate) well design (Fig. 1). As can be seen from the figure, drilling for each casing is carried out with different bit diameters. Volume of rock drilled:

$$V_{dr} = 0{,}785 * Fc * (D_{bi} * \alpha i)^2 * Li, \quad (1)$$

where Fc is the rock compaction factor, 1.2;

D_{bi} - bit diameter in the drilling interval, m

αi - average well cavity ratio;

Li - drilling interval, m, including intervals:

0–20 m $V_{dr} = 0{,}785 * 1{,}2\ (0{,}660 * 1{,}10)^2 * 20 = 10$ m^3

20–1000 m $V_{dr} = 0{,}785 * 1{,}2\ (0{,}406 * 1{,}10)^2 * 980 = 185$ m^3

1000–4800 m $V_{dr} = 0{,}785 * 1{,}2\ (0{,}311 * 1{,}04)^2 * 3800 = 375$ m^3

4800–5100 m $V_{dr} = 0{,}785 * 1{,}2\ (0{,}200 * 1{,}27)^2 * 300 = 19$ m^3

Total = 589 m^3

When cleaning the drilling mud, not all of the drilled rock is removed. For example, the following indicators are used for calculation: the degree of cleaning on a

vibrating screen is 20%, on a hydrocyclone and sludge separator - 20%, on a centrifuge - 20%, and settling in troughs and receiving tanks - 15%. The total is approximately 75%. Thus, the total volume of drilled rock separated from the drilling mud for this well is

$$V_{dc} = 589\ m^3 * 0{,}75 = 442\ m^3,$$

Let's calculate the volume of these soft clay rocks:

$$V_{dr} = (10\ m^3 + 185\ m^3 + 375/2) \times 0{,}75 = 300\ m^3$$

From a depth of 2900 m, sandstones, siltstones, mudstones, shales, and limestones are strong. The volume of these strong rocks is from 2900 to 5100 m:

$$V_{dr} = 442\ m^3 - 300\ m^3 = 142\ m^3$$

According to the calculation, the volume of spent washing fluid will be 1641 m^3. In addition, the volume of mud for well testing - 154 m^3.

The volume of drilling wastewater will be 3,282 m^3.

The total volume of drilling waste for the well with a design depth of 5100 m is estimated to be approximately

$$V_{dw} = 442 + 1641 + 154 + 3282 = 5519\ m^3.$$

As can be seen from this calculation, the vast majority, almost 89%, is liquid and semi-liquid drilling waste (Fig. 2). Moreover, solid and semi-solid waste for this well is only 442 m^3, or 8 %. Exceptionally hard - 142 m^3, or ≈ 2.6 %. It should be noted that, depending on the technological discipline, the volume of liquid waste at different drilling rigs may be significantly less than the estimated amount.

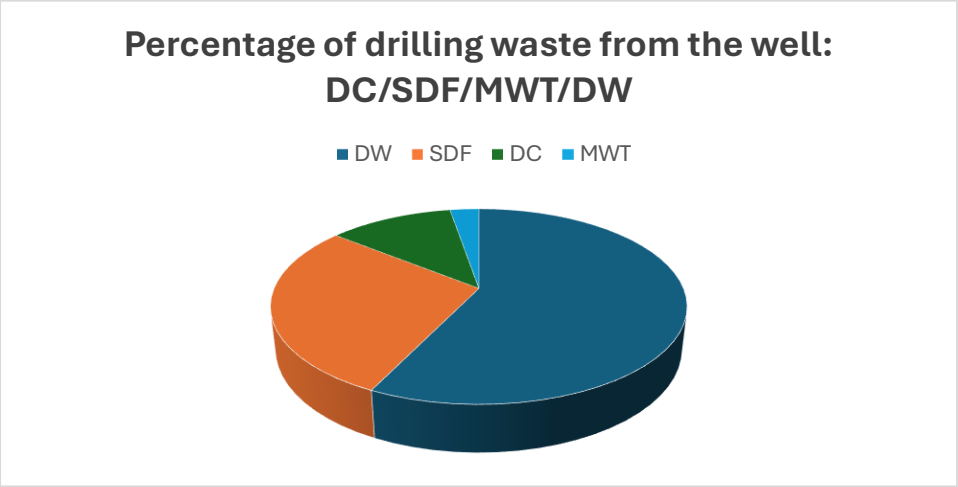

Fig. 2

In accordance with the waste management hierarchy, measures are taken at most wells to prevent the generation of drilling waste. The drilling site is planned to

minimise rain and melt water from entering the cuttings pits. The pits are usually bunded. Water consumption is recorded. Wastewater is used to wash equipment and treat drilling fluids, etc.

Drilling wastewater is pre-treated to prepare it for reuse. Spent drilling fluids are also treated and recycled accordingly and can be transported to other wells for use.

The main methods of drilling waste treatment are thermal, chemical, biochemical (biological), physical, physical and chemical, and others.

Thermal method.

This method is quite common. It includes drying, pyrolysis, thermal desorption, electric fire treatment, thermolysis, and heat treatment.

This method does not require any preliminary preparation (cleaning from debris, stones, oil products). The volume of the processed product is several times smaller than the initial volume of drill cuttings.

The method of thermal treatment of drill cuttings is generally a rather expensive process, and mainly burns (dries) the water contained in it and sintered rock. Moreover, drilling cuttings are not classified as hazardous waste that must be incinerated.

Physical disposal method. It is based on changes in the physical properties of drill cuttings under the influence of various factors.

The following processes can be conditionally distinguished:

gravity settling;

separation in a centrifugal field;

separation by filtration.

Physical and chemical methods. This method is based on the use of flocculants, coagulants, etc. that change the physical and chemical properties, followed by treatment with special equipment.

In Ukraine, physical and chemical methods of drill cuttings treatment are most commonly used. Vibrating screens, hydrocyclones, sludge separators and centrifuges are used to separate drill cuttings from the drilling mud and discharge them into sludge pits, where they are neutralised, solidified and disposed of using various preparations.

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