Mud Pit Liquidation and Reclamation Technology on the Licensed Plots of Oil Producing Companies

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Abstract. Economic activity connected with the mastering of oil deposits has man-induced impact on the condition of environment. During the well drilling using materials and chemical reagents (drilling agents) with different degree of danger for the environment (III-IV class of hazard), drilling cuttings are lifted to the day surface (the bore mud, used drilling mud, drilling waste waters) with their following placement in the mud pits (temporary storage tanks, slurry reservoirs). Man-induced impact from the use of mud pits is expressed in the pollution of the atmosphere by the pollutants from the mud pit surface, pollution of the top-soil, surface and ground waters and negative influence on the animal and plant world of the territory. Mud pits liquidation and recultivation technology will allow decreasing of the man-induced influence on the environment.

1. Introduction

Well-boring is connected with formation of drilling waste represented by the bore mud, used drilling mud, drilling waste waters [1]. Mud pits occupy significant territories on the area of oil deposits arrangement. In Khanty-Mansisk autonomous district Ugra it's extracted about 50% of Russian oil and almost 7% of the world oil. According to the data of Federal Service for Supervision of Natural Resource Usage (Rosprirodnadzor) in KMAD-Ugra there are 70% of all oil-producing wells of Russian Federation. Thus, according to the assessments of Autonomous Institution “V.I.Shiplman research and analytical Centre”, the average formation of drilling waste on the territory of KMAD-Ugra is 5.4 mln. m3. Analogous phenomenon is typical for Yamalo-Nenetz autonomous district and Tuymen region [2].

There is a series of technologies on utilization of drilling waste used by oil companies on the territories of KMAD-Ugra, YANAD and Tuymen region [1]. Technologies on the treatment of drilling wastes are based on the ways of thermental decontamination, solidification, encapsulation with the following obtaining of building materials, grounds etc [3,4,5].

Adopted drilling waste utilization technologies, as a rule, include collection, accumulation, and/or placement of drilling wastes in the mud pits. However despite the use of such measures as dike of the mud pits, hydroisolation of the walls and bottom, the reliable protection of environment from pollution by the drilling wastes is not provided [6,7,8].

The drilling wastes have negative physical and chemical, physical, chemical properties: high content of salts, heavy metals, increased alkalinity, toxicity level, total lack of structure, soil overcrust, low airing, low filterability etc [9,10].
Polluting elements of the bore muds accumulating in the soil layer lead to the loss of soil fertility: loss of soil structure, appearance of strengthening of erosion process, decrease of biological activity of the soil and its ability to the self purification. High mineralization and alkalinity of drilling wastes, as well as the presence of liquid hydrocarbons in their composition are the main factors of their negative influence on the soil cover [11,12]. The migration of toxic salts of components (ions of chlorine, sodium, sulfate ions, hydrogen bicarbonate ions) and oil products, both in vertical and horizontal directions, leads to deterioration of soil properties: the water-air regime of the soil is disturbed, the concentration of soil solution increases, sodium into the soil-absorbing complex, the microflora is inhibited, which makes the soil unsuitable for plant growth [13,14,15]. This leads to the destruction of existing ecosystems on the territory, followed by contamination of adjacent environments [16,17].

2. Materials and Methods

As the study object there was chosen drilling waste pit – the mud pit. The process of liquidation and recultivation of the mud pit is carried out in three stages: preparatory, technical and biological stages.

During the preparatory stage it's evaluated: location of the mud pits on the certified lots of oil producing companies; availability of project documentation of mud pits arrangement; attribution of plots of land damaged due to the building of the mud pits to the categories of lands, lands of settlements specially protected designated natural areas, water fund, other categories of lands or water protection zones of surface water objects and zones of water abstraction sanitary protection; availability of technical possibility to pump liquid phase of drilling wastes during the liquidation of mud pits in the oil collector; characteristics of the mud pit (dimensions of the mud pit; place for the machinery approach; ground volume for the forming of cutting strips; ground volume for the forming of root area for the planting of cereal and leguminous crops, applied on the biological stage of reclamation).

All necessary materials and equipment are brought to the industrial site for the carrying out of technological stage.

For the preparation to the biological stage of works the mineral fertilizers, grass mixture of seeds processed by the biological preparation are delivered.

3. Results

On the stage of preparatory works, the project documentation is considered. Based on this documentation, the working plan on liquidation and reclamation of the mud pit is made up.

Technical stage of works includes the following:

*Collection of liquid oils (oil emulsion) from the surface of liquid phase.*

In case if liquid oil is in the mud pit, then before its pumping the oil-gathering devices of any type are used. For more careful collection, especially in case of very thin oil layer, it's advisable to use oil gathering vessels installed on the water surface on the pontoons. For the pumping in case of significant thickness of oil layer, as a pumping device there can be used cementing devices, slime pump machines and other equipment appropriate for the oil pumping. The collected liquied oil (oil emulsion) is pumped into oil collector.

In case of possibility to connect to the oil collector on the multiple-well platform where bore mud utilization works are carried out, the pumping of liquid oil (oil emulsion) is carried out by the pumping equipment into the special machinery – oil truck and after it's transported to the territory of multiple-well platform with an oil reservoir.

To accelerate the process of cleaning of the mud pit surface from separate oil stains on the surface of the pit, in the most remote zone from the oil equipment installation point, small flexible sectional booms with a length sufficient for "partitioning" or other devices suitable for this purpose are mounted. The booms are installed along the periphery of the oil stain and are moved in the necessary direction manually from the shore by means of ropes attached to the end sections.
If it is necessary to provide normal conditions for the use of oil-gathering equipment and small mobile booms to tighten the oil stains, an additional volume of water is pumped into the mud pit (in the absence or thickness of the water layer in the pit less than 30-50 cm). The additional volume of water is supplied by a motor pump through a pressure hose from the vehicle (a water tank equipped with a sealed tank). Water is imported from water supply systems.

Pumping of the liquid phase from the mud pit.

The water from the mud pit is pumped by the equipment intended for these purposes. The pumping of water phase is carried out into the oil collector. The pumping is carried out till there is a possibility to pump the whole volume of water free from weighted mechanical parts.

Creating of cutting strips.

For the carrying out of works on the utilization of the bore mud, the cutting strips are poured out to provide possibility of carrying out the works on the whole area and with the highest power of the mud pit. The mud pit is divided into sections. The arrangement of cutting stripes is carried out by the bulldozer on the whole width of the passageway for the special machinery. Cutting strips are poured out by the method including preliminary release of some area of the mud pit from the bore mud to its bottom with the following addition of the ground to the space clean from the bore mud for the road building.

The cutting strips are built by turn to prevent the displacement of bore mud from the mud pit. The ground for the road building is delivered by dump-body trunks and loaded into the mud pit. The cutting strips have a type of technological passageway in a form of elevated approach of trapezoid shape with the width of upper basement no less than 4 m and incline 45°. Calculation of the road ground volume necessary for the creation of the cutting strip is carried out taking into account the depth of the mud pit and ground compaction. Soil shrinkage is calculated by the data of technical documentation for the road building. Number of the cutting strips should be minimal and calculated to provide the possibility of the machine working on the whole area of the mud pit. Distance between the cutting strips shouldn't exceed two radiuses of excavator working zone.

Utilization of the bore mud in the mud pit.

In each section of the mud pit separated by cutting strips, a mixture of components is added and mixed by the bucket of the excavator to a uniform consistency.

The resulting product can be used at the site of its production at the technical stage of land reclamation, disturbed due to the construction of a mud pit.

At the end of the technical stage of reclamation, the biological stage is carried out.

At the biological stage, the following types of work are performed:

Territory cleaning. The territory is cleaned from the approach roads, ramps etc. using excavator and bulldozer. The appeared technologic rubbish is taken to the nearest solid wastes landfill and/or passed to the specialized enterprise.

Planning of the territory. The entire reclaimed territory of the mud pit is leveled out and planned using excavators and bulldozers, so that in the reclaimed territory, if the adjacent relief allows, there will be no degradations in which water will later stagnate and a marsh biocenosis can form.

Forming of conventionally-fertile layer. After the work in the mud pit, the surface is covered with peat that meets the requirements of GOST R 51661.3, GOST R 51661.4, with a layer of 10-15 cm and is mixed with the basic mineral soil (sand) to form a reclamation layer with a capacity of at least 20 cm (Table 1) [18],[19].

The ratio of peat and soil (sand) in the reclamation layer is 1:1.

The creation of a conventionally fertile layer is made by a milling cutter mounted with a tractor or a motor block with a milling attachment with a diameter of the milling disc providing the required depth of milling. After milling, the total projected capacity of the reclamation layer is about 150-200 mm, which provides sufficient depth for the rooting plant horizon - meliorants.

Peat is transported to the site of reclamation by dump trucks and is loaded into a pile in close proximity to the reclamation barn, or directly to the site of a liquidated barn. The layout of the site of
the buried barn with peat crumb is made by a mechanized method - a bulldozer, or manually - a trench tool (shovels, rakes).

### Table 1. Characteristics of peats used for the reclamation.

| Parameter name                                      | Peat for the improvement of the soil | Neutralized peat |
|-----------------------------------------------------|--------------------------------------|------------------|
| Moisture, % no more than                            | 60                                   | 63               |
| Acidity, pH KCl                                     | > 4.6                                | 2.5-6.0          |
| Ash content (on dry basis), % no more than           | 25                                   | 20               |
| Impurity (toe, wood, rhizome particles more than 25 mm), % no more | 8                                    | 8                |

**Mineral fertilization.** Mineral fertilization is carried out superficially with the following covering by the rakes before the milling. Mineral fertilization before the sowing of grass is supposed.

For the presowing fertilization the technologies of top placement are used (fertilizers are evenly distributed on the soil surface and embedded in soil by rakes, cultivator or leave without embedding), contact placement (placement of seeds and fertilizers mixture).

Recommended doses of mineral substances for presowing surface application: nitrogen fertilizers (ammonium nitrate or urea) – 90 kg ha of active substance.

The introduction of fertilizers before seeds sowing is carried out in July, and also in August with the fertilizing of plants, thereby facilitating the assimilation and accumulation by the plants of spare nutrients, which in turn increase the resistance of plants during dormancy and activate the processes of growth and development in the spring.

Depending on the conditions of location of the mud pit section of the reclamation subject, a planting material for phytorecivation is selected.

**Planting of grassland vegetation on the deliriet land.**

For the acceleration of mat-forming, recovery and forming of rooting layer and its enrichment with organic substances, the grass mixtures from few types of grass are sowed in organo-mineral ground (peat-sand mix), including annual and perennial, cereal and legumes. The preference is given to the grass mixtures imitating the combination of plants in the natural communities. To increase the germinating ability of seeds it’s recommended to carry out their processing with biological preparations before sowing.

Taking into account the soil and climatic conditions of the sites subjected to biological reclamation, the seed sowing rate is – 100 kg/ha.

The inclusion of perennial ryegrass into the composition of the grass mixture is due to its ability to accelerate the processes of humus formation due to the intensive growth of biomass and the formation of a dense, even sod, which, in turn, allows improving the soil structure as soon as possible.

In case of cold or dry summer, on the biological stage of reclamation, it's advisable to to introduce annual grass (oat, rye). Since grain-crops develop more quickly, in the first year the grasses will be under the covering of the oat that will allow hampering of weed development, create thick herbage already in the year of sowing and accelerate the processes of soil fixation from erosion.

When sowing seeds, it is necessary to take into account the correction for the economic suitability of each particular site, in accordance with RD 13.020.40-KTN-208 [20].

Seeding of seeds in the reclamation layer on the surface of the sites of reclaimed pits is carried out using seeders or manually by evenly spreading over the surface of the site. Before sowing, if the peat is dry, one should water the area using a fire hose with a spreader nozzle.
Data on the proposed grass mixture, herbs (cereals and legumes) and their quantitative ratio for reclamation of the mud pits are given taking into account RD 39-30-925-83 in the Table 2 [21].

Table 2. Grasses recommended for phytoamelioration of the mud pits.

| №   | Names of the grass types                      | Amount kg/ha |
|-----|-----------------------------------------------|--------------|
| 1   | Bromopsisinermis (Leyss.) Holub               | 25           |
| 2   | Festucarubra L.                               | 25           |
| 3   | Elytrigiarepens (L.) Nevski                  | 20           |
| 4   | Agrostispratensis L.                          | 20           |
| 5   | Melilотusofficinalis                          | 5            |
| 6   | Medicago sativa                               | 5            |
|     | Total:                                        | 100          |

4. Conclusion

The technology is applicable for the reclamation and liquidation of the mud pits in the areas of the oil production deposits with developed transport infrastructure as well as being autonomous and using sump drilling.

5. References

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