Disposal technology of waste oil drilling cuttings in drilling engineering

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Abstract. with the continuous expansion of shale gas development in drilling engineering, there are more and more waste oil drilling cuttings, which has become a heavy burden on the oilfield. If not treated effectively, it will cause great harm to the natural and address environment around the oilfield. This paper mainly studies several kinds of waste oil cuttings disposal technology, and puts forward the most mature technology of eight medium oil cuttings disposal at present, in order to help the relevant treatment work.

Keywords: Drilling engineering; Shale gas; Waste oil cuttings; Processing technology.

1. Preface
Petroleum resource is an important resource that affects national industrial development and national defense construction. With the increasing demand for petroleum at present, China's shale gas development has entered the white-hot stage. In the exploration and development of shale gas, the most conventional oil based drilling fluid technology is adopted, but the oil based drilling fluid will also produce waste oil drilling cuttings with production consumption. Nowadays, it has brought a heavy burden to environmental protection. How to deal with it effectively has become the focus of current research. If not treated, it will cause pollution of soil, surface and groundwater, and directly or indirectly cause great harm to animals, plants and human health.

At present, the technology of oil drilling cuttings treatment of oil drilling fluid is to remove the oil in free state on the surface of oil drilling debris by means of mechanical external force of the dry cleaner, heat treatment and chemical oil drive, and then control the oil fraction of oil drilling fluid to below 5%. This paper will enumerate the treatment technology of oil cuttings at home and abroad to solve the technical problems of environmental protection in drilling engineering.

2. Thermal distillation treatment technology
At present, thermal distillation treatment technology is a relatively mature waste oil drilling cuttings treatment technology, which can treat waste oil drilling cuttings on a large scale. Therefore, the application of this technology is relatively common, and many countries in the world are applying it to treat waste oil drilling cuttings. In particular, the so-called hot distillation treatment technology refers to the waste oil drilling cuttings are introduced into a closed decompression system, which is provided with
heat from the outside to fully volatilize the hydrocarbon in the drilling fluid, and then it is condensed and recycled to realize recycling.

The related research found that when the temperature reaches 260-300 ℃, the waste oil drilling cuttings can be volatile enrichment and recovery of oil, water, recovery rate can reach more than 90%. The hydrocarbons in the recycled waste oil cuttings can be used as fuel, as well as for the allocation of oil-base drilling fluids, or for other purposes, and the solid residue can be used for engineering construction. However, the technology has the defects of high energy consumption, high cost and low safety.

3. Solvent extraction treatment
Solvent extraction treatment technology refers to the use of some low boiling point organic solvents, such as acetic acid acetic acid, hexane, chlorinated hydrocarbon, etc. in the waste oil drilling cuttings of hydrocarbon dissolved extraction, and the extraction liquid is evaporated out by flash steam for recycling. The advantages of this treatment technology lie in that it is easy to operate and realize, so it is very suitable for the treatment of some oil drilling chip recovery oil. However, due to its high solvent volatility, the cost is higher and the safety requirements are higher.

| Processing technology    | Advantages                                      | Disadvantages                                    |
|--------------------------|--------------------------------------------------|--------------------------------------------------|
| Thermal distillation     | Applicable to large-scale treatment, oil extraction rate is high. | High energy consumption, strict equipment requirements, low safety. |
| The pit is sealed and buried | Simple process, easy construction, low cost. | The conditions are simple and easy to leak causing underground pollution. |
| The chemical demulsification | Simple equipment, mild conditions, high oil extraction. | Chemical agents are highly targeted and do not have universal applicability. |
| Curing                   | Simple construction, low cost, strong practicality. | High cost for subsequent treatment or comprehensive utilization. |
| Solvent extraction       | Low condition, high oil yield, solvent recovery. | High solvent volatility, high energy consumption and high processing cost. |

4. Supercritical fluid extraction treatment technology
The principle of supercritical fluid extraction and treatment of waste oil drilling cuttings is to mix oil based drilling fluid with supercritical fluid. The commonly used supercritical fluid is propane, carbon dioxide, etc. The hydrocarbon in drilling fluid will be extracted into these supercritical fluid, which can be extracted for recycling after decompression.

Based on the supercritical fluid extraction treatment technology, a supercritical co2 extraction oil - based drilling fluid was developed. In general, the critical conditions of supercritical fluids such as propane and carbon dioxide are relatively easy to reach, and the oil recovery rate is high, and the treatment effect is good.

5. Sealing and burying technology in pit
Pit sealing technology is a special landfill treatment method. Specifically, it needs to cover the bottom and sides of the pit with a layer of organic soil, the upper layer with a layer of plastic cushion, and finally a layer of organic soil, so that waste oil drilling debris can be buried in the pool. However, this method is unable to recycle the remaining oil resources in oil base drilling fluid, resulting in a large amount of waste of oil resources, so the practical value is relatively low. Furthermore, the method is also prone to risk of leakage and pollution. The most important thing of this method is to choose a safe and suitable ground for burial. The method is widely used in the United States and the buren area of north sea.
6. Biological repair treatment technology
Bioremediation technologies include microbial degradation and bioflocculation. The former is to use microorganisms to degrade the hydrocarbon in the waste oil drill chip, making it a low molecule or gas with little environmental pollution. The latter is to demulsify the drilling fluid by adding some special microorganisms to the waste oil drilling cuttings and then flocculate the hydrocarbon. Generally, factors affecting microbial degradation mainly include temperature, pH value, nitrogen and microbial activity, etc. However, the most critical factor is the biodegradation ability of carbon and oxygen compounds. The key to bioremediation is that the selection of microorganisms must be appropriate and difficult to deal with, because genetic engineering and cellular engineering are often involved. In addition, due to the late start of research on bioremediation treatment technology in China, the current application is not very extensive, and many bacteria cannot have universal applicability in practical application, which still needs further research.

7. Chemical demulsification treatment
Chemical demulsification technology is to add chemical agents, flocculant and auxiliary agents with demulsifying property to waste oil drilling cuttings, so that hydrocarbon substances can be flocculated after demulsification. After demulsification and flocculation, oil-base drilling fluid will form three phases of oil, water and waste residue. After oil recovery, it can be used as base material and fuel, etc. After water treatment, it can be recycled, and waste residue can also be recycled, for example, as building materials.

Therefore, chemical demulsification treatment technology is also a kind of waste oil drilling chip treatment technology with high recycling efficiency, which is widely applied and studied at home and abroad. Currently used demulsifiers mainly include surfactant, acid and high-priced metal salts.

8. Curing technology
Curing technology is to add curing agent into abandoned drilling fluid, so that it can be converted into solid with high cementation strength or into soil, and then be buried in situ or used as building materials. This method is most effective for Cr, pH, COD and Cr pollution which is difficult to be treated in abandoned drilling fluid. According to the toxicity measurement of the solidified fluid, the abandoned drilling fluid with the highest water content is combined with the solid-liquid separation technology to obtain the best treatment effect. There are many mature technologies for solidification of waste drilling fluids, which can be used for solidification treatment of different waste drilling fluids.

9. Physical and chemical methods
The French company STB's waste drilling fluid treatment system works by pouring the waste drilling fluid into the recycling tank, stirring and mixing, and then performing centrifugal dehydration treatment. The centrifugal separated liquid phase is pumped into the recovery tank for chemical flocculation treatment. The lower water phase is filtered by precipitation before being recycled. The solid phase produced by centrifugal dehydration is extruded and shaped to be used as building materials. In addition, an on-board mobile device has been developed, which can be processed in the well site.

10. Conclusion
To sum up, the disposal of waste oil drilling cuttings is always a difficult problem. Only when this problem is solved, can the sustainable development of oil industry be realized. In our country at present, often USES waste oily sludge treatment technology mainly include thermal distillation, solvent extraction processing technology, supercritical fluid extraction technology, pit sealed landfill treatment technology, bioremediation technology and chemical demulsification treatment technology, etc., these technologies all each have advantages and disadvantages, the future still need to continue to strengthen its advantages, improve its shortcomings, and constantly develop new technology and methods.
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