

## Environment-friendly drilling operation technology

Huaidong Luo<sup>1</sup>, Ning Jing<sup>1</sup>, Yanna Zhang<sup>2,4</sup>, Hongjun Huang<sup>3</sup>, Jun Wei<sup>1</sup>

<sup>1</sup> CNPC international (Chad) co., LTD, China

<sup>2</sup> China petroleum exploration and development research institute, China;

<sup>3</sup> CNPC Drilling research institute, China

E-mail: zh-yanna@qq.com

**Abstract:** Under the circumstance that international safety and environmental standards being more and more stringent, drilling engineering is facing unprecedented challenges, the extensive traditional process flow is no longer accepted, the new safe and environment-friendly process is more suitable to the healthy development of the industry. In 2015, CNPCIC adopted environment-friendly drilling technology for the first time in the Chad region, ensured the safety of well control, at the same time increased the environmental protection measure, reduced the risk of environmental pollution what obtain the ratification from local government. This technology carries out recovery and disposal of crude oil, cuttings and mud without falling on the ground. The final products are used in road and well site construction, which realizes the reutilization of drilling waste, reduces the operating cost, and provides a strong technical support for cost-cutting and performance-increase of drilling engineering under low oil price.

### 1. Introduction

As people's emphasis on environmental protection, National Medium and Long-Term Science and Technology Development Plan Outline, Twelve Five-Year Plan Outline, Five-Year Science and Technology Development Planning all give priority to develop environmental protection technology [1, 2]. A large amount of drilling waste, including drilling sewage, drilling fluid, drilling cuttings and waste oil, causes great pollution to the environment during the oil drilling process. Currently, digging operation is used in most of the drilling sites, and anti-seepage cloth is placed in the mud pool [3-5]. But the cloth damage often occurs, which leads to environmental accidents such as leakage of mud and mud-contaminated soil and water. At the same time, drilling waste is discharged into the mud pool. Although air-dry buried, these wastes are still soluble, and will cause serious environmental risks to the surrounding soil, water, crops and air once soaked in the rain or washed by rivers [6].

In 2013, due to the local workers' labor insurance events of handling drilling mud pool, it led to environmental disputes between Chad's government and CNPCIC and caused a number of unfavorable conditions for construction in Chad. Meanwhile drilling waste discharge in the mud pit for dry burial, but these wastes still have soluble organic pollution, heavy metal pollution, inorganic hydrocarbon pollution, so they would have serious environmental risks on the surrounding soil, water, crops, and the air once immersed in rain and eroded by river. Therefore, China International (Chad) Co., Ltd. carried out the environment-friendly drilling operation technology for chad project region H.

The drilling fluid system used in the Chad region since 2007 is the Bio-Pro system. This system's single-agent and the system itself both passed environmental standards check and met the local environmental protection requirements. Therefore, there is no pollution source in the drilling fluid



system itself. But because the highly saturated oil in this region, and formation pore of high pressure, so the overflow is caused frequently during the process of drilling, resulting in crude oil's invasion of drilling fluid, cuttings mixed in, or return of oil-contained cuttings, causing serious environmental pollution. So the main feature of drilling waste in this region is oil-contained, so the difficulty in the treatment of oil wastewater, oil sludge, oil cuttings is without falling on the ground.

## 2. Methods

In order to thoroughly solve the waste mud governance problem, Chad project department is phasing out past passive centralized way of waste mud "end-treatment" way-landfill method, actively seek pollution thoroughly, advanced way of sludge treatment in line with the "reduction, harmless and recycling" cleaner production principle, so that to fundamentally solve waste mud pollution risk.

### 2.1. Oil water separation technique

When the crude oil mixed with water-based drilling fluid, it will form an oil-in-water emulsion with water as a continuous phase, use water-soluble inorganic polymer demulsifier - polymerized aluminum sulfate (PAS) [7-9], and added amount is 50mg / L with an obvious layer between oil and water and a short time, and the addition of demulsifier will not cause pollution to the environment.

### 2.2. Oil sludge separation technology

At home and abroad about the oil (crude oil, lubricating oil) aqueous waste drilling mud solid-liquid separation process are rare, generally thermal desorption is adopted in only a few research report of the oil waste mud solid-liquid separation, while the waste oil of solid-liquid separation research has not been reported under the normal temperature [10-12].

According to the characteristics of waste in Chad region, By using "oil-displacement" principle, appropriate amount of oil-displacement agent can effectively realize the displacing of oil and mud particles, and by the treatment of coagulant and flocculating agent [13,14], oil water can be separated from sediment effectively. After treatment the mud mixture bypasses the oil separation device where sedimentation and floatation oil is conducted. The lower layer of separation device waste mud is pumped into the vacuum belt filter for dehydration by a mud pump, and recover the upper layer oil.

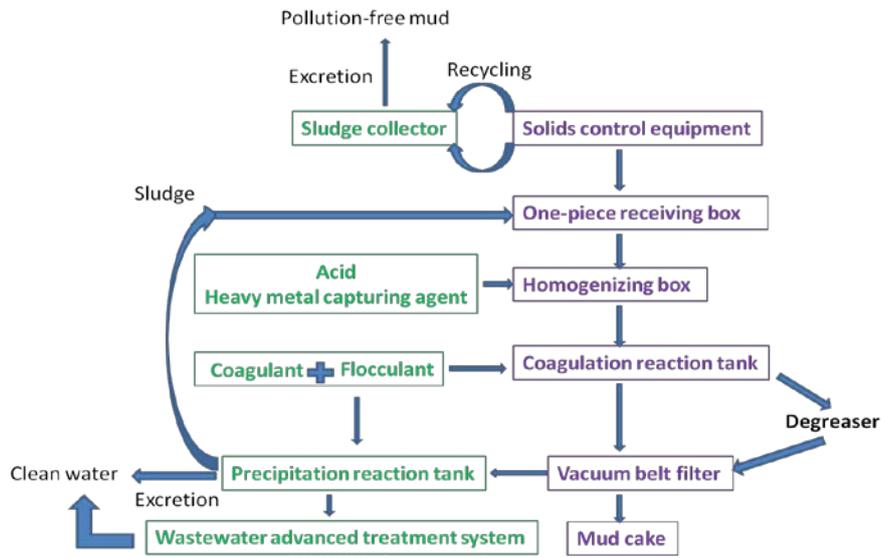
### 2.3. On-site waste mud treatment process

The drilling waste mud treatment system of this technology adopts skid-mounted, modular assembly equipment, the whole process of the treatment of drilling waste mud assures collection without falling or reuse or compliance treatment; Throughout the treatment process, according to drilling design scheme, drilling depth and changes of the mud system, the treatment process is adjusted timely.

## 3. Results

The key of the environment-friendly drilling operation is to abandon the traditional extensive drilling method and adopt the no-falling receiving and treatment technology to realize the closed-loop recovery and utilization of the drilling waste [15,16]. It is not only with the stringent environmental requirements, but also can be better adapted to the international security situation increasingly stringent environmental standards.

In 2014, Kazakhstan company contracts the transportation of waste drilling mud and debris to specialized contractors result from the process of drilling and workover, to centralized disposal and realize the environment friendly, but the local government taxes burden is too high to cost. To the three important steps of the cuttings and mud receiving, transporting, and treatment on-site, scientific demonstration and design have been carried out, thus assures the smooth implementation of the environment-friendly operation technology in the field, the operation procedure is shown in Figure 1 and Figure 2.



**Figure1** Environment friendly operation technology



**Figure 2** Processing equipment of drilling waste at the scene

#### 4. Discussion

In the Chad Baobab region, because the well C1-4 has a narrow formation security density window during the drilling process of the three open buried hill formation, overflow and well leakage and other complex situations occurred many times, including 17 times overflows, crude oil spillage of 520m<sup>3</sup>, mud leakage about 670 m<sup>3</sup>. In view of the coexistence of gushing and leaking and the high risk of environmental pollution, the operation department takes the advantages of environment-friendly drilling operation to completely control the spilled crude oil in the equipment, and to realize the closed-loop recovery of the wellbore output fluid to ensure that the crude oil does not fall and reduce the environmental risks. It saves about USD 240,000 than traditional operation (See Table 1), and at the same time it shortens the construction cycle and accumulates valuable experience in dealing with the complexity of the buried hill formations, and has been endorsed by the Chadian government's on-site inspection team.

This well using environmentally friendly operation, not only effectively prevent environmental pollution risk, but also avoid the mud pit excavation, backfilling, laid impervious cloth, the most important is to reduce the amount of single well waste processing. Return of cuttings and waste pulp waste are collected at the scene of the two steel tank or buffer tank, so the waste need cleaning up and transfer is actually only the drilling returns solid and liquid wastes, therefore directly save disposal charge about \$150000. The second open completion mud is collected in the buffer tank, part will be used in two wells under construction. In theory, the well drilling fluid can be reused 3 times, so the average single well mud cost and handling fees will save \$70000. As a result, the relative of pit operation, single well save \$240000 on average. The detail can be seen in the table below.

**Table 1** Environment friendly operation cost savings

<b>Project</b>	<b>cost ( USD )</b>	<b>remark</b>
Avoid mud pit excavation	6000	Average mud pit excavation cost of single well
Avoid backfilling slurry pit	15000	Average mud pit backfilling cost of single well
Save the impervious cloth	14000	Impervious cloth, 50m*50m,14000USD
Reduce pollution produced by the digging soil disposal	150000	Reduce the contaminated soil in the mud pit wall and bottom about 500m <sup>3</sup> .Solid processing costs about \$300 per square , Single well solid handling to reduce \$150000.
The main part hole completion mud recycling	70000	Second mud 150 square, average every time a new mud can be reused, three times the average per well save two open mud 100 square, mud costs an average of \$500/square, total average single well save materials and handling about \$70000
Add Device	15000	Increase equipment costs about \$15000 for average single well
<b>Single well average direct cost savings</b>	<b>240000</b>	

#### 5. Conclusion

Environment-friendly drilling operation technology improves on-site operating efficiency, reduces environmental protection risks, and provides a strong technical support for cost-cutting and performance-increase of drilling engineering under low oil price and stringent international safety and environmental standards of the host country of the resources. And it can adapt more suitably to the tendency of more stringent international safety and environmental standards.

## References

- [1] Mo Yuting, Wu Zhenlin 2010 Analysis of Obstacles and Countermeasures of Contract Project in Kazakhstan under the Financial Crisis *Foreign Investment in China* **223** 106-107.
- [2] Peng Yuan, Yang Xu, Sun Changjian 2007 Research on Harmless Treatment of Waste Mud *Environmental Science and Management* **04**
- [3] Song Zhanpei 2012 Solidification Treatment Technology of Abandoned Drilling Fluid in Iran Y Oil Field *Environmental Science and Management* **03**
- [4] Liu Yucheng, Wu Mian 2010 Chen Mingyan. Research Progress and Prospect of Solidification Treatment Technology for Drilling Waste Mud *Environmental Science and technology* **S1**
- [5] Lu Guangliang, Wang Jian, Lu Daosu, Liu Changlong 2009 Research on Photo Fenton Oxidation / Flocculation Combined Treatment of Weak Gel Containing Oil Field Sewage Technology *Journal of Chongqing University of Science and Technology (Natural Sciences Edition)* **05**
- [6] Cong Xiaoqiang, Zhang Yi, Wang Haiyan, Jiang Yi 2012 Advances in Treatment Technology of Oilfield Drilling Fluid Waste *Guangzhou Chemical Industry* **09**
- [7] Cao Hongyu, Wang Jinliang 2011 Brief Discussion about Harmless Treatment Technology of Drilling Mud *China Petroleum and Chemical Standard and Quality* **07**
- [8] Veloso J and Dos Santos G B 2013 The Challenges for the Treatment of Drilling Fluid Wastes Generated by E&P Industry in Brazil *Society of Petroleum Engineers*.
- [9] Antle G, Gover P and Pruett J O 2003 Integrated Waste Management: Successful Implementations of Thermal Phase Separation Technology for Oil- and Synthetic-Based Cuttings and Drilling Fluid Waste *Society of Petroleum Engineers*
- [10] Morillon A, Vidalie J F, Hamzah U S, Suripno S and Hadinoto E K 2002 Drilling and Waste Management *Society of Petroleum Engineers*
- [11] Svensen T and Taugbol K 2011 Drilling Waste Handling in challenging Offshore Operations *Society of Petroleum Engineers*
- [12] Denney D 2011 Holistic Drilling-Fluid and Waste Management in the Fayetteville Shale *Society of Petroleum Engineers*
- [13] Priatna R, Sjahroezah A and Bledog R I 2000 Waste Management: An Approach to the Management of Drilling Waste *Society of Petroleum Engineers*
- [14] Kakadjian S, Thompson J E, Torres J R and Quintero H 2014 Stable Fracturing Fluids From Waste Water *International Petroleum Technology Conference*
- [15] Svensen T and Taugbol K 2011 Drilling Waste Handling in Challenging Offshore Operations (Russian) *Society of Petroleum Engineers*
- [16] Veil J A 2002 Drilling Waste Management: Past, Present, and Future *Society of Petroleum Engineers*