Trends in the Drilling Waste Management.

Dariusz Knez*[1], *Andrzej Gonet, Jerzy Fijał *and* ***Lucyna Czekaj***

Trendy v manažovaní ukladania odpadu pri vŕtaní

Petroleum Industry is trying to achieve sustainable development goals. Each year new solutions are implemented to minimize the environmental impact of drilling operations. The paper presents trends in the drilling waste management caused by introducing the sustainable development into the petroleum industry. Old solutions such as the drilling waste disposal at the waste dump or dumping ground are not acceptable from the environmental point of view. The paper presents an analysis of new solutions as the sustainable solutions. The most important problem is the chemical pollution in cuttings and the waste drilling mud. The industrial solutions as well as the laboratory research on the pollution removing from drilling wastes are analysed. The most promising method seems to be the recycling and design for the environment of drilling mud.

Key words*: Drilling waste, cuttings, drilling fluids, utilization*

Introduction

The drilling waste management is one of the most important challenges in the petroleum industry [7]. The used drilling mud and cuttings are the main problem. The main pollution of cuttings is caused by [9]:

- biocides,
- oil,
- completion or stimulation fluid components,
- corrosion inhibitors,
- reservoir fluids (crude oil, brine),
- drilling mud chemical components.

The current way of drilling waste management in operations the Middle Europe onshores is unacceptable from the ecological point of view. The drilling wastes are mainly collected in tanks near the drilling rig and sometimes, after some initial treatment, are dumped or buried. It is known as a open system of drilling waste management (Fig. 1).

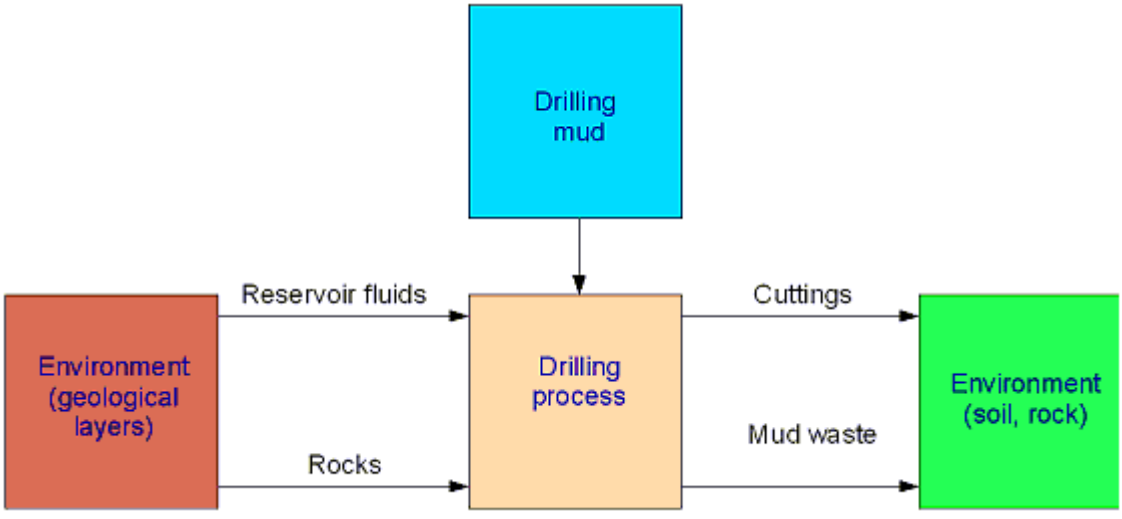

Fig. 1. Open system of drilling waste management.

[1] *dr. inż. Dariusz Knez, prof. dr hab. inż. Andrzej Gonet, dr hab.Jerzy Fijał, Lucyna Czekaj* ,Faculty of Drilling, Oil and Gas, AGH University of Science and Technology, Cracow, Poland
(Recenzovaná a revidovaná verzia dodaná 5. 10. 2006)

A sustainable development assumes the zero discharge of wastes into the environment [11]. Drilling operators have to follow the national environmental policy worldwide. Because the sustainable development becomes a basis of the environmental policy it is no more possible to continue the open system of drilling waste management. Research institutions and drilling operators are looking for a technology meeting the closed system requirements (Fig. 2). There are three main points in such approach:

- amount of waste has to be minimized as much as possible,
- reusing and recycling is necessary,
- only safe and similar to the local environment material can be deposited.

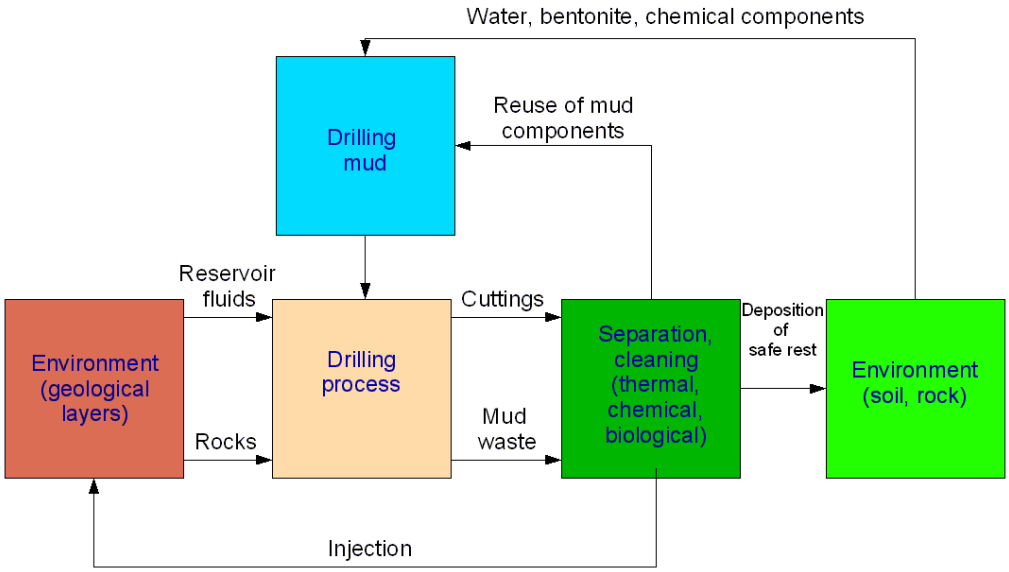

Fig. 2. Closed system of drilling waste management.

Methods

One of the worldwide most popular method of drilling waste treatment is solidification and stabilization [2]. If a pollution is below the allowed limit, drilling waste can be solidified. Cement and silica are the most popular agents [13]. In this way we can get two targets: better mechanical properties by the solidification and the stabilization by the pollution encapsulation. The stabilization minimizes the solubility and mobility of the pollution. The solidification changes the suspension or detached rock into the solid rock. A modification of this method is cementing in the CO_2 atmosphere [8]. In the regular cementing large blocks arise, but in CO_2 a granulated product can be achieved.

The injection of cuttings into injection layers or salt caverns is a very often used method [14]. It is successful as well in onshore as in offshore operations. For example, the Argonne National Laboratory has 300 injection wells from 400 m to 5000 m deep. Only a very fine suspension can be injected. So, the ball mill or the ultrasonic processor is often necessary to prepare proper particles for the suspension.

The thermal method is very useful for cleaning the cuttings. It can be done by burning, the low temperature thermal desorption (LTTD), the thermal phase separation, the rotary kiln and the cement kiln [2].

Because oil based muds give better drilling parameters, they are preferred in many cases. Unluckily, oil included in cuttings makes its treatment more complicated. To achieve the required maximum oil saturation level in cuttings (usually below 0,5 %) extraction can be the effective method. There are three main methods of extraction. One, using hydrocarbon gases , second using supercritical carbon dioxide and another by using surface-active agents [2,12,15].

A more sustainable solution is to use natural forces and processes. Bioremediation can be done in five ways: composting, bioreactors, vermiculture and landfarming [2,5]. But the true sustainability can be meet by a combination of some of the above methods and a new design of proecological drilling process [4]. As a result, we can get a new sustainable model of drilling waste management (Fig. 3).

Very promising results can also be achieved by using the chemo-bioremediation method to detoxify the oil-polluted drilling wastes [3]. Both laboratory and field experiments confirmed the method as a particularly useful in the remediation of tixotropic, colloid wastes, with a low permeability and accessibility to oxygen. The process combined the catalytic reaction of oxidation and transformation of hydrocarbons molecules, followed by the microbial bioremediation.

The key issue is a reduction of the necessary drilling mud volume and the reuse of it [1]. This improvement minimizes significantly amount of the drilling wastes. Recycling of drilling mud components and drilling cuttings components is a challenge faced by the drilling operators and the petroleum research institutes. But a large decrease in the waste volume is expected by the full recycling introduction into the petroleum industry [10]. The recovery can be done in specialized "recovery systems" offered by industry. At the end, only a very minimal amount of the rest could be treated. The target is a zero discharge into the environment.

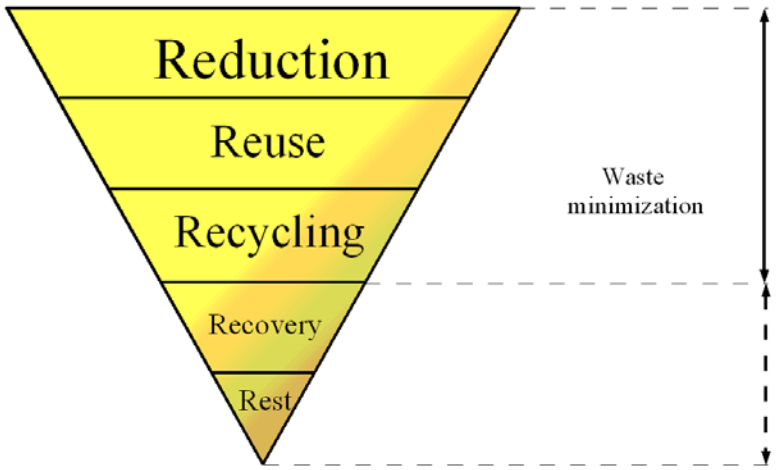

Fig. 3. Sustainable model of drilling waste management [6].

Conclusions

1. It is necessary to change the drilling waste management from the open system to the closed system but a further research is needed to meet the zero discharge requirement.
2. Drilling waste injection has to be replaced by more sustainable solutions like the thermal or chemical treatment but the most promising solution is bioremediation.
3. The chemo-bioremediation methods are particularly recommended for those kinds of polluted wastes for which both the microbial and extractive treatments are inefficient.

Financed from statutory research program 2006
WWNiG no 11.11.190.01

Literature - References

[1] Cordah, A.: Research on the Re-use of Drill Cuttings Onshore, *prepared by Cordah Limited, Aberdeen, Scotland, for Talisman Energy (UK) Limited, September 11 2001*.
[2] El-sayed, A., Abu El-Naga K.: Treatment of Drill Cuttings. *The SPE/EPA/DOE Exploration and Production Environmental Conference, San Antonio, Texas, 26–28 February 2001*.
[3] Fijał, J., Gonet, A., Stryczek, S., Czekaj, L.: Sposób usuwania toksycznych związków organicznych ze środowisk mineralnych. *Wniosek patentowy nr P-352202, 2002.*
[4] Getliff, J., M., Bradbury, A., J., Sawdon, C., A., Candler, J., E., Loklingholm, G.: Can Advances in Drilling Fluid Design Further Reduce the Environmental Effects of Water and Organic-phase Drilling Fluids? *SPE 61040, SPE International Conference on Health, Safety, and the Environment, Stavanger, Norway, June 26-28. 2000.*
[5] Growcock, F., B., Curtis, G., W., Hoxha, B., Brooks, W., S., Candler, J., E.: Designing Invert Drilling Fluids to Yield Environmentally Friendly Drilled Cuttings *IADC/SPE 74474, IADC/SPE Drilling Conference, Dallas, TX, February 26-28. 2002*.
[6] MI Swaco "Waste Management" Presentation, 2005.
[7] Morillon, A., Vidalie, J., F., Syahnudi, U., Suripno, S., Hadinoto, E., K. :Drilling and Waste Management, *SPE 73931, presented at the SPE International Conference on Health, Safety, and Environment in Oil and Gas Exploration and Production, Kuala Lumpur, Malaysia, March 20-22. 2002*.
[8] Page, P., Segret, G., Johnson, D., Bradshaw, K., Jones, H.: Stabilisation of Oil Based Mud Drill Cuttings Using Accelerated Carbonation Technology. *The Seventh SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Calgary, Canada 29-31 March 2004*.
[9] Patin, S.: Environmental Impact of the Offshore Oil and Gas Industry. *EcoMonitor Publishing East Northport, NY 11731, USA, pp. 425*.

[10] Paul, W., Greaves, Ch., Lawson, R., Hayes, S., Boyle, F.: Options for the Recycling of Drill Cuttings. *Exploration and Production Environmental Conference, San Antonio, Texas, 10-12 March 2003*.

[11] Paulsen, J., E., Omland, T., H., Aas N.: Drill Cuttings Disposal, Balancing Zero Discharge and Use of Best Available Technique. *Middle Easte Drilling Technology Conference and Exhibition, Abu Dhabl, UAE, 20-22 October 2003*.

[12] Perry, M., L., Griffin, J., M.: Chemical Treatment of Cuttings Drilled with Oil-based Mud Employing a Labolatory Simulated Soil Washing Procedure. *Exploration and Production Environmental Conference, San Antonio, Texas, 26-28 February 2001*.

[13] Quintero, L., Limia, J., Stocks-Fischer, S.: Silica Micro-encapsulation Technology for Treatment of Oil and/or Hdrocarbon-contaminated Drill Cuttings. *Society of Petroleum Engineers, March 2001*.

[14] Saasen, A., Paulsen, J., E., Holthe, K.: Environmental Priorities of Re-injection and Land Based Handling of Drilled Cuttings and Affiliated Fluids *The SPE International Conference on Health,Safety, and the Environment in Oil and Gas Exploration and Production, Stavanger, Norway, 26–28 June 2000*.

[15] Saintpere, S., Morillon-Jeanmaire, A.: Supercritical CO_2 Extraction Applied to Oily Drilling Cuttings. *Annual Technical Conference and Exhibition Dallas, Texas, 1-4 October 2000*.