WASTES OF OIL DRILLING: TREATMENT TECHNIQUES AND THEIR EFFECTIVENESS

Abbas Hadj Abbas[(1)*], Hacini Messaoud[(2)], Abidi saad aiassa, [(3)] Aiad Lahcen[(4)],

[1] université de Kasdi Merbah Ouargla, department de forage et MCP, Laboratoire de géologie de Sahara, Rouissat Ouargla, Ouargla, 30130, Algeria
[2] université de Kasdi Merbah Ouargla, department de forage et MCP, Laboratoire de géologie de Sahara, Rouissat Ouargla, Ouargla, 30130, Algeria
[3] université de Kasdi Merbah Ouargla, department de forage et MCP,
[4] la société de National Oil Well Varco, Hassi Messaoud, Rouissat Ouargla
*e-mail of the corresponding author: abbashadjabbas@gmail.com

Abstract. In Hassi-Messoud's oil industry, the systems which are water based (WBM) are generally used for drilling in the first phase. For the rest of the well, the oil mud systems are employed (OBM). In the field of oil exploration, panoply of chemical products is employed in the drilling fluids formulation. These components of different natures and whose toxicity and biodegradability are of ill-defined parameters are; however, thrown into nature. In addition to the hydrocarbon (HC, such as diesel) which is a major constituent of oil based mud, we also can notice spills as well as a variety of other products and additives on the drilling sites. These wastes are usually stored in places called (crud wastes). These may cause major problems to the ecosystem. To treat these wastes, we have considered two methods which are: solidification/ stabilization (chemical) and thermal. So that we can evaluate the techniques of treatment, a series of analyses are performed on dozens of specimens of wastes before treatment. After that, and on the basis of our analyses of wastes, we opted for diagnostic treatments of pollution before and after solidification and stabilization. Finally, we have done some analyses before and after the thermal treatment to check the efficiency of the methods followed in the study.

Keywords: Wastes treatment, the oil pollution, the norms, wastes drilling, stabilization, solidification, well.

I. Introduction

The development of the oil industry has created many environmental problems that contribute in the degradation of some natural ecosystems, especially sheets of groundwater. The environmental laws require adequate treatment of these wastes in order to avoid any degradation. The oil industry in the region of Hassi Messaoud is very developed which produces industrial waste with dangerous elements. During the drilling a large quantity of solid and liquid industrial wastes are generated. These releases contain toxic chemicals such as heavy metals and organic pollutants. (6). These elements cause problems for the humans, animals (3) and plants. (2). Additional information can be given by (8). So, what are the treatment methods and their effectiveness?
The study area is in the field of Hassi Messaoud, which is about 850 km in the south of Algiers and 350km from the Tunisian border. (2).
The aim of this work is to find solutions that can reduce or stop the influence of these toxic elements. For this purpose we adopted a method of work, beginning with a literature search for oil drilling, drilling fluids and waste products used (9). We made site visits to recognize near by the identity of these wastes, their chemical components and their influence on the environment and we have seen the appropriate means to treat these wastes and to a make limit concerning their negative influence. It was found that there are two methods of treatment which are chemical and thermal (5). These methods based on the utilization of cement inerting and utilization of high temperatures to trap toxic

elements (4). More details on this process can be given by (7).
This field work is made to diagnose the treatment methods of these wastes, and make the neutralizing of these toxic products efficteve. Sampling of waste is done according to conventional methods. Samples before and after treatment during several phases of drilling to make a homogeneous mixture, the latter are of the oil drilling waste of Hassi Messaoud area before and after each method of treatment, and then transported these samples to the laboratory for analysis and retrieve results that can improve the use of these methods (use of equipment catalog of heavy metals, CRD (2010)).

2. Results and Discussion

2.1. Results of analysis of the Crude wastes (before treatment)

the results of analysis of Nine samples showed that the toxic components are the hydrocarbon , heavy metals (Pb , Cu, Cr , Cd , Zn , Mn).The concentrations of hydrocarbon exceed the conventional norms in Algeria or the variation of between 1.98 % and 9.61 %, the maximum value was recorded in the sample 5 (9.61 %) , the minimum value in the sample 4 (1.98) . while norms.The concentrations of heavy metals from 14.1mg/l (sample 4) and 46.5mg/l (sample 2) for the lead, between 0.1 mg/l (sample1) and 0.2 mg/l (sample 4) for cadmium, from 5.3mg/l (sample 4) and 12.6 (sample 2) to the Zinc.and between 1.2mg/l (sample 4) and 1.8mg/l (sample 1) to manganese. While the norms of lead, copper, chromium, cadmium, zinc and manganese are 01, 03, 0.1, 0.2, 05, and 01 in succession. These norms are indicating in the Official Gazette of the Republic of Algeria (1993). Some environmental laws in the Official Gazette 2005 version, (2005) and 2007 version (2007).
After comparing the results of the previous elements their norms and standards who indicate in the reference (11).
we can say that there are values that exceed the maximum limits for example in (sample 1) the value of lead is equal to 32.6 mg /l, so it exceeds the norm of lead that is equal to 0.1 mg/l, and the same value for the zinc in the (sample 2) is equal to 12.6 exceeds the maximum value (0.5 mg/l) and the same for manganese.
For oils Tenures there are two values that exceed the norms in the 5 and 6 samples (9.61%>5%). According to the above table so the hydrocarbon and heavy metals are harmful elements conventionally.

Table. 1: Results of the test of hydrocarbon and heavy metals for the crude wastes (before treatment)

samples	Heavy metals concentration in mg/l						Content of oils (%)
	Lead (pb)	copper (Cu)	chromium (Cr)	Cadmium (Cd)	Zinc (Zn)	manganese (Mn)	
1	32.6	00	00	0.1	8.5	1.8	4.40
2	46.5	00	00	0.1	12.6	2.1	4.00
3	15.8	00	00	00	7.4	1.7	4.65
4	14.1	00	00	0.2	5.3	1.2	1.98
5	/	/	/	/	/	/	9.61
6	/	/	/	/	/	/	6.56
7	/	/	/	/	/	/	9.40
8	/	/	/	/	/	/	3.2
9	/	/	/	/	/	/	2.2

2.2. Results of analyzes before and after solidification / stabilization

According to the results shown in the table 3 (last page), it was found that the concentrations are generally less than maximum limit indicated by the Algerian state and Sonatrach. But we record a value that exceeds the maximum values for example the value of lead in (sample 1) is equal to 1.8mg/l > 1 mg/l, to justify this result we suppose that the amount of cement added is not sufficient to trap the metal.
On the other hand we record the content of chromium in the treated samples is equal to 0.23mg/l which is higher than those of untreated samples 00mg/l; thus the presence of this metal in the cement used for solidification is the origin of this augmentation.

2.2.1 Optimization of the method of solidification/stabilization (chemical method).

2.2.1.1Optimization of cement

From the figure, it was found that the content of hydrocarbons in the presence of a fixed concentration of sodium silicate, is inversely proportional to the concentration of added cement but, it can also be noticed, that between the values of the concentration of cement between (200 and 300 kg/m^3) the reduction is not very important (from 5.08 to 4.28 % for almost double the amount of cement added). This can be justified by the fact that cement creates a solid matrix which protects the film formed by the sodium silicate and enhances encapsulation. The content of hydrocarbons decreases as we add cement, but by reaching a certain value of the quantity of cement added. The content of hydrocarbons continues to decrease but at a slower manner. The effect of the cement is more interesting at high hydrocarbon levels.
For economic reasons (the cost of cement), so we have an optimal concentration of cement equal to 200kg/m^3 and tries to improve the solidification with sand.

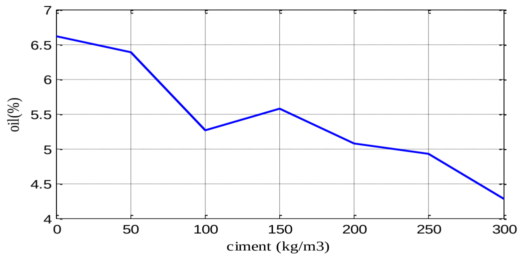

Fig. 1. Changes in the content of hydrocarbons according to the concentration of CPA425 cement.

2.2.1.2. Optimization of sand

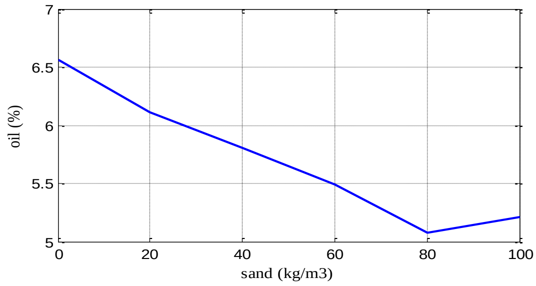

Fig. 2. Changes in the content of hydrocarbons according to the concentration of sand.

According to the shape of the curve, we can say that the result obtained above is improving as we add sand. The hydrocarbon content is decreased by 6.56% (the sand concentration is zero) to 5.21% after addition of 100 kg of sand, this is logical because this because latter it strengthens the matrix formed by the cement (solidifying).
We stopped at a concentration of sand equal to 100kg/m^3 (we will consider in the following as optimal) for two reasons:
•The decrease in the hydrocarbon content is very low, almost 1% to 100 kg/m^3 of sand.
• The particle size of the sand can increase the permeability of our treated waste, thus making it less resistant to the infiltration liquids inside the matrix.

2.2.1.3. Optimization of sodium silicates

On this curve, it is found that the percentage of hydrocarbons decreases to a value equal to 6.25 %, which corresponds to a concentration of sodium silicate of 10 l/m^3. After this value it is obtained practically a bearing (or a very small decrease) in silicate form a covering around the contaminant and attracts Ca++ (from the cement). The latter in turn attract other molecules silicates. This force of attraction becomes weak gradually as the silicate covering are superimposed on each other and this is what explains the shape of the graph. The Retention of hydrocarbons stagnant, once when it was exceeded a certain concentration of sodium silicate, in our case the concentration is 10 l/m3 (when it is considered as optimal).

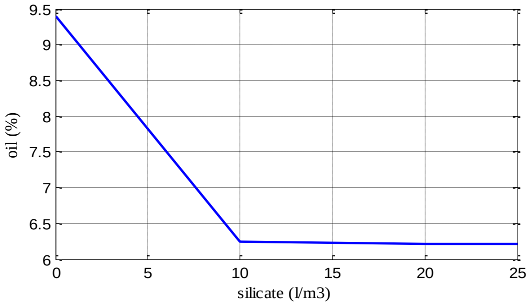

Fig. 3. Changes in the content of hydrocarbons according to the concentration of sodium silicates.

2.2.1.4. Optimization of activated carbon.

From the presented curve, it is found that the content of hydrocarbons decreases to a value equal to 5.88% which corresponds to a concentration of the activated carbon equal to 30 kg/m^3, after this value the hydrocarbon content rises.
We notice again that our graph has an optimum, which is moving towards a concentration not to exceed, to avoid the contaminants immigration.

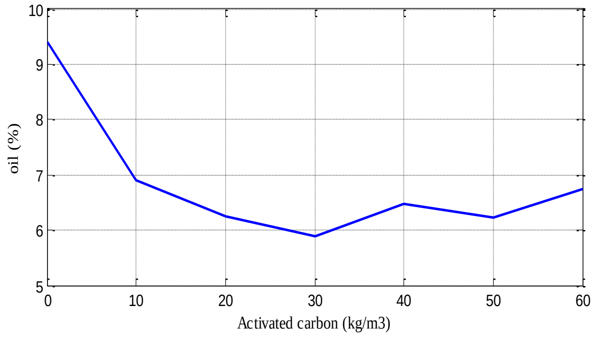

Fig. 4. Changes in the content of hydrocarbons according to the concentration of the activated carbon.

2.2.1.5. *Test result of solidification of the matrix: resistance of free compression*

According to the graph above, we see that the resistance of free compression for our sample treated increases as we add cement.
We have two things: firstly making concrete from the treated waste, requires the addition of large quantities of cement, secondly, the pre-treatment sample was very brittle.

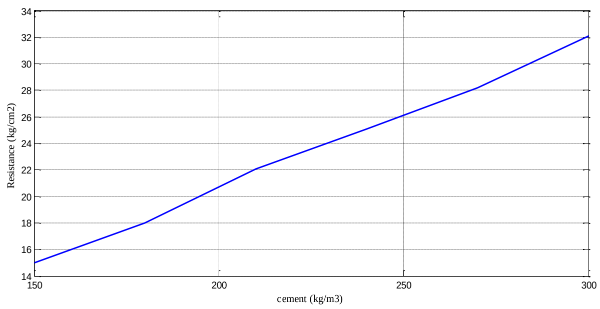

Fig. 5. Variation of the mechanical resistance as a function of the concentration of CPJ425 cement.

2.2.2.The content of the oil before and after the heat treatment (TDU or TPS).

From the results recorded in the previous table it was found that our treatment (thermal treatment) is very effective for the hydrocarbon, besides the results of the analysis of the sample after treatment respond to fully the norms (lower to the maximum tolerated values). But heavy metals retain the same concentration before and after treatment. So, this method is effective for hydrocarbon, and its inverse for heavy metals.

Table. 2: Results before and after treatment

Samples	Mass of oil expressed in (g)	Test sample expressed in (g)	hydrocarbon concentration (%)
Before treatment	3.20	100	3.20
After treatment	traces	100	traces

3. Conclusion

Based on the results obtained at the end of this study, we argue that oil discharges present risks to the environment because of their compositions which exceed the maximum limits conventional by the Algerian state (degree of contamination of discharges of approximately 9.61 % of the oil, so this value exceeded the 5% crud waste).

According to the application of the methods of treatment it is found that the method of solidification is effective for the trap of heavy metals, So the optimum concentrations (200 kg/m^3) for the cement, (100 kg/m^3) for the sand, (10 l/m^3) for the silicate and (30 kg/m^3) for the activated carbon .

On the other side, the thermal treatment is effective for the pollution of hydrocarbons (some traces).

From the results shown in table 2, it is found that the method of solidification is not a final solution (according to the forces of free compression and moisture that can Liberation of toxic elements so this is the filtration of these toxic elements into the water table.

For a good result of treatment, it is necessary to apply a combination of solidification and heat treatment.

References

[1] Askri, H., Belmecheri, A., Benrabah, B., Boudjema, A., Boumendjel, K., Daoudi, M., Drid, M.,Ghalem, T., Docca, A. M., Ghandriche, H., Ghomari, A., Guellati, N., Khennous, M.,Lounici,R., Naili, H., Takherist, D. et Terkmani. M. Geology of Algeria. WEC Algeries Algeria 2003.

[2] Atlas, R.M. (1984), Petroleum microbiology. Edition, Macmillan Publishing Company, P.685. (1984)

[3] Cranford, P.J., Gordon Jr. D.C., Lee, K. Armsworthy, S.L. and Tremblay, G.-H., (1999) Chronic toxicity and physical disturbance effects of water and oil -based drilling fluids and some constituents on adult sea Scallops (Placopecten magellaniccus). Marine Environmental Research, 48, 225-256.

[4] F. Damou, The Adaptability Study for the Use of Thermal Desorption and Solidification/Stabilization Processes for the Treatment of Drill Cuttings in HASSI MESSAOUD Field, Faculty of Design and Technology, School of Engineering, The Robert Gordon University, Aberdeen, September 2007.

[5] Khodja.M., Study of the performance and environmental consideration, University Louis Pasteur, Strasburg - France, 2008.

[6] Lefebrre, G. Chemistry of Petroleum Corporation Editions Technip. Publication I.F.P 1978.

[7] Mohamed Cherifi (Drilling Waste Management for environmental protection in Hassi Messaoud Field, faculty Design and technology, school engineering, the Robert Gordon university Aberdeen june 2006.

[8] Scriban, R. Biotechnologie. 5ème édition, Tec. et Doc. Lavoisier, Paris, France (1999).

[9] Yacine YAICHE, Environmental Impact Assesment of the Drilling Activities in the Hassi Messaoud Field, Faculty of Design and Technology, School of Engineering. The Robert Gordon University, Aberdeen, June 2006.

[10] (Use of equipment catalog of heavy metals). CRD Hassi Messaoud 2010.

[11] Official Gazette of the Republic of Algeria (10/07/1993).

[12] Official Gazette of the Republic of Algeria (11/09/2005).

[13] Official Gazette of the Republic of Algeria (22/05/2007).

Table. 3: Concentrations of heavy metals

Samples	Heavy metals concentration in mg/l						hydro carbon concentration (%)
	Lead (Pb)	copper (Cu)	chromium (Cr)	Cadmium (Cd)	Zinc (Zn)	Manganese (Mn)	
Sample 1 before treatment	32.6	00	00	0.1	8.5	1.8	4.40
Sample 1 after treatment	1,8	00	00	0.1	0.56	0.1	1.40
Sample 2 before treatment	46.5	00	00	0.1	12.6	2.1	4.00
Sample 2 after treatment	00	00	00	0.1	00	00	1.30
Sample 3 before treatment	15.8	00	00	00	7.4	1.7	/
Sample 3 after treatment	00	00	0.23	00	00	00	0.53
Sample 4 before treatment	14.1	00	00	0.2	5.3	1.2	1.98
Sample 4 after treatment	00	00	0.34	0.1	00	00	1.51