

Aqueous Cleaning of Drill Cuttings ex BP (Wytch Farm, UK)

Overview

Drill cuttings arise from drilling exploration wells, new production wells and work-overs on producing wells. They contain agglomerates of rock fragments, crude oil and drilling muds, which include chemicals**, some hazardous and toxic, and consequently the direct route of disposal to landfill is no longer possible without decontamination treatment.

The hazardous and toxic chemicals present in drill cuttings prevent the use of low cost biological remediation techniques to break down the oils. The current techniques used to decontaminate drill cuttings prior to disposal to landfill are energy

intensive and costly: by thermal desorption at temperatures up to 650°C and by incineration.

High pressure washing systems and many conventional surfactant formulations have been tested previously as methods to clean drill cuttings, but these tests failed because they were unable to separate the agglomerates and release the fine clay particles and crude oil from the larger particulates. This is due to the chemistry of drilling muds, which are formulated not to separate under extreme temperature and pressure conditions found in the wells.

Global Advantech's Solution for the Treatment of Oil Well Drill Cuttings

Global Advantech has developed several chemical products for use in washing oil and water-based drill cuttings, so that all the agglomerates separate into their components: fine clays, other minerals, crude oil and larger particulates. These products are used with a purpose-built cavitation scrubbing machines which include multi-stage operation starting with high pressure turbulent mixing to ensure that the process solution penetrate the

agglomerate to a final screening stage for separation of the fines from the larger particulates. The heavy metals, present in the drill cuttings accumulate in the process solution and may be removed using an electrocoagulation system permitting the solution to be cost-efficiently recycled many times through the washing process.

Trial

A trial to demonstrate the effectiveness of Global Advantech's products for washing drill cuttings was carried out as follows:

A 25 Kg sample of oil well drill cuttings (courtesy of BP Plc, from their Wytch Farm site) were:

1. Washed twice with a 2% solution of Global Advantech's OBM Drill Cuttings Aqueous-Phase Washing Agent DC511, which was processed using a 150 micron filter, followed by an oil separator and sedimentation tank

before recirculation to minimise waste and discharge cost.

2. The plant was drained down, refilled with clean water and the drill cuttings were then passed through the plant for two consecutive rinses. Again, the rinsed solution was recirculated to end up in the sedimentation tank. The oil separator recovered 92% of the oil.

***drilling muds: minerals; clays; ground husks; chemicals: surfactants, emulsifiers, biocides, corrosion inhibitors, heavy metal oxygen scavengers, viscosity/rheology modifiers, density enhancers; lubricating oils and water, plus rock fragments, sand and crude oil hydrocarbons (if from production zone).*

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Results

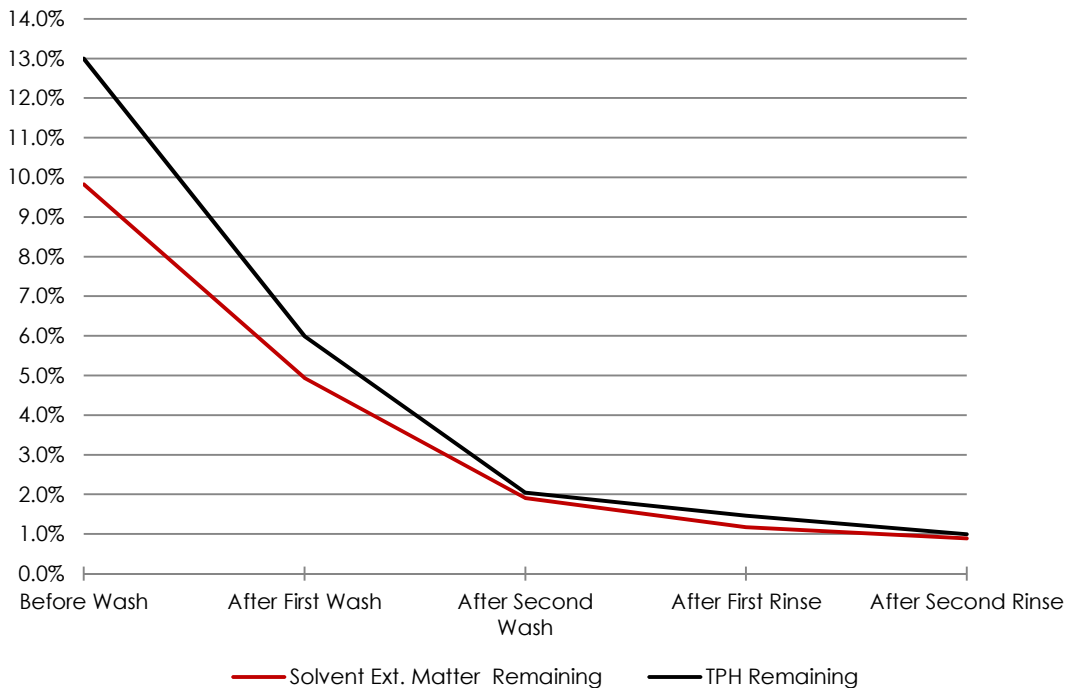
After the washing and rinsing, the oil well drill cuttings through the plant, approximately 9Kg weight of the larger particulates (greater than 150

microns in size) were collected off the dewatering deck of the plant. This represents 35% by weight of the original drill cuttings.



The resulting separation of larger particulates (right) from oil well drill cuttings ex BP Wytch Farm (left)

Drill Cuttings Wash Trial



The crude oil remaining in the oil well drill cuttings during the full washing cycle: before the trial after each washing and rinsing stage.

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These full trial results are given in the table below:

Sample No.	Before Wash	After First Wash	After Second Wash	After First Rinse	After Second Rinse	Used Process Solution After Second Wash ⁽²⁾	Units
Solvent Extractable Matter <i>(as a percentage of original drill cuttings)</i>	9.8%	4.9%	1.9%	1.2%	0.9%⁽¹⁾	N/A	
Total Petroleum Hydrocarbons <i>(as a percentage of original drill cuttings)</i>	13.0%	6.0%	2.0%	1.5%	1.0%⁽¹⁾	N/A	
TPH (Total)	129,994	59,900	20,434	14,633	9,925	10.7	mg/Kg
TPH EC5-EC6	0.6	0.4	<0.1	<0.1	<0.1	<0.1	mg/Kg
TPH EC6-EC8	3.8	2.1	1.5	1.2	0.7	<0.1	mg/Kg
TPH EC8-EC10	6.3	9.7	12.6	11.3	12.7	<0.1	mg/Kg
TPH EC10-EC12	49,531	22,400	7,783	5,592	3,685	5.4	mg/Kg
TPH EC12-EC16	72,565	32,882	11,650	8,369	5,850	2.6	mg/Kg
TPH EC16-EC21	939	437	123	86	63	0.8	mg/Kg
TPH EC21-EC25	4,198	2,328	482	287	171	0.4	mg/Kg
TPH EC25-EC28	157.8	108.9	30.0	25.0	8.3	0.5	mg/Kg
TPH EC28-EC35	250	276	89	66	36	0.6	mg/Kg
TPH EC35-EC40	2,334	1,450	273	194	108	0.3	mg/Kg
TPH EC40-EC44	19.7	17.8	<20	<20	<20	0.1	mg/Kg
Solvent Extractable Matter	98,226	49,375	19,017	11,742	8,853	N/A	mg/Kg
Loss on Ignition⁽³⁾	5.3%⁽³⁾	6.6%⁽³⁾	7.4%⁽³⁾	10.8%⁽³⁾	11.3%⁽³⁾	N/A	

Notes

(1) The remaining hydrocarbon content of the larger particulates is due both to absorption of crude oil by organic material fragments from the drilling muds (sugar cane bagasse, almond and walnut shells, etc.) and pine needles that collect in the mud circulation system.

BP's Wytch Farm site is situated in the middle of a large pine forest and large quantities of

pine needles shed from the trees collect in the drilling mud circulation system. Pine needles contain natural hydrocarbons (terpenes, pinenes, etc.) and the presence of pine needles in the larger particulates will give rise to elevated analytical results (total petroleum hydrocarbons and solvent extractable material), reporting higher than actual levels of residual petroleum hydrocarbons.

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- (2) This shows that the crude oil rapidly separates out from the process solution, showing it may be recirculated without recontaminating drill cuttings with crude oil. (As the process solution is recirculated the concentration of heavy metals will build up unless they are removed, e.g. with an electrocoagulation system.)
- (3) The increased loss on ignition observed in the trial results, even though the hydrocarbon content is observed to reduce substantially, is due to presence of larger fragments of organic material in the drill cuttings collected from Wytch Farm, in particular quantities of pine needle fragments.

Conclusion

The drill cuttings washing trial showed the effectiveness of Global Advantech’s OBM Drill Cuttings Washing Agent DC502 in breaking down the agglomerates of fine clays, chemicals, crude oil and larger particulates present in the drill cuttings. This allowed the larger particulates (in the trial, larger than 150 microns in size) to be separated from the fine particulates and crude oil in the washing plant, with crude oil being collected in an oil separator. The chemicals that would inhibit bioremediation, e.g. biocides,

corrosion inhibitors and heavy metal oxygen scavengers, have been removed in the washing process; the remaining crude oil may be readily removed from the particulates with bioremediation.

The trial demonstrates that this method of washing drill cuttings is a highly effective method of decontaminating oil well drill cuttings. A comparison between this method and the other techniques is given in the table below:

	Washing	Thermal Desorption	Incineration
Energy requirement	Minimal	Very high	Very high
Oil recovery	Most	Most	None
Emissions control	N/A	Required	Required
Environmental impact	Minimal	Very high	Very high