TECHNOLOGY DATA SHEET TDS830

Aqueous Cleaning of Drill Cuttings Produced Using Oil-Based Muds/Fluids

OVERVIEW

Drill cuttings arise from drilling exploration wells, new production wells and work-overs on producing wells. They contain agglomerates of rock fragments, oils, hydrocarbons, salts, drilling muds and other chemicals, some of which are hazardous and toxic. The chemistry of many modern oil-based drilling muds is formulated to remain stable under the high temperature and pressure conditions present during drilling.

Current techniques used to clean and decontaminate drill cuttings prior to disposal are energy intensive and costly: e.g. by thermal desorption using hammer mills or drying at temperatures of 350°C or higher. High pressure washing systems and various surfactant formulations have been tested for cleaning drill cuttings. However these tests failed, because

they were either unable to separate the agglomerates and release crude oil particulates or they created large volumes of difficult to manage secondary waste.

GLOBAL ADVANTECH'S TECHNOLOGY

Global Advantech combines proven physical and electrochemical technology with innovative chemistry to build systems, which efficiently clean and remediate drill cuttings from wells drilled using oil-based muds/fluids. These systems utilise:

- Cavitation scrubbing (see page 4) to separate adhering and adsorbed oil and hydrocarbons from drill cutting particulates
- Electrocoagulation cells to remove hydrocarbons, suspended particulates, most organic compounds, heavy metals, etc., from the process solution, enabling it to be recycled many times through the cleaning process
- Chemistry to increase the rate of release of adsorbed oils and hydrocarbons from the cutting particulates

FEATURES AND BENEFITS

The features and benefits of Global Advantech's aqueous systems for cleaning and decontamination of drill cuttings include:

- Mobile and static plant configurations available
- Throughput capacities: 1 tonne per hour to 20+ tonnes per hour
- Oil/hydrocarbon reduction to <1/0% and two cleaning passes to 0.2%-0.5%, depending upon porosity of rock fragments
- Non-thermal processing – ambient temperature operation, therefore substantially lower energy consumption (<20%) compared to thermal desorption plant with similar processing capacity
- Low environmental impact, with minimal emissions
- Use available water supplies for operation - fresh, brackish or seawater
- 75% lower capital costs and 80% lower operating costs compared to thermal desorption plant with similar processing capacity
- All process water recycled - treated to remove dissolved/emulsified oils, suspended ultra-fines, heavy metals, etc.

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COMPARISON WITH THERMAL DESORPTION

	Global Advantech's Cavitation Scrubbing System (5 tonne/hour)	Thermal Desorption Hammer Mill (3 tonne/hour max.)
Energy requirement	150KW (peak electricity demand)	1,000KW (750KW diesel engine + electricity demand)
Hydrocarbon recovery	Most, no degradation	Most, with thermal degradation
Gaseous emissions control for combustion products + plant exhaust	N/A	Required
Carbon footprint	Low	Very high
Environmental impact	Minimal	Very high
Freshwater requirement	None, process works with seawater	Cooling, emissions abatement
Water treatment system	Integral Oil, BOD+COD removal	Additional Oil, BOD+COD removal required
ATEX Zone 2 configuration available	Yes	No
Building requirements	Mobile configurations: self-contained in ISO containers, with integral bunds	Building with concrete floor and steel support structure for plant required
System maintenance costs	Low	High
System capital cost	USD 1.1million	USD 4.5million -3 tonne/hour 0% moisture content -1 tonne/hour 15% moisture content

PROCESSING SYSTEM

Please refer to the schematic diagram after this section.

1. Drill cuttings are loaded into the feed hopper above the first elevated screw conveyor and are transferred to the cavitation scrubbing unit. Depending upon whether they contain heavy hydrocarbons (e.g. from a production zone), a viscosity reduction agent may be blended with the drill cuttings by the screw conveyor.
2. The particulates and hydrocarbons are ejected by the cavitation scrubbing unit tangentially into the cyclone separator, where the larger particulates (typically greater than 65 microns) in are separated. These larger particulates drop out from the bottom of the separator and are either discharged back into the cavitation scrubbing unit for further cleaning and recycling through the system; or via the screw elevator/drier.
3. Process solution overflows from the top of the cyclone separator carrying finer particulates (less than 63 microns) and hydrocarbons into the secondary separator, where any hydrocarbons coalesce and most fine particulates carried over settle out. From here the water/process solution flows into the system reservoir tank.
4. Water/process solution from the reservoir tank is either:
5. Fed to the high pressure pump, which drives the cavitation scrubbing unit; or
   a. Treated using two stages of electrocoagulation, each with different cell chemistry, to remove accumulating suspensions of ultrafine particulates, clays, most organic compounds and any emulsified hydrocarbons. Each electrocoagulation stage includes flocculation/sedimentation tanks after the cells to remove all the flocculated and precipitated ultrafine particulates, clays, heavy metals, organic compounds and hydrocarbons.
   b. After the electrocoagulation/electro-oxidation stages, the water is either pumped back to the reservoir tank for use in the process; or further filtered prior to discharge.
6. Sludges, flocs and sediments from the flocculation/sedimentation tanks and secondary separator are pumped to a filter press for dewatering prior to discharge.
7. Water/process solution, which drains from the screw elevator/drier and the filter press, is pumped back for treatment within the system.

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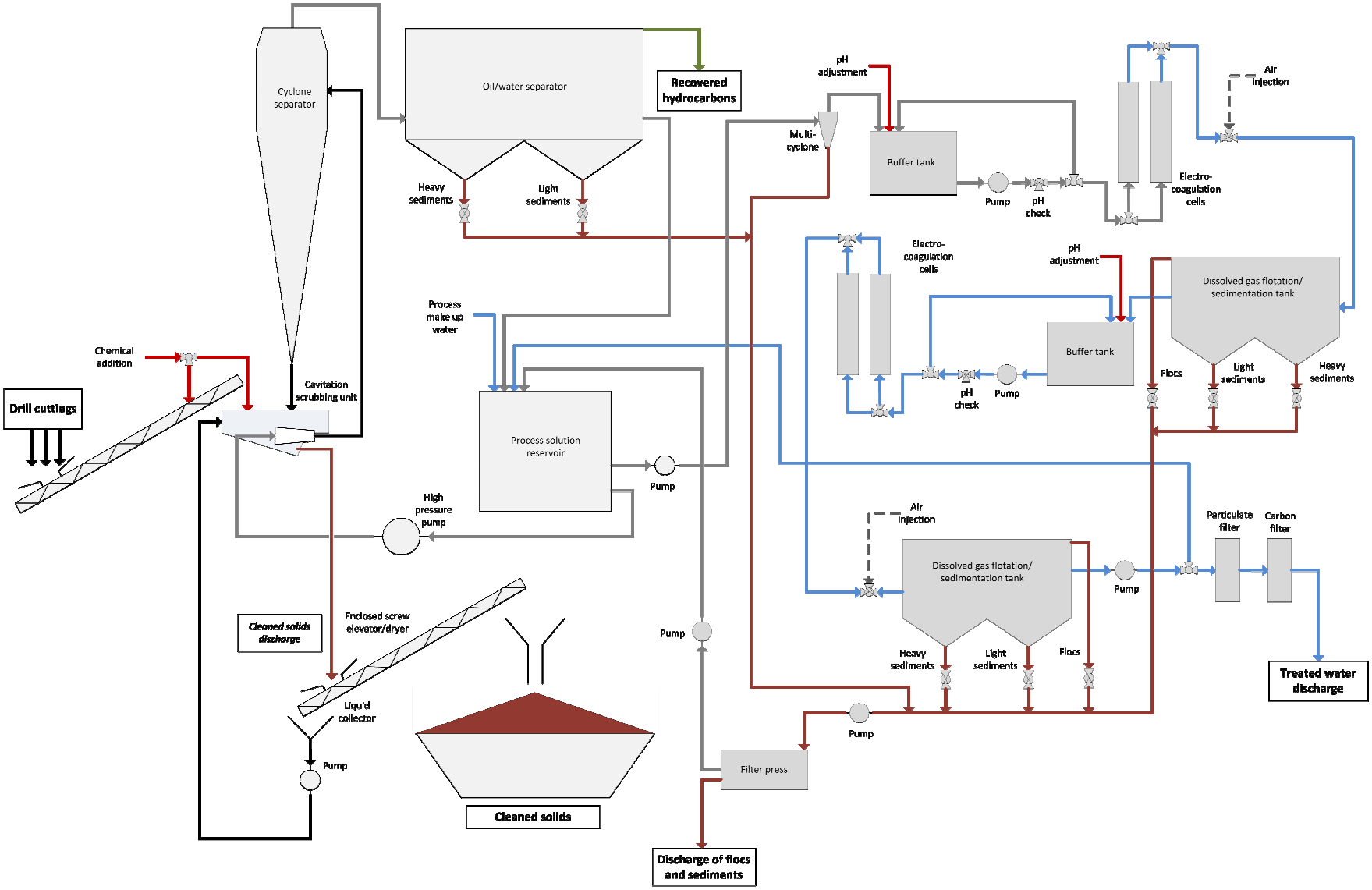

Schematic of typical system to remediate oil-based drilling fluids and cuttings

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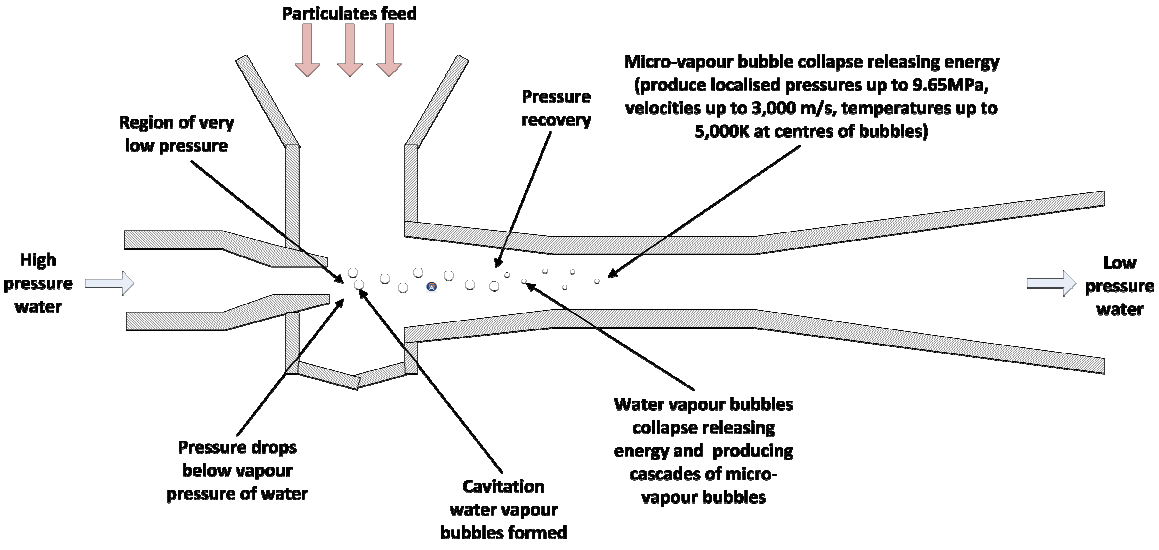
CAVITATION

Cavitation is a physical phenomenon, it occurs when flowing water or another liquid is subjected to rapid changes of pressure. Vapour bubbles form in lower pressure regions of the water/liquid, when these vapour bubbles enter regions of higher pressure, they collapse. These collapses release significant amounts of trapped energy and produce shock waves, which exert localised pressures reaching 9.65Mbar. The collapsing vapour bubbles also generate high velocity micro-jets of liquid (up to 3,000m/s), which impinge against hard particulates and surfaces in the immediate vicinity. In many situations cavitation can be highly destructive, damaging ships' propellers, pumps, valves, pipes, etc. However, cavitation scrubbing systems harness these energy releases and shock waves to efficiently separate hydrocarbons and fine particulates from larger solids.

GLOBAL ADVANTECH'S CAVITATION SCRUBBING SYSTEMS

Global Advantech's cavitation scrubbing systems are designed to maximise generation of hydrodynamic cavitation using water pumped at high pressure. Global Advantech's cavitation scrubbing systems contain a number of innovative design features and benefits to ensure effective and continuous operation:

- Multiple cavitation stages in series to ensure complete removal of heavy hydrocarbons, bitumen and tars from solids.
- Multiple oil/hydrocarbon recovery stages.
- Sub-systems to drain and dry cleaned solids and recycle collected water/process solution residues.
- Chemical formulations available for pre-treatment of solid materials and to make up the process solutions. These formulations improve the rate of removal of heavy hydrocarbons, carbonised oils, etc. from contaminated materials.
- Mobile cavitation scrubbing systems available built into standard ISO-sized containers with integral bunds to prevent accidental release of process solution to the local environment



Hydrodynamic cavitation generation

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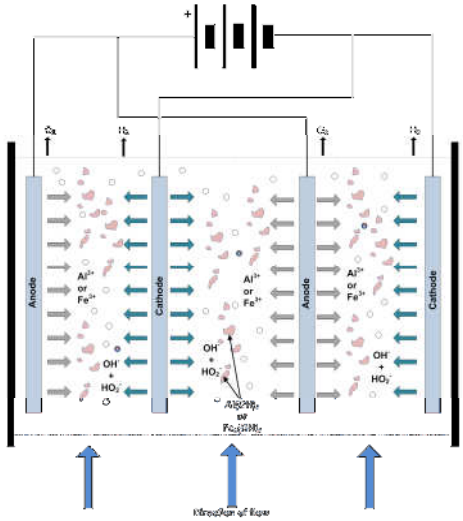
ELECTROCOAGULATION PROCESS

Electrocoagulation is a proven and cost effective electrochemical process to remove most contaminants/pollutants from water: suspended solids, emulsified hydrocarbons and many dissolved organic compounds, heavy metals, arsenic, bacteria, algae, larvae, etc., from water for re-use/discharge. The electrocoagulation process is continuous flow and is low in energy consumption.

Electrocoagulation cells consist of pairs of parallel metal plate electrodes separated by a few millimetres with a low voltage applied at high current densities. The current flowing between the electrodes destabilises electrical charges, which maintain suspensions of particulates, e.g. clays, and emulsions/micro-emulsions of hydrocarbons and insoluble organic compounds. The particulates coagulate together into flocs. The hydrocarbons and insoluble organic compounds coalesce into larger droplets and rise in the flotation/ sedimentation tanks. Some anodic oxidation of organic compounds also takes place within the cells – this process may be enhanced by re-configuration and the addition of chemical agents.



For more information, please refer to Technology Data Sheet: *TDS801 Electrocoagulation and Advanced Electrochemical Oxidation.*

GLOBAL ADVANTECH'S ELECTROCOAGULATION SYSTEMS

Global Advantech's systems contain a number of innovative design features and benefits to ensure effective and continuous operation:

- Cells use optimised electrochemistry, with a large number of parallel plate electrodes for efficient operation.
- Hydrodynamic design of cells ensures water flow is through the whole cell volume and electrodes are evenly consumed.
- Upward flow cells with air injection prior to flotation/sedimentation tanks to dilute hydrogen gas below explosion and flammability limits.
- Cells may be reconfigured to operate in advanced electro-oxidation (electro-Fenton) mode.
- All systems are PLC controlled, programmed to prevent metal plate passivation (development of oxide layers of the surfaces of electrodes, which acts as insulation preventing cells from continuing to operate efficiently).
- The cell electrodes are mounted in carrier cartridges to facilitate rapid replacement.
- Multi-cell configurations enable a single cell to be taken off-line for maintenance.
- Instrumentation options include plate consumption monitoring, remote telemetry.
- Compact single and full-size multi-cell systems, capable of handling from 1m^3 per hour to more than 1,000m^3 per hour water flow available.
- Electrocoagulation systems are available configured for safe area operation and for operation in ATEX Zone 2.