TECHNOLOGY DATA SHEET TDS831

Remediation of Water-Based Drilling Fluids and Cleaning of Cuttings

OVERVIEW

Water-Based Drilling Fluids are environmentally friendly compared with oil-based drilling fluids; however their safe disposal can still be a challenge. There are normally no hydrocarbons present, except in fluids that have been used for drilling in production zones and cuttings from these zones, Water-based drilling fluids by their nature have high water contents plus a number of additives: clays, barytes, water-soluble organic polymers, biocides, etc. These organic polymers are problematic for the disposal of used muds/fluids, because they are difficult to remove from solution and contribute to the chemical oxygen demand (COD) of the water. It is also necessary to remove these polymers from the drill cuttings prior to disposal.

GLOBAL ADVANTECH'S TECHNOLOGY

Global Advantech combines innovative chemistry with proven physical and electrochemical technology with to build systems, which efficiently remediate water-based drilling fluids and clean cuttings arising from their use. These systems utilise:

- Chemistry to hydrolyse and break-up clays and organic polymers used as viscosity modifiers and suspending agents.
- Cavitation scrubbing (see page 4) to separate adhering and adsorbed organic polymers, oil and hydrocarbons from drill cuttings.
- Electrocoagulation (see page 5) to remove most organic compounds, clays, ultrafine particulates, heavy metals, hydrocarbons, etc., from the water in the drilling fluids, enabling it to be discharged or re-used.
- Electro-oxidation (electro-Fenton) to oxidise and breakdown some dissolved organic compounds.
- High pressure reverse osmosis to remove dissolved salts and volatile fatty acids (C2-C5) if present from anaerobic activity in storage vessels.

FEATURES AND BENEFITS

The features and benefits of Global Advantech's aqueous systems for remediating water-based drilling muds/fluids and cleaning drill cuttings include:

- Dual purpose – able to remediate water-based drilling muds/fluids and clean drill cuttings.
- Mobile and static plant configurations available.
- Throughput capacities: 1 tonne per hour to 20+ tonnes per hour.
- Low environmental impact, with minimal emissions.
- Hydrocarbon reduction with one cleaning pass of contaminated drill cuttings to less than 1.0% and two cleaning passes to 0.2%-0.5%, depending upon porosity of rock fragments.
- Non-thermal processing – operates at ambient temperature, therefore substantially lower energy consumption (<20%) compared to thermal desorption plant with similar processing capacity.
- Water/process solution treated to meet demanding discharge consents, CODs of less than 100 achievable.

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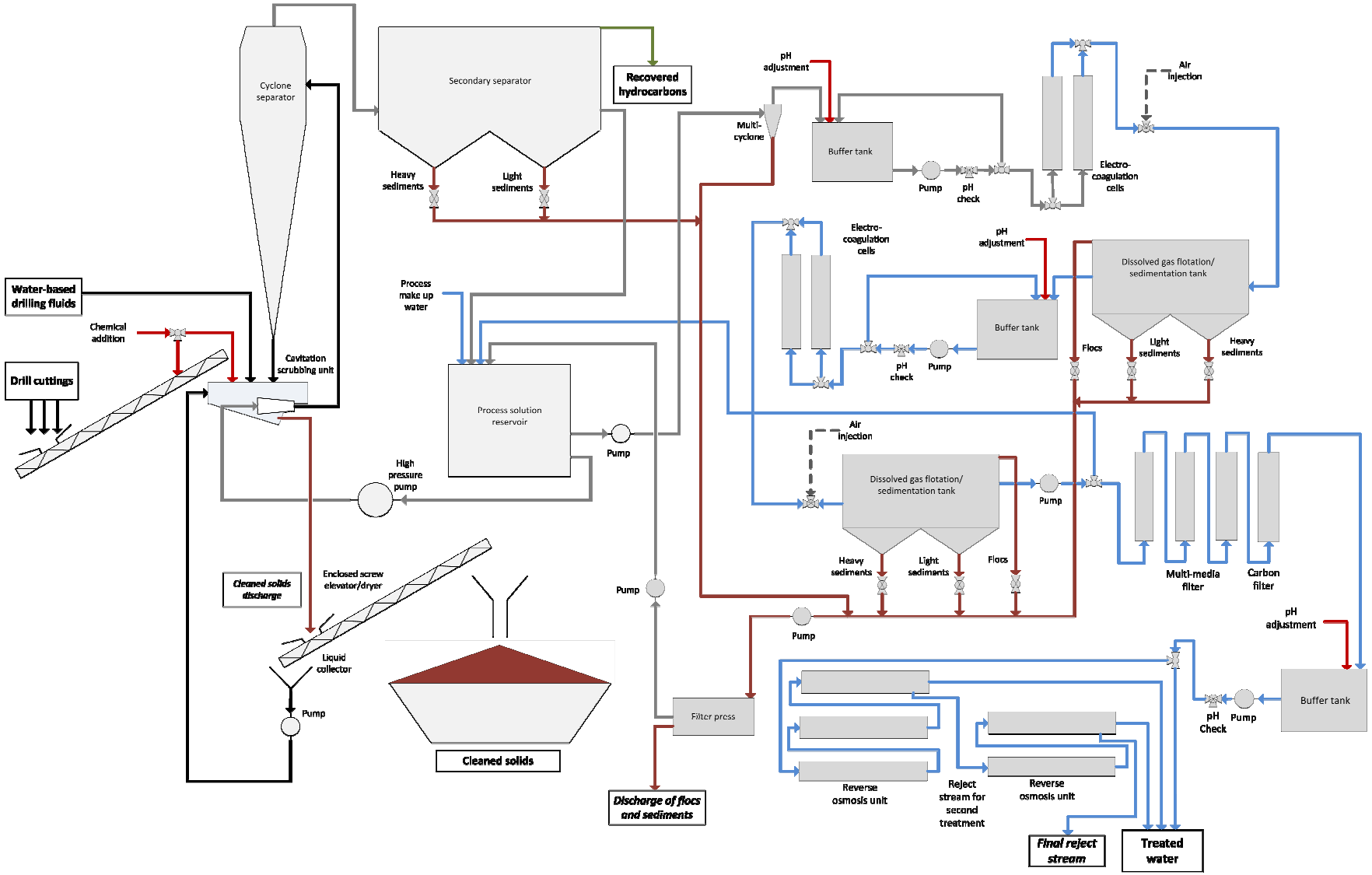
Remediation of Water-Based Drilling Fluids and Cleaning of Cuttings

PROCESSING SYSTEM

Please refer to the schematic diagram after this section.

1. The systems to remediate water-based drilling muds/fluids and clean drill cuttings are fed with either:
   a. Water-based drilling fluids, which are to be broken down and remediated, are fed directly into the cavitation scrubbing unit, simultaneously with the appropriate chemical agents to breakdown the particular polymers present.
   b. Drill cuttings, which are to be cleaned are loaded into the feed hopper above the first elevated screw conveyor and are then transferred to the cavitation scrubbing unit. Depending upon the nature of the drill cuttings and whether they contain heavy hydrocarbons (e.g. from a production zone), a hydrocarbon viscosity reduction agent may be sprayed over the drill cuttings as they are being loaded by the screw conveyor.
2. The particulates and any 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:
   a. Back into the cavitation scrubbing unit for further cleaning and recycling through the system; or
   b. Via the screw elevator/drier.
3. Water/process solution overflows from the top of the cyclone separator carrying finer particulates (less than 63 microns), organic polymers and any 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:
   a. Fed to the high pressure pump, which drives the cavitation scrubbing unit; or
   b. 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.
5. Optionally, one of the electrocoagulation stages may be configured to act as an electro-Fenton system to oxidise and breakdown some organic compounds.
6. After the electrocoagulation/electro-oxidation stages, the water is either:
   a. Further treated prior to discharge – remediation of water-based drilling fluids; or
   b. Pumped back to the reservoir tank for use in the process – cleaning drill cuttings.
7. Further water treatment includes:
   a. Filtering with multi-media and activated carbon filters to remove any remaining suspended solids, etc.; and
   b. High pressure reverse osmosis membrane filtration to remove dissolved salts and any volatile fatty acids present.
8. Sludges, flocs and sediments from the flocculation/sedimentation tanks and secondary separator are pumped to a filter press for dewatering prior to discharge.
9. Water/process solution, which drains from the screw elevator/drier and the filter press, is pumped back for treatment within the system.

Remediation of Water-Based Drilling Fluids and Cleaning of Cuttings



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

Remediation of Water-Based Drilling Fluids and Clean-up of Cuttings

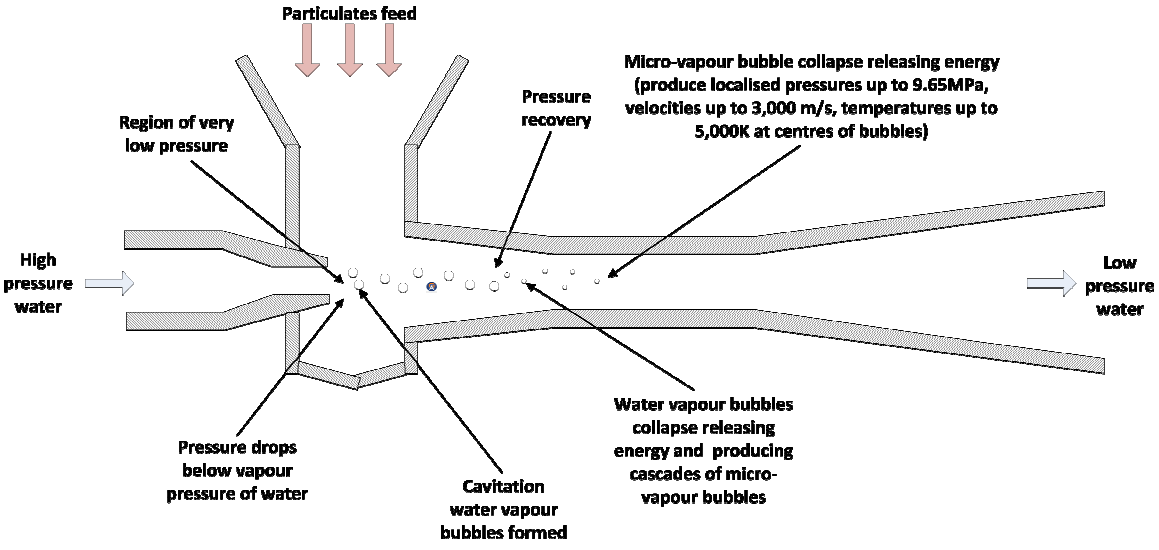
CAVITATION

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.



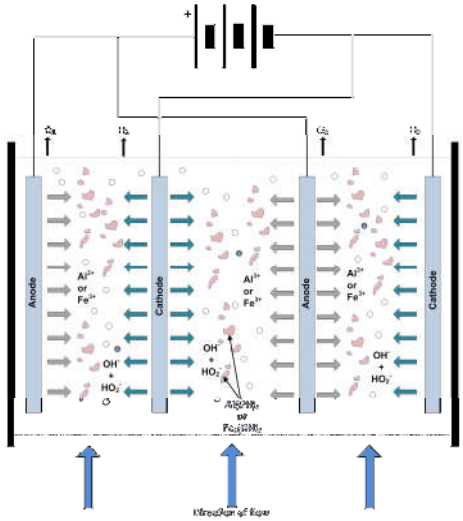
Hydrodynamic cavitation generation

Remediation of Water-Based Drilling Fluids and Cleaning of Cuttings

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.