As featured by the Offshore Technology Conference 2022:

Spotlight on new TECHNOLOGY

Environmental Systems

INNOVATION IN THE TREATMENT OF OILFIELD WASTE

Vacuum Assisted Pure Oil Recovery

A leader in the treatment and recycling of contaminated or otherwise impacted materials, R3 Environmental Systems, in collaboration with Astec Industries, has developed a revolutionary technology for the treatment of waste drilling fluids. Our patented Vacuum Assisted Pure Oil Recovery technology uses fractional vacuum distillation to optimize the treatment of waste drilling mud and cuttings. By leveraging a proven concept to support this novel technology, R3 Environmental Systems can completely recover valuable synthetic drilling fluid while generating almost no residual waste that requires landfilling or further treatment.

ASTEC™

HELPING RESTORE THE ENVIRONMENT AND RECOVER OUR RESOURCES

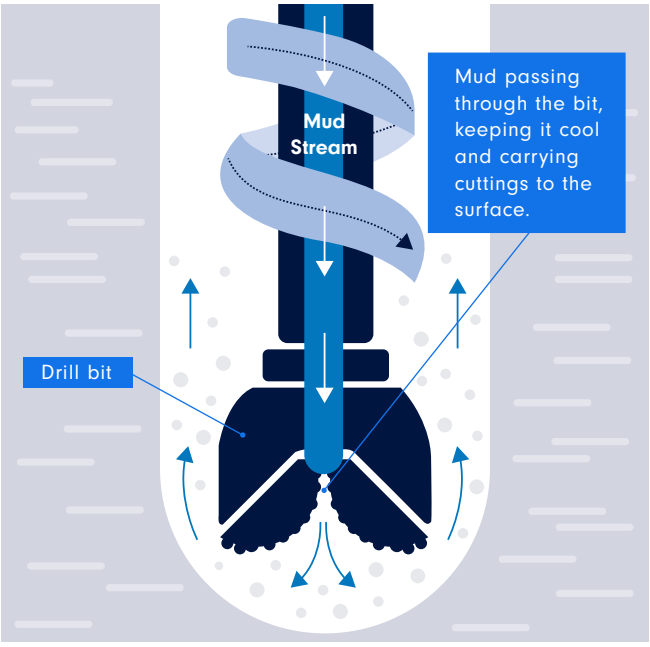
The Vacuum Assisted Pure Oil Recovery technology helps reduce the carbon footprint and other environmental impacts of oil and gas exploration and production. The high quality of the drilling fluid recovered when using the technology means the recovered fluid can be used as a direct substitute for virgin drilling fluid in the formulation of new drilling mud products. As a result, companies can significantly reduce the amount of virgin drilling fluid they need to purchase, transport, and eventually dispose of.

Recovering and reusing the base drilling fluid instead of using new drilling fluid is an opportunity for the industry to meaning fully reduce greenhouse gas emissions while maintaining quality standards. The quality of the recovered drilling fluid has been independently evaluated by a third-party engineering firm and the Chemical Abstract Service, a division of the American Chemical Society, both of which found the fluid to be equivalent to the virgin drilling fluid. As a result of this evaluation, the recovered drilling fluid, which we market as SecondSource drilling fluid, has been assigned the same CAS number as the original base drilling fluid.

AN INNOVATIVE AND EFFICIENT SOLUTION

Due to the environmentally sensitive nature of oil and gas exploration and production, and the growing need to drill through difficult formations, companies are being forced to use advanced drilling techniques that utilize high-performance drilling fluids. These high-performance drilling fluids are typically comprised of low-toxicity mineral oil (LTMO) or synthetic oil that contains hydrocarbon molecules in the C_{10}–C_{24} range. Although these fluids are generally less toxic and less persistent in the environment, they are extremely expensive when compared to the traditional diesel-based drilling fluids.

When an oil or gas well is drilled into a formation containing hydrocarbons, the drilling process generates drill cuttings which are washed back to the surface by the circulation of drilling mud in the well. The drill cuttings are usually contaminated by hydrocarbons from the reservoir and by the drilling mud that is pumped into the well. The contamination of the cuttings presents challenges for the operator as environmental regulations require the cuttings be treated to reduce the residual hydrocarbon content to acceptable levels before they can be safely disposed of. Recovering the used drilling mud for subsequent use in future drilling events and cycles is both more environmentally conscious and less costly.



The Vacuum Assisted Pure Oil Recovery technology was conceived and developed as a safe, cost effective and robust solution to the problem of treating waste drilling mud and cuttings without thermally cracking or degrading the valuable synthetic drilling fluid. A secondary goal of the new technology was to minimize the generation of residual waste requiring additional treatment and/or disposal. To achieve this, the technology utilizes a two-stage process that consists of 1) a low vacuum distillation unit (VDU) and 2) a pelletizing process to produce a product that can be utilized as an alternative industrial fuel source. Figure 1 presents a general Process Flow Diagram of the Vacuum Assisted Pure Oil Recovery process.

THE DRILLING FLUID RECOVERY PROCESS

The first stage of the Vacuum Assisted Pure Oil Recovery process requires heating the material under a low vacuum (i.e. 20–40 mmHg) to evaporate the oil and water fractions, which are subsequently collected, condensed, and separated into hydrocarbon and water products. The process allows for the removal, separation, and recovery of hydrocarbons based on the boiling point of the specific hydrocarbon fractionation. In this manner, the specific hydrocarbon compounds associated with the drilling fluid (typically C_{10}–C_{24}) can be separated and recovered from the general hydrocarbon mixture contained within the waste drilling mud and cuttings.

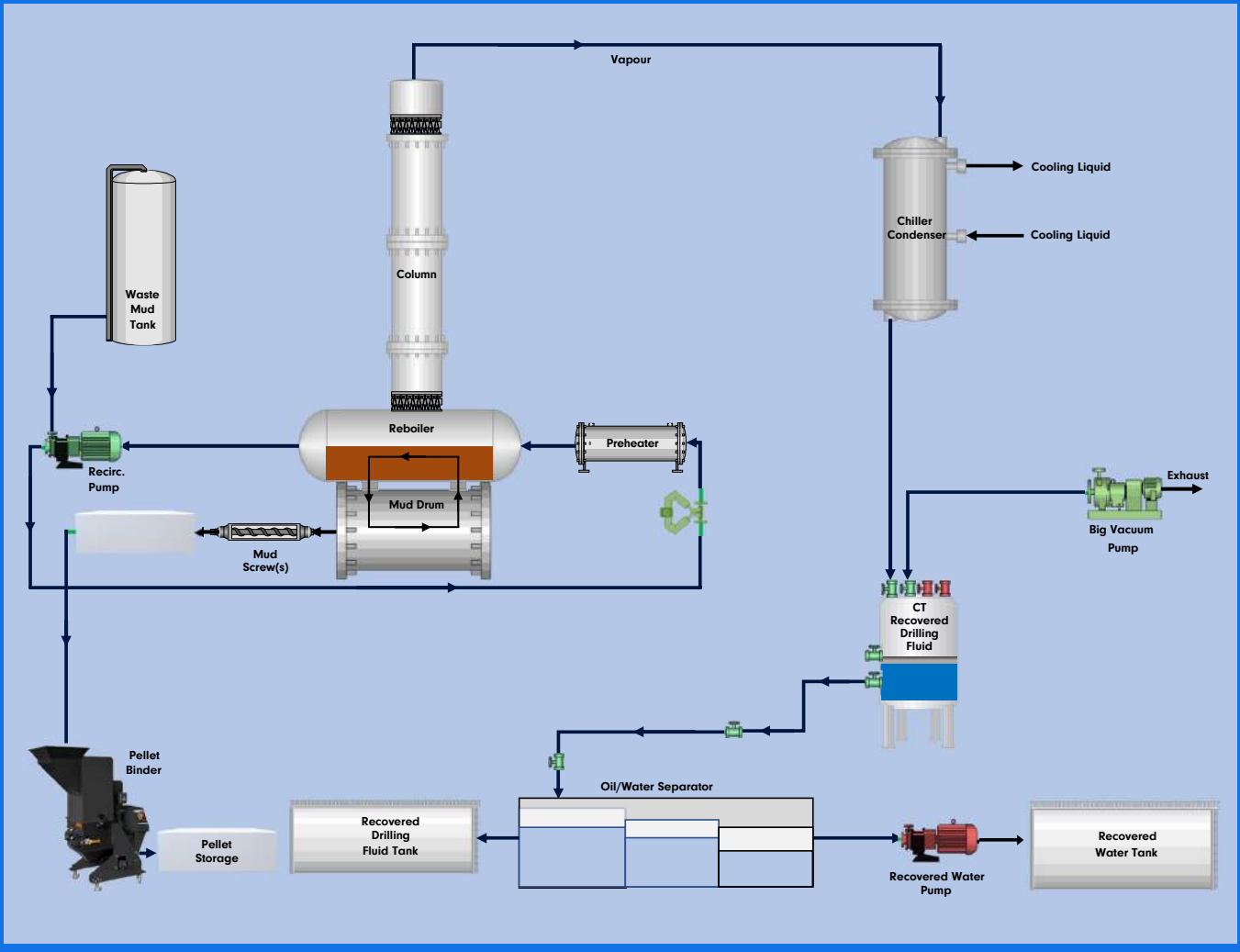
Inside the vacuum distillation unit, the pressure is reduced to 20–40 mmHg and heat from a thermic fluid heating system is transferred to the waste drilling mud and cuttings through a series of heat exchangers. The use of a low vacuum within the vacuum distillation unit significantly lowers the temperatures required to evaporate the hydrocarbons associated with the drilling fluid. This reduction in boiling point temperatures reduces energy consumption and guarantees that the operational temperature never reaches levels that would result in thermal cracking or degradation of the drilling fluid.

In addition to the high-quality recovered drilling fluid, the technology also generates recovered water and an alternative fuel pellet product. Although different regulatory jurisdictions may have varying discharge criteria, the quality of the recovered water is typically within the environmental criteria for discharge to surface (i.e. < 5 mg/L Total Petroleum Hydrocarbons). Table 1 and Figure 2 show the output and analytical data of the recovered products generated while processing waste mud/cuttings generated from oil exploration activities offshore Nova Scotia, Canada. It resulted in over 200 m^3 of drilling fluid being recovered for reuse.

The main technical challenges typically associated with the recovery of the drilling fluids are associated with the following parameters:

1. The drilling fluid, comprised of hydrocarbon molecules in the C_{10}–C_{24} range, are mixed with reservoir hydrocarbons that typically contain hydrocarbon molecules in the C_4–C_{60} range.
2. The drilling fluid will begin to thermally crack at temperatures in the 300–350°C range.
3. The temperatures required to remove the high molecular weight reservoir hydrocarbons can approach 600°C.

Figure 1 – Process Flow Diagram: Vacuum Assisted Pure Oil Recovery Technology



THE PELLET PROCESS

Once the drilling fluid has been recovered, the residual solids will still contain the high molecular weight hydrocarbons that came from the reservoir oil (i.e. > C_{24}). Traditionally these residual solids/sludges have been sent for landfill disposal or to a low temperature thermal desorption unit where the hydrocarbons are destroyed. Neither of these traditional options allowed for the utilization of the hydrocarbons within the solids.

In the Vacuum Assisted Pure Oil Recovery process, the residual hydrocarbons and solids can be processed to generate an alternative fuel that can be utilized as an industrial fuel source. This is achieved by utilizing the residual hydrocarbons in the solids as the energy source for the fuel pellet. To manufacture the fuel pellets, the residual solids, along with several proprietary binders, are placed in a specially manufactured pellet plant where the mixture is homogenized and fuses together, forming a solid mass. This material is then extruded from the pellet mill in predetermined sizes and shapes.

Each fuel pellet is tailor-made to fit the needs of the end user by adjusting the heating value, moisture content, ash content, and pellet dimensions. The energy content of the produced pellets is very similar to that of a traditional wood pellet (i.e., approximately 7000 Btu/lb).

A PORTABLE SOLUTION

Another distinctive feature of our Vacuum Assisted Pure Oil Recovery technology is that it was specifically designed to be highly portable (see Figure 3). The entire unit was designed as a series of "modules" that can be transported by traditional methods to remote exploration sites anywhere in the world. Using our new technology at remote sites can greatly reduce the quantity of virgin drilling fluid required and the production of waste that will need to be removed from the site at the end of the exploration program. Once the project comes to an end, the recovered drilling fluid can be removed from the site and reused during another exploration project. Additionally, the recovered water can be reused onsite and the produced fuel pellets used in onsite boilers and heaters.

Figure 2: Raw Feed and Outputs from the Vacuum Assisted Pure Oil Recovery Technology

Table 1: Recovered Drilling Fluid (SecondSource) vs. Virgin Fluid

Parameter	Recovered Drilling Fluid (SecondSource)	Typical LTMO
Flashpoint (°C)	101	94
Specific Gravity	0.80	0.80
% Water	0.01%	0.0%
% Solids	ND	NA
% Hydrocarbons	99.9%	100%
Aniline Point (°C)	81.2	82 max
Pour Point (°C)	< -62	-54
Kinematic Viscosity at 40°C (cSt)	2.3	2.6 max
BTEX	0.0014%	0.1%
Total PAHs	< 0.001 %	0.35%

The values quoted above are estimates of typical and normal production. They do not constitute a specification.

Figure 3: Modular Design of R3's Vacuum Assisted Pure Oil Recovery Technology

The advanced Vacuum Assisted Pure Oil Recovery technology represents a significant milestone in environmental sustainability and stewardship for oil exploration and production activities. No other commercially available technology can match the output quality of the Vacuum Assisted Pure Oil Recovery technology while maintaining the same levels of safety, cost competitiveness, and ease of operation.

SecondSource Drilling Fluid

TYPICAL PERFORMANCE DATA

PROPERTY	SECONDSOURCE
Chemical & Physical Properties (Based on Analytical Data)	
Flash Point, °C	101
Hazardous Material Label Combustible Liquid (OSHA)	No
Paraffin Content, Weight %	> 99.9
Total BTEX	0.0014% Max
Polynuclear Aromatics, ppm	< 10
Density @ 15°C, kg/L	0.80
Viscosity, cSt @ 40°C	2.3
Colour	< 1 Water White
Aniline Point, °C	81
Pour Point, °C	-62
Approximate Toxicological Summary (Based on Original Fluid Properties)	
Marine Amphipod Toxicity, LC_{50} mg/kg	> 1400
Bioconcentration Factor (BCF)	< 3 (dry wt)
Biodegradability, %	> 60 (Readily Biodegradable)
Meets UK CEFAS Offshore "E" Classification Criteria	Yes
Approximate Human Health & Safety Summary (Based on Original Fluid Properties)	
Meets USFDA White Oil Criteria	Yes
Chemical Abstract Service Number (CAS #)	445411-73-4
Primary Dermal Irritation/Corrosion	Dermal irritant but not corrosive
Acute Inhalation Toxicity, LC_{50} mg/L	> 5 mg/L
Mutagenicity	Negative
Potential Carcinogenic Label	No

The values quoted above are estimates of typical and normal production. They do not constitute a specification. Some properties/values are based on an independent, third-party analysis of the recovered fluid versus the original virgin base fluid, and not on analytical data.

Certified System Environment ISO 14001 SAI GLOBAL

Certified System Quality ISO 9001 SAI GLOBAL

Part of the Municipal Group of Companies, R3 Environmental Systems is a waste management company that provides resource recovery solutions for contaminated soil, oilfield drilling wastewater, and waste oil.

R3 Environmental Systems is a recognized leader in the development and implementation of the latest innovations in treatment and resource recovery technologies. The ability to develop in-house technologies and acquire existing innovative technologies makes R3 Environmental Systems an invaluable partner in navigating the changing environmental, regulatory, and industry needs for a safer and greener environment.

R3 Environmental Systems

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