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# Continuous Improvement in Slop Mud Treatment Technology

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## Abstract

Oil-based drilling fluids can become contaminated with significant quantities of water as a result of low efficiency well bore displacements to water or brine and from operations such as rig and pit cleaning. The presence of excess emulsifiers and oil-wet solids in typical oil-based drilling fluids allows large quantities of water to be emulsified. These oil-continuous emulsions are often termed slop muds.

This paper presents analytical data on the effects of water contamination on oil-based mud, the resultant slop-mud structure, the influence of shear, and quantification of the critical factors controlling phase-separation and chemical dose. Data will be presented showing the principles of continuous slop-mud treatment both on the laboratory and full-scale defining the important process parameters such as mixing energy, phase recovery rate, recovered drilling fluid properties, and treated water properties.

Development of an understanding of the slop mud stream enabled a novel continuous treatment system to be built which provides efficient and fast phase-separation with recovery of the valuable drilling fluid phase, with significant advantages over current batch-type systems. The process requires in-line injection and mixing of surfactant into the slop mud, then continuous separation of the waste into water and drilling fluid using a gravity separator. The drilling fluid remains as a water-in-oil emulsion containing solids and other chemical additives, which can be reconditioned to acceptable properties for re-use. The water recovery rates are typically 70 to 90 vol% of the total water present in the slop mud. This recovered water is treated using centrifugation, filtration or other water-treatment techniques to meet or exceed discharge consent limits of 15 mg/L total petroleum hydrocarbon. Water collected in the rig deck-drain system which may also be contaminated with oil or oil-based mud can also be treated in the same manner as the recovered slop water.

Because the process allows continuous treatment of the slop mud stream, the resultant equipment has significant benefits over the current batch-type systems including higher throughput and decreased footprint.

## Introduction

As a result of rigorous environmental regulations moving towards zero-discharge, drilling wastes are the focus of attention in the oil and gas exploration industry. Drilling with oil-based muds (OBM) often generates large quantities of waste known as slop, which is produced when the invert emulsion drilling fluid becomes contaminated with water.

Slop muds can be generated during the drilling process itself if significant quantities of formation water combine with the drilling fluid. Rig and boat cleaning operations can also generate slops where storage tanks, shale shakers and the rig floor are hosed with water (and possibly surfactant) between operations and the oil-based drilling fluid, sediments and wash water mix together to form a slop emulsion. An average of 500 bbl of slop is produced on a daily basis during normal drilling activities.[1]

Oil-based muds are generally invert-emulsion systems, consisting of a continuous hydrocarbon phase and an emulsified aqueous phase. Fluids also typically contain emulsifier systems, weighting agents, fluid-loss additives, viscosity regulators, and other chemicals as needed for stabilizing the system and to establish the desired performance properties. Typically, the oil/water ratio (OWR) of a drilling fluid is in the range 60:40 to 90:10. After contamination however, the slop mud may contain 50 to 90 vol% water and 10 to 50% by vol of the original drilling fluid.[2] The effect of this contamination is a lowering of the OWR, an increase in viscosity and a decrease in emulsion stability which ultimately renders the fluid unusable.

Batch treatment processes were previously developed as a method to treat the slop and have been utilized in large land-scale operations and as smaller offshore systems.[2] In such systems, the slop mud is pumped into stirred treatment tanks to which demulsifying chemicals are added causing the water droplets to coalesce. When sufficiently mixed, the slop mud is allowed to separate under gravity for 8 to 24 hours during which time a lighter, water-continuous layer, migrates to the surface. The denser oil-continuous layer separates to the bottom, containing almost all of the solids and weighting agents of the original mud. Interface detection with pumps and/or gravity drains allows the separation of the upper water phase and the lower oil-continuous phase. The aqueous phase