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Engineered Magnet System Reveals True Quantity of Metal Contamination in Drilling Fluid

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Abstract

An engineered magnet system retrieves upwards of 100 pounds of magnetic debris during daily drilling operations, increasing tool reliability and revealing a magnetic metal presence in drilling fluids that is much larger than previously thought. Magnet systems are recognized as a best practice for debris removal, but the power and positioning of these magnet systems is often overlooked. The specially designed system was deployed on multiple drilling rigs with a surprising increase in debris removal even when installed downstream of the existing rig magnet systems. After continued use, detailed evaluation confirms substantial amounts of residual magnetic debris, including finer particles that are not retrieved by conventional ditch magnets.

The patented magnet system utilizes a special flow path with geometrically aligned neodymium magnet rods to maximize surface area and facilitate easy cleanup. The portable design facilitates installation across different rig designs. After multiple trials, X-ray fluorescence (XRF) reveals the sources and scale of metallic debris within drilling fluids alongside the weight of debris collected throughout the drilling process.

It is well-documented that magnetic debris interferes with MWD measurements, logs, and may contribute to RSS failure. The type and quantity of magnetic debris in fluid offer new opportunities to improve drilling system reliability – particularly as laterals grow longer and tool hours increase.

Introduction

Magnet systems are not new to drilling operations. There are many shapes and forms, but they are often overlooked as potentially trip-saving tools.

In most cases, a set of conventional magnets are set in the flow line, the header box before the shakers, or in the fluid ditch just past them. Most careful monitoring occurs during operations such as milling, where the quantity of swarf recovered is an important metric, particularly in a cased hole sidetrack where residual swarf can impact tools and measurements at the milled window.

Magnet performance is measured by trends. The rate of collection may act as an indicator of increasing wear or sufficient removal during an operation. In milling operations, it may be that 80% by weight of the expected swarf is recovered on magnets before proceeding.

The engineered magnet system, a flow positioned ditch magnet system (Saasen et al., 2019) features high-powered neodymium magnets arranged to account for maximum surface area and the flow dynamics of fluid passing through the system. System concepts were tested and proven offshore, but the new box apparatus provides greater adaptability to land rigs with minimal modifications. After numerous evaluations with positive results, the magnet box system has been deployed on more than 30 drilling rigs.

Hazards of Magnetic and Metal Debris

Magnetic debris impacts drilling performance by abrasion, interference with measurement tools, and jamming of magnetized tool parts.

Abrasion

Metal debris acts as a highly abrasive material that can lead to premature failures from erosion of critical parts. Abrasion is a function of several factors, including specific gravity, hardness, particle size distribution, shape, velocity, and flow regime.

Particle momentum is a function of mass and velocity. For two particles moving at the same speed and of the same size, a denser particle will have a higher impact force (change in momentum). Saasen et al (2001) also note that thinner fluids increase abrasion tendency. The high specific gravity of steel relative to other weight materials (Table 1) provides a relative comparison.

Table 1: Specific Gravity Comparison

Material	Specific Gravity
Calcium Carbonate	2.7 – 2.8
Barite	4.1 – 4.2
Hematite	4.7
Ilmenite	5.1
Carbon Steel	7.8

The hardness differential of materials is another factor for abrasion. If a harder material impacts a soft one, the soft material may erode. Barite is a preferred weight material because it is