

Optimized CARBONOX® WBM Weighted Up to 2.55 sg (21.3 lb/gal) for High-Pressure Exploration Well

PARVA NEGRA FIELD, NEUQUÉN, ARGENTINA

CHALLENGES

Formulating a high-density WBM kill mud presented two key challenges:

- » Locating a reliable source of quality hematite
- » Avoiding an adverse impact ECD control

SOLUTION

Hematite samples from three suppliers were tested for performance in the WBM.

RESULTS

- » Increased WBM density to 2.55 sg (21.3 lb/gal) to safely kill well
- » Successfully completed well abandonment operation with zero NPT
- » Reduced rig time by approximately three days, saving USD 108,000

SALTWATER AND GAS INFLUX DEMANDS ULTRA-HIGH-DENSITY KILL MUD

An operator in Argentina's Parva Negra field planned to re-enter and deepen an extended-reach well that had been temporarily abandoned in 2015. A high-density drilling fluid would be needed to maintain well control. The ability to control equivalent circulating density (ECD) and optimize rheological properties would be critical to the success of this exploratory well operation.

Total measured depth (MD) on the original well was 2,032 meters (6,667 feet) and the bottomhole temperature was 199°F (93°C). The objective for the re-entry was to drill through the Quintuco and Vaca Muerta formations. A managed pressure drilling (MPD) system was installed to help provide an adequate ECD without increasing the surface mud weight.

The water-based mud (WBM) selected for the operation was formulated with a wetting agent and CARBONOX® filtration control agent. Using a wetting agent can alter the surface tension on dispersed particles in WBM, leading to lower flow properties and improved ECD management.

A saltwater and gas influx occurred in the Vaca Muerta formation at 2,214 meters (7,264 feet). The mud density was increased from 2.10 sg to 2.21 sg (17.5 lb/gal to 18.4 lb/gal) as drilling continued with the MPD system. The operator wanted to proceed with well abandonment, but a higher-density kill mud would be required to complete this operation.

HEMATITE WEIGHTING AGENT TESTED FOR IMPACT ON RHEOLOGICAL PROPERTIES

Baroid technical personnel evaluated sources for the hematite weighting agent in Argentina. The use of hematite instead of barite for the ultra-high-density kill mud required a Management of Change (MOC) document to analyze potential risks and to address logistics concerns about obtaining the necessary quantities of hematite needed to perform the job without delays. The document was prepared through collaboration between the operator's representatives and the Baroid technical team.

Hematite samples from three different suppliers were tested with the water-based CARBONOX system. Extensive analysis was completed at the Halliburton lab in Neuquén and at the rigsite to optimize the rheological properties (Table 1). The kill mud must provide sufficient suspension capacity to support a mud weight of 2.55 sg (21.3 lb/gal) while exhibiting the lowest possible plastic viscosity, yield point, and gel strength values (properties shown in the table). This would help minimize the ECD increase during the kill operation.

Particle size distribution (PSD) testing was also performed on the hematite samples to determine which candidate was best for ECD management (Table 2).

Table 1: Impact of hematite additions on rheological properties

Property	CARBONOX® Fluid Samples		
	From PVN x -1004	From NQN lab	From PVN x 1004
Mud weight (SG)	2.17	2.50	2.55
Plastic viscosity (cP)	20	46	52
Yield point (lb/100 ft ²)	21	13	29
Gel strength (lb/100 ft ²)	6/16/20	13/26/36	12/26/29
Total solids content (%)	28.5	40	44

Rheological properties as WBM density increased from 2.17 sg to 2.55 sg

Table 2: Particle size distribution (in microns) for 10%, 50%, and 90% of the particles in each hematite sample

Hematite Sample	PSD Results			
	Obtained Results	First Run	Second Run	Average Result
MP168	D (v, 0.1)	10.9	11.5	11.2
	D (v, 0.5)	46.1	47.8	46.9
	D (v, 0.9)	90.4	101.4	95.9
MP169	D (v, 0.1)	16.0	16.0	16.0
	D (v, 0.5)	44.7	45.8	45.2
	D (v, 0.9)	107.0	122.9	115.0
MP170	D (v, 0.1)	20.1	19.4	19.7
	D (v, 0.5)	44.1	42.7	43.4
	D (v, 0.9)	113.5	120.0	116.7

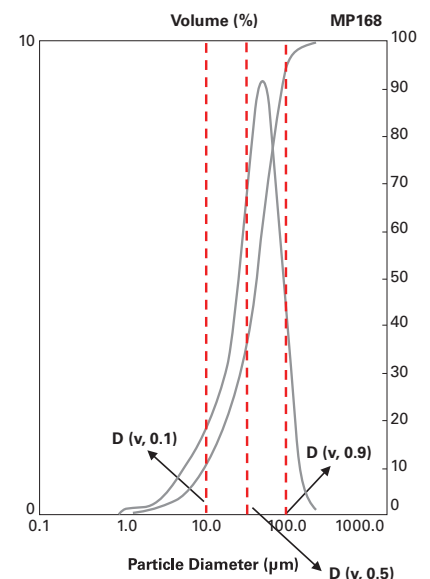
MP168 and MP169 were selected for this well because they provided density up to 2.55 sg while minimizing increases in rheological properties.

OPERATOR COMPLETES SUCCESSFUL WELL ABANDONMENT WITH ZERO NPT

The optimized WBM formulation, weighted with hematite to 2.55 sg (21.3 lb/gal), was displaced into the wellbore prior to commencing the abandonment operation. This was the highest WBM mud weight used in this area for well control.

The operation helped reduce rig time by approximately three days, resulting in an estimated cost savings of USD 108,000.

The abandonment procedure was carried out successfully through the collaboration of all service companies under the operator’s leadership. Zero nonproductive time (NPT) was recorded.



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