

Red Rock Dam

Pella, IA

PROJECT BACKGROUND

Schnable Foundation Co., contacted Baroid IDP because they were having hole cleaning problems on the Red Rock Dam project in Pella, IA. The 5.625" tie back holes were not being cleaned adequately, prior to cementing.

CHALLENGE AND EQUIPMENT

Allen Stanton, Project Manager – Schnable Foundation Company, contacted Baroid IDP because they were having problems cleaning the –45 degree angled tie back holes being drilled RC on the Red Rock Dam prior to cementing. The geology consisted of overburden which was primarily clay with interbedded gravel and the bedrock was limestone with some calcareous sandstone, and dolomitic shale. They drilled through the overburden and are setting the tie-backs in about 40' of bedrock. The fluid they were originally using was a bentonite based fluid (AQUA-GEL®/QUIK-TROL® GOLD). They had switched from a roller cone to a PDC bit which drilled faster with larger cuttings and solids loaded the hole. They then flushed the bentonite drilling fluid out of the hole with fresh water prior to inserting the anchor for cementing. Our goal was to a) develop a polymer fluid, b) address the hydraulics issues and clean the hole as well as c) improve cement bonding. Based on a site visit by Orlando Salazar the mixing equipment was a 1,000 gallon mixing tank with a Baroid M3 mixer, 4,000 gallon suction pit and a 4,000 gallon intermediate pit for solids control. The rig was an RC Klemm Bauer-Pileco 806.

THE SOLUTION

The solution required an alternative slurry system and a refinement of the hydraulic flow profile. A POLY-BORE™/QUIK-TROL® GOLD fluid was recommended to resolve the cement bonding question. The original AQUAGEL®/QUIK-TROL® GOLD system provided sufficient rheological hole cleaning properties however the issue for Schnable was the quality of the cement bond for the tie-back. Following the institution of the polymer system the cement bonding issue was resolved.



A CASE STUDY: *Red Rock Dam*

A hydraulics analysis of the original drilling operation showed that the AV was too low (~27'/min, see formula below) to maintain a cuttings free annular space. However there were severe pressure restrictions in place by the Corps of Engineers to mitigate any fracturing in the dam base. Therefore it was decided to go back to the roller cone bit to reduce cuttings loading and implement high viscosity sweeps (80 sec/qt, 100 to 200 gallons of freshly hydrated POLY-BORE™/QUIK-TROL® GOLD) once the hole reached total depth. The AV was also increased to 43 ft/min to facilitate improved hole cleaning (see below). The Corps of Engineers required the stand pipe pressure to not exceed 200psi and at 40gpm that pressure was not exceeded.

Hole Volume	$((5.625^2 - 3^2)/24.52) \times 180 = 166\text{g} + 29\text{g pipe volume} = \sim 195\text{g}$
Initial Annular Velocity (AV)	$[24.52/(5.625^2 - 3^2)] \times 25\text{gpm} = 27.07\text{ft/min}$
Suggested AV	$[24.52/(5.625^2 - 3^2)] \times 40\text{gpm} = 43.32\text{ft/min}$
Suggested Drilling Fluid Additives	Soda Ash 10#/1,000 gallons to remove free calcium and raise the pH to 8.5-9.5 QUIK-TROL® GOLD 5#/1,000 gallons Highly Dispersible Filtration Control Additive POLY-BORE™ 8#/1,000 gallons Borehole Stabilizing Dry Polymer

FLUID PROPERTIES

Proposed Polymer Properties

Viscosity 60-70 seconds/qt
Density 62.4-72 #/ft³
pH 8.5-9.5
Calcium <100 ppm

Actual Polymer Properties

Viscosity 65
Density 64#/ft²
pH 9
Calcium 100 (300 make up water)

AQUAGEL™/QUIK-TROL® GOLD properties:

Viscosity: 48 seconds/qt
PV: 13
YP 9
Filtration: 12 ml/30 minutes
Ca: 100
pH: 8.5
Sand: trace
Cake: 2
(Make up water: 6pH, 300 Ca)



OBSERVATIONS AND CORRECTIONS

A Moyno Progressive Cavity Pump was used to move the polymer from the mixing tank to the suction pit. The return line from the hole was put into the 4,000 intermediate pit and run through four 5" desanders and the over flow returned to the suction pit. All of the fluid to this point has been recycled.

Following implementation of the polymer slurry solution (see above) the completed hole rate increased from 1/day to 3 /day. The drill crew was able to maintain a pump rate of 40 gpm (25gpm originally) to improve hole cleaning without increasing the bottom hole pressures past allowable Corps of Engineer limits. At TD each hole is being swept with an 80 sec/qt viscosity polymer slurry sweep prior to cementation. The site superintendent feels that the cement bond is considerably improved as well. Of the 153 tiebacks in the project they have completed 73 and are now waiting on crews in front of them to finish their operations.



Figure 1: Tie backs on dam wall





Figure 2: 1,000 g premix and M3



Figure 3: Polymer slurry suction kit

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