Large Diameter Community Water Well Stiff Foam Drilling Project

INTRODUCTION

Following up on a lead generated at the 2014 NGWA Convention, Baroid IDP contacted Denning Drilling in Idaho Falls, Idaho to gather information about a large diameter water well project. Denning Drilling is a diversified drilling contractor specializing in domestic water wells, large diameter community wells, agricultural wells, and ground source geothermal wells. Mr. Denning stated that they were planning to drill a 20 inch community water well to approximately 800 feet using a DTH hammer and standard 4.5 inch O.D. drill pipe. He stated that he would like to have a Baroid IDP representative assist him with using stiff foam. He also stated that they were planning to hammer drill an eight inch, conventional-air test well in order to examine the formations by sampling and by a DTH camera. The well would then be drilled to 20 inches. Discussions were had concerning the equipment necessary to mix and circulate stiff foam. Tentative plans were made for Baroid IDP personnel to be on the project when the drilling of the 20 inch hole commenced.

Figure 1: Drill location and set up

PROJECT SCOPE

The scope of the project was to drill a 20 inch rock hole to approximately 800 feet using conventional air rotary method. The plan was to use three air compressors to circulate the cuttings up and out of the bore hole. Denning Drilling wanted to use stiff foam for the project which would require using only one air compressor. The challenge was to efficiently circulate the drill cuttings from the bit and up the large annular space and to reduce fuel costs associated with operating three large air compressors. An additional challenge was to reduce bore hole erosion associated with high volume/high pressure air. Two zones were identified by observations of the test hole that were soft and fractured and were thought to be volcanic pumice.

IDP SOLUTION

Stiff foam using Soda Ash (to treat out calcium hardness and to raise the pH of the make-up water), EZ-MUD® polymer emulsion (added to raise the viscosity of the make-up water and to strengthen and concentrate the bubbles), and AQF-2™ foaming agent (added to create bubbles) was recommended as a basic formulation. Initial recommended concentrations per 200 gallon tank of water were 2# of Soda Ash, 1 quart of EZ-MUD polymer emulsion (or a Marsh Funnel viscosity of 35 to 40 second/quart), and 2 gallons of AQF-2 foaming agent(1% by volume.) The initial injection rate of 5 to 7 gallons per minute of the stiff foam mixture was recommended based on previous experience. This recommendation also helped the drilling contractor to estimate required amount of materials.

DRILL AND MIXING EQUIPMENT

Drill	Reich Drill T-690-W with a 900/350 air compressor and Bean 20 gpm injection pump.
BHA	8x20 inch hole opener with a 12 inch hammer.
Mix tanks	(1) 200 gallon mix tank with (2) 200 gallon injection tanks.
Mixer	(1) A stand-alone venturi mixer with (1) 2 inch contractor pump
Additional	(1) 900/350 air compressor and (1) 1070/350 air compressor

Figure 2: Mix tank and Injection tank set up

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A CASE STUDY: *Stiff Foam Drilling Project*

PROJECT DISCUSSION

Baroid IDP personnel arrived at Denning Drilling Community Well Project on 2-17-2015 and met with the driller, Jed Denning. He stated that they were drilling out a cemented section from 200 to 260 feet. The zone was cemented to stabilize a fractured caving zone. He stated that they were not creating foam and not cleaning the hole.

The make-up water chemistry was checked. It showed a total hardness of 140 ppm, a chloride content of 120 ppm and a pH of 6. It was decided to mix the stiff foam mixture which consisted of 200 gallons of water, 2 quarts of Soda Ash and 2 quarts of QUIK-TROL® GOLD PAC polymer which was mixed through a high shear mixer. The total hardness after adding the Soda Ash was near zero and the pH was measured at 9.

The viscosity was measured at 37 seconds/quart. The QUIK-TROL GOLD PAC polymer was recommended over EZ-MUD® polymer emulsion due to its higher tolerance to cement contamination. Once this was mixed, it was transferred to the 200 gallon injection tank where 2 gallons of AQF-2 foaming agent were stirred in gently. The driller then began injecting the mixture down the pipe.

After approximately eight to ten minutes of injecting the stiff foam mixture, stiff foam appeared at the discharge line. The rate of penetration increased and the torque was reduced once the annular space cleared of cuttings. The foam injection rate was varied and it was determined that 8 to 9 gallons per minute was optimal.

The air volume/pressure was decreased so as to have just enough air to fire the hammer efficiently by configuring an air dump system in the rig air plumbing. The volume of air was reduced by half and the pressure reduced by 35 to 40 psi. Still, excessive air was breaking through the foam. The geology of the bore hole was highly- welded volcanic tuffs and it was thought that it was not likely to be susceptible to hole erosion.

At the end of each 20 foot drill pipe, circulation was required for approximately 30 minutes to clean the annular space as approximately 260 gallons of cuttings needed to be removed from the bore hole. A couple small zones required cementing to stabilize the bore hole but generally the drilling went well. The excess air breaking through foam may have been a factor in destabilizing these zones. The well was drilled to 720 feet and then cased with 16 inch casing. The hole was then drilled to 805 feet with an 11 inch tricone.

Drilling continued using the stiff foam mixture but the volume of hole water reduced the stiff foam to a runny foam. The foam injection was increased to maximum pump output but the high volume of water still reduced the foam to runny foam. It was necessary to use the three compressors to unload the hole due to the high volume of water which was estimated to be 800 gpm. The hole was completed without incident.

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Figure 3: Stiff foam

ECONOMIC VALUE CREATED FOR THE CUSTOMER

The economic value created for the customer was that the well was drilled in an efficient manner utilizing Soda Ash, QUIK-TROL® GOLD PAC polymer, and AQF-2™ foaming agent to create stiff foam. The large diameter hole would have normally required the use of three air compressors which would have incurred high fuel requirements and high costs. The project was drilled to 720 feet using only one compressor. Additionally, the penetration rate was increased and the rotational torque was decreased due to the fact that the drill cuttings were efficiently removed from the face of the bit and transferred to the surface. Baroid personnel's experience with large diameter stiff foam drilling combined with the expertise of Denning Drilling formulated a successful solution.

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