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Horizontal Directional Drilling: Bringing a Knife to a Gunfight and Winning

The most significant change this author/mud man extraordinaire has seen in the last 15 years of experience in the horizontal directional drilling (HDD) industry is not in the equipment or technology, but in the capabilities and accomplishments of drilling contractors, especially in the mini to mid-sized HDD drilling market. Today, contractors with 40,000-pound drills routinely are completing projects that contractors would not have attempted without maxi-sized drills just 10 years ago, and it is not uncommon to see contractors pulling product back in which the static weight of the product line far exceeds the actual push/pull capacity of the drill. HDD contractors who are successful in completing large projects with mini to mid-sized HDD drills are substituting the shear brute strength/horsepower and pumping capacity of larger drills for brainpower, experience and, last but not least, patience. Let's face it: If you're going to bring a knife to a gunfight and expect to win, you had better be really good with a knife!

Attempting larger HDD projects with smaller drilling equipment immediately narrows one's margin for success because there is little room for mistakes. One must realize the shortcomings in utilizing smaller drilling equipment, such as less rotary torque, less thrust for pushing and pulling, and less mud-pumping capacity, and understanding how to work within these parameters. Contractors have to be on top of their game when it comes to matching drilling fluids and downhole tooling to soil conditions, not only on the final ream/pullback, or even pre-reaming, but on the pilot hole as well. Failure to control downhole conditions, such as sticking and swelling clays or fluid-loss control in sand, while drilling the pilot hole will rob the drill of much needed torque that could be applied to the reamer. Inadequate drilling fluid gel strength also will narrow the margin of success by leaving drill cuttings in the borehole to pack around the drill stem, contribute to differential torque, backpressure and/or stuck product line. In order to complete large projects with smaller drilling equipment, it is imperative that the hole is open and free of obstructions.

Hole Dia. (in.)	Gal/Lin. Ft.=(Dia.^{2} ÷ 24.5 gals./ft.)	Coarse Soils, (Sands) 2 to 3 times Volume Of hole	Fine Soils, (Clays) 3 to 5 times Volume Of hole
2	0.16	.32 to .48	.48 to .80
4	0.65	1.3 to 1.95	1.95 to 3.25
5	1.02	2.04 to 3.06	3.06 to 5.10
6	1.47	2.94 to 4.41	4.41 to 7.35
7	2.00	4.00 to 6.00	6.00 to 10.00
8	2.61	5.22 to 7.83	7.83 to 13.05
9	3.30	6.60 to 9.90	9.90 to 16.5
10	4.08	8.16 to 12.24	12.24 to 20.4
12	5.87	11.47 to 17.61	17.61 to 29.35
14	8.00	16 to 24	24 to 40
16	10.44	20.88 to 31.32	31.32 to 52.2
18	13.22	26.44 to 39.66	39.66 to 66.10
20	16.32	32.64 to 48.96	48.96 to 81.6
24	23.49	46.98 to 70.47	70.47 to 117.45
30	36.73	73.46 to 110.19	110.19 to 183.65
36	52.88	105.76 to 158.64	158.64 to 264.4

An HDD pumping chart.

Using soda ash is a no-brainer for getting the most out of fluid-loss control and gel strength in a bentonite drilling fluid. Any time you are mixing Wyoming sodium bentonite drilling fluid, you should be using soda ash at ¼ pound to ½ pound per 100 gallons of water, added before mixing bentonite. It is well worth the investment to utilize a good HDD specialty drilling fluid – which can have up to three times the gel strength of high-yield bentonite, as well as improved fluid-loss characteristics – as well as soda ash. PAC (poly anionic cellulose) polymer will boost fluid-loss control to help maintain borehole stability, and an xanthan gum-based gel strength enhancer will dramatically increase gel strength with a minimal increase in viscosity. Remember, viscosity is the resistance to flow; therefore, the ideal HDD drilling fluid will perform all of the required functions of a drilling fluid at the lowest viscosity possible. Grab some of the drilling fluid mix in a clear container, stir in a bit of soil from the entry or exit pit, and see what happens. If the material settles in the container, it is going to settle in the hole, leaving cuttings that will cause an increase in pullback pressure. If the material gets sticky and thickens up, you will have to add something to take care of reactive clays.

Today contractors with mini to mid-sized HDD drills are routinely completing projects that would not have been attempted without maxi-sized drills just 10 years ago.

Clay on a spiral reamer.

Getting the product back is everything.

Backreamer designs are especially critical in doing large shots with mini to mid-size HDD drilling equipment. Backreamers should not block the return flow from going to the exit side, and when working in reactive (sticking and swelling) clays, avoid backreamers with large amounts of surface area for clay to stick to. Backreamers, such as packer reamers, spiral reamers and/or fluted reamers, can become completely blocked with clay, create huge increases in rotary torque and pullback pressure, and are a frac-out just waiting to happen. A good clay reamer will have a minimal amount of surface area, yet have good chopping and mixing capabilities, and can mean the difference between a failed or successful bore.

Drilling technique also is a critical component in expanding the capabilities of drilling equipment. While drilling the pilot hole, contractors should closely monitor drilling fluid returns, and note changes in the soil conditions to avoid surprises or problems during backreaming operations. Contractors also should avoid creating any bottlenecks in the bore path, which can occur when drillers do not pull back and rotate the bit through sections of the pilot hole where push-steering was performed, resulting in reduced annular space around the drill stem that will block returns and create additional rotational torque.

When tackling large-diameter projects with smaller HDD drilling equipment, mud-pumping capacity is dramatically less, and because the pullback speed of a backreamer is limited to the drilling fluid volume delivered to the backreamer, much more time must be taken for backreaming operations. This is where patience comes into play, and this is where many contractors fail. A backreamer not only is cutting soil, but it also is mixing soil with drilling fluid into what should be a flowable mixture that can be pushed out to the exit side. It takes two to three times the amount of drilling fluid vs. soil in coarse soil conditions, such as sand, and four to five times the amount of drilling fluid vs. soil in reactive clays. Monitoring return flow when backreaming is essential to success, because the returns will provide a wealth of information, such as changes in soil conditions, how the drilling fluid is interacting with the soil conditions, and the adequacy of flow/pumping volume. Contractors always should have someone monitoring the return flow. That person needs to be in direct contact with the driller, and can tell the driller if he is out-running the drilling fluid or if the mixture needs to be adjusted to changing soil conditions.

When tackling large-diameter HDD projects with mini to mid-sized drilling equipment, be aware of the shortcomings of the equipment being utilized and the narrow window of success that comes with this challenge, and take every precaution to improve one's chances for success. Remember that you are substituting brainpower, experience and patience for the lack of horsepower/brute strength and pumping capacity of larger drilling equipment, and, therefore, you must be on the top of your game to increase the chances to be successful. As previously mentioned, if you are going to bring a knife to a gunfight and expect to win, you had better be really good with a knife. ND

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