Recently, this author was on an HDD project in northwest Idaho where the contractor was failing miserably at installing product line under a road. Soil conditions included rocks and cobble, and the contractor was using a drilling fluid that was not capable of suspending and transporting the drill cuttings to the surface, resulting in stretched ductile, stuck pipe and numerous fracouts. This is a scenario that happens far too often. Having the proper training and understanding of drilling fluids to know if a drilling fluid is capable of performing the task at hand can save contractors a lot of grief and money.

Gel strength/suspension is one of the most important functions of a horizontal directional drilling fluid. In order to make a hole in the ground, dirt must be removed, and drilling fluid returns are the conveyer belt that makes the removal of drill cuttings possible. Therefore, one must have returns, and the drilling fluid must be capable of suspending the soil encountered.

To ensure good returns, it is essential that drillers swap the hole (pull back and rotate the bit through areas where push steering was performed) to avoid creating bottlenecks in the bore path in which drill cuttings can pack off and create back pressure. The correct reamers must be used so that they do not restrict return flow to the exit side. Common mistakes include using spiral or fluted reamers in sticky swelling clay.

When it comes to gel strength/suspension, one of the easiest ways to tell whether a drilling fluid has enough suspension to do the job is to take an empty clear plastic water bottle, cut the top off and pour in some of the drilling fluid. Then go to the entry or exit pit, get some of the soil to be drilled through, and mix it up thoroughly and let it set. If the material settles in the test sample, it will settle downhole, and the drilling fluid does not have sufficient gel strength/suspension. Unless one is doing a short shot under a driveway and pulling back behind the drill head, using such a fluid will most certainly lead to problems such as high rotary torque and pullback pressure, stuck drill stem or product line, or fracouts to clean up (or worse, destroyed pavement).

There are two methods of increasing the suspension/gel strength of a drilling fluid. One can add more bentonite, but this also increases viscosity (the resistance to flow) and annular pressures. The other is to add a gel-strength-enhancing polymer (such as xanthan gum) that can dramatically increase gel strength with a minimal increase in viscosity and annular pressures. Another gel-strength-enhancing additive is mixed metal products. These include mixed metal oxide (MMO), which is designed for extreme conditions like gravel and cobble. MMO products (if used correctly and according to the manufacturer) can create the extremely high gel strengths needed for such severe soil conditions.

Another critically important function for a horizontal directional drilling fluid is filtration control for borehole stability. In order to maintain borehole stability (keep the hole open) drilling fluid must create an impermeable barrier between the soil and the drilling fluid, and this is accomplished via a filter cake for bentonite drilling fluids or a polymer gel membrane with synthetic (polymer) drilling fluids or slurries. Positive pressure is then applied against the impermeable barrier via hydrostatic head pressure, which is accomplished by having the hole full of drilling fluid. If the filter cake does not adequately seal, or the hole is not completely full of drilling fluid when encountering coarse, unconsolidated soil conditions, the hole will most certainly fall in.

Just like checking for gel strength/suspension, one can take an empty water bottle with the top cut off, grab some coarse soil from the entry or exit pit, and put about a 3-inch layer in the bottom. Next, gently pour some of the drilling fluid on top. Ideally, you would see just a thin wet line where the soil and drilling fluid interface, and below that the soil should be dry. This is not an ideal way to check for filtration control, but it is often helpful.

There are two ways to improve filtration control in a drilling fluid. One is to add more bentonite, but this increases viscosity and, ultimately, annular pressures. The other method of improving filtration control is to utilize a PAC (polyanionic cellulose) polymer, which can dramatically increase filtration without raising the viscosity and annular pressure.

One can do similar cup testing to check and see whether soil is fine (reactive clays) or coarse (anything else but clay). Soil identification may sound simple, but this mud man extraordinaire has seen even the best drilling contractors fooled by what they thought were clay soil conditions (the material balled up in their hands) but, when mixed in water, there was very little clay and lots of sand. Simply put water in a clear container, add soil from the entry or exit pit, and give it a stir. If the water thickens and/or if one sees clay sticking to whatever is used to stir the sample, then reactive clays are present and the drilling fluid needs to have the ability to control the reactive clays.

One way of controlling reactive clay is to delay the hydration of the clay (that is, inhibit the clay) with a synthetic polymer. Clay has to soak up water in order to stick and swell, and a synthetic polymer will coat the clays and delay the sticking and swelling. If a contractor uses a drilling fluids recycling system, they need to utilize a low molecular weight/short chain clay inhibiting polymer that will not blind the vibratory screening equipment.

Another method of dealing with reactive clays is to use a clay cutter or breaker type of product or even a clay dispersant, but these products are not recommended when recycling drilling fluid because the fine clay will be retained in the drilling fluid and contaminate it. Once again, mixing the drilling fluid with suspected clay from the entry or exit pit can give one an idea of how well the fluid is going to work in those conditions.

When considering the use of bentonite-free HDD drilling fluid products, know and understand their capabilities and limitations. These types of products are designed for small-diameter short bores. Bentonite-free HDD polymer products are still in their infancy, and will get better with time and technology.

What constitutes a good horizontal directional drilling fluid? A good HDD drilling fluid is properly matched to the soil conditions. Utilizing the correct polymers and additives is of extreme importance in controlling downhole conditions while managing viscosity and annular pressures, and important for the overall success of a drilling project. As previously mentioned, having enough knowledge to know if a drilling fluid is capable of performing the task at hand before getting into trouble can save contractors a lot of grief and money.

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