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Drilling Fluids

Buoyancy Related to Vertical Loop Installations

Over the past few years, ground source heating/cooling using vertical loop installations has taken over our industry, and has provided a great new opportunity for many of us in the water well and drilling industry. With new opportunities also comes a new learning curve to accomplish the job effectively and efficiently. One of the major problems I encounter on a regular basis is installing loops after the borehole is drilled. These boreholes range in depth from as shallow as 100 feet to 600 feet in depth, with the average being about 300 feet.

Borehole sizes normally range from between 4 inches to 6½ inches, depending on the size of loop being installed, and in some cases, the size of the drill pipe. Smaller seems to be better, as it reduces drilling and grouting costs. But with a smaller-diameter borehole also comes potential problems with getting the loop to the bottom of the hole. A smaller borehole does not allow much extra space for swelling clays or from unconsolidated materials such as rocks or cobbles from sloughing into the borehole. This will hinder getting the loop placed to depth, and possibly cause the need for the borehole to be re-drilled, which can be costly. But the number one problem I see with new contractors getting into loop installations is their not knowing how to overcome pipe buoyancy.

With vertical loop installations, knowing how to overcome pipe buoyancy is key.

Drilling normally is done with either air or conventional mud drilling, depending on drilling conditions and available equipment. Some sonic drill rigs are being utilized. With loop boreholes drilled using air either with a tricone bit or air hammer, in most cases, the boreholes are dry or have little or no water, which allows for easy installation of the loop and tremie pipe. Both need to be placed at or near the bottom of borehole to properly seal the annular space. However, mud drilling poses some potential problems, which need to be understood before placing a loop in the borehole. The number one concern should be buoyancy. Poly-pipe loops, even pre-filled with water, have buoyancy, and weighted drilling fluids drastically increase the buoyancy of the loop.

Figure 1 shows what weight is needed to be added to the loop filled with water to offset the buoyancy from heavy drilling fluid. These increased weights normally are found because of the lack of solids control found with contractors doing loop installations. You might not have the space for utilizing a mud-cleaning system or the resources to purchase one, but there should be no reason that you could not be using a de-sanding cone while drilling. The de-sanding cone alone can reduce your added mud weights from sand and silt by as much as 90 percent to 95 percent. When looking at the chart, if you can reduce your mud weights from 10 (lb./gal.) to 9 (lb./gal.) on a 1-inch loop, you can cut your weight required by 21.1 pounds per 100 feet of loop. When looking at a 300-foot loop, we drop the added weight required to get the loop to the bottom from 112.8 pounds to 49.5 pounds. Some contractors are using sinker bars attached to the bottom of the loop to assist getting the loop and tremie pipe in the hole, but a lot of rigs I have seen do not even have a sand line or other method to use a sinker bar. This leaves them using weighted loops or brute force to get the loop installed.

Not understanding buoyancy has had a number of contractors pulling the loops back out of the borehole and re-drilling, thinking they had a problem downhole only to find a good hole and the same problem getting the loop down. Smaller-diameter holes also can add to problems getting the loops installed as mentioned with swelling clay and materials sloughing in, but friction from the pipe and sides of borehole need to be considered.

So, if you are drilling with mud, do what you can to reduce the mud weight, or be ready to weight up the loops before installing. ND

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A smaller borehole does not allow much extra space for swelling clays or from unconsolidated materials.

Weighting to Overcome Buoyant Forces (lbs/100 ft of borehole)[1]

U-bend	Tremie	Drilling Fluid Weight (lb/gal)				
PE SDR-11	PE SDR-11	8.3	9.0	9.5	10.0	10.5
¾"	¾"	1.5	10.5	17.2	24.0	30.7
	1"	1.7	12.5	20.5	28.5	36.6
	1¼"	1.8	15.6	25.8	35.9	46.0
1"	¾"	2.0	14.5	23.8	33.1	42.4
	1"	2.3	16.5	27.0	37.6	48.2
	1¼"	2.7	19.6	32.3	45.0	57.7
1¼"	¾"	3.1	20.8	34.3	47.8	61.3
	1"	3.4	22.8	37.6	52.3	67.1
	1¼"	3.8	26.0	42.8	59.7	76.5

Figure 1. Loop weight information, assuming both the U-bend and tremie are filled with water.