Drilling the Maas River

Innovative tracking software was utilized to drill this project From Both Sides

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A water installation project under the Maas River in the province of Limburg in the village Heel, the Netherlands, provided the opportunity for the use of the HDD industry's latest tracking software to complete complicated drilling on both sides of the river.

The local authorities are changing their water distribution system and needed the waterline to provide drinking water on both sides of the river. The project involved installation of one 8-in. (200-mm) and one 36-in. (900-mm) steel pipe through heavy gravels on both sides of the river by means of HDD. Total length of the river crossing was 2,640 ft (800-m). The gravel density precluded reaming operations sized above 12 in. (300-mm) due to hole instability.

Haustadt & Timmermann GmbH Co. KG, Berheimer, Germany, elected to case off the gravel sections on both sides of the river with 60-in. (1,500-mm) casing, centralize strings of 12-in. (300-mm) casing inside the 60-in. casing (1,500-mm), drill a pilot hole to a planned intersection point midway and using another rig, drill an intersection hole from the exit point.

After intersecting, the pipe would be pushed through the entry side hole into the 12-in. (300-mm) casing centralized inside the 60-in. (1,500-mm) casing. Once a complete drill string was established from entry to exit, normal reaming operations would commence and the 36-in. (900-mm) product line installed.

Haustadt & Timmermann carried out the project using its new 400-ton (360-m ton) Herrenknecht rig and a Hütte 60-ton (54-m ton) rig.

Casing Program

Before starting the installation of the 60-in. (1,500-mm) casing pipes, H&T designed the drill profile for the 36-in. (900-mm) steel pipe. To overcome any problems occurring from imperfections of the line and grade of the casing, H&T designed the profile using a radius of 3,300 ft (1,000 m), much larger then the allowed minimum bending radius of the 36-in. (900-mm) product pipe and extended the initial design by 330 ft (100 m).

For the installation of the casing pipes, H&T developed a special technique combining an auger machine with an additional hydraulic jacking unit mounted on a jacking frame. A 60-in. (1,500-mm) steel casing was installed to a length of 363 ft (110 m) from the entry point to a depth of -69ft (-21 m). At the exit side, the casing string extended a total of 462 ft (140m) to a planned elevation of -86 ft (-26 m).

Installation of the 60-in. (1,500-mm) casing pipes

In fact, due to great difficulty in guiding the augers through the heavy gravels, the casing on both sides moved more than 6.5 ft (2 m) higher than planned. Since this was not indicated by the gyro surveys of the 60-in. (1,500-mm) casing after installation, a re-plan of the entire job geometry was required after drilling had commenced. Once it was determined that the new geometry allowed the planned radius to be met, drilling continued.

Twelve-inch (300-mm) flanged casing was installed inside the 60-in. (1,500-mm) casing using a roller centralizer assembly attached with the flanges. This allowed the casing to be run and removed rapidly.

Guidance Program

Navigation of the pilot hole was done with the proprietary ParaTrackII equipment and software developed for the HDD market by Vector Magnetics, Ithaca, New York, USA. ParaTrack software coupled with its new state of the art magnetic steering tool allows very accurate ranging measurements from a variety of magnetic sources. It was designed to drill parallel holes alongside a single electric cable installed either on the surface or in a generally parallel borehole.

The use of AC current in the guidewire allows a high degree of accuracy due to the fact that many single measurements can be taken very quickly and the results averaged to filter out the fluctuating magnetic fields experienced so often with other methods. If a cable can be installed from entry to exit, ParaTrack has no blind spots and is used as a continuous navigation tool.

In this case, the ParaTrack guidewire was installed inside an 8-in. (200-mm) steel product line located around 39.5 ft (12 m) left of the object bores. At this range, the amplitude of signal allows an accuracy envelope smaller than the diameter of the drill bit. When attempting an intersection, these accuracies are required.

Drilling Program

Drilling from the entry, it was planned to drill through the horizontal section and to a point about 1,815 ft (550 m) from entry.

In order to achieve the largest reasonable target for the directional engineer, the plan called for push reaming a 24-in. (600-mm)

reamer from entry to the end of the horizontal section. To affect the ream through the 60-in. (1,500-mm) casing and remain centralized, it would be necessary to run a bull nose on drill pipe inside the 12-in. (300-mm) casing to about 396 ft (120 m). Then the 12-in. (300-mm) casing would need to be removed and the 24-in. (600-mm) reamer made up. The reamer could then be pushed to the bottom of the 60-in. (1,500-mm) casing while being supported by the 12-in. (300-mm) casing run with it. Once the 12-in. (300-mm) casing was on the bottom, the 24-in. (600-mm) push ream could begin. The next step was to start drilling from the exit side using a 60 ton (54 m ton) Hütte rig and 3.5-in. (8.75-mm) drill pipes.

Haustadt & Timmerman used Its new 400 ton (360-m-ton) Herrenknecht rig for part of this job.

Once again, the exit side, 12-in. (300-mm) casing was found to be 6.6 ft. (2 m) higher than expected. These elevations were confirmed by both the steering tool sensors and by the first ParaTrack, ranging measurements from the 8-in. (200-mm) bore hole located 33 ft (10 m) away. The 8-in. (200-mm) product line had been gyro surveyed and its data used to confirm the inaccuracy of the 60 in. (1,500-mm) surveys. As performed on the entry side, drilling stopped while a re-plan of the geometry was done. Since the entry side hole had stopped 198 ft. (60 m) from the exit side casing, H&T planned to intersect at that point. Due to the inaccurate 60-in. (1,500-mm) locations, this was not possible if the 3,300-ft (1,000 m) radius tolerance was met.

Drilling commenced with an intercept target of 1,386 ft (420 m) from entry. The drilling plan was to bring the exit side bore in line and above them target bore and allow a gradual drop into the target bore. In fact, at 1,402 ft. (425 m) from entry, the drill operator stopped drilling and advised of a very soft push. Watching angles and directions carefully, H&T pushed into the target bore 3 ft (1 m) at a time until the intersect was confirmed. After carefully pushing two joints into the target bore, H&T began tripping the drill string into the target bore rapidly.

After pushing the 3.5-in. (87.5-mm) string to about 99 ft (30 m) from the mouth of the 60- and 12-in. (1,500-and 300-mm) casing, H&T was unable to continue. Since H&T was tripping into a sand formation, the crew needed to push the jetting assembly on high side to ensure it did not accidentally sidetrack the hole. Pushing through the entry curve also indicated that it would be too dangerous to rotate and push, again due to the risk of sidetracking. After unsuccessfully working with the 3.5-in. (87.5-mm) string to attempt to free up the hole, the decision was made to trip the 3.5-in. (87.5) string out and push the 5-in. (125-mm) string from the entry.

Since the original intercept was made at 1,402 ft (425 m) from entry and from a position above the target bore, it would not be possible to use the hole already drilled from the exit side. A sidetrack was made and the new hole drilled to a point just above the old 6-in. (150-mm) hole about 165 ft (50 m) from the mouth of the 60- and 12-in. (1,500- and 300-mm) casing. The 6-in. (150-mm) hole was intersected by the 10-in. (250-mm) jetting assembly and pushed directly into the 12-in. (300-mm) casing string and on to the exit point.

After successfully finishing the pilot hole, reaming was done in three steps up to a hole diameter of 54 in. (1,350mm).

Meanwhile, the 36-in. (900-mm) steel pipe was completed on pipeside. As the exit angle was 10 degrees, it was necessary to support the product pipe on a more then 26-ft (8-m) high over bend construction. On Oct. 9, the 36-in. (900-mm) water pipe was successfully installed under the Maas River.

Conclusion

The 36-in. (900-mm) product line was installed under the Maas River successfully using standard directional drilling techniques in combination with augured casing and a new guidance system. A special technique of this kind is expected to throw up a number of foreseen and unforeseen difficulties.

The feasibility of planning and executing underground intersects of two well bores has been practiced in the oilfield industry for some time. The use of an intersect to connect two sides of a river with a pipeline has also been done once or twice. In the past, there has not existed a method/technology to allow positive control of an underground intersect.

Now, with the introduction of ParaTrack and ParaTrack II, there is. In this case, a bore of 2,640 ft (800m), using two techniques of intersection, was successfully executed.

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