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Latest Advances in Thermal Grouting for Underground Electrical Utilities

By Guy Dickes

Thermal grout around underground electrical transmission and distribution lines dissipates heat generated by electric current into the surrounding ground. This serves two basic functions: improving electrical transmission and increasing insulation life span.

Thermal grouts are installed around conduits installed in horizontally directionally drilled (HDD) or by other trenchless means casings. Typical mix designs for thermal grout include cement, silica sand, water and specialty chemical admixtures. Other materials such as bentonite, flyash and pozzolan may be used to meet project requirements. Each of the following projects used different grout mix designs to accomplish the engineering and construction requirements. It is important that a comprehensive quality control program be in place as grout is installed. There is only one chance to get it right. Grout must be tested prior to going into the bore. Typical on-site checks will include unit weight (specific gravity); air content; and, depending on mix design, efflux or flow. Unit weight determines that the correct material percentages are maintained.

These grouts should not be confused with fluidized thermal backfills (FTBs), which are used in open-cut applications. Both classes of materials remove heat from around cables. Thermal grouts should be very flowable and pumpable—characteristics not typically required of FTBs. As a general rule, FTBs are less expensive than thermal grouts.

Major Projects

Long-distance grouting of underground electrical conduits became a reality in summer 2006 with the completion of two 2,000-foot HDD installed conduits-in-casings by Mears Group Inc. in Austin, Texas. This project proved grouting could be accomplished over very long distances. Previously, grouting of underground casings had been limited to a few hundred feet. Since the Austin project, several other projects have been completed. Jacobs Civil of Houston wrote that the grouting was the only major concern the technical professional consulting firm had going into this project. The casings run under the Austin Country Club Golf Course and Lake Austin. This was a multiple-use bore with force main pipes and distribution lines co-located within the casings. Some 360 cubic yards of grout was pumped.

The longest (roughly 2,800 feet by 800 meters) uncased, drill mud-filled bore was grouted in summer 2011 in Vancouver. The project, Vancouver Central City Transmission (VCCT), was drilled by Michels Canada. This project demonstrated that when executed properly, thermal grout can displace modified drill mud. Nearly 420 cubic meters (550 cubic yards) were pumped, replacing nearly 92 percent of the drill mud, above engineers' expectations. BC Hydro is the utility; Golder Associates was the engineer. Some 230 kV will be delivered to downtown Vancouver from the south side of False Creek.

The longest cased bore successfully grouted was 6,131 feet by Southeast Directional Drilling at Wolf Bay, Ala., completed in spring 2012. This project will deliver 115kV to 230kV from the Orange Beach, Ala., substation under Wolf Bay to Sapling Point, Ala. This massive project used 670 cubic yards of thermal grout produced by a local ready-mix supplier in two days of grouting. Waldemar E. Nelson was the engineer; PowerSouth is the utility.

Numerous other long bores and short bores (100-450 feet) have been grouted by the author and others. Grouting is not a four-letter word. This construction process should be part of the engineering design, rather than left to the contractor to decipher, "Fill the annular space with thermal grout." Too often, this is the extent of the specifications. Similarly, the improperly written specifications include an FTB mix design that is impractical to use in cased conduits.

Often the shorter bores run into problems. The typical installation around the Washington, D.C., metropolitan area and elsewhere is to place a jack-and-bore casing under a highway such as I-95. Casing lengths run from 50 to 450 feet or longer; diameters in the 24- to 48-inch range. The local tunneling or jack-and-bore contractor is required to grout without having the proper understanding of grouting operation. Having a pump is not enough. Education and engineering is required. Mix designs for these shorter bores are less expensive because locally sourced materials will suffice.

Often, conduits placed in casings are separated and spaced apart by custom bore spacers. Placed every 5 to 8 feet, these will act as baffles and restrict the flow of grout, hence the need for very fluid grouts. Stiff, mortar-like grouts will crush the conduits because of pumping pressures. It is also necessary to understand that cementitious grouts develop heat as they set (heat of hydration). Care must be taken either to control heat of hydration, cool the conduits or both to protect the installation. Cellular cement grouts, which are not suitable as thermal grouts because they act as insulation, can reach hydration temperatures of more than 210 F.

Grouting is the last step before cable installation and not a time to make a mistake. This mistake is very expensive to correct. The following photograph shows what can happen if grouting is performed improperly. Some 250 feet of completed HOBAS pipe needed to be removed and replaced.

As experience is gained by the engineering community and contracting community, longer directionally bored casings will be installed.

- Thermal grouts and FTBs are similar in function only.
- Thermal grouts need to be fluid and pumpable; these are not the same characteristics.
- A mix design in one location may not produce the same thermal or physical characteristics in another location.
- Thermal resistivity should be tested for every mix design, using site-specific materials.
- For any given thermal grout design, reducing water, air content or both will improve thermal characteristics.
- Chemical admixtures must be tested with every mix design and cement source.

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