THERMAL EFFECTS AND FIRE HAZARDS OF PLASTIC PIPES

Generally, engineers ignore thermal effects and fire hazards when designing sanitary sewers, storm drains and culverts. Most individuals do not know of the flammable nature of plastics, especially polyethylene pipes, and are unaware that fires can occur in buried pipes, thus damaging and/or destroying all or part of the system.

THERMAL EFFECTS OF POLYETHYLENE PIPE

Polyethylene pipes, black in color, can change in length as much as 6 or 7 inches per 100 feet due to temperatures. In addition to a change in length, polyethylene pipes will suffer a significant decrease in Pipe Stiffness due to hot weather, which, in most sizes, is already less than the long established minimum Pipe Stiffness of 46 psi.

The American Association of State Highway and Transportation Officials (AASHTO) have stated in their Design Manual, Section 18.4.1.4, the following:

> "PE and PVC are thermoplastic and, therefore, subject to reduction in stiffness as temperature is increased."

On page 15 of the Transportation Research Board Report No. 225, "Plastic Pipe for Subsurface Drainage of Transportation Facilities", it states:

> "The coefficients of thermal expansion of plastic pipe materials are much greater than those of conventional piping materials."
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> "For example, the coefficients for PVC and PE, respectively, are 5 and 12 times that of steel. Thus, thermal expansion of plastic pipe materials can result in movements of 3-1/2 to 9 inches per 100 feet of pipe per 100 degrees F temperature change."
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> "The effects of large movements resulting from significant temperature excursions must be accounted for in design and particularly during field installations."

Initially, it would seem impossible for pipes to have anything near a 100 degree change in temperature. However, a closer examination of thermal effects on pipes will indicate that it is very possible for this to happen.

Since polyethylene pipes are black in color, they will absorb heat and often record temperatures of approximately 140 degrees F, even though the ambient temperature is significantly lower. As ambient temperature rises, so will the temperature of the pipe material. Pipe temperatures as high as 155 degrees F have been recorded during the summer months in Phoenix, Arizona.

Pipes exposed to direct sunlight for several hours prior to installation will become more flexible, which means that the Pipe Stiffness decreases. Since polyethylene pipes have a very low Pipe Stiffness, typically less than 46 psi, it becomes imperative to account for thermal effects that reduce the Pipe Stiffness even more. An example would be a HDPE pipe with an elevated material temperature of 140 degrees placed in a trench and backfilled. The in-ground temperature of approximately 60 degrees will cause a change of 80 degrees in the pipe temperature, which could mean a reduction in length of approximately 7-1/4 inches per each 100 foot section of the system, affecting joint integrity, etc.

HDPE Pipe Stiffness under similar temperature conditions (140 degrees F) will decrease by a factor of approximately 3 as the pipe modulus changes due to elevated temperatures, possibly resulting in excessive deflection and non-uniform shapes.

FIRE HAZARDS

There are recorded cases where PVC and HDPE pipes have burned so severely that the pipe collapsed, causing the backfill material above the pipe to cave in. An additional problem with burning plastic pipes is toxic fumes. Burning PVC emits mild hydrochloric acid fumes.

Petroleum spills are very common and the spillage often ends up in the underground sewers. Volatile fumes can travel through the system and be ignited by pilot lights in homes and businesses or by other means. In rural areas where farmers burn weeds along ditch banks, fires are very common in culverts. Polyethylene melts at approximately 475 degrees F, which means that the melted resin helps feed the fire at the source.

The National Fire Protection Association (NFPA) states in their NFPA 820 booklet, "Fire Protection in Wastewater Treatment Plants" the following:

> "7-3.1.2 For sanitary sewers that may handle flammable or hazardous materials and for all combined sewers, only materials meeting the definition of noncombustible or limited combustible should be used."