COPPER TUBING IN SOILS

Copper tubing buried in the earth is used for the refrigerant-to-earth heat exchanger in the EarthLinked® (direct geoexchange geothermal) heat pump system of EarthLinked Technologies, Inc. (ETI). Copper was chosen for the buried earth loop heat exchangers for several reasons.

Copper tubing is strong, ductile, resistant to corrosion, has a very high thermal conductivity, and is available in many different diameters and in long coil lengths. Copper connections can be brazed, the tubing may be bent, and copper tubing is economically available. In addition, copper has a long history of use in air conditioning and refrigeration, and is the material of choice for potable water for water lines buried underground and in buildings.

In 2001, ETI retained the services of Dr. T. D. Burleigh (a university professor with a Ph.D. in Metallurgy from the Massachusetts Institute of Technology, who is a NACE certified Corrosion Specialist and a registered Professional Engineer) to analyze the system and recommend the best methods to assure that the copper loops would never corrode. A comprehensive study was conducted in cooperation with Robert W. Cochran, a Professional Engineer with ETI. Following is a summary of the results of that proprietary study and the description of the protective system developed by ETI.

Copper metal has a very long and indefinite lifetime in most soils. Copper buried in the earth is naturally corrosion resistant because it generally requires an oxidizing environment to corrode, and most soils are reducing, thus they contribute electrons to the copper and protect it against corrosion. In those areas where corrosive conditions may exist, corrosion can be prevented with a small amount of "impressed electrical current" applied to the copper loop via an insulated cable.

For long life and reliability, ETI chose the Impressed Current method of Cathodic Protection. ETI developed an electronic control system, known as the Cathodic Protection System (CPS) to deliver a steady flow of electric current to the earth loops, manifolds, and line sets, without regard to weather, changing soil conditions, and other subsurface conditions. The copper loop is connected to the negative terminal of a rectifier, and a buried inert metal or graphite anode is connected to the positive terminal. The earth completes the electric loop. The amount of current is pre-set at the factory to match the amount of copper in the system to be protected.

Corrosion of metals is an electrochemical process of deterioration that results from a loss of electrons as they react with water and oxygen. As the current flows from the CPS, the metal surface to be protected is given a uniform negative electrical potential that precludes corrosion.

The CPS was designed by ETI in consultation with Dr. Burleigh in 2001 to preclude corrosion of Earth loops in hostile environments.