EARTH TO AIR SYSTEMS
ADVANCED GEOTHERMAL HEATING AND COOLING

Underground Tubing and Refrigerant Information

Two common questions are;
"How long will the underground copper tubing last?
and
"Is the underground system environmentally safe?"

Underground Tubing

The first question is generally answered via a treatise by James R. Myers, a Corrosion Consultant, of Franklin, Ohio, and by Arthur Cohen, Manager of Standards and Safety Engineering for Copper Development Association, Inc., of New York, New York.

The first introductory paragraph of the treatise written by these gentlemen reads as follows: "The belief by knowledgeable engineers, architects, and water works personnel that copper is not adversely affected by the vast majority of worldwide soils is well-founded. Unusually well preserved copper artifacts continue to be recovered in Mesopotamia from beneath the clay deposited by the "Great Flood," which is believed to have occurred about 4,000 B.C. Many of the under- ground copper pipes used to convey water in Egypt nearly 5,000 years ago are still in existence. Further, copper is one of the few metals which exist naturally as an element. There is also the outstanding history of copper water tube's performance as a highly corrosion resistant material in most underground environments."

Several potential corrosive situations are outlined, such as soils with high sulfate and/or chloride content in combination with poor drainage and more than 30 inches of rainfall per year; soils containing organic or inorganic acids; soils containing appreciable amounts of ammonia; and soils subject to stray electric currents (principally direct currents as opposed to alternating currents) and/or galvanic action. However, these conditions are generally rare and infrequent. Soils such as clay, sand, gravel, loam, and chalk are usually completely safe.

When rare corrosive sub-surface environments are present, Earth To Air Systems, Inc.'s ("ETA") in-ground copper lines are either completely encased in a protective solid cement type Grout 111, or are enclosed in a watertight, environmentally safe, polyethylene plastic pipe, which, after insertion of the copper refrigerant tubing, is filled with water and propylene glycol (a harmless, food grade, anti-freeze). Consequently, rare, but potential, underground corrosive elements are totally prevented from reaching and affecting the system's copper refrigerant transport tubing. Further, the copper tubing installed within protective plastic piping is accessible for servicing without having to re-drill a deep well, and without having to re-excavate.

Even if the copper tubing was installed directly into the ground without a protective grout encasement, or without a sealed plastic protective encasement, the copper tubing would still generally not be subject to danger from acidic or basic elements so long as the surrounding soil's pH level was above 5.5 or below 10, which is typically the case.

The said treatise also explains: "Copper is essentially immune to corrosion in that it behaves like a noble metal in most underground environments because of the naturally protective film which forms on the metal's surface. If this film, which often consists of reddish- brown cuprous oxide (CU2O) is destroyed and cannot be repaired, copper can be expected to corrode (when situated within a corrosive sub-surface environment is implied). Fortunately, the protective film on copper remains intact or is readily repaired under most soil conditions."

Former, and older generation, direct expansion/exchange heating/cooling systems often required the in-ground copper tubing system components to be located as close to the home or business as possible, due to operational design limitations, taking care not to go too close to a septic system, or too close to trees and shrubs, all while keeping the sub-surface tubing at least 15 feet away from the foundation to avoid freezing damage. Further, if corrosive soils were encountered, an additional expense to provide cathodic protection for the in-ground copper became necessary. The new generation ETA design, with the copper tubing encased within a watertight protective plastic piping or cementitious grout, overcomes all of these prior limitations and concerns when and if rarely applicable.

ETA includes its underground tubing in its standard system limited warranty. Extended warranty provisions can be purchased from ETA.

Refrigerant Fluid vs. Earth's Ozone and Sub-Surface Environment

The second question, "Is the underground system environmentally safe?", primarily concerns the system's refrigerant fluid, as some refrigerant fluids/gases can affect the earth's upper ozone environment. To a lesser extent, the second question involves the affect of propylene glycol and of the system's compressor lubricant oil (which mixes with the system's refrigerant) upon the sub-surface environment.

Former, and older generation, direct expansion/direct exchange ("DX") heating/cooling systems generally utilized a refrigerant fluid known as a hydrochlorofluorocarbon (HCFC), specifically HCFC-22, or R-22 ("Freon" being a common trade name), circulated within sub-surface copper tubing that typically was never more than 5 to 100 feet deep (a near-surface system design).

Since most refrigerant fluids are stable chemicals, the U.S.E.P.A. issued a letter confirming that the U.S.E.P.A. was not aware of any soil or groundwater toxicity issues that would discourage the use of R-22 in direct expansion heat pumps. The compressor lubricant oil, which was mixed and circulated with the refrigerant, was typically an environmentally safe, refined mineral oil, such as Suniso Refrigeration Oil 3GS. Thus, the only cause for concern was the use of a refrigerant, such as R-22, containing a chlorofluorocarbon because of its upper atmosphere ozone depletion potential.

In March of 1988, a report of the Ozone Trends Panel (a global group of scientists led by NASA) concluded that chlorofluorocarbons (CFC's) are most likely the primary cause of the Antarctic Hole phenomenon, whereby stratospheric ozone is depleted. Subsequently, sufficient international support was received by at least eleven nations, representing a combined minimum of 2/3 of global CFC consumption, to implement the "Montreal Protocol on Substances that Deplete the Ozone Layer."

Ozone Depletion Potential (ODP) of Select Chemicals

Chemical	ODP
CFC –11	1.0
CFC-12	1.0
CFC – 113	0.8
CFC – 114	1.0
CFC – 115	0.6
CFC – 502	0.3
HCFC - 22	0.05
HCFC - 123	0.02
HFC - 134A	0.00
HFC - 410A	0.00

The Montreal Protocol dictated an orderly schedule to reduce global consumption of CFCs 11, 12, 113, 114, and 115 (plus certain halons unrelated to refrigeration) over the subsequent ten years, and called for a ban on imports of these chemicals, and products containing them, from non-participant nations. In August of 1988, the U.S. Environmental Protection Agency (EPA), issued certain regulations which directly follow the Montreal Protocol provisions and identified a system of production quotas as the preferred means of plan implementation

HCFC-22, the refrigerant fluid primarily, and virtually exclusively, utilized in all older generation direct expansion/direct exchange geothermal heating/cooling systems, was neither banned nor scheduled for phase out within the subject first 10 year period.

This is because HCFCs, such as R-22, contained hydrogen, as opposed to chlorofluorocarbons (CFCs), which do not contain hydrogen. The addition of hydrogen makes the chemical unstable in the troposphere, where most of it is removed through conversion into water, carbon dioxide, and other water-soluble compounds.

Scientific evidence demonstrated it was the chlorine in refrigerant gases which reacted with, and depleted, ozone. Consequently, because of its instability in the troposphere, very little of the chlorine in HCFCs had an opportunity to reach the stratosphere, where ozone depletion occurs.

The following chart identifies the potential effects on ozone depletion of various, and previously common, refrigerant fluids. While the potential ozone depletion effect of HCFC-22, or R-22 ("Freon"), is relatively low in comparison to other refrigerant fluids, the ozone depletion potential is still there. Consequently, current EPA guidelines are reported to call for the phase-out of HCFC-22 production commencing in 2006, the ban of HCFC-22 production for new equipment in 2010, and the total ban of HCFC-22 production in 2020.

All of the new generation ETA direct expansion/direct exchange heating/cooling systems are designed to operate with a refrigerant fluid known as R-410A (the refrigerant identification number assigned by ASHRAE). R-410A is a non-ozone depleting HFC (hydrofluorocarbon) refrigerant, containing absolutely no chlorine. Besides having no potential adverse effect upon the earth's ozone, R-410A is a stable chemical, is not subject to hazardous polymerization, and is not a hazardous waste. It is a fact that refrigerant fluids are typically stable, non-poisonous, inert, and harmless in their natural state (except for potential frostbite when discharged under pressure, and except when displacing oxygen in a confined area). This is why refrigerant fluids are safely and commonly used in home refrigerators and freezers. Further, the compressor lubricating oil used with R-410A is Polyol Ester. Polyol Ester is a non-hazardous product according to OSHA (1910.1200).

Consequently, the owner of a state-of-the-art geothermal ETA system does not have to worry about his unit's R-410A refrigerant having any adverse impact upon the earth's upper ozone layer, does not have to worry about older R-22 design components soon becoming obsolete, does not have to worry about his sub-surface copper tubing being affected by corrosive elements, and may rest assured that his/her system will not harm our environment.

Note: The above information is based upon data and reports believed to be accurate and prepared by credible sources, but which data and reports have not been independently verified by ETA.