

THE SCIENCE OF REFRIGERANT-BASED GEOTHERMAL

Gregor Vialette - 02.25.16

"Copper loops corrode and fail"

→ Alternatives: "Ground eats the copper"; "Minerals in the ground will cause the copper to leak"

✤ Copper

- Extracted from the ground itself
- Long history of use in HVAC
- A noble metal naturally resistant to corrosion
- Naturally compatible with > 90% of the land in North America
- Corrosion in Copper
 - Patina: a natural protective coating
- Earth Loop Protection System (EPS)
 - Impressed Current Cathodic Protection (ICCP)
 - Anode connected to a DC source
 - Optimized to provide enough current for protection of target structure
 - Permanent, uniform and automatic protection
 - Long life and reliability

"Systems contain too much refrigerant"

→ Alternatives: "The code requires an industrial type machinery room for these systems"

- EarthLinked® Geothermal Systems
 - \checkmark ≈5 to 7 pounds of refrigerant per nominal ton of system capacity
- ✤ ASHRAE standards
 - Standard 15-2013 and Standard 34-2013
 - Complies with 2012 International Mechanical Code
 - Refrigerant Concentration Limit (RCL) = allowed concentration in occupied space
 - RCL(R-410A) = <u>26 lb/Mcf</u> = 26 lb/1000 ft³
- Case study: extreme scenario
 - ▶ 2000 ft² home \rightarrow 4-ton job
 - EarthLinked system: 28 lb of R-410A
 - ▶ 7-foot ceilings \rightarrow 14000 ft³ of conditioned space $\rightarrow \approx$ 9 Mcf of occupied space
 - ✓ 410A Concentration = $\frac{28}{9}$ = 3.11 lb/Mcf → 8 times less than RCL

"They are not recognized by the Code"

→ Alternatives: "These systems don't comply to the Mechanical Code"

- ✤ ASHRAE standards
 - Standard and guidelines for the HVAC industry
 - Complies with 2012 International Mechanical Code
- ✤ IgCC: DX is mentioned in the International Green Construction Code
- * <u>CSA</u>
 - C448 Series-16
 - Design and installation of earth energy systems"
 - Bi-national Standard for Design and Installation
 - A reference for IGSHPA
- Testing standards



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ASHRAE



→ Alternatives: "What if there is a leak?"

- EarthLinked® Geothermal Systems
 - Refrigerant-based
 - No antifreeze
 - Very limited risk
 - Seal tested at factory
 - Seal test in the field (400 PSIG nitrogen for a minimum of 8 hours)
- ✤ <u>R-410A refrigerant</u>
 - ➤ Boiling point: -60.5°F
 - Would immediately vaporize and seek the atmosphere
 - MSDS available
- ✤ POE oil
 - ✓ Insoluble in water \rightarrow would not contaminate aquifers
 - MSDS available

"Loops in DX are too short"

→ Alternatives: "The ground cannot keep up", "The ground will heave or dry out", "Copper is too conductive for the ground"

✤ Fourier's law (1807)

$$\checkmark Q = -k.A.\frac{dT}{dx}$$

- Compact loop system
 - Higher thermal conductivity of Copper
 - Greater temperature range of operation for R-410A
 - The combination of Copper + R-410A allows for a larger temperature gradient (ΔT) than HDPE and an antifreeze solution would
- Proper design
 - Design the system to meet Q (House load)
 - Heating and Cooling loads -> Manual J
 - Geographic location of the site
 - Selection of Earth Loop configuration depending on space, performance and installation cost
 - Otherwise: performance issues
 - True for all geothermal systems

"Loops in DX are too short"





"Complicated and expensive to install"

→ Alternatives: "DX is harder to install than water-source"

✤ <u>Simple</u>

- NO anti-freezing agents, system flushing, circulating pump, water well drilling or plumbing
- Earth loops are pre-engineered and factory-assembled
- Less maintenance
 - No need to top off water and glycol levels
- ✤ Compact
 - Smaller footprint (see Myth #5)
 - Reduced installation cost (drilling and excavating)
 - Smaller borehole diameters
 - Smaller drill rigs
 - No deeper than 100'
- ✤ Efficient
 - One-step heat exchange process
 - More efficient
 - Lower installation cost
 - Quicker to install

→ Alternatives: "Bad oil return could cause a compressor failure"; "Oil returns are an issue"

- R-410A and POE oil: perfectly soluble
- Patented oil return mechanism: boils the refrigerant out of the ACC
- ✤ No compressor failure since 2010
- Proper sizing
 - Adequate refrigerant velocity



"These systems overwork compressors"

→ Alternatives: "Without the circulator pump the workload of the compressor is increased"

✤ <u>Run time</u>

- Our compressors do not run any longer
- Operated within recommended operating conditions
 - Proper designing
- Many differences between water-based and refrigerant-based
- Compression ratio
 - Apples to apples comparison
 - CASE STUDY
 - Compression ratio = $\frac{\text{absolute discharge pressure (psia)}}{\text{absolute suction pressure (psia)}}$



"It's not a proven technology"

→ Alternatives: "Most DX manufacturers don't hold their product line long"

Direct Geoexchange

- Oldest type of geothermal heat pump technology
- Robert C. Webber (1940s)

EarthLinked Technologies

- Established in 1980 by Robert Cochran, PE
- Older than most water-source companies
- Thousands of units sold worldwide
 - > 100,000,000 hours of service
 - 18 countries and 48 US states
- Reputable and excellent track-record
- Tested by the EPA: 75% energy savings
- ✤ <u>Time-tested</u>
 - Our oldest systems (1980s) still performing as designed today
 - Technology: mature and innovative

"It's only a small part of the market"

- → Alternatives: "Direct Exchange geothermal is a fraction of the geothermal market"
- ✤ HVAC market
 - Geothermal heat pumps as a whole are only ≈2% of the HVAC industry
- Geothermal market
 - Growing quickly
 - Will triple by 2020
 - ➤ Predicted Compound Annual Growth Rate ≈14% (between 2015 and 2020)
- Current market barriers: why EarthLinked has key advantages
 - US Department of Energy
 - Technological challenges
 - Loops are complex and expensive
 - Installation-specific design and engineering of the ground loop
 - Market challenges
 - Initial upfront cost and Payback
 - Space constraints
 - Outdated Regulatory Policies
 - Low market awareness

