DIRECT EXCHANGE: WHAT IS IT? WHAT IS ITS RELATIONSHIP TO GROUND WATER?

WATER/ENERGY SUSTAINABILITY SYMPOSIUM AT THE GWPC ANNUAL FORUM 2009

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Geothermal Heat Pump Consortium
DIRECT EXCHANGE (DX)

- CONCEPT
- DISTINGUISHING FEATURES
- GROUND WATER IMPLICATIONS
DIRECT EXCHANGE

A GEOTHERMAL HEATING AND COOLING SYSTEM THAT UTILIZES “DIRECT EXCHANGE” OF HEAT WITH THE EARTH, BY CIRCULATING REFRIGERANT THROUGH BURIED COPPER PIPING

“DX”
DIRECT EXCHANGE

COMPONENTS:
- HEAT PUMP
- EARTH LOOP
- DISTRIBUTION SYSTEM
HEAT PUMP
Diagram of earth taps connecting to the compressor unit
EARTH LOOP TYPES

- Vertical
- Diagonal
- Horizontal
DISTRIBUTION SYSTEM

- DUCTWORK (FORCED AIR)
- IN-FLOOR PIPING (HYDRONIC)
  - (NOT RADIATORS OR BASEBOARD)
GHP TERMINOLOGY

HEAT PUMP

• MOVES HEAT FROM COLD TO HOT
HEAT FLOW

HOT

NATURAL

COLD

HOT

HEAT PUMP

COLD
REFRIGERANT

GAS

ABSORB
HEAT

LIQUID

GAS

GIVE
OFF
HEAT

LIQUID
DX REFRIGERANT CYCLE

HEAT PUMP SCHEMATIC

- Reversing Valve
- Outlet
- Compressor
- Vapor Line
- ECR Active Charge Control (ACC)
- ECR Liquid Flow Control (LFC)
- Blower
- Air Handler
- To Manifold
- Heating Mode

GEOEXCHANGE®
DX REFRIGERANT CYCLE

HEAT PUMP SCHEMATIC

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- Outlet
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- Vapor Line
- ECR Active Charge Control (ACC)
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- Air Handler
- Liquid Line
- ECR Liquid Flow Control (LFC)
- To Manifold

Cooling Mode
DX DISTINGUISHING FEATURES

• Conventional Heat Pump
  – Air Source (conventional A/C or refrigerator)
  – Water Source (boiler/cooling tower)

• Ground Source Heat Pump (earth or water)

• Geothermal Heat Pump
  – Water Source (except not boiler/cooling tower)
  – Direct Exchange

• GeoExchange®
DX REFRIGERANT CYCLE

HEAT PUMP SCHEMATIC

- Reversing Valve
- Compressor
- Vapor Line
- ECR Active Charge Control (ACC)
- ECR Liquid Flow Control (LFC)
- Cooling Mode
- To Manifold
- Outlet
- Blower
- Air Handler
- Liquid Line
WATER-SOURCE HP
WATER-SOURCE
Boiler/Cooling Tower
GHP TERMINOLOGY

- **Heat Pump**
- **Conventional Heat Pump**
  - Air Source (conventional A/C or refrigerator)
  - Water Source (boiler/cooling tower)
- **Ground Source Heat Pump** *(earth or water)*
- **Geothermal Heat Pump**
  - Water Source (except not boiler/cooling tower)
  - Direct Exchange
- **GeoExchange®**
WATER-SOURCE HP
DX GEOTHERMAL HEAT PUMP
Diagram of earth taps connecting to the compressor unit
DX DRILL RIG
DX REFRIGERANT MANAGEMENT

DX REFRIGERANT UNDERGOES A PHASE CHANGE UNDERGROUND, NECESSITATING CONTROL OF FLOW OF LIQUID REFRIGERANT, LIQUID REFRIGERANT AND COMPRESSOR OIL.
WATER SOURCE (Gx)
Gx DRILL RIG
<table>
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<th>GHP Features</th>
<th>DX</th>
<th>Water Source</th>
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<td>Heat Transfer</td>
<td>Refrigerant to Earth</td>
<td>Refrigerant to Water to Earth</td>
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<td>Earth Connection</td>
<td>3” Borehole 100’ Deep or Trench</td>
<td>4”to 6” Borehole 400’ Deep or Trench</td>
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<td>Piping</td>
<td>Soldered copper tubing</td>
<td>Heat-fused PE pipe</td>
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<td>Electrical</td>
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<td>Application</td>
<td>Residential and Small Commercial</td>
<td>Residential to Industrial</td>
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TERMINOLOGY

• **HEAT PUMP**
  – Moves heat from cold to hot

• **GEOTHERMAL HEAT PUMP**
  – Exchanges Heat with Earth instead of Air

• **DIRECT EXCHANGE (DX) GHP**
  – Direct Refrigerant-to-Earth Heat Transfer
GROUND WATER IMPLICATIONS

• Ground Water Regulation
  – Aquifer Protection (Shallower Boreholes)
  – No Anti-freeze in DX Systems, but Compressor Oil
  – Copper Pipe Cathodic Projection Systems

• Refrigerants (R-407C, R-22, R410a, etc.)

• Licensing
  – Ground Loop Design
  – Drilling

• Labor Pool not as likely to be Water Well Drillers
GHP MARKET

![Graph showing the growth of GHP market from 2002 to 2007. The x-axis represents the years 2002 to 2007, and the y-axis represents rated capacity in tons. The graph indicates a steady increase in capacity over the years.]
GHP SYSTEM EFFICIENCY

Yields:
5 units of energy for the building

4 units of energy from the earth

1 unit of energy from the grid

500 % End-Use Efficiency (167% Source Energy Efficiency)
GHPs use the only renewable energy resource that is available at every building’s point of use, on-demand, that cannot be depleted (assuming proper design), and is potentially affordable in all 50 states.
GHP EFFICIENCY

U.S. DOE:

The biggest benefit of GHPs is that they use 25%–50% less electricity than conventional heating or cooling systems.
GHP EFFICIENCY

U.S. EPA:
Geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air-source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment.
GHPs have the potential to offset about 35 to 40 percent of the projected growth in building energy consumption between now and 2030.
WATER-SOURCE
Boiler/Cooling Tower
WATER SOURCE (Gx)
THANK YOU

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