

Chapter 13

HVAC Applications for PE Pipe

Introduction

The performance and use characteristics of polyethylene pipe make it an ideal choice for use in certain HVAC – Heating, Ventilation, and Air Conditioning – applications. Typically, HVAC is thought of as flexible vent pipes, steam pipes, etc. However, since the 1980's polyethylene pipe's flexibility, strength, and ease of use has had a major impact on HVAC applications such as geothermal heat pumps and radiant heating systems.

This chapter presents information and general design criteria for the use of polyethylene pipe in applications such as:

Ground Source Heat Pumps – basic use and standards, configuration, joining methods and installation considerations.

Solar Applications – use of PE pipe for solar water heating applications.

Vacuum Systems – use and design limitations.

Ground Source Heat Pump Systems

Due to polyethylene pipe's versatility, flexibility, durability, leakproof fusion joints, and ease of use, it has become a key component in the success of Ground Source Heat Pumps systems.

There are two basic types of heat pumps – air source and ground source. An air source system utilizes temperature variations in the air to gain operating efficiency. A ground source, or Geothermal Heat Pump (GHP) system uses an electric pump to circulate fluid from the heat pump cycle through a series of polyethylene pipes buried in the ground to take advantage of the relatively constant ground temperatures. These pipes are known as Ground Heat Exchangers. In simple terms, in the summer the heat pump's refrigerant cycle transfers heat from the building into the circulating fluid. The fluid is then circulated through the ground heat exchanger where the ground acts as a heat sink, cooling the fluid before it returns to the building. In the winter, the system works in reverse. The heat pump uses the earth to warm the circulating fluid, which is then transferred back to the inside heat

exchanger. In addition to heating and cooling the air, a desuperheater can be added to this cycle that can provide most, if not all, hot water for use in the building as well.

The properties that control this process are based on the ability of the PE pipe to transfer heat either out of, or into, the system. The heat transfer by conduction mechanism that governs this system is the same as any heat exchanger. It is assumed that the ground is at a steady state condition. This type of heat transfer mechanism is governed by the basic equation:

$$q = (k A / x) (T_1 - T_2)$$

WHERE

q = Heat loss, BTU/hr

k = Thermal conductivity, BTU/in/ft²/hr/°F

A = Heat transfer area, ft²

x = Wall thickness, inches

T_1 = Outside temperature, °F

T_2 = Inside pipe temperature, °F

Note: The above equation only addresses the question of heat transfer through the PE pipe. Depending on the application (ground source heat exchange systems, snow melting, radiant heating, etc.) there are other factors that may have a significant influence on the accuracy of the heat transfer calculation including the thermal conductivity of the surrounding embedment material, the inside and outside film coefficients of the pipe and perhaps others. Therefore it is recommended that such calculations should be referred to engineers who are expert in this field.

Polyethylene itself is typically considered an insulator and holds heat rather well. However, in this application, the benefits of the polyethylene pipe far outweigh this performance characteristic. There are many other variables that need consideration when designing a GHP system. Most manufacturers have software available to aid in the determination of the size of the unit and the footage of pipe needed for the geothermal heat exchanger.

Geothermal heat pumps are very economical to operate and can save a substantial amount of money in operating costs over the life of the system. It has been reported⁽¹⁾ that a traditional furnace uses one unit of energy but returns less than one unit back as heat. A ground source heat pump uses one unit of energy but returns as much as three units back as heat. The polyethylene pipe acting as the heat transfer medium in the ground helps make this possible.

Types of Ground Heat Exchangers

There are two basic types of heat exchangers: open and closed loop systems. Both can be configured several different ways depending on the size of the system, surrounding land, or availability of a large open water source.

Open systems require a suitable supply of water where open discharge is possible.

This type of system uses the HDPE pipe to bring fresh water to the heat pump, and

then discharges the water back into the water supply. Only fresh water is used, and there is no need for a special heat transfer or antifreeze solution. A key PE pipe design consideration for an open system is the fact that the system will have a suction and discharge loop. This means the pipe may need to be designed to handle negative vacuum pressures and positive pumping pressures.

The more common type of GHP installation is a closed loop system. A closed system is just that — a “closed loop” recirculating system where the HDPE pipe circulates an “antifreeze” solution continuously. This type of system can be installed several different ways such as: a pond loop system, a vertical loop system, or a horizontal (slinky) loop system. Each of these types of installation utilizes the basic performance benefits and versatility of HDPE pipe to get the most beneficial type installation for the surrounding conditions.

