THE GROUND SOURCE HEAT PUMP COMPONENT LIBRARY (GENERAL DESCRIPTIONS)

Type501: GROUND TEMPERATURE PROFILE

This subroutine models the vertical temperature distribution of the ground given the mean ground surface temperature for the year, the amplitude of the ground surface temperature for the year, the time difference between the beginning of the calendar year and the occurrence of the minimum surface temperature, and the thermal diffusivity of the soil. These values may be found in a variety of sources including the ASHRAE Handbooks (refer to soil temperature).

Type504: WATER SOURCE HEAT PUMP

This component models a single-stage liquid source heat pump with an optional desuperheater for hot water heating. The heat pump conditions a moist air stream by rejecting energy to (cooling mode) or absorbing energy from (heating mode) a liquid stream. This heat pump model was intended for a residential ground source heat pump application, but may be used in any liquid source application.

The heat pump has a desuperheater attached to a secondary fluid stream. In cooling mode, the desuperheater relieves the liquid stream of some of the burden of rejecting energy. However, in heating mode, the desuperheater requires the liquid stream to absorb more energy than is just required for space
heating.

This model is based on user-supplied data files containing catalog data for the capacity (both total and sensible in cooling mode), and power, based on the entering water temperature to the heat pump, the entering water flow rate and the air flow rate. Other curve fits are used to modify the capacities and power based on off-design indoor air temperatures. Type504 takes either air relative humidity or absolute humidity ratio as an input. It is identical to Type505 in the TESS HVAC Equipment Library. Formerly, Type504 took air humidity ratio as an input while Type505 took air relative humidity.

Type556: DETAILED BURIED PIPE

This model is based on work done by John Giardina at the Solar Energy Lab at the University of Wisconsin. This subroutine models a horizontal ground coupled heat exchanger or, more simply, a horizontal pipe buried in the earth. The model is based on an earlier work by V.C. Mei of Oak Ridge National Laboratory.

This model accounts for ground seasonal temperature variations and backfilling of the trench containing the pipe. The fluid convection, the pipe wall, and the backfilled material are all represented as a net resistance. The inner soil nodes, those in contact with the backfill are also modeled without capacitance. The rest of the nodes within the soil are modeled as capacitors connected by resistors in both the radial and circumferential directions.

Type557: VERTICAL U TUBE OR TUBE IN TUBE GROUND HEAT EXCHANGER

This subroutine models a vertical ground heat exchanger that interacts thermally with the ground. This ground heat exchanger model is most commonly used in ground source heat pump applications. This subroutine models identical vertical U-tube ground heat exchangers or identical vertical tube in tube heat exchangers. A heat carrier fluid is circulated through the ground heat exchangers and either rejects heat to, or absorbs heat from the ground depending on the temperatures of the heat carrier fluid and the ground.

In typical U-tube or tube in tube ground heat exchanger applications, a vertical borehole is drilled into the ground. A u-tube or tube in tube heat exchanger is then pushed into the borehole. The top of the ground heat exchanger is typically several feet below the surface of the ground. Finally, the borehole is filled with a fill material; either virgin soil or a grout of some type.

The model assumes that the boreholes are placed uniformly within a cylindrical storage volume of ground. There is convective heat transfer within the pipes and conductive heat transfer to the storage volume. The temperature of the surrounding ground is calculated from three parts; a global temperature, a local solution, and a steady-flux solution. The global and local problems are solved with the use of an explicit finite-difference method. The steady-flux solution is obtained analytically. The resulting temperature is then calculated using superposition methods.

This subroutine was written by the Department of Mathematical Physics at the University of Lund, Sweden, and is considered to be the state-of-the-art in dynamic simulation of ground heat exchangers. Further information about this model

may be found in: Hellstrom, Goran, “Duct Ground Heat Storage Model, Manual for Computer Code,” Department of Mathematical Physics, University of Lund, Sweden.