Late Season Injection

A substantial amount of extra heat can be injected during the course of the heating season. When the air temperature is higher than the heat exchange fluid temperature then the heat injection box can be started up and the heat from the air will be fed directly to the heat pump providing the connections to the central boreholes have been opened (i.e., after about January 1).

If the air is warm then the heat pump will not need the extra heat at that time but the fluid will cycle through the six boreholes and will be stored in the ground for use on subsequent cold days. Since this extra heat will be stored close to the tubes it will provide a boost to the power handling capacity as well as adding more heat.

The winter heat absorption capacity is particularly high because at that time the ground will be cold, heat is concurrently being extracted, and because it is being injected into six boreholes, not just two. The result is that the temperature difference between the fluid remains stable and does not diminish with time as it does during summer injection. Even when the air temperature is only 10 degrees the rate of energy absorption from the air will typically be higher than the heat absorption rate on a warm summer day.

The amount of heat that can be recovered from the air in this early part of the year is comparable to the amount that can be injected during the summer so the overall storage capacity is considerable increased and the ground storage capacity is used twice without needing any additional facilities. However the total storage capacity is not doubled because the spring injection will serve primarily to replace the heat extracted from the center in preparation for the following year.

Subsequent events When the heating season is finished there will still be a "doughnut" of warm ground surrounding the center because most of the heat is utilized during a brief two month period. The velocity of the heat flow in the ground limits the potential for using all of the stored heat. Over the summer that heat will spread into the cold outer and central zones, thus providing the principle mechanism for achieving a net zero annual balance for heat injection vs. heat extraction. This balance can be set to zero or (more commonly) provides for a net absorption of heat from the surrounding ground by selecting a suitable borehole spacing and via the timing and amount of heat injection.

Air-source heat pumps Air-source heat pumps are commonly used in Ontario as a means of supplementing other heating systems, such as heating with natural gas. However, AE systems inherently provide a means of storing the heat that can be collected on the warmer winter days so the overall efficiency is much better.

Heating in the fall Ordinary air-source heat pumps are normally used in both the fall and the spring, whenever the air is warm enough to operate the heat pumps. However, in the fall the central ground volume is warm and the outer zones are not much below the ambient ground temperature so there is less opportunity to store any heat that is collected. Without the storage capability there is not much point in collecting that air-source heat, especially as it would require rerouting of the fluid flow.

Four different heat sources An AE system uses four different sources of heat in sequence:

(1) At the beginning of the heating season heat is extracted from the ground, just as in a conventional ground source heat pump. This source of heat will reach an equilibrium point when source (2) takes over, but heat will continue to flow into the outer zones from the surrounding ground.
(2) Next, the heat flowing out from the warm central zone will become the primary source of heat because it penetrates into the outer thermal wells. This source will also continue to supply heat through the balance of the heating season.
(3) When the connection to the central boreholes is opened there will be a flood of additional heat that is shared with the four outer holes, and that uses those outer holes for short term storage. This greatly increases the energy supply, the capacity to operate at a high power level, and the ground heat exchange rate (because there are two more sets of tubes) to provide the greatest energy supply during the period when it is most needed. This source will also continue to be available through the balance of the winter because it takes time to extract heat from the central pool.
(4) Finally, after the coldest part of the winter has passed the primary heat source will progressively become the heat that is extracted from the air and temporarily stored in all six boreholes. Most of that heat will effectively be stored for use in the following winter.

Late season injection increases both the total AE storage capacity and the late winter power capacity, and it ensures that the system will not run out of heat in the event of a long winter. It also starts the recovery process for the following winter.