To: Deuterium Array Group

From: Alan E.E. Rogers

Subject: Proposed use of geothermal heat exchange for receiver box temperature stabilization

The soil temperature a few feet below the surface is a relatively constant 50º F (10º C) in the local area. The large thermal mass and relatively low thermal conductivity of the soil results in very little annual variation in temperature just a few feet down.

I propose to test the use of geothermal heat exchange with the soil to cool the receiver box to a relatively constant temperature. The simplest method is to use a fan to circulate air through the receiver box and then through a section of thin walled PVC pipe buried a few feet below the surface and connected to the receiver box via flexible hoses, as shown in figure 1.

a) Air circulation rate required

The receiver box dissipates about 400 W so that given the specific heat of air 1 kJ/kgm/K) and density (1.25 kg/m³) it will take a flow rate of 67 cu.ft/min to maintain 10º C temperature differential.

b) Surface area of pipe required

With a flow rate of 67 cu.ft/min the velocity of air in a 4” diameter pipe is 3 ft/sec. With this flow rate a surface area of about 1 m² is needed to transfer the heat to the pipe with less than 10º C temperature rise.

c) Length of pipe required

If we assume heat conduction from a buried pipe is radially normal to the pipe the heat loss is

$$2\pi k L \Delta T / \ln \left( \frac{r_2}{r_1} \right)$$

where

- $k$ = soil conductivity = 1 w/m/K
- $L$ = length of pipe m
- $\Delta T$ = temperature difference between the pipe radius $r_1$ and the radius at which the flow becomes radial.
The \( \ln(r_2/r_1) \) function changes slowly so that the assumed values of \( r_1 \) and \( r_2 \) are not critical. Assuming \( r_1 = 2'' \) and \( r_2 = 200'' \) the heat loss is about 1.4 w/m/K so that a pipe length of about 100 feet to transfer 400 w with under 10° C temperature rise. [The recommended pipe length for homes which use geothermal heat exchange is about 100 feet per kilowatt.] The requirement for 100 feet more than satisfies the surface area requirement even if 1” diameter pipe is used.

![Diagram of earthpipes and receiver box with circulation fan](image-url)