$$\frac{dq_o}{dp_{av}} = -1074\,(0.0201v + 0.055)\,A_r \qquad (22)$$

When selecting the heat exchanger, it will be necessary to allow for the thermal properties of the antifreeze solution. The manufacturer should be given data on the type and concentration of antifreeze, the temperature range of operation, the source of heat (steam, hot water, etc.), and the flow rate through the exchanger.

Hydraulic Requirements

After determining the heating requirements, it is necessary to determine the hydraulic requirements of the system. This can be done by means of the procedures explained in Chapter 4, Fluid Flow, but it is necessary to use the proper physical properties of the antifreeze solution. A complete discussion of the hydraulic problem is given in Reference 16.

The main consideration is the proper allowance for viscosity. Table 7 gives viscosities for typical fluids used as antifreezes for snow melting systems. Viscosities are given in ft squared per second. Table 8 can be used

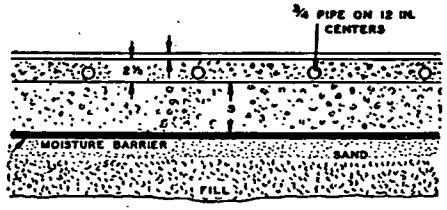


FIG. 19. DETAIL OF SNOW MELTING PANEL

F = Depth of Finish Coat—Assumed as ½ in. of concrete. Finish Coat may be asphalt but then cover slab should be reduced from 3 in. Depth of slab should always keep thermal resistance equall to 3 in. of concrete.

S = Depth required by structural design.

in conversion of viscosity units. A large increase in viscosity will be noted for glycols and oils—about 20 times—as the fluid temperature changes from 160 F to 0 F. This viscosity change has two effects. First, an increase in viscosity will increase the fluid friction in the piping circuit. Second, an increase in viscosity will decrease the pump capacity—in both volume and head. The effect of viscosity on fluid friction in the piping circuit is illustrated in Fig. 20.

For large installations, the friction losses can be calculated by the Fanning equation

$$h_f = \frac{flV^2}{2gD} \qquad (23)$$

where

h_f = the loss in head of the fluid under conditions of flow, in feet.
l = the length of the pipe, in feet.
V = the velocity, in feet per second.
g = the acceleration due to gravity = 32.174 ft per (second) (second).

D = the internal diameter of the pipe in feet.
f = a dimensionless friction coefficient which can be determined from Fig. 4, Chapter 4. The Reynolds number can be computed from data in Table 7.

Solutions for the pipe friction should be plotted for temperatures at the starting condition (probably 0 F) and at the operating condition (use either 120 or 160 F). Then on the same graph, the operating curve of the pump should be plotted (see Reference 16 for such a graph). The intersection of the fluid friction curve and pump operating curve will give the operating point for the system. Table 9 can be used to allow for the viscosity effect on the pump.

The designer must decide on the tolerable viscosity limit. Generally it

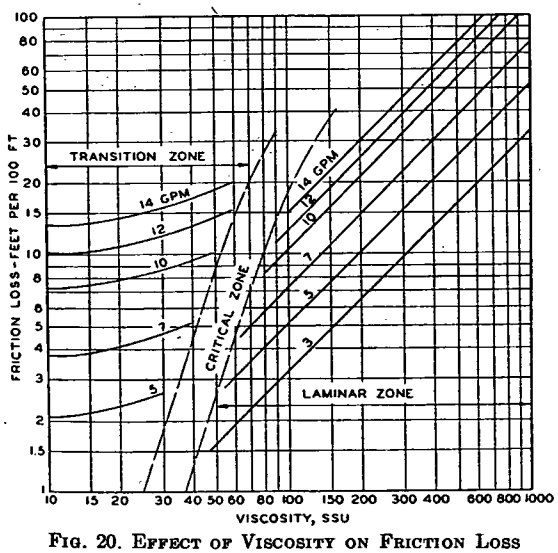


FIG. 20. EFFECT OF VISCOSITY ON FRICTION LOSS
(For 1-in. Pipe)

is between 300 and 500 SSU, although for commercial or private systems (where R_A is 0.5 or 0) it may go to 750 SSU.

Efficiency loss is not important, but head and capacity losses are. Reduced flow means a longer period of time for the system to become operative from a cold start.

The viscosity limit is controlled by means of a low-limit thermostat. For example, if it is desired to hold the viscosity of the solution to less than 200 SSU (43.1 ft sq per sec), then for the oil shown in Table 7, the low limit control would be set at 0 F.

For small installations, a quick method of determining the fluid friction for a one-inch IPS pipe circuit is given in Fig. 20.

The pump capacity, in pounds of fluid per hour is given by the equation: