

q_t = total heat requirement (slab output, q_o , plus back and edge losses) Btu. per (hour) (square foot).

c_m = specific heat at temperature t_m , Btu per (pound) (Fahrenheit degree).

Δt = temperature drop through circuit, Fahrenheit degrees.

For a temperature drop of $\Delta t = 20$ F, Equation 15 becomes

$$G = \frac{A_p q_t}{160 w_m c_m} \quad (16)$$

where

G = gallons per minute.

w_m = mean specific weight at temperature t_m , pounds per cubic foot.

INSTALLATION

There are certain precautions that must be taken during installation. They concern internal corrosion, flammability, toxicity, cleaning, joints,

TABLE 6. VISCOSITY EFFECT ON CENTRIFUGAL PUMP CHARACTERISTICS

KINEMATIC VISCOSITY SSU*	CORRECTION FACTORS		
	Pump Head	Pump Capacity	Pump Efficiency
0 to 30	1.00	1.00	1.00
50	1.00	1.00	0.94
100	0.98	1.00	0.88
200	0.96	0.98	0.79
300	0.95	0.97	0.73
400	0.93	0.96	0.68
500	0.92	0.96	0.65
600	0.91	0.95	0.62
700	0.90	0.94	0.59
800	0.89	0.94	0.57
900	0.88	0.93	0.55
1000	0.87	0.92	0.53

* SSU = Universal Saybolt second.

and hookup. A comprehensive discussion of these precautions may be found in Reference 9.

Safety

Since ethylene glycol and petroleum distillates are slightly toxic, the system should be installed and maintained independently. There should be no permanent connection between the snow melting system and the drinking water supply.

Ethylene glycol is not considered flammable. In fact, aqueous solutions of less than 60 percent glycol are used for fire sprinkler systems. These solutions do not freeze, and they are effective fire extinguishing agents.

Petroleum distillates suitable for fluids in snow melting systems are classified as non-flammable, but have fire points between 300 and 350 F. When using fluids of this type, care should be taken to collect any oil dripping from the seals on the pump. It is good practice also to provide some barrier between the oil lines and the boiler so that in the event of a leak, a flash back from the boiler will not ignite the oil.

There are other non-flammable fluids, such as those used in some transformers, that can be used as the antifreeze. These fluids are three or four times as expensive as the glycols or oils, but combine the fire protection of the glycols with the corrosion protection of the oils.

Internal Corrosion

Ethylene glycol solutions tend to become corrosive in service; therefore, rust inhibitors are generally included. Even with an inhibitor, the solution should be tested annually to determine any change in acidity. If the test indicates that the inhibitor has been exhausted, the entire system should be drained and a fresh solution installed.

To increase the life of the inhibitor, the heat exchanger surfaces should be kept below 285 F which corresponds to about 40 psig steam. Temperatures above 300 F accelerate the deterioration of the inhibitors.

Slab Construction

It has been found satisfactory to use $\frac{3}{4}$ pipe or tubing on 12-in. centers as a standard coil. If pumping loads require a reduction in friction the pipe size may be increased to 1-in., but the slab depth must be increased accordingly.

The piping should be supported in such a manner that there is a minimum of 2 in. of concrete above and below the pipe. This requires a 5-in. slab for $\frac{3}{4}$ -in. pipe and 5 $\frac{3}{8}$ -in. for 1-in. pipe.

If an insulating material is used, it is generally good practice to provide a moisture barrier between the insulation and the fill. A roofing material (such as a 55 lb. felt) is often used as a moisture barrier. The joints should be mopped, and the fill made smooth enough so that there will be no holes or gaps for moisture transfer. Also, the edges of the barrier should be flashed to the surface of the slab so that the ends are sealed. See Fig. 16.

If the pipe must pass through an expansion joint, a protective coating should be applied to the pipe for a foot or two on both sides of the joint.

If the pipe is kept dry at all times in both summer and winter, no external corrosion problems will occur.

Thermal Stresses

This problem is discussed in Reference 11. In general, there will be no ill effects from the thermal stresses if these rules of installation and operation are followed:

1. Keep the temperature difference between the fluid and the slab surface to a minimum by:
 - a. Close pipe spacing (see Fig. 16).
 - b. Low temperature drop in fluid, $\Delta t \leq 20$ F deg.
 - c. Continuous operation (if economically feasible).
2. Keep pipe near surface—about 2 in. cover.
3. Use reinforcing steel designed for thermal stress if high structural loads are expected (such as on highways).

Testing

After installation and before pouring concrete, all piping should be tested to about 100 psi. This pressure should be maintained until all welds and connections have been checked for leaks. If an oil is used as an anti-freeze, the test should be performed with air or some gas (only 50 psi required with an air test) but *not with water*. The danger of using water is that the pipe may not be thoroughly dried when the oil is introduced.