

or deteriorate, the age allowance on the pipe will probably be a sufficient allowance for the anti-freeze. If there is no age allowance, but the table is for 60 F water, then the following allowances for heated anti-freeze solutions will be adequate:

1. For fluid temperatures less than 100 F, add 15 percent.
2. For fluid temperatures between 100 and 130 F, add 10 percent.
3. For fluid temperatures above 130 F, no allowance.

If friction data for higher temperature water are used as a basis, the allowances needed will be much greater.

If the system is operated intermittently, fluid temperatures may drop to the freezing protection point. At that temperature, the fluid may be

TABLE 5. PHYSICAL PROPERTIES OF ANTI-FREEZE SOLUTIONS

SOLUTION	FREEZING PROTECTION TEMP., F	% BY VOLUME	ITEM	FLUID TEMPERATURE, F			
				80	120	160	200
Ethylene Glycol ^a	0	31.4	$\mu \times 10^4$	1.92	1.14	0.77	0.56
			c	0.839	0.854	0.874	0.899
			w	65.1	64.4	63.6	62.7
	-20	42.7	$\mu \times 10^4$	2.55	1.46	0.95	0.68
			c	0.813	0.832	0.856	0.883
			w	66.0	65.3	64.4	63.4
Light Oil ^b	-40	51.2	$\mu \times 10^4$	3.16	1.77	1.14	0.80
			c	0.788	0.809	0.835	0.866
			w	66.8	65.9	65.0	64.0
	-40	100	$\mu \times 10^4$	5.60	3.13	2.06	1.50
			c	0.426	0.444	0.462	0.479
			w	60.7	59.8	59.0	58.1

^a Interpolated from Reference 9. ^b From Socony-Vacuum Oil Co.

μ = kinematic viscosity, (feet squared per second) (e.g. for oil at 80 F, $\mu = 0.000056$ ft² per sec.)

c = specific heat, Btu per (pound) (Fahrenheit degree)

w = specific weight, pounds per cubic foot

so viscous as to prevent the pump from discharging. If such conditions are expected the pump manufacturer should be consulted for advice in selecting the pump.

Another allowance must be made in sizing the pump for anti-freeze; the volume of fluid to be pumped must be increased because of its low specific heat. Table 5 lists typical specific heat values, but here again, on large jobs the manufacturer should be consulted for accurate data on his product.

INSTALLATION

There are certain precautions that must be taken during installation. They concern internal corrosion, flammability, toxicity, cleaning, joints, and hookup. A comprehensive discussion of these precautions may be found in Reference 8.

Safety

Since ethylene glycol is 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 a flash point between 260 and 280 F. When using fluids of this type, care should be taken to collect any oil dripping from the packing seal on the pump.

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.

Draining

Proper drainage is necessary for both the slab surface and the coil.

The slab must be sloped so that the water from the melted snow can run off. Puddles are objectionable on sidewalks or drives. They cause splashing, and they retard heat flow from the embedded pipes.

The pipes must be placed so that they may be drained. If the anti-freeze becomes corrosive it must be drained. It is not good practice to rely entirely on blowing of air through the system.

Drifting Snow

It is quite likely that some drifting will occur on every system that is adjacent to a wall or vertical surface. The designer should try to anticipate this condition and add extra piping in these areas. If possible, coils should be added in the vertical surface. Another expedient is to carry