AN EFFECTIVE ANTIFREEZE FOR STORAGE RAINGAUGES

M. J. McSaveney*

ABSTRACT

Commercial antifreeze (ethylene glycol) will not protect a storage raingauge from freezing: it is too dense (1.109 kg/l) and does not mix with rainwater without stirring. The right density for an effective raingauge antifreeze is about 0.995 kg/l, so that the undiluted antifreeze floats between the evaporation-inhibiting oil layer and the water-antifreeze mixture. Such an antifreeze is self-stirring during rain. An antifreeze of this density can be made by mixing almost equal quantities (1:1.12) of commercial antifreeze and methylated spirits. A slight excess of the latter lighter alcohol (0.790 kg/l) is needed, and the correct density is best achieved if a hydrometer is used to test the mixture. The amount of mixture needed for adequate protection must be determined by experience. It varies between gauge types and capacities, with rainfall and winter temperature, and even with the frequency of reading.

THE PROBLEM

In New Zealand, a widely accepted procedure intended to keep storage raingauges from freezing, is to add undiluted commercial antifreeze (ethylene glycol). The procedure does not work, because this antifreeze is too dense (1.109 kg/l): it lies at the bottom of the raingauge without mixing with rainwater or snow, even though water and glycol are fully miscible in any proportion. During rain, water is added too slowly and gently to mix with the dense layer of antifreeze, or even with any layer of mixed antifreeze and water formed by previous stirring. The layer of water that floats on top can freeze.

Although few storage gauges are destroyed by such surface freezing, frozen gauges or gauges with low density snow over ice cannot be read, unless the gauge can be weighed accurately. An even greater problem in our experience, is that a frozen gauge cannot be emptied, and the loss of continuity of record when a gauge overflows is a very high price to pay.

THE SOLUTION

The problem is simple to correct. Commercial antifreeze can be made less dense by mixing it with methylated spirits (ethanol plus methanol), density 0.790 kg/l, or with pure methanol (0.791 kg/l). These lighter alcohols are also antifreezes, but so light that they float on most antievaporant raingauge oils. A satisfactory density is about 0.995 kg/l. A mixture of this density floats between the oil and any rainwater-antifreeze mixture. Raindrops, after falling

*Water and Soil Division, M.W.D., P.O. Box 1479, Christchurch, New Zealand.

through the oil, slowly sink through a layer of pure antifreeze mix. This gives enough time for some mixing to occur before the rain water-antifreeze solution settles as a layer at the bottom of the raingauge.

In theory, should this water-antifreeze solution begin to freeze, tiny ice needles of density 0.90 kg/l form and float through the pure anti-freeze layer, where they are dissolved. In practice, the mixture has not been used at a low enough temperature for this to happen while pure antifreeze is present. Freezing has occurred only where excess rain has fallen to dilute the antifreeze to an ineffective level.

THE RECIPE

A mixture of approximately the right density (0.995 kg/l) can be made by thoroughly mixing almost equal quantities of commercial antifreeze and methylated spirits (with slightly more methylated spirits, the ratio is about 1:1.12). As both components may be contaminated with water, the best method of producing the desired density is to measure it with a suitable hydrometer. Where scientific hydrometers are unavailable, a vintner's hydrometer has a suitable range, but a battery tester does not.

VARIATIONS

At present in New Zealand a more economical antifreeze is made by mixing glycol with methylated spirits. In practice, any mixture of alcohols with a density of approximately 0.995 kg/l can be used. Wood alcohol (methanol) might be a viable low-density option. Glycerol (glycerine) could also substitute for ethylene glycol in the mix. It would be preferable to use a single higher alcohol of the appropriate density should one exist, as this would lessen the inevitable evaporation loss. The principal reason for selecting commercial antifreeze and methylated spirits is one of supply. Both are widely available in commercial quantities in New Zealand.

QUANTITY

The amount of this antifreeze to use in a storage raingauge has to be determined by experience. So many variables are involved that there is no satisfactory practical formula. These variables include gauge type, expected rainfall, expected temperatures (minimum, mean and temperature at time of reading), site aspect, the amount of protection sought, and the frequency of reading. Rainfall intensity and the drop size of the droplets able to break the surface tension of the oil layer also may be factors to be considered.

The antifreeze appears able to function effectively until the last of the concentrated antifreeze below the oil is gone. Depending on local conditions and gauge type, this will occur at dilutions of 1:5 to 1:10. When the concentrated antifreeze has gone, the diluted mix can begin to freeze; at low dilutions to an ice-needle mush, but at high dilution, we have had gauges freeze so as to prevent emptying. These dilutions provide a basis for other users to conduct their own experiments to determine quantities for use, appropriate to their particular circumstances.

It should be noted that the concentration of the eventual water mix is determined by both the rate and the distance that water drops fall through the antifreeze: only the distance can be controlled by the user.

EFFECTIVENESS WITH SNOW

In order for an antifreeze to be effective with snow, the weight of snow resting on the oil layer must be sufficient to break the surface tension of oil over antifreeze. In use, no problems have arisen, either because this is easily achieved, or because the snow has melted sometime between snowfall and reading time.

EVAPORATION

Methylated spirits is very volatile and severe evaporation could be expected under some circumstances. The strong smell of *ethanol* from the methylated spirits through even a thick layer of raingauge oil, suggests that some evaporation loss is inevitable, but it has not been found to be significant in use. Over a 60-day test in midsummer sun, a loss of less than 2 mm per month was measured. Losses of this magnitude certainly have not been measurable in winter use in the Southern Alps of New Zealand where monthly rainfall varies between 100 mm and 1900 mm.

In our work in a region of very high rainfall, with over 11,500 mm recorded at one site in 12 months to March 1979, the advantages of being able to empty gauges when they become full, and to make regularly reliable raingauge readings after snow and freezing conditions, far outweigh the disadvantage of some small evaporation loss that is less than 25 mm a year.

COST

The ingredients of this antifreeze are not cheap, and for a large network, or high precipitation area, the quantities used in a winter are appreciable. We use about 200 l of mix in a winter to protect 30 gauges. The diluted mixture has no known use, and although biodegradable it is toxic to alpine and subalpine plants. For these reasons, it should be used sparingly, only where it is essential that a storage raingauge never freezes.

In many cases, a sunny site, or ground heat can be used more cheaply and much more effectively.

Published with the permission of the Commissioner of Works.