How to Choose the Correct Antifreeze Loop Tester

The Wrong Choice Can Have Disastrous Consequences
Michael D. Rainer, *Sprinkler Age*/November 2002

NFPA 13 calls for the use of antifreeze solution in automatic sprinkler systems to protect against the possibility of a system freeze-up or bursting pipes. It is required that these solutions have a freezing point below the expected minimum temperature for the locality in which the system is installed. This article covers the test methods for accurately determining the freezing point and percent concentration of these fluids.

Propylene glycol ("PG"), and glycerin mixed with water are currently most commonly used as antifreeze solutions for fire sprinkler systems. If the sprinkler system is supplied by public water, only glycerin or PG is permitted to be used. Ethylene glycol ("EG"), considered poisonous, can be used if the system is not connected to a potable water source. Systems constructed of CPVC plastic pipe should never be charged with EG or PG antifreeze and should instead be filled only with glycerin. Glycol solutions will chemically attack CPVC pipe joining compound.

The NFPA handbook cautions against over concentrating antifreeze in a system because beyond a certain point the antifreeze no longer lowers the freezing point of the solution. Over concentration will both cost you money and may reverse the protection. Systems that are over-concentrated (above 70% antifreeze) will actually freeze at a warmer temperature. NFPA also points out that charging a system with 100% antifreeze is harmful because the fluid will have tendency to thicken at or near +32°F.

NFPA 25 requires that the freezing point of a sprinkler system antifreeze solution be tested at LEAST once a year. However, periodic testing of systems is critical to maintaining the proper concentration and freezing point of the antifreeze fluid. Leaks, pressure surges, and temperature changes to the sprinkler system can cause antifreeze to flow out of or into the system changing the freezing point.

In addition to determining the freezing point of the solution as required by NFPA 25, it is often desirable to know the percent concentration of the antifreeze solution to determine how muck new antifreeze must be added to a system to establish the correct freeze protection.

Fluid Testing Methods
Substantially all physical properties of an antifreeze solution, including concentration, freezing point, boiling point, specific gravity, refractive index, etc. are all interrelated. If you know one physical property it is possible to correlate to the other physical properties.

There are three main methods available for determining the physical properties of antifreeze in a given sprinkler system. The first method is laboratory testing. Although laboratory testing can give you a plethora of information, it is often very expensive and is of little value if all you want to know is the concentration or freezing point of the fluid.

Having to take a sample from a system and mail it away to a lab takes time and ensures you will have to make a return trip to the customer's site. Even if you are not charged for lab diagnostics, what is the cost to you for not having timely information about the system? Being able to diagnose and treat a system on the spot saves you money and represents a better value for your customers.

How to Choose the Correct Antifreeze Loop Tester

The Wrong Choice Can Have Disastrous Consequences
Michael D. Rainer, *Sprinkler Age*/November 2002

Hydrometers
The second method available for determining fluid properties is hydrometers. Hydrometers measure the specific gravity of a fluid that can then be related to freezing point. There are basically two types of hydrometers, floating ball or "turkeybaster" type and laboratory-grade.

We have seen the little floating ball or "turkey-baster"type hydrometers, some available for as little as $2.99. We strongly recommend against using inexpensive floating ball hydrometers to determine the freeze protection of a fire suppression system. Most of these cheap hydrometers claim to display the freezing point of the test fluid. It is not commonly known, but freezing point data is related to one and only one type of fluid. You therefore would need a different hydrometer for EG, PG, and glycerin. Using the wrong hydrometer with the wrong fluid can have disastrous consequences.

A common example of this error is using an automotive floating ball hydrometer for testing a PG based fluid. The specific gravity of PG varies greatly from EG engine coolant, and any freezing point readings taken will be completely WRONG. Likewise, readings of glycerin will also be wrong. This point is important and simply cannot be over emphasized. Would you ever want to admit in front of a jury that as a professional you relied on a $2.99 tester to diagnose a fire protection system?

This is not to say that all hydrometers are bad. NFPA 13 and NFPA 25 mention using hydrometers for measuring the specific gravity of antifreeze as one potential method for determining the physical properties of these solutions. However, her NFPA refers to the more expensive laboratory type devices, not those available from the Wal-Mart automotive department.

Scientific-grade hydrometers are used in labs around the world. These hydrometers, contrary to the little floating ball devices, are indeed accurate under lab conditions. A lab hydrometer looks like a long glass thermometer with a weight on one end and graduated scale divisions along the side. They are calibrated for certain ranges and you must select one that covers the range of interest. To measure using a hydrometer, you must fill a tall glass/plastic cylinder with antifreeze solution and then float the hydrometer in the solution. A reading is taken at the point the meniscus of the fluid intersects the scale on the hydrometer.

Because substantially all fluids expand when heated and contract when cooled, some physical properties including specific gravity and refractive index are very temperature dependent. For most lab grade hydrometers to work properly, the fluid temperature and the ambient temperature must be equal at precisely 60°F. It is, therefore, important to use a thermometer to measure the room and fluid temperature and only take the reading when the two temperatures are the same. If the reading is taken at any temperature other than 60°F you must apply a temperature correction to the reading.

Bubbles and other contaminants adhering to the sides of the hydrometer can cause errors as well. It should also be considered that these hydrometers are made from glass/plastic are rather fragile, and are often not suitable for field use. Finally, specific gravity readings taken on hydrometers must be converted to usable freezing point or percent concentration values to be used. This requires carrying conversion charts for each different fluid and can be an additional source of error.

How to Choose the Correct Antifreeze Loop Tester

The Wrong Choice Can Have Disastrous Consequences
Michael D. Rainer, *Sprinkler Age*/November 2002

Refractometers
Refractometers offer a cost effective, accurate alternative to hydrometers without they're many limitations. Refractometers provide a more accurate means of determining glycol and glycerin properties instantly, using as little as two drops of a sample of fluid. Refractometers use a series of prisms and magnifying lenses to accurately measure very small changes in the speed that light travels through a liquid. These subtle changes can be directly related to concentration values, freeze point, etc. making them an ideal field test tool for water based solutions.

Refractometers represent the most accurate method available for field-testing sprinkler systems. The proper use of refractometers for testing fire sprinkler systems is described in the Automatic Sprinkler Handbook, published by NFPA.

The view-through glycol & Battery Tester refractometer can accurately determine the freezing point of EG & PG based fluids in a sprinkler system but CANNOT measure glycerin.

These view-through refractometers are easy to use. To measure, simply take one to two drops of solution from the system and place them on the measuring surface. Look through the eyepiece and the reading is instantly and accurately displayed on the internal screen.

Automatically temperature compensated, the view-through can be used in the field at temperatures between 0° F and 104°F. These refractometers are housed in rugged injection molded chemical resistant bodies and are designed for industrial use.

For glycerin measurements, a digital fiberoptic refractometer is recommended. The DFR units measure both glycol and glycerin. The DFR is a probe type of refractometer that operates by submerging the probe into a small sample of fluid and pressing a button on the keypad. The fluids properties are instantly displayed on the LCD display. The DFR is programmed with up to five scales; it displays the freezing point and percent concentration for both PG and glycerin.

It is recommended that the calibration of the refractometer be verified on a periodic basis. This can be accomplished simply by placing a sample of water on the measuring surface and ensuring the freeze temperature +32°F is displayed on the scale.

Conclusion
No matter which test method you use for maintaining sprinkler systems, one key to obtaining successful results is to ensure that the antifreeze is thoroughly mixed to the proper freeze point before adding it to the system. This is especially important in static systems, like automatic sprinkler piping, that do not have a constant flow to mix the fluids in line.

Periodic testing of sprinkler systems is critical to maintain the proper concentration and freezing point of the antifreeze fluid. Do not rely on inexpensive floating ball hydrometers to measure fire sprinkler systems. They are not accurate enough to rely on for safety proposes. Likewise, lab hydrometers have many limitations for field use. A refractometer represents the most accurate and cost-effective means for testing antifreeze in fire sprinkler systems. Be certain that the refractometer model being used provides the correct scale appropriate to the fluid being measured. Always be sure to check the calibration of the refractometer to ensure that it is working properly.