Cold Weather Guide

Satellite® POLYPORTABLES

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COLD WEATHER GUIDE

Thanks for allowing us to be of service to you as you build your portable restroom business.

Satellite | PolyPortables is committed to the portable sanitation industry, which it helped to establish more than 30 years ago, and enjoys a reputation as a provider of durable, no-nonsense equipment. We know that our own success depends solely on your success, and that is why Satellite | PolyPortables is known for a relentless pursuit of the smaller scale but more profit-significant improvements in both manufactured products as well as customer support services such as this informational booklet.

This guide is intended to provide up-to-date information about servicing portable restrooms in cold weather, giving you the tools necessary to make decisions regarding some tough issues.

For further assistance, call your Regional Manager at: 1.800.883.1123 or visit www.satelliteindustries.com

Deicing: How it works

Much has been written about deicing in relation to our nation's roads, sidewalks, driveways, and airport runways in winter, but there is relatively little information regarding the use of deicers for portable restrooms. Even the Salt Institute, which claims all the major U.S. salt producers as members, has nothing on this topic. For just an overview of deicers, the following is a great article written for a university newspaper:

How Stuff Works: Melting ice

With winter approaching, salt bins are being filled in preparation for the inevitable first snowfall. Salt, and other ice-melting chemicals (known as deicers) work by lowering the freezing/melting point of water so that it is lower than the ambient temperature, and the unwanted ice melts.

Relatively pure water turns to ice when it is cooled to 32°F (0°C), but a 1:9 salt/water solution won't freeze until 20°F (-6°C). Likewise, a 1:4 solution won't freeze until it reaches 2°F (-16°C). At temperatures lower than 6°F (-15°C), spreading sodium chloride on icy pavement has no effect at all — that's why you're more likely to see sand spread on the road in extremely cold climates: melting the ice is next to impossible, but the sand provides some traction. The trouble is that salt won't react with completely solid ice — it has to first come into contact with some liquid moisture to form a brine, or saltwater solution, that can penetrate through the ice to form more water. On roadways, friction with vehicle tires generally creates enough heat to melt a small portion of the ice and get the process started.

Other, more effective, chemical alternatives exist, but most local governments consider them to be too expensive to spread on the roads, even though they won't contaminate groundwater and topsoil as quickly as salt (sodium chloride) does. Almost all commercially available deicers are made from some combination of salt, calcium chloride, magnesium chloride, potassium chloride, and urea, which is found, believe it or not, in urine. Calcium chloride deicers generally provide the best performance, working at much lower temperatures than salt can — down to -25°F (-32°C). Calcium chloride and magnesium chloride are also better at initially penetrating ice at low temperatures than other chemicals.

Another drawback to salt and some other chemicals is the fact that as they dissolve in water, they draw heat from their surroundings, reducing temperatures even further and sometimes marginalizing the effects they have on the melting point of the water. Calcium chloride and magnesium chloride, on the other hand, release heat into their surroundings as they dissolve into water, which facilitates the melting process.

Another factor that affects both the effectiveness and cost of deicers is their physical shape — the more expensive, pellet-shaped versions of these chemicals are much more effective. Due to their small contact area, they tend to work down rather than horizontally, so they penetrate the ice and facilitate easy removal without overuse of chemicals. Deicer flakes, on the other hand, work horizontally and have no effect on the bond between ice and pavement, meaning that an impractically large (and environmentally dangerous) quantity of deicer is required to completely clear an area of ice.

DEICING

All readily available deicing chemicals can damage plant life if used in excessive amounts, but salt is the worst. All of the chlorides will accelerate rust in unprotected metals, but urea won't. Urea, however, is effective over an even narrower temperature range than salt. Overusing deicers is a frequent mistake made by both governments and individuals which results in environmental damage. A small amount of these chemicals will begin to break down the structure of the ice — and break the bond between the ice and the pavement — facilitating mechanical removal (by a snowplow, for example). Dumping huge amounts of deicer on the road and waiting for complete melting is costly and slow. Plant life (and steel cars) will suffer as a result of the high chemical concentration. If you're using ice or another chemical to clear ice from your driveway or walkway, always follow the manufacturer's instructions and be prepared to manually clear the loose ice that remains after the chemicals have done their job."

—from *The Tartan*, Carnegie Mellon University's student newspaper, Nov.'02.

Types of Deicers:

Rock Salt (sodium chloride)

Salt (magnesium chloride)

Methanol

Ethylene Glycol

Propylene Glycol

Calcium Chloride

Strange but true: *Almost all commercially available deicers contain urea, a soluble, crystalline solid found in urine or made synthetically.*

Fact: *Calcium chloride and magnesium chloride release heat into their surroundings as they dissolve into water, which facilitates the melting process. Rock salt does not.*

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Maintaining Your Tank: Salt

Keeping portable restroom tanks from freezing during cold winter months can be a challenge. A number of materials can prevent the tank water from freezing, but ordinary rock salt dissolved in water to make a brine solution is the most common and least expensive alternative.

Salt works best at temperatures near 0° C (32° F) because melting occurs quickly with a relatively small amount of salt. As the temperature falls, it takes more salt and more time to melt ice because a higher concentration of brine is required. Generally, bulk rock salt is less expensive than granulated-evaporated salt (table salt). However, rock salt contains more impurities. Granulated-evaporated salt is 99.9+% NaCl (sodium chloride). Rock salt purity varies between 95 and 99% NaCl depending on the source. Another option is solar evaporated salt with a purity of 97 to 99% NaCl, depending on the source.

Whatever form of salt you choose, make sure you mix it with water to make salt brine before adding it to the tank. Salt by itself will settle to the bottom of the tank and the water just freezes on top of it.

An article from **Pumper Magazine** suggests the following procedure:

"Buy a 300-gallon farmers stock tank. In that tank place a 55-gallon drum with one end cut out. Place a pipe in the 55-gallon drum, then fill it with rock salt. The idea is to get the water down the pipe so that it comes out in the bottom of the 55-gallon drum and flows up through the rock salt, spilling over into the 300-gallon tank. Pump this brine solution into your truck, which keeps it from freezing as well as your portable restroom tanks. If you mix one-half pound per gallon of water, you get a freeze protection to 26° F. If you up that to one pound per gallon, you'll get a freeze protection to 19° F. Two pounds per gallon of water protects to 0° F and that is the maximum amount of salt that can be dissolved in a gallon of water. This can be checked by using a hydrometer. Now, you may have days when it gets considerably colder than 0°. So it is also a good idea to place a small screen over the urinal hole opening and fill the urinal with rock salt. This allows the brine in the holding tank to stay undiluted."

The potential for adverse environmental impacts of salt is well recognized. These impacts include impacts on wild-life habitat and vegetation as well as contributing to corrosion of vehicles. Brines are corrosive to steel and brass. Be sure to flush pumps, drums, and tanks thoroughly with fresh water after using a brine solution.

As temperatures fall, don't be tempted into adding more and more salt. With more than two and a quarter pounds the solution will be super-saturated. Two things happen with a super-saturated solution. First, the solution will actually freeze at a warmer temperature. Second, the excess salt will settle and leave a residue in the storage tank in the building, or in the tank on the truck.

During the servicing procedure the interior washing can still be accomplished, but care must be exercised to dry the unit with rags. If only a squeegee is used, a salt residue will be left. If a unit does become frozen to the ground you can use the brine solution or rock salt to melt the ice and free the unit for movement.

SALT

Making a Brine Solution

One of the most common methods of making brine solution is to purchase rock salt by the bag or in bulk. Buy a 300 gallon stock tank (cattle feeding). Take a 55-gallon drum and cut out one end. Place the 55 gallon drum in the stock tank with the open end up. Put a pipe in the 55 gallon drum. Empty salt pellets into the drum. Run water into the pipe so that the water comes up through the salt, overflowing the top of the barrel as a brine solution. Pump brine into the truck for service work. It may also be helpful to put rock salt in the urinals so that you do not dilute the mixture.

*from **Portable Sanitation Association International**

ROCK SALT (SODIUM CHLORIDE)	
Amount of salt in water	**Freezing point**
0 lb / gal	32^0 F
.5 lb / gal	26^0 F
1 lb / gal	19^0 F
1.5 lbs / gal	11^0 F
2 lb / gal	0^0 F

SALT (MAGNESIUM CHLORIDE)	
Amount of salt in water	**Freezing point**
.5 lb / gal	26^0 F
1 lb / gal	18^0 F
1.5 lbs / gal	0^0 F
2 lbs / gal	-20^0 F
2.25 lbs / gal	-26^0 F

"The biggest mistake we see is adding salt to a tank without mixing it first...the salt will settle to the bottom and the water just freezes on top of it."

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Maintaining Your Tank: Methanol

Methanol has been commonly used to deice portable restroom tanks and much has been said about its advantages. It has a lower freezing rate than salt and is relatively inexpensive. However, methanol is a known toxin and highly flammable. Plus, when it burns it is almost invisible to the eye so you can get severe burns because you don't see the flame. The U.S. Environmental Pollution Control Agency has this to say about methanol:

Because of its toxicity, not all wastewater treatment plants will accept methanol. One other caution about methanol usage is having someone place an electric heater in the unit. If they select a heater with a ribbon type element, this has a very hot burning surface. If methanol is spilled into the heater on this hot surface, it can create a lethal formaldehyde gas. The only acceptable heater is a calrod heater. The heating element is about the thickness of a pencil.

The advantages to methanol are that it gives a much greater freeze protection than salt, it is not corrosive to your truck or its fittings, and it bounces back from extreme cold, so you can have frozen toilets one week, but with methanol they will melt as the temperature goes up. With methanol you are able to wash down your restrooms just as you would in the summer and not have to worry about freezing, and you only need a small amount carried on your truck for this purpose. If you use a brine solution for your wash down procedures, when it dries it will leave a white residue which looks very unsightly and gets on clothes. If you have an extremely cold situation, you may want to just pour a little methanol in the unit and you will find that this will help melt the ice in the tank for the following week's service.

Percent of methanol is for gallons of water used in the mixing tank. For example, for 400 gallons of water x 30% methanol, use 120 gallons of methanol plus 280 gallons of water. A 500 gallon mixing tank at 30% would need 150 gallons of methanol plus 350 gallons of water. A higher mix rate than 30% methanol and 70% water can be flammable.

A combination of salt and methanol is commonly used to protect chemical toilets from freezing. First, determine the appropriate freeze point of the solution suitable for the weather conditions (see chart). Make a 20% salt brine by adding two pounds of salt per gallon of water. To determine the total amount of methanol needed, multiply the ounces of methanol per gallon of salt brine by the number of gallons of salt brine that will be used. Mix the methanol with the salt brine. To check the correct methanol content, a Baume hydrometer may be used, but the Baume hydrometer reading must be accurate before methanol is added. (See table on opposite page)

Human health effects associated with breathing or otherwise consuming smaller amounts of methanol over long periods of time are not known. Workers repeatedly exposed to methanol have experienced several adverse effects. Effects range from headaches to sleep disorders and gastrointestinal problems to optic nerve damage. Laboratory studies show that repeat exposure to large amounts of methanol in air or in drinking water cause similar adverse effects in animals.

—from the U.S. EPA

METHANOL	
Amount of methanol in water	**Freezing point**
6.4 oz / gal (5%)	28^0 F
12.8 oz / gal (10%)	23^0 F
19.2 oz / gal (15%)	17^0 F
25.6 oz / gal (20%)	11^0 F
32 oz / gal (25%)	4^0 F
38.4 oz / gal (30%)	-4^0 F
42.2 oz / gal (33%)	-9^0 F
Methanol solution becomes flammable if used in quantities exceeding 33%.	

METHANOL & SALT COMBINED		
Amount of salt in water	**Amount of methanol in water**	**Freezing point**
2 lbs / gal	0 oz / gal (0%)	0^0 F
2 lbs / gal	6.4 oz / gal (5%)	-6^0 F
2 lbs / gal	12.8 oz / gal (10%)	-11^0 F
2 lbs / gal	16.6 oz / gal (13%)	-15^0 F
2 lbs / gal	21.8 oz / gal (17%)	-19^0 F
2 lbs / gal	28.2 oz / gal (22%)	-25^0 F
2 lbs / gal	32 oz / gal (25%)	-30^0 F
2 lbs / gal	38.4 oz / gal (30%)	-40^0 F

Need to convert something from the metric? Your computer will do it for you...just go to the Online metric converter - US customary & metric conversions for unit measurements by Science Made Simple, Inc. Here's the web address: www.sciencemadesimple.com/ conversions.html

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METHANOL

Maintaining Your Tank: Ethylene Glycol & Propylene Glycol (Antifreeze)

Ethylene glycol is the antifreeze commonly used to deice planes. Chloride salts are prohibited for use on aircraft because they can be corrosive. So like automobile antifreeze, aircraft deicing fluids are aqueous solutions of a glycol, or mixture of glycols, along with proprietary additives. Depending on the formulation required, the additives might include a surfactant, polymer thickening agent, pH buffer, corrosion inhibitor, flame retardant, or dye. Glycols and other deicing chemicals are efficient freezing-point depressants—that is, they act as a solute to lower the freezing point of the solvent, in this case water. Propylene glycol or ethylene glycol generally are the major components of aircraft deicers, making up 30 to 70% of the solution. Either alone or in combination, the glycols, calcium magnesium acetate, sodium acetate, sodium formate, and urea are used on runways and airport roadways.

Ethylene glycol has been the standard for antifreezes and deicers for years because of its low cost. It is a colorless, slightly viscous liquid with a freezing point of -13° C, and it can lower the freezing point of water to about -50° C, depending on dilution. The sweet taste of ethylene glycol belies its acute toxicity to mammals, and occasionally it has led to the death of animals that have licked up antifreeze that has leaked onto the ground. When ingested, it depresses the central nervous system and can be fatal to humans even in small quantities.

Before using ethylene glycol, check with your local wastewater treatment plant to determine if they will accept it into their system. The main chemical in regular antifreeze is ethylene glycol. All you really need is that chemical, not the other additives that can raise the price. Two ounces of deodorizer can be used with the antifreeze as a slight mask.

Propylene glycol also is a colorless, viscous liquid at room temperature. It doesn't have a true freezing point, but becomes glasslike at -51° C, and it can lower the freezing point of water to about -60° C. Because propylene glycol is essentially nontoxic, its share of the U.S. aviation deicer market has grown from 10% (124 million lb.) to more than 70% (about 140 million lb.) during the past five years at the expense of ethylene glycol, according to R&D consulting firm SRI International.

Propylene glycol is a recent innovation in improved antifreeze formulations. Its key advantage over more traditional engine coolants made from ethylene glycol is lower toxicity to people, domestic pets and wildlife. It is considered safe by the U.S. Food and Drug Administration as well as the E.P.A. Unlike ethylene glycol, you can buy pure propylene glycol in bulk quantities, so you would use less of it than standard antifreeze. Prestone, the largest seller of antifreeze, now makes a product made with propylene glycol instead of ethylene glycol. It's called Prestone LowTox®.

If you use methanol for a tank deicer or winter wash down, you might experiment with propylene glycol. It could be a far safer alternative.

The only effects noted in one study of individuals exposed to low levels of ethylene glycol by inhalation for about a month were throat and upper respiratory tract irritation. Rats and mice chronically (long-term) exposed to ethylene glycol in their diet exhibited signs of kidney toxicity and liver effects. Several studies of rodents exposed orally or by inhalation showed ethylene glycol to be fetotoxic. An epidemiologic study on renal cancer mortality did not find an increased risk for workers exposed to ethylene glycol. EPA has not classified ethylene glycol for carcinogenicity.

—from the U.S. EPA

Fact: Propylene glycol, found in Prestone LoTox® antifreeze, is considered safe by the FDA and the EPA. It's share of the U.S. aviation deicer market has grown from 10% to more than 70% in five years.

ETHYLENE GLYCOL				
Temperature	**%**	**Ethylene Glycol**	**Water**	**Total**
31^0 - 35^0 F	10 %	1/2 gal	4 - 1/2 gal	5 gal
26^0 - 30^0 F	15 %	3/4 gal	4 - 1/4 gal	5 gal
21^0 - 25^0 F	20 %	1 gal	4 gal	5 gal
16^0 - 20^0 F	20 %	1 gal	4 gal	5 gal
11^0 - 15^0 F	25 %	1 - 1/4 gal	3 - 3/4 gal	5 gal
6^0 - 10^0 F	30 %	1 - 1/2 gal	3 - 1/2 gal	5 gal
0^0 - 5^0 F	35 %	1 - 3/4 gal	3 - 3/4 gal	5 gal
Numbers are based on a five gallon charge				

GLYCOL

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Maintaining Your Tank: Calcium Chloride

Calcium chloride is available in flakes, pellets or liquid. Liquid calcium chloride provides unmatched performance due to its ability to depress the freezing point of water, even when in very dilute concentrations. Calcium chloride produces an exothermic reaction, giving off heat. Because of this, it often performs better than many other deicing salts, especially at lower temperatures. Some highway departments spray liquid calcium chloride over rock salt to lower its melting temperature. Liquid calcium chloride also mixes with water better than rock salt, and won't leave the salt residue. Calcium chloride is more corrosive than salt, so it's important to clean your equipment after using it.

The growing need for corrosion-inhibited deicers has prompted manufacturers to explore their production. One example of this is a new corrosion-inhibited grade of liquid calcium chloride introduced by General Chemical Corp. In addition to providing low corrosion versus salt, it has calcium chloride's operational benefits in that it continues to melt snow and ice at 20^0 F, the temperature at which salt becomes an inefficient deicer.

The Idaho DOT began using corrosion-inhibited calcium chloride in January 1996 for deicing and anti-icing. Those using the material in Idaho report that it aggressively melts snow and ice, and that it offers operational benefits versus magnesium chloride, which has been the primary deicer used in that state due to local availability.

Evaluations show that 25%, 30% and 32% aqueous solutions of the inhibited liquid calcium chloride produce just 4 to 7 mils/year of corrosion or 80% to 90% less corrosion than sodium chloride (see table). Testing was done by Control Services, Kerville, Texas, a leading independent corrosion testing laboratory, using the NACE methods in the Washington specification. The tests compared sodium chloride, regular and corrosion-inhibited calcium chloride, and water. Water is taken as the baseline, so its effects were subtracted from the corrosion values of the other materials.

Other advantages of the new corrosion-inhibited calcium chloride are its ability to cut through snow and ice more quickly than salt or magnesium chloride, lack of sediment problems in tanks and easy clean-up of vehicles.

Demand for corrosion-inhibited deicers appears to be here to stay. Washington and Idaho have pioneered programs to limit corrosion through strict specification on the corrosiveness of deicing chemicals, and oter states and provinces are exploring its use. The availability of corrosion-inhibited products like the new corrosion inhibited liquid calcium chloride, offers people an opportunity to move in this direction.

LIQUIDOW ARMOR from Dow Chemical is a patented, corrosion-inhibited, calcium chloride solution which meets or exceeds the product specifications developed by the Pacific Northwest Snowfighters. Passing this test virtually assures the end user that LIQUIDOW ARMOR will not freeze in storage even under severe weather conditions.

CALCIUM CHLORIDE

Rock Salt and Calcium Chloride

Use a 200 gallon (approximate) tank for mixing. Fill the tank with water. Add 100 pounds crystal rock salt. Add 100 pounds calcium chloride. Mix well (an electric drill with a paint mixer is good). Pump mixture into truck using a small pump. After filling tank, run at least three gallons of fresh water through the pump to be sure all the brine is washed out.

This mix will be used when the temperature begins to average around 30° F in the mornings. Increase the calcium chloride to 200 pounds (still to be used with 100 pounds of crystal rock salt) when the temperature begins to remain below freezing throughout the day. The timetable for cold weather servicing must be worked out according to temperature changes in your particular area. You will need to monitor this procedure carefully. Your drivers should let you know every few days how the mixture is working.

*from **Portable Sanitation Association International**

TYPICAL COROSION VALUES:

Sodium Chloride: 41 - 46 mils / year

Calcium Chloride: 18 - 21 mils / year

Corrosion-inhibited calcium Chloride: 4 - 7 mils / year

*Using the test method defined in the Washington State Department of Transportation. Corrosion values reflect a water baseline - i.e., the corrosion of distilled water, taken as 4 mils / year, has been subtracted from all values.

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Beyond Portable Restroom Tanks

Portable restroom tanks are usually the main concern in cold weather, but there are a number of other things to consider as well. No matter what kind of deicer you're using, you're going to have to take extra care in wipe downs to get the units looking good. Many people mix methanol with their wipe down water, but weigh the advantages and disadvantages with other deicers. Methanol is probably the most dangerous of them all.

In early fall it's particularly important that the pick up and delivery people are aware of placement on the job site. Although this is something they should take notice of at all times, it's most important in fall because the unit could sit in that location all winter. Placement should not be in a low area. Low areas will collect water and when it freezes the unit could be frozen in until the spring thaw. Units should be spotted to guarantee access for service once it snows. Always try to find a place out of the wind to place a restroom, but when that's not possible, identify the direction of the prevailing wind and place units so the door faces into the wind.

Make sure your trucks are prepared for cold weather. Get them in for a tune-up, before cold-associated problems start, and have the mechanic check brakes, battery, exhaust system, and fluid levels, plus add antifreeze and winter-weight oil. Install snow tires if needed. Be sure each truck is equipped with cold weather tools such as snow and ice scraper, chains, sand, salt, shovel, etc.

The primary problem faced by winter drivers is skidding on slick and icy roadways. Make sure your trucks have clear mirrors and wipers and defrosters in good working order. Use low gears when traveling on slick surfaces and hills. Gear down when slowing up and reducing speed. A pumper's truck carries a heavy load that can shift if the vehicle turns or breaks suddenly. In case of a skid, when slamming your foot on the brake seems so instinctive, the best thing to do is to remove your foot from the accelerator without braking, and turn your truck in the direction you want the front wheels to go, using a steady, gentle hand on the steering wheel. Turning too much or too fast can make a bad situation worse. If you forget and hit the brakes and you're sliding down the road like an Olympic ice skater, turn into a snow bank. Freeway exits and bridges are particularly dangerous when icy.

Got a truck stuck in the snow? Don't just sit there spinning your wheels, cutting those ruts deeper and deeper. Use the sand you've got in your vehicle to drop around the wheels to improve traction.

An article that appeared in the Michigan Septic Tank Association's newsletter suggested adding water softener pelllets to the urinals "to keep the concentration levels up for easier service" and a bag of fine salt such as baker's salt, which added to a coffee can with small holes cut in the lid like a salt shaker "works to keep the floor and entrance area clear of ice." The article also suggests the use of windshield washer solvent "to help keep your wipe down water from freezing on contact with the units."

The winter months often require more frequent servicing, especially during extra-cold weather. A tank is not near as likely to freeze if it's serviced twice a week, and the restroom itself will be cleaner.

Oh, and while you're at it, bundle up yourself and your drivers, too. Like mom always says, "Put on your hat and mittens or you'll catch cold!" Dressing appropriately for the weather is just good plain common sense; it will cut down on employee illnesses and cold-related complaints.

False: When your vehicle goes into a skid, the first thing you should do is hit the brakes.

True: When your vehicle goes into a skid, the first thing you should do is take your foot off the accelerator and turn the steering wheel in the direction you want your vehicle to go.

Other Tips:

Straw or hay bales pushed up to the outside of the unit around the tank work as an insulator.

If you use flush toilets, carry a spare flush lid and hoses in your truck; if one is frozen, you can replace it with the spare. The frozen items will unfreeze on the way to the next stop.

When you're done pumping a tank, always make sure to open up your valve and let the vacuum push out what-ever may be left in your hose before you drive to your next location. If you don't pull the vacuum lever, you won't have any pressure at the next stop because ice will have formed inside your hose.

Large snowfall accumulating on your restroom roofs causing them to collapse? Try standing up a 2 X 4 inside the unit to keep the roof propped up.

SODIUM CHLORIDE BRINE TABLES FOR 60° F (15.5° C)

BRINE STRENGTH				POUND / GAL BRINE		GRAM / LITER BRINE		FREEZING POINT *	
Salometer Degree	Specific Gravity	Baume Degree	NaCl % Wt.	NaCl	Water	NaCl	Water	°F	°C
0	1.000	0.00	0.00	0.000	8.328	0.0	998	32.0	0.0
2	1.004	0.60	0.53	0.044	8.318	5.3	996	31.5	-0.2
4	1.007	1.10	1.06	0.089	8.297	10.6	995	31.1	-0.5
6	1.011	1.60	1.58	0.133	8.287	16.0	993	30.5	-0.8
8	1.015	2.10	2.11	0.178	8.275	21.4	991	30.0	-1.1
10	1.019	2.70	2.64	0.224	8.262	26.8	990	29.3	-1.5
12	1.023	3.30	3.17	0.270	8.250	32.3	988	28.8	-1.8
14	1.026	3.70	3.70	0.316	8.229	37.9	986	28.2	-2.1
16	1.030	4.20	4.22	0.362	8.216	43.4	985	27.6	-2.4
18	1.034	4.80	4.75	0.409	8.202	49.0	983	27.0	-2.8
20	1.038	5.30	5.08	0.456	8.188	54.6	981	26.4	-3.1
22	1.042	5.80	5.81	0.503	8.175	60.3	979	25.7	-3.5
24	1.046	6.40	6.34	0.552	8.159	66.1	977	25.1	-3.8
26	1.050	6.90	6.86	0.600	8.144	71.9	976	24.4	-4.2
28	1.054	7.40	7.39	0.649	8.129	77.7	974	23.7	-4.6
30	1.058	7.90	7.92	0.698	8.113	83.6	972	23.0	-5.0
32	1.062	8.50	8.45	0.747	8.097	89.5	970	22.3	-5.4
34	1.066	9.00	8.97	0.797	8.081	95.4	968	21.6	-5.8
36	1.070	9.50	9.50	0.847	8.064	101.4	966	20.9	-6.2
38	1.074	10.00	10.03	0.897	8.047	107.5	964	20.2	-6.5
40	1.078	10.50	10.56	0.948	8.030	113.5	962	19.4	-7.0
42	1.082	11.00	11.09	0.999	8.012	119.6	960	18.7	-7.4
44	1.086	11.50	11.61	1.050	7.994	125.8	957	17.9	-7.8
46	1.090	12.00	12.14	1.102	7.976	132.0	955	17.1	-8.3
48	1.094	12.50	12.67	1.154	7.957	138.2	953	16.2	-8.8
50	1.098	12.90	13.20	1.207	7.937	144.5	951	15.4	-9.2
52	1.102	13.40	13.73	1.260	7.918	150.9	949	14.5	-9.7
54	1.106	13.90	14.25	1.313	7.898	157.2	946	13.7	-10.2
56	1.110	14.40	14.78	1.366	7.878	163.7	944	12.8	-10.7
58	1.114	14.80	15.31	1.420	7.858	170.1	941	11.8	-11.2
60	1.118	15.30	15.84	1.475	7.836	176.7	939	10.9	-11.7
62	1.122	15.80	16.37	1.529	7.815	183.2	936	9.9	-12.3
64	1.126	16.20	16.89	1.584	7.794	189.8	934	8.9	-12.8
66	1.130	16.70	17.42	1.639	7.772	196.5	932	7.9	-13.4
68	1.135	17.20	17.95	1.697	7.755	203.7	929	6.8	-14.0
70	1.139	17.70	18.48	1.753	7.733	210.0	926	5.7	-14.6
72	1.143	18.10	19.00	1.809	7.710	216.7	924	4.6	-15.2
74	1.147	18.60	19.53	1.866	7.686	223.5	921	3.4	-15.9
76	1.152	19.10	20.06	1.925	7.669	230.6	918	2.2	-16.5
78	1.156	19.60	20.59	1.982	7.645	237.4	916	1.0	-17.2
80	1.160	20.00	21.12	2.040	7.620	244.4	913	-0.4	-18.0
82	1.164	20.40	21.64	2.098	7.596	251.5	911	-1.6	-18.6
84	1.169	21.00	22.17	2.158	7.577	258.5	908	-3.0	-19.4
86	1.173	21.40	22.70	2.218	7.551	265.7	905	-4.4	-20.0
88	1.178	21.90	23.23	2.279	7.531	272.9	902	-5.8	-21.0
**88.3	1.179	22.00	23.31	2.288	7.528	274.1	901	-6.0	-21.0
90	1.182	22.30	23.75	2.338	7.506	280.1	899	-1.1	-18.5
92	1.186	22.70	24.28	2.398	7.479	287.4	896	4.8	-15.0
94	1.191	23.30	24.81	2.459	7.460	294.7	893	11.1	-11.6
95	1.193	23.50	25.08	2.491	7.444	298.4	892	14.4	-9.8
96	1.195	23.70	25.34	2.522	7.430	302.1	890	18.0	-7.8
97	1.197	23.90	25.60	2.552	7.417	305.8	888	21.6	-5.8
98	1.200	24.20	25.87	2.585	7.409	309.6	887	25.5	-3.6
99	1.202	24.40	26.13	2.616	7.394	313.4	886	29.8	-1.2
99.6	1.203	24.50	26.29	2.634	7.386	315.6	885	32.3 &	0.2 &
100	1.204	24.60	26.40	2.647	7.380	317.2	884	60.0 #	15.5 #

The above table applies to brine tested at the temperature of 60° F.
For brine tested at warmer or colder temperatures than 60° F see Table of Salometer Correctiosn on reverse side of this card.
* Temperature at which freezing begins. Ice forms, brine concentrates, and the freezing point lowers to eutectic.
** Eutectic point. For brines stronger than eutectic, the temperates shown are the saturation temperatures for sodium chloride dihydrate.
Brines stronger than eutectic deposit excess sodium chloride as dihydrate when cooled, and feeze at eutectic.
& Transition temperatue from anhydrous salt to dihydrate.
# Saturated brine at 60° F.

HOW TO USE A SALOMETER

A salometer is a hydrometer that measures the density of a sodium chloride brine using a scale marked for percent of saturation, 0°S to 100°S. A 70°S brine, for example, is 70% of fully saturated brine, which at 60°F would contain 1.75 lbs. of NaCl/gallon with a specific gravity of 1.139.

There are different types of salometer scales. Some are based on a different saturation point, with 100°S representing 25% NaCl rather than 26.4%. Most are calibrated at 60°F but some are intended for cooler temperatures such as 38°F.

Proper procedure for taking a salometer reading are:

1. Start with a clean, straight-walled glass cylinder with a diameter at least twice that of the salometer bulb with sufficient height to allow for complete immersion of the salometer scale. The cylinder should be tall enough to allow the salometer to float at a 0°S reading.
2. Place the cylinder on a level surface and fill with a sufficient volume of brine to raise the liquid level near the top of the cylinder after the salometer is immersed.
3. Record the brine temperature. If significantly different than 60°F, a temperature correction to the reading will be necessary (see chart).
4. Carefully immerse a clean, dry salometer in the brine. Assure that the salometer is floating and not touching the cylinder walls. After the salometer has stabilized, take a reading at the brine surface at eye level at the bottom of the meniscus, the concavity formed on the cylinder walls at the brine surface (see appendix B for diagram).
5. Check new salometers by first placing them in clear water, where the reading should be nearly 0°S at 60°F. Empty the cylinder, rinse it with saturated salt solution and then refill with saturated brine at 60°F. The reading should be near 100°S and not less than 98°S.

When sodium chloride brines are tested at temperatures other than 60°F (15.5°C), the recorded corrections in the chart below should be applied to readings before entering the salometer chart (opposite page). Extrapolate correction values for intermediate salometer readings and temperatures.

Salometer Correction (°S)*							Variation of Solubility		
	Temperature of Brine						NaCl Saturation		
Brine Salometer Reading	0° F -18° C	20° F -7° C	40° F 4° C	60° F 15.5° C	80° F 27° C	100° F 38° C	Temp °F (° C)	g/L Water	% Wt. Brine
100°	- 7.2	- 4.8	- 2.4	0	+ 2.7	+ 5.4	0 (-18)	313	23.83
80°	- 6.7	- 4.5	- 2.2	0	+ 2.6	+ 5.1	21 (0)	356	26.30
60°	-	- 4.1	- 2.0	0	+ 2.4	+ 4.7	40 (4)	357	26.33
40°	-	- 3.5	- 1.7	0	+ 2.1	+ 4.1	60 (15.5)	359	26.40
20°	-	- 2.6	- 1.3	0	+ 1.6	+ 3.3	80 (27)	361	26.67
0°	-	-	+ 1.0	0	+ 1.2	+ 2.4	100 (38)	364	26.68
Below 60° F, subtract correction from salometer reading. Above 60° F, add correction to salometer reading.									

APPENDIX A: Methanol Safety

The following comes from the **Portable Sanitation Association International**:

STORAGE

Local fIre departments or fIre marshals in each community will have regulations concerning flammable liquids storage such as methanol. Many communities pattern their regulations after the requirements set forth in the National Fire Protection Association's Flammable and Combustible Liquids Code #30. Information gathered from NFP A #30 includes the following:

A. Indoor storage of flammable materials can only be done in those rooms which were specifically designed for that purpose. Methanol should not be stored inside.

B. Methanol can safely be stored in 55-gallon barrels if those barrels are isolated in an outdoor storage yard. The following requirements are listed.

1. No more than 40 barrels can be stored together in a group.

2. A five foot distance must be maintained as an aisle between each group of 40 barrels.

3. Barrels should be at least 50 feet from adjoining property and at least 10 feet away from the nearest street, alley or public way.

4. The storage area cannot be more than 200 feet away from a 12 foot wide access into the yard for fire equipment.

5. A maximum of 20 barrels can be stored adjacent to a building located on the same premises and under management provided that the building is limited to one story of flre-resistive or non- combustible con struction.

6. Storage yards should be constructed such that possible spills cannot drain to neighboring building or property. Also, keep in mind that from a safety standpoint, the empty drums need to be handled just as carefully as the full one due to the presence of vapors in the drums. Tossing the drums about may cause sparks and result in explosion.

SAFETY

Knowledge of the potential hazards on methanol is important for safety instruction. Note especially, the following sections from that literature:

Section 3.1 states that methanol is highly toxic when ingested. It is harmful when prolonged inhalation of vapor or repeated skin contact occurs.

Section 5.2 outlines personal protective measures which lessen these dangers. Eye protection with goggles and hand protection with gloves should be used for those persons directly responsible for mixing the antifreeze solutions.

Methanol should be handled in well-ventilated areas to reduce the build-up of flammable and toxic vapors as outlined in Section 4.3.

In addition, NO SMOKING signs should be clearly posted where methanol is handled. All other sources of ignitions such as sparks from electrical equipment should be eliminated. Carbon dioxide or dry chemical flre extinguishers should be within reach.

HANDLING AND TRANSFERRING

Do not use equipment to handle methanol that has not been approved, especially electric pumps. When transferring methanol from drums to the mixing tank, it is important that the operation be properly bonded and grounded (Section 4.5.1 and 7.5.2). Flammable liquids such as gasoline and methanol can build up dangerous static electrical charges on the surface of the liquid. If a flammable vapor-air mixture is present and a static spark discharges, an explosion or fire could result. Connecting the drum to the mixing tank by means of conductive wire clamped firmly to each will minimize the static difference between the two. This is called bonding. Connecting a conductive wire from the mixing tank to the ground will ground the system of drum, tank and ground. The con-nections between all containers should be inspected such that paint and other non-conductors will not interrupt the grounding.

FIRST AID AND SPILL PROCEDURES

Preventive measures as outlined above and the knowledge of the hazards of methanol will greatly reduce the need for using flrst aid. Nevertheless, prompt attention in the case of eye contamination or oral ingestion must be followed. Spills should be quickly taken care of with large amounts of water to dilute the flammable spill. Rags or mops used to clean the spill should be thoroughly rinsed with water before disposal.

METHANOL MIXING

Percent of methanol is for gallons of water used in the mixing tank. For example, for 400 gallons of water x 30% methanol, use 120 gallons of methanol plus 280 gallons of water. Caution: Do not use more than 30% methanol - a higher mix rate, above 30% methanol and 70% water -can be flammable.

APPENDIX B: Resources

Thanks to the following for information found in this pamphlet.

Carnegie Mellon University

Chemical & Engineering News

Bob Denome, Crescent Tank Manufacturing

Troy Dresel, Cesspool Cleaner Co., LLC

Michigan Septic Tank Association

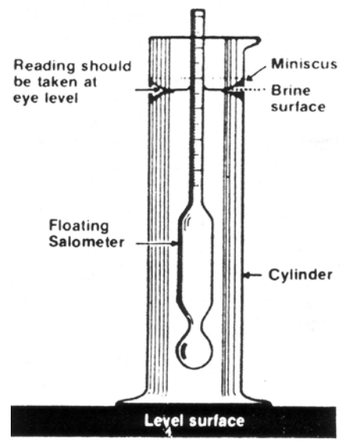
Portable Sanitation Association International

Prestone

Kandi Sikkema

The Salt Institute

U.S. Environmental Protection Agency



SALOMETER READING

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