Preparation of Salt Brines for the Fishing Industry

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The use of salt brine for refrigerants and fish curing is common in the seafood industry. It is important to understand a few basic principles to make and use brines properly. This bulletin attempts to point out some of those basic ideas and principles and provides charts that are useful to anyone who uses brines frequently.

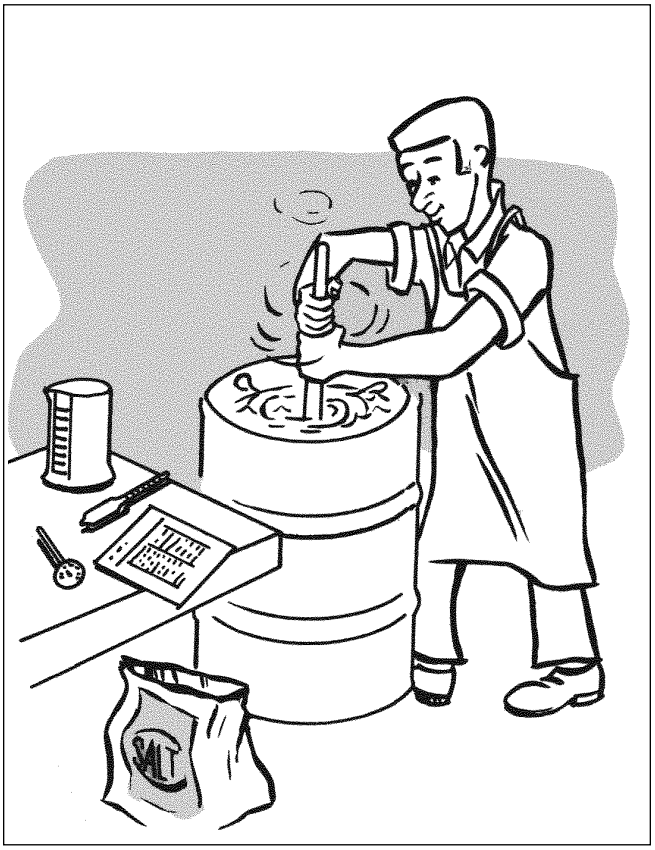
Properties of Salt Brine

When added to water, salt lowers the freezing point of water by a known and predictable degree, making it useful as a secondary refrigerant (freezing solution). Figure 1 shows the relationship of a brine's freezing point to its concentration of salt. Note that the lowest freezing point obtainable in a saltwater mixture is about -6°F at 23.3% salt. This is called the eutectic point. Any concentration of salt above or below this point will result in a solution with a freezing point higher than -6°F. Table 1 gives specific data on freezing point, concentration, and relationships useful in preparing salt brines.

Preparing Salt Brines

After selecting the desired brine concentration for any desired purpose, use table 1 to find how much water and salt are needed. Column 2 in table 1 gives freezing points while column 3 is computed in percent salt by weight. Salometer degree (°SAL) is a useful way of describing and measuring brines and is explained later in "Measuring Salt Solutions."

An easy way to prepare a brine solution of any given strength is to refer to column 4 in table 1 and then add the proper amount of salt per gallon of water. Salt will increase the volume of the solution, however. Thus, if an exact quantity of brine is needed, use columns 5 and 6 to find the weight of salt and volume of water needed to make a gallon of brine at the desired concentration.



Be sure to mix thoroughly!

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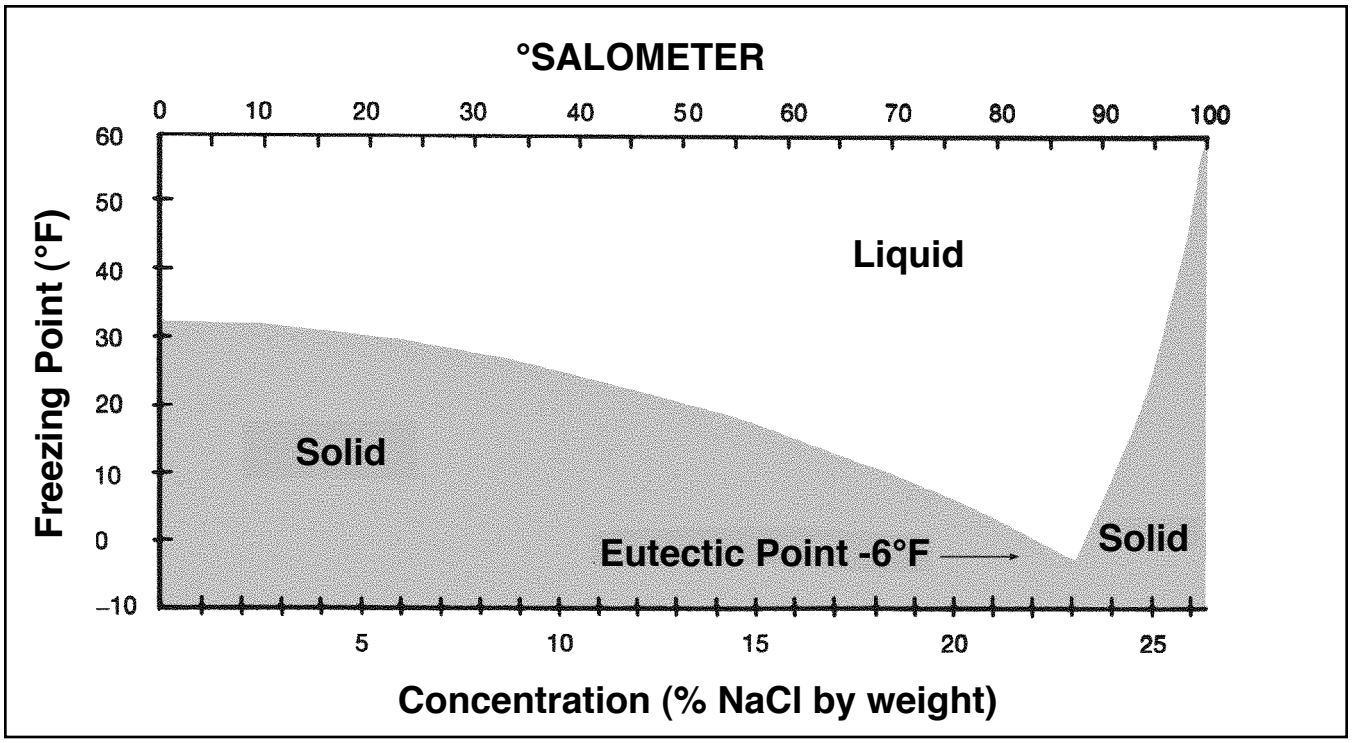

Figure 1. Freezing point of salt brine mixtures

Examples

About 20 gallons of brine are needed at 15.8% salt (60° SAL) to brine salmon for smoking. If it isn't necessary to have exactly 20 gallons, simply find 60° SAL (15.8% salt) in column 1 and note that 1.568 pounds salt/gallon of water (column 4) is needed. Put 20 gallons of water in a tank and dissolve 31 $^{1}/_{3}$ pounds of salt (20 gallons x 1.568 pounds salt/gallons water).

The result will be a solution that has exactly 15.8% salt by weight (60° SAL). It will be found, however, that the resulting solution is more than 20 gallons; it will be more like 21 gallons. This increase in volume is usually insignificant; if precision is needed and an exact quantity desired, use the data in columns 5 and 6.

For example, if exactly 500 gallons of 88° SAL brine (-5.8°F freezing point) is needed for a brine freezing tank on board a vessel, column 5 in table 1 will show that each gallon of 88° SAL brine needs 2.279 pounds of salt and .904 gallons of water (column 5). Adding 1,140 pounds of salt (500 gallons x 2.279 pounds salt/gallon brine) to 452 gallons of water (500 gallons x .904 gallons water/gallon brine) would give exactly 500 gallons of brine at 88°SAL (23.3%) with a freezing point of -5.8°F.

Measuring Salt Solutions

Although careful attention to proportions will give good control of salt concentration in brine, the best way to be sure is to measure it. Sometimes, after a brine has been used and possibly diluted, it is useful to be able to measure its concentration.

Figure 2 shows the basic tools used to measure salt solutions. These may be purchased at most scientific supply houses for about $15. A salometer is a device that measures brine density saturation (26.4% salt at 60°F) on a convenient scale of 0 to 100. Each °SAL would therefore represent about .26% salt by weight as fully saturated brine contains about 26.4% salt.

To read a salometer, place it in a vessel, like the graduate cylinder shown in figure2, and allow it to float. The depth that it floats measures the brine concentration. Readings are taken by noting the point on the scale where the salometer emerges from the surface of the brine solution. These readings in °SAL can then be used with table 1 to obtain data such as freezing point and percent salt by weight.

The thermometer is used to determine the temperature of the brine as it is being tested with the salometer. If the temperature varies more than a few degrees from 60°F, then a correction factor should be used for accurate work.

A rule of thumb states that for every 10°F the brine is above 60°F, one degree salometer should be added to the observed reading before using table 1, which is standardized for 60°F. For each 10°F the brine is below 60°F, one degree salometer should be subtracted from the observed salometer reading. For instance, if a salometer reading was observed to be 80°SAL in a brine which was 40°F, the corrected salometer reading would be 78°SAL (subtract 1°SAL for each 10°F below 60°F).

Table 1. Sodium Chloride Brine Tables for Brine at 60°F

(1) Salometer Degrees	(2) Freezing Point Deg. F.[a]	(3) Percent Sodium Chloride by Wt.	(4) Pounds Salt Per Gallon of Water	(5) Pounds per Gallon of Brine		(6) Gallon Water Per Gal. of Brine	(7) Specific Gravity	(8) Salometer Degrees
				NaCl	**Water**			
0	+32.0	.000	.000	.000	8.328	1.000	1.000	0
2	+31.5	.528	.044	.044	8.318	.999	1.004	2
4	+31.1	1.056	.089	.089	8.297	.996	1.007	4
6	+30.5	1.586	.134	.133	8.287	.995	1.011	6
8	+30.0	2.112	.179	.178	8.275	.993	1.015	8
10	+29.3	2.640	.226	.224	8.262	.992	1.019	10
12	+28.8	3.167	.273	.270	8.250	.990	1.023	12
14*	+28.2	3.695	.320	.316	8.229	.988	1.026	14*
16	+27.6	4.223	.367	.362	8.216	.987	1.030	16
18	+27.0	4.751	.415	.409	8.202	.985	1.034	18
20	+26.4	5.279	.464	.456	8.188	.983	1.038	20
22	+25.7	5.807	.512	.503	8.175	.982	1.042	22
24	+25.1	6.335	.563	.552	8.159	.980	1.046	24
26	+24.4	6.863	.614	.600	8.144	.978	1.050	26
28	+23.7	7.391	.665	.649	8.129	.976	1.054	28
30	+23.0	7.919	.716	.698	8.113	.974	1.058	30
32	+22.3	8.446	.768	.747	8.097	.972	1.062	32
34	+21.6	8.974	.821	.797	8.081	.970	1.066	34
36	+20.9	9.502	.875	.847	8.064	.968	1.070	36
38	+20.2	10.030	.928	.897	8.047	.966	1.074	38
40	+19.4	10.558	.983	.948	8.030	.964	1.078	40
42	+18.7	11.086	1.039	.999	8.012	.962	1.082	42
44	+17.9	11.614	1.094	1.050	7.994	.960	1.086	44
46	+17.1	12.142	1.151	1.102	7.976	.958	1.090	46
48	+16.2	12.670	1.208	1.154	7.957	.955	1.094	48
50	+15.4	13.198	1.266	1.207	7.937	.953	1.098	50
52	+14.5	13.725	1.325	1.260	7.918	.951	1.102	52
54	+13.7	14.253	1.385	1.313	7.898	.948	1.106	54
56	+12.8	14.781	1.444	1.366	7.878	.946	1.110	56
58	+11.8	15.309	1.505	1.420	7.858	.943	1.114	58
60	+10.9	15.837	1.568	1.475	7.836	.941	1.118	60
62	+9.9	16.365	1.629	1.529	7.815	.938	1.122	62
64	+8.9	16.893	1.692	1.584	7.794	.936	1.126	64
66	+7.9	17.421	1.756	1.639	7.772	.933	1.130	66
68	+6.8	17.949	1.822	1.697	7.755	.931	1.135	68
70	+5.7	18.477	1.888	1.753	7.733	.929	1.139	70
72	+4.6	19.004	1.954	1.809	7.710	.926	1.143	72
74	+3.4	19.532	2.022	1.866	7.686	.923	1.147	74
76	+2.2	20.060	2.091	1.925	7.669	.921	1.152	76
78	+1.0	20.588	2.159	1.982	7.645	.918	1.156	78
80	-.4	21.116	2.229	2.040	7.620	.915	1.160	80
82	-1.6	21.644	2.300	2.098	7.596	.912	1.164	82
84	-3.0	22.172	2.372	2.158	7.577	.910	1.169	84
86	-4.4	22.700	2.446	2.218	7.551	.907	1.173	86
88	-5.8	23.338	2.520	2.279	7.531	.904	1.178	88
88.3[b]	-6.0[b]	23.310	2.531	2.288	7.528	.904	1.179	88.3[b]
90	-1.1	23.755	2.594	2.338	7.506	.901	1.182	90
92	+4.8	24.283	2.670	2.398	7.479	.898	1.186	92
94	+11.1	24.811	2.745	2.459	7.460	.896	1.191	94
95	+14.4	25.075	2.787	2.491	7.444	.894	1.193	95
96	+18.0	25.339	2.827	2.522	7.430	.892	1.195	96
97	+21.6	25.603	2.865	2.552	7.417	.891	1.197	97
98	+25.5	25.867	2.906	2.585	7.409	.890	1.200	98
99	+29.8	26.131	2.947	2.616	7.394	.888	1.202	99
99.6	+32.3	26.285	2.970	2.634	7.386	.887	1.203	99.6
100[c]	+60.0[c]	26.395[c]	2.987	2.647	7.380	.886	1.204	100[c]

The above table applies to brine tested at 60°F. For other brine temperatures the observed salometer readings must be converted before using them in the table. For practical purposes, add one degree salometer for each 10 degrees above 60°F and deduct one degree salometer for each 10 degrees below 60°F.

* Approximate salinity range for seawater.

[a] Temperature at which freezing begins. Ice forms, brine concentrates, and freezing point lowers to eutectic.

[b] Eutectic point. For brines stronger than eutectic, the temperatures shown are the saturation temperatures for sodium chloride dihydrate. Brines stronger than eutectic deposit excess sodium chloride as dihydrate when cooled, and freeze at eutectic.

[c] Saturated brine at 60°F.

Important Points to Remember

Dissolving salt: Finely ground salt such as canner's salt or table salt dissolves much faster than coarsely ground salt (rock salt). It is essential that all salt added is dissolved if a solution is to have the proper strength.

Salt dissolves much faster in hot water than in cold water. It may take days for salt to dissolve in a brine freezer at 0°F.

Salt dissolves much slower as the salt concentration increases. The last bit of salt in a 90°SAL solution may take a long time to dissolve.

Agitation greatly increases the rate at which salt dissolves. A layer of salt on the bottom of a tank may take days to dissolve if left undisturbed.

In summary, try to dissolve salt in a warm, well agitated container or tank and make sure it is all dissolved before using it or measuring its concentration.

Brine refrigeration: Always make up a brine to be used for refrigeration so that its freezing point is well below the temperature you want to maintain. If you don't, it may freeze to the refrigeration coils or heat exchanger surfaces as they usually run 5 to 10°F colder than the operating temperature of the brine.

Using seawater for brines: Seawater may contain as much as 3 to 3.5% salt (12 to 14°SAL), which is equivalent to about .3 pounds of salt per gallon. Take this into consideration when making brine from seawater and deduct it from the amount of salt needed to make up a brine.

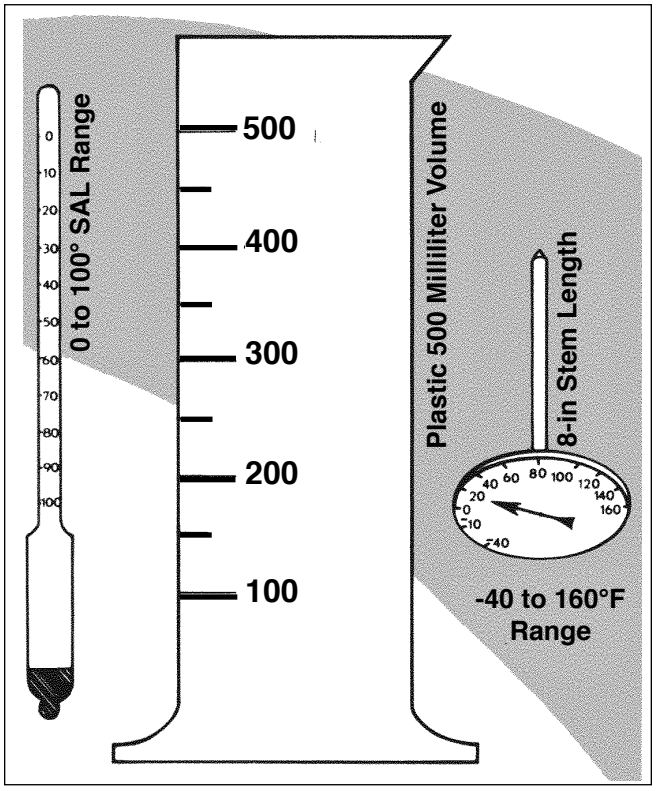

Figure 2. Equipment for measuring salt concentration in brine. Left, salometer; center, graduate cylinder; right, dial thermometer.

Adding salt to existing brines: If you want to increase the concentration of salt in a brine (decrease its freezing point), be sure to measure its strength and estimate its volume first. Then use the data in table 1, columns 5 and 6, to calculate how much more salt needs to be added.

Table 2. Metric/customary conversion factors (approximate) for the units cited in this bulletin.

To convert	to	multiply by
liters	gallons	0.26
gallons	liters	3.78
kilograms	pounds	2.20
pounds	kilograms	0.45
grams per liter	pds per gallon	0.0083
pounds per gallon	grams per liter	119.8
degrees Celsius (formerly Centigrade)	degrees F.	$\frac{9}{5}$ then + 32
degrees Fahrenheit	degrees Celsius	$\frac{5}{9}$ after - 32

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