salt concentration. Viscosities are given in Figs. 4 and 8. Figs. 5 and 9 show the thermal conductivity of calcium and sodium brines at varying temperatures and concentrations.

The applications of brine in refrigeration are mainly in the industrial machinery field, where the calcium chloride solution is a widely used secondary refrigerating medium, and in skating rinks. Corrosion is the principal problem encountered in use of calcium chloride brines, especially in ice-making tanks where galvanized iron cans are immersed.

Ordinary salt (sodium chloride) is used where contact with calcium chloride could not be tolerated, as, for example, in the brine fog method of freezing fish and other foods. A common application is in air cooling in unit coolers, as spray for preventing formation of frost on coils. For most refrigerating work, the lower freezing point of calcium chloride solution makes its use more convenient.

Commercial calcium chloride is marketed in flake, solid, and solution forms, the first being the most extensively used. It is available as Type 1 (77 percent min) and Type 2 (94 percent min). Commercial sodium chloride is available both in crude (rock salt) and refined grades. The presence of magnesium salts in either brine is undesirable, as they tend to form sludge.

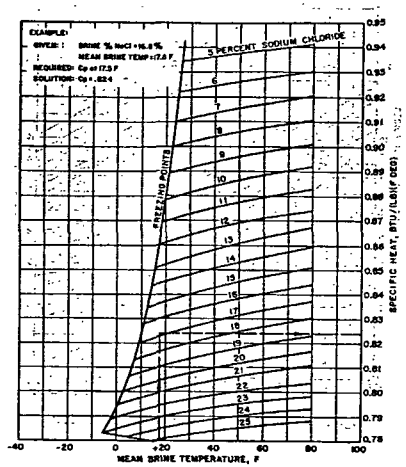


Fig. 6 .... Specific Heat of Sodium Chloride Brine[1]

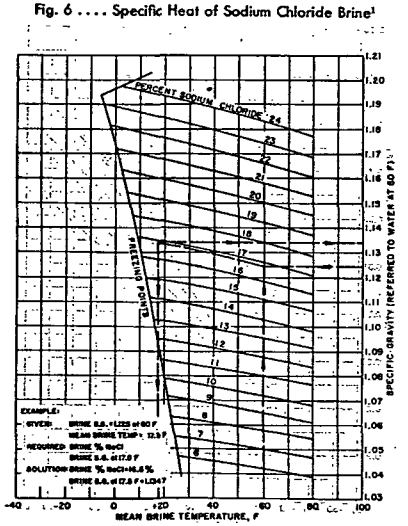


Fig. 7 .... Specific Gravity of Sodium Chloride Brine[1]

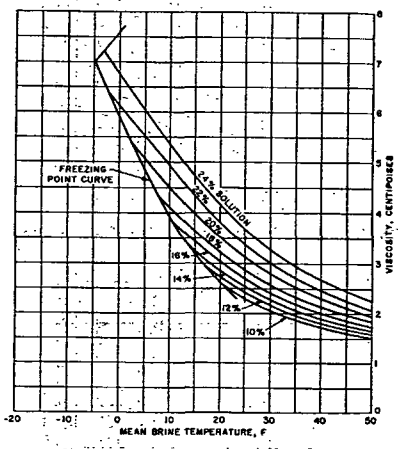


Fig. 8 .... Viscosity of Sodium Chloride Brine[1]

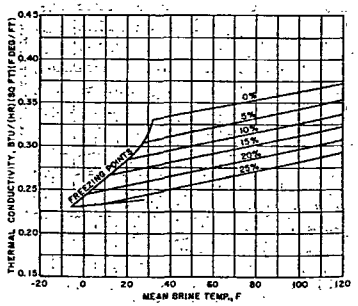


Fig. 9 .... Thermal Conductivity of Sodium Chloride Brine[1]

Table 3 .... Summary of Physical Properties

Property	Ethylene Glycol	Propylene Glycol
Molecular Weight	62.07	76.10
Specific Gravity at 68/60 F	1.1155	1.0381
Weight per Gallon at 68 F, lb.	9.28	8.64
Boiling Point in F		
at 760 mm Hg	387	369.4
at 50 mm Hg	253.4	240.8
at 10 mm Hg	192.2	185.0
Vapor Pressure at 68 F, mm Hg	0.05	0.07
Freezing Point, F	+8.6	Sets to glass below −76
Viscosity in cps, F at 32 F	57.42	243
at 68 F	20.93	60.5
at 104 F	9.52	18.0
Refractive Index, n_D at 68 F	1.4316	1.4329
Specific Heat at 68 F Btu/(lb) (F deg)	0.561	0.593
Heat of Fusion at +8.6 F Btu/lb	80.5	—
Heat of Vaporization at 1 atm Btu/lb	344	304
Heat of Combustion at 68 F Btu/lb	8,280	10,312

Corrosion

Neutral brines are comparatively noncorrosive. However, brines are subject to contamination from various sources which influence the brine's corrosive effects. Air (oxygen) and carbon dioxide are such contaminants. Excessive aeration of the brine should be avoided; it should be kept in closed systems whenever possible. The brine should be inhibited with sodium chromate or dichromate and adjusted to an alkaline condition (*pH* 7.0 to 8.5).

The recommended inhibitor concentrations are: 125 lb (as $Na_2Cr_2O_7 \cdot 2H_2O$) per 1000 cu ft of calcium chloride brine, and 200 lb (as $Na_2Cr_2O_7 \cdot 2H_2O$) per 1000 cu ft of sodium chloride brine. Sufficient caustic must be added to convert the dichromate to chromate in solution. Periodic testing of the brine for inhibitor strength and for *pH* is recommended. Adjustments can be made to keep the *pH* between 7.0 and 8.5 by adding caustic soda to correct for acidity (*pH* below 7.0) or adding dichromate to correct for excessive alkalinity (*pH* above 8.5).

INHIBITED GLYCOLS

Ethylene glycol and propylene glycol, inhibited for corrosion control, have been widely used as aqueous freezing point depressants and heat transfer media in heating and cooling systems. Their ability to lower the freezing point of water, together with their low volatility and relatively low corrosivity when properly inhibited, represent the chief attributes of these materials. As with other inhibited fluids, it is advantageous to maintain a monitoring schedule on glycol fluids to insure that undesirable inhibitor depletion is avoided.

Inhibited ethylene glycol solutions are normally preferred over propylene glycol solutions because of their more desirable physical properties, especially at lower temperatures. However, in certain applications involving possible contact of the coolant with food or beverages, toxicity considerations may require the use of propylene glycol. Under these circumstances, reference should be made to pertinent Regulations under the Food Additives Amendment to the Federal Food, Drug and Cosmetic Act. Selected applications such as snow melting and ice skating rink systems are described in separate chapters in the 1964 Guide And Data Book.

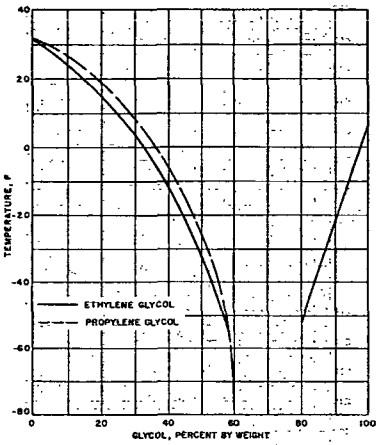


Fig. 10 .... Freezing Points of Aqueous Solutions of Ethylene Glycol and Propylene Glycol

Physical Properties[7]

Ethylene and propylene glycol are colorless, practically odorless liquids, which are completely miscible with water as well as with many organic compounds. A tabulation of the more important properties of the pure materials is shown in Table 3.

The freezing point versus composition curves of pertinent aqueous mixtures are given in Fig. 10. Pure ethylene glycol freezes at + 9 F. The ethylene-glycol-water freezing point curve implies occurrence of a eutectic, but the exact composition and temperature of the eutectic are not known, since solutions with freezing points in this range set to a viscous, glassy mass that makes determination of true freezing points difficult. On the dilute side of the eutectic, ice forms upon freezing; while on the concentrated side, solid glycol separates from solution when freezing commences. The freezing velocity of such solutions is often quite slow, but, given enough time, these solutions may set to a hard, solid, mass.

The curves depicted in Figs. 11 and 12 show the boiling point and condensation temperature versus composition relationships for aqueous solutions of ethylene glycol and propylene glycol. It should be noted that there is a relatively small increase in boiling temperature with increase in glycol content over much of the composition range. As a further note, vapor compositions above hot glycol solutions of normal dilutions (25 to 60 percent) are very low in glycol content and, therefore, in certain open applications, significant concentration of the coolant is possible.

Figs. 13 and 14 give the specific gravity versus composition curves at various temperatures for aqueous solutions of ethylene glycol and propylene glycol. It is important to note