still a controversial matter. When any chemical is used, so many relevant factors are involved that it is always advisable to seek adequate technical counsel in inaugurating the treatment. Very often, where such precaution is not taken, new troubles are created that are more aggravating than the original difficulty [17].

Silicate of soda is used to protect iron, lead, and brass water pipe [18]. For most waters, a solution of $Na_2O;3SiO_2$ is recommended. Sodium silicate equivalent to about 10 ppm added silica, should be fed to the water for the first month after which it may be reduced to give 5 or 6 ppm added silica. Where careful control of the silicate feed is exercised, the water is not injured for domestic use by this treatment. The rate of corrosion of iron pipe has been reduced by 70 per cent and dezincification of brass pipe practically stopped by this simple treatment. The amount required and the effect are not the same in all waters.

Pipe Materials. Brasses with 60 to 67 per cent copper are dezincified in some corrosive waters and in certain localities are not much more serviceable than galvanized iron or steel pipe. The zinc in brass pipes is leached out locally, leaving a plug of porous copper. The weakening of such pipe is especially noticeable under the threads. Dezincification is retarded by the use of silicate of soda (8 ppm added silica) [19].

In salt or fresh water, there is no material difference in rate of pitting of wrought iron, steel, low metalloid steels, or copper bearing steels. This is contrary to the relative performance of these metals in atmosphere.

TABLE 7. QUANTITIES OF SODIUM DICHROMATE TO BE ADDED TO MAINTAIN INITIAL CONCENTRATION

SPECIFIC GRAVITY OF BRINE TO BE STRENGTHENED	LB SODIUM DICHROMATE PER 100 LB $CaCl_2$ ADDED
1.16	0.695
1.18	0.621
1.20	0.556
1.22	0.502
1.24	0.455
	LB OF SODIUM DICHROMATE PER 100 LB NaCl ADDED
1.12	1.79
1.14	1.47
1.16	1.32
1.175	1.18

Refrigerating Systems

Corrosion in refrigerating systems is confined to surfaces in contact with brines and/or those in contact with the refrigerant.

Brines. Refrigerating brines usually are comprised of sodium chloride, calcium chloride, or calcium and magnesium chlorides. The corrosivity of dilute brines is higher than their more concentrated solutions. The corrosivity of sodium brines, other conditions being fixed, is about 1.5 times greater than brines of the alkaline earth metals.

Brines are excellent electrolytes. Contact of dissimilar metals of wide potential differences when in contact with brines results in rapid corrosion by galvanic action.

The leakage of air, acid refrigerants, or both, accelerates the corrosivity of brines. Ammonia precipitates calcium and magnesium salts thus clogging the system at restricted points.

The addition of caustic soda and sodium dichromate to brine solutions to inhibit corrosion of iron is a more or less general practice. Sodium silicate and sodim phosphate are also used at times, but tests indicate they are not as effective as is sodium dichromate. It has been suggested [20] that 125 lb of sodium bichromate per 1000 cubic feet of calcium chloride brine, and 200 lb per 1000 cubic feet of sodium chloride brine be added to inhibit brines; that when salt or calcium chloride is added to "strengthen" brine, sodium dichromate also be added in the amounts shown in Table 7.

Refrigerants. The common refrigerants, except those of the hydrocarbon type, will attack the common metals and alloys if *moisture is present.* Even a very small amount of water may cause severe corrosion with certain refrigerants. The amount required need only be sufficient to produce a water film on the metal surface.

With the halogenated hydrocarbons, complete elimination of water is much to be desired. Where ammonia is used, copper and its alloys, aluminum and zinc, are attacked especially at elevated temperatures. When sulphur dioxide is used more than 50 ppm (0.005 per cent) of water will cause appreciable corrosion of virtually all the common materials.

Minimizing Condensate Corrosiveness

There are four expedients that may be utilized to minimize corrosion in steam condensate systems: (1) treatment of the boiler feedwater so as to eliminate deleterious gases entrained with the steam, (2) design of the condensing equipment to minimize dissolution in the condensate of the deleterious gases entrained with the steam, (3) chemical treatment of the condensate, (4) use of resistant metals.

Boiler Feedwater Treatment. Elimination of oxygen from boiler feedwater and, therefore, from the steam developed, can be accomplished either mechanically or chemically. In some steam generating stations, both expedients are employed.

Tests [21] have indicated that in small low-pressure heating boilers, where the boiler input contains less than about 50 ppm of carbonate hardness, the CO_2 in the steam can be controlled by adding calcium hydroxide to the boiler. In Fig. 5 are shown the equilibria conditions proposed for boilers operating at pressures up to about 5 psi gage. This expedient may *not* be used in higher pressure boilers, because of the possibilities of scale and sludge formations. In the latter, the only method used to date for treating the feedwater consists (a) in removing the alkaline earth salts, *i.e.*, softening (b) in subsequent acidulation followed by deaeration at temperatures near the atmospheric boiling point of water [22].

Design of Condensing Equipment. In the design of water heaters and comparable types of condensing equipment [23], it is possible to shift the accumulation of non-condensible gases to a location away from the condensate level and, subsequently, vent these gases to the atmosphere. Venting an amount of steam equal to about one-half per cent of the total steam entering the condenser is the optimum vent rate.

Venting, is of little practical value, when the CO_2 content of the incoming steam is below about 5 ppm. When the steam contains more than 5 ppm, venting provides a means of producing a condensate containing a