Open Recirculating Systems

Where water from condensers and similar equipment is passed through a spray pond or cooling tower and then returned to the equipment, there is an increase in the concentration of solids because of the evaporation of some of the water into the cooling air, and, moreover, the aeration removes carbon dioxide. Both factors promote the tendency to deposit scale. If the conditions are particularly adverse, it may be necessary to subject the water to a softening treatment before use, this being the more feasible because of the reduced water requirement in such a recirculating system. When this is not practicable, or when the tendency to scale formation is only moderate, a considerable improvement may be effected by the

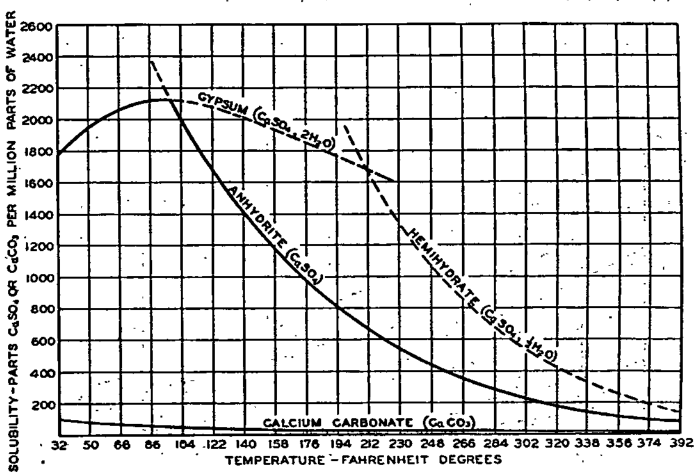

Fig. 3. Solubility of Calcium Sulfate and of Calcium Carbonate for Comparison

($CaCO_3$ in Equilibrium with Normal CO_2 Content of the Atmosphere)

Fig. 3 Adapted from Bull. No. 15, Univ. of Mich. "Formation and Properties of Boiler Scales" by P. E Partridge.

addition to the water of organic compounds such as gelatine, glucosates, dextrine, and tannin which tend to prevent precipitated material from forming adherent scales. In systems of this kind, the loss of liquid as spray from the cooling towers or spray ponds may limit adequately the final concentration of solids in the cooling water. If not, provision must be made for sufficient purging of used water.

Heating Systems

In hot water heating systems or in steam heating boilers where all condensate is returned, troubles from scaling should not be severe. If necessary, sodium phosphate or sodium carbonate may be added to the water to prevent the formation of adherent calcium sulphate scale.

Boilers and High Temperature Equipment

Where temperature exceeds 250 F, complete softening of the water is the only practical method for minimizing sludge formation. This is

usually accomplished by artificial or natural zeolites (called also ion-exchange materials) or by hot-process precipitation softeners.

In boilers operating at pressures above 100 psi virtually all the calcium, magnesium, silica, iron, and manganese salts entering with the feed water are potential scale or sludge formers.

In low pressure boilers (100–250 psig), the formation of adherent calcium sulphate (anhydrite) scales is most to be feared. Such deposits form on the *hottest* evaporative surfaces. It is a material of low heat conductivity. Even a layer of egg shell thickness may so impede the rate of heat transfer as to bring about over-heating of the metal.

The ortho-phosphates of sodium are most frequently used to prevent sulphate scales. The concentration of phosphate required is such as to cause the precipitation of calcium phosphate as sludge, thus keeping the boiling water under-saturated with respect to calcium sulphate. To a lesser extent, sodium carbonate (called also soda ash and sal soda) is also used. Most of the effective boiler compounds contain either phosphates or soda ash, or both. Certain organic materials and colloids are sometimes found to minimize scale formation. Where chemicals are introduced directly into the boiler in amounts adequate to prevent scale, sludge is formed in amounts proportionate to the calcium and magnesium salts entering with the feed water. To prevent troublesome accumulation of this sludge, as well as soluble salts, as evaporation occurs, some *blowdown* of boiler water is necessary.

CAUSES AND PREVENTION OF SLIMES

A water containing slime-producing organisms will produce prohibitive amounts of slime *only* when the conditions of use are such as to propagate their life processes. Whenever sufficient food material from normal water or from airborne dust combines with optimum temperature conditions, such as exist on cooling surfaces and air washers, serious quantities of slime will be produced.

Some natural well waters do not contain sufficient foods to support luxuriant slime growths. Algae, which require light for carrying on their life processes, are likely to cause difficulty in cooling towers and other areas where sunlight is abundant. The ordinary slime-forming bacteria are capable of using a wide variety of nitrogenous and cellulose material as food sources. These bacteria thrive best under dark conditions such as exist in condensers and other heat transfer surfaces. Other organisms capable of causing similar difficulties use such a wide variety of food material as algae,[11] iron compounds,[12] and inorganic sulphates.[13]

At present, the use of toxic chemicals and irradiation are the two general means employed in slime control. The value of ultra-violet light, used so broadly in the beverage industry, is somewhat in dispute.

Anti-fouling paints have been developed and are fairly satisfactory for the prevention of the growth of macro-organisms such as *barnacles* and *mussels*, but these paints must be renewed at frequent intervals, and are not applicable to inaccessible areas such as the inside of pipe lines and cooling towers. Satisfactory *anti-sliming* paints have *not* been found.

Names and other pertinent data relating to some of the more common chemicals used in slime control are shown in Table 6.

Chlorine is the only chemical to which is attributed the ability to destroy slime-forming organisms. The others are presumed to poison marine organisms, most of which *recover* when the chemical is not used regularly.