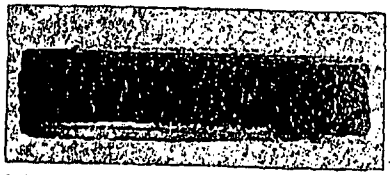
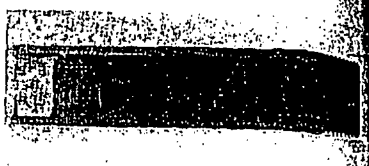
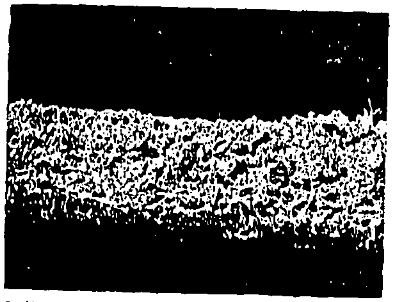


1 Metal left to itself corrodes rapidly, and scales up in cooling-water systems to upset smooth plant operation



2 Immediate, good treatment lays down a thin protective scale, which is scarcely visible, to safeguard the metal



3 Wood in cooling towers, handling constantly reaerated water, suffers from concentrated salts that are left behind

4 Resins leach out from the wood, material softens and fibers frays as these concentrated sodium salts go to work

Recirculating-Water Systems Need Expert Treatment Supervision

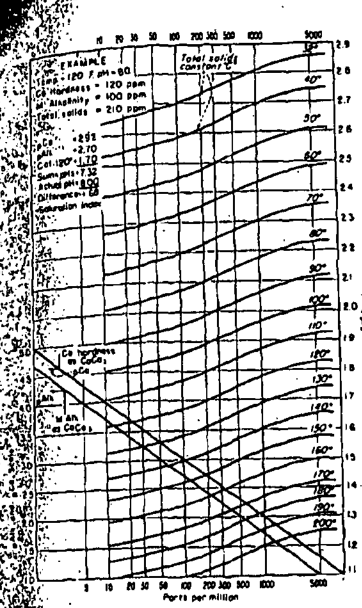
For industry's needs, cooling-water supplies have had to come from much-used streams, falling-water tables. Then, when recirculated again and again, it's prone to scale, foster algae, become corrosive. Here's some practical help on the problem

By SHEPPARD T POWELL, *Chemical Engineer*

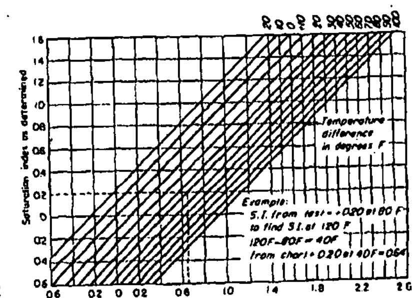
► SCALE FORMATION and corrosion represent the two chief problems in cooling-water operations. Scale, by itself, comes readily under control with proper water treatment. But its presence complicates the corrosion problem. And with today's heavy use of cooling-purpose water, emphasis is on corrosion control in these low-temperature piping systems.

The old once-through cooling system, still prevalent in small plants, just pushes the water through its cooling duties and then dumps it to waste. It's a system that has the twin merits of low equipment cost and only the slightest scale and corrosion headaches. But so much water is needed for the job it does that operating costs become prohibitive. As a direct result, water recirculating systems, like the one in Fig. 7, serve most of industry's wants.

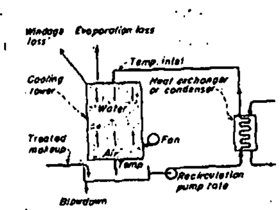
The open system of water recirculation, Fig. 7, employs spray ponds or cooling towers to release the heat picked up by the circulating water. These sprays or cooling towers sacrifice a part of the water by evaporation to the atmosphere to effect the cooling action. In doing this, though, they make an active problem of corrosion by (1) building up the concentrations of the scale-forming solids in the water left behind (2) introducing the corrosive agents of oxygen and carbon dioxide. Add to this the possibility that micro-organisms may be present in the water to influence the choice of corrective water treatment, and you begin to appreciate the job's complexity, and the room for the score of treatment methods now common.



5 Basic Langelier Saturation Index lets you predict whether your cooling water has any corrosive or scaling tendencies



6 Where operating temperature makes it hard to lay down a scale, heat water for a short while according to the chart



7 Principal elements of a typical open recirculating system are shown above

Basically, however, you can reduce corrosion to a safe rate by control of pH and dissolved solids alone. But actually you need a thorough knowledge of your circulating-water analysis and its behavior in the recirculating system. Protecting any metal from corrosion by water depends on conditioning the supply to correct its corrosive characteristics or creating and maintaining a physical dam between the anodic and cathodic part of metal surface and water.

Protective Coating. How do you go about getting this protection? One way is to put on a protective coating using organic or inorganic materials, or both. Also, you may lay down a deposit as a product of cathodic or anodic corrosion reactions, or as a precipitate from the liquid on all areas. In any case, the deposit should be nonporous and continuous if it is to give complete protection.

Water treatment can guard against corrosion provided some steps, like deaeration, are taken to remove any gases that form. For instance, a thin, impervious, adherent deposit of calcium carbonate scale can be laid down by regulating and adjusting pH, alkalinity and calcium ions. This scale is a good general inhibitor against corrosion. It covers both anodic and cathodic areas.

There are a few natural waters, such as those of the Great Lakes, that meet the requirements for laying down a proper calcium carbonate scale. Most waters need treatment to bring about the desired state of equilibrium for the calcium carbonate in solution. Fortunately, Professor W F Langelier[1] pioneered in developing the idea of a calculated saturation index as a means of predicting the corrosive or scaling effect of a natural water. His idea has been so advanced that its use is widely accepted.

Because most natural water carries dissolved calcium and magnesium in the form of bicarbonate and noncarbonate hardness (chlorides and sulfates mainly) there is a tendency for that water when heated or made more alkaline to deposit a scale or corrosively attack the metal. But there are also sodium salts, dissolved carbon dioxide, oxygen and other gases in the water. Just which way the water goes—that is, to lay down a protective scale or attack the metal—depends on how this dissolved material balances out.

If the various forms of carbon dioxide (free CO_2, bicarbonate and carbonate) are at equilibrium, they cause neither scale nor corrosion. The surest way of judging the state of the water, corrosive or not, and the steps that will correct it, is to determine the solubility equilibrium relations of calcium carbonate. The Langelier Saturation Index chart, Fig. 5, is a convenient way of doing this.

Langelier chart makes use of logarithmic expressions of calcium hardness, methyl orange alkalinity and a factor for temperature and total solids. (Temperature accelerates corrosion or scale-deposit formation, whichever way the water tends to go.) If you know the value of calcium hardness, alkalinity and total solids, you pick off the chart the information to figure out the saturation pH (*pHs*) and the saturation index.

(Continued on page 88)

[1] Langelier, W F, "The Analytic Control of Anti-Corrosion Water Treatment," *Journal, American Water Works Assn*, 28: 1950 (1936).