Cooling Water Problems and Solutions

An Online Continuing Education Course for Engineers

Course Number: HV-5001

Credit: 5 Hours / 5 PDH / 5 CPD

Course: COOLING WATER PROBLEMS AND SOLUTIONS

Course by: A. Bhatia

Course Description

The three primary reasons that the cooling water treatment may be required are to control corrosion, scale formation, and the growth of biological agents. Any of these problems – or more usually a combination of them – can cause a loss of efficiency, shorten equipment life and push up operating costs. Imagine the large amounts of dollars lost when insufficient cooling suddenly curtails operations of process equipments.

A very high percentage of people responsible for operation and maintenance of cooling water systems have little or no knowledge of water technology and are therefore totally reliant on specialist water treatment companies to provide up to date cost-efficient water treatment programs suitable for their particular plants.

This 5-hr course presents an overview of common chemical treatment program that may be required to maintain cooling water systems in good operating condition. Reasons and means are discussed for controlling scale, deposition, corrosion, and biological fouling. The discussion also covers the information on chemicals used for control, and methods available to permit operation within the limits.

It is applicable to all engineers and designers involved in power plants, oil and gas, chemical and petrochemical process facilities, refineries, industrial plants and HVAC systems in commercial buildings.

The reader must take a multiple-choice quiz consisting of twenty five (25) questions at the end of this course to obtain PDH credits.

Learning Objective

At the conclusion of this course, the student will:

1. Understand the critical parameters such as conductivity, TDS, pH, alkalinity and saturation index applicable to cooling water treatment

2. Understand the factors responsible for scale and corrosion

3. Understand the types of scale and methods to minimize its formation
4. Understand relationship between the cycles of concentration and blowdown
5. Understand the physical methods of treating water such as softener, dealkalizer, ion-exchanger, filtration, and electronic de-scaling equipments
6. Understand the corrosion types and the control techniques to mitigate corrosion
7. Learn four types of corrosion inhibitors including, anodic, cathodic, mixed and adsorption types
8. Understand the principles of cathodic protection
9. Learn the possible types of biological fouling and the treatment methods including oxidizing and non-oxidizing biocides
10. Understand the chemical feed equipment for closed and open cooling water systems
11. Learn the five application methods for dosing chemicals including their benefits and limitations
12. Learn the control sensors and monitoring devices used in cooling water treatment

Once you finish studying the above course content, you need to take a quiz to obtain the PDH credits.

COOLING WATER PROBLEMS AND SOLUTIONS

Water is used in cooling systems as a heat transfer medium and frequently also as the final point to reject heat into the atmosphere by evaporating inside cooling towers. Depending on the quality of available fresh water supply, waterside problems develop in cooling water systems from:

- Scaling
- Corrosion
- Dirt and dust accumulation
- Biological growth

Any of these problems – or more usually a combination of them – result in costly unscheduled downtime, reduced capacity, increased water usage, high operation and maintenance costs, expensive parts replacements, and acid cleaning operations which reduce the life of the cooling system.

There is no single method of treating cooling water. Selection of water treatment program for a specific system depends on:

1. System design, including system capacity, cooling tower type, basin depth, materials of construction, flow rates, heat transfer rates, temperature drop and associated accessories
2. Water, including make up water composition / quality, availability of pre-treatment and assumed cycle of concentration
3. Contaminants, including process leaks and airborne debris
4. Wastewater discharge restrictions
5. Surrounding environment and air quality

In this course, we will discuss the reasons and means for controlling scale, corrosion and biological fouling.

Critical Parameters

The critical parameters for cooling water are: conductivity, total dissolved solids (TDS), hardness, pH, alkalinity and saturation index.

Conductivity and Total Dissolved Solids (TDS)

Conductivity is a measure of the ability of water to conduct electrical current and it indicates the amount of the dissolved solids (TDS) in water. Pure distilled water will have a very low conductivity (low minerals) and sea water will have a high conductivity (high minerals). Dissolved solids present no problem with respect to the cooling capacity of water, since the evaporation rate of seawater, which has 30,000ppm total dissolved solids, is only 1% less than that of distilled water. The problem with dissolved solids is that many of the chemical compounds and elements in the water will combine to form highly insoluble mineral deposits on the heat transfer surfaces generally referred to as "scale". The scale stubbornly sticks to the surfaces, gradually builds up and begins to interfere with pipe drainage, heat transfer and water pressure.

The primary maintenance objective in most circulating water systems is to minimize the formation of scale deposits and conductivity can be used as the controlling value after the TDS/conductivity relationship is determined.

pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/baseness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.

Control of pH is critical for the majority of cooling water treatment programs. In general, when pH points to acidic environment, the chances for corrosion increase and when pH points to alkaline environment, the chances for scale formation increase.

Alkalinity

The pH values above 7 signify alkalinity. At pH values less than 8.3, most of the alkalinity in the water is in the bicarbonate form, and scale formation is normally not a problem. However, when the pH rises above 8.3, the alkalinity converts from the bicarbonate to the carbonate and the scale will start to form.

Hardness

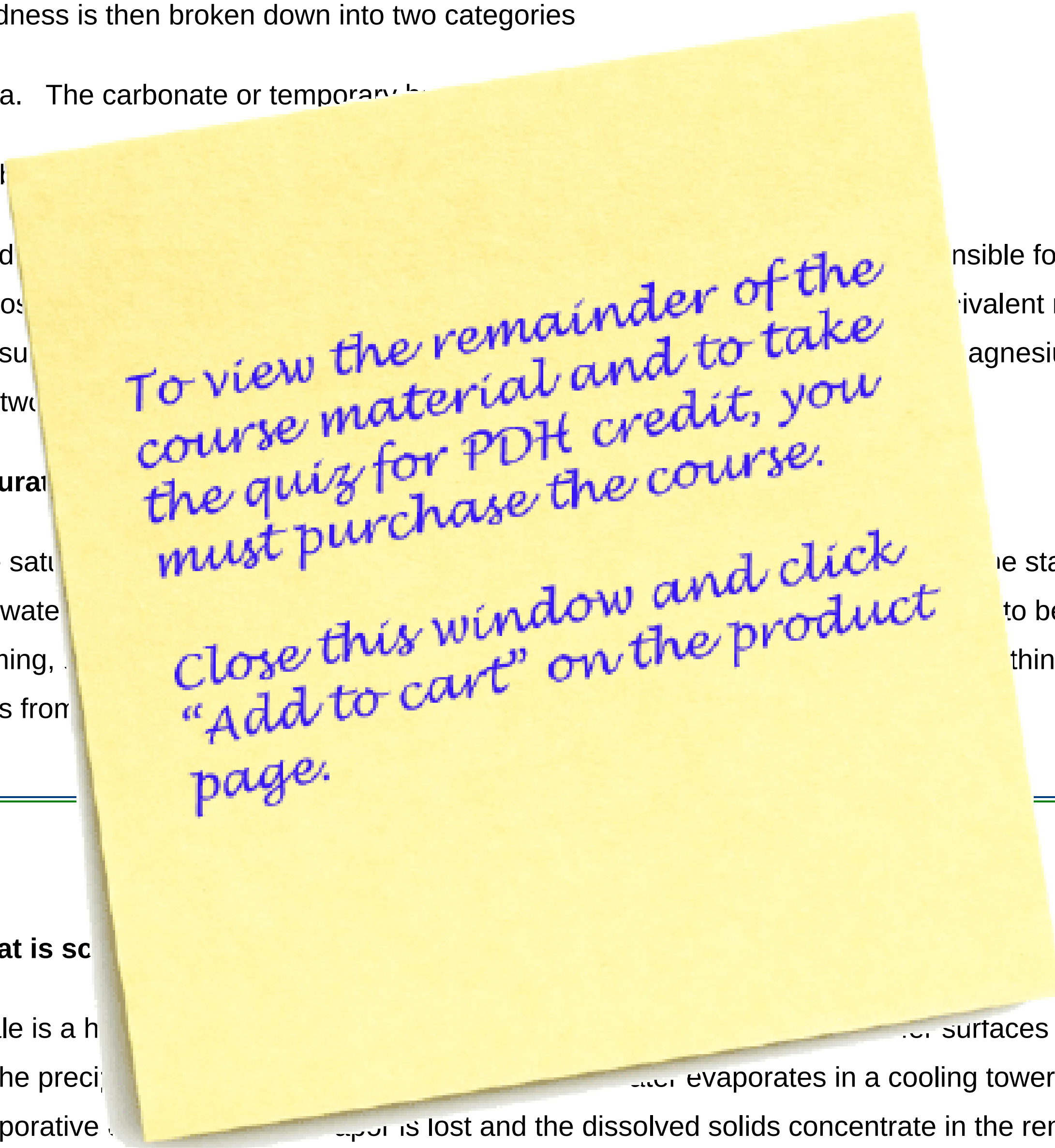
The amount of dissolved calcium and magnesium in water determines its "hardness." The total hardness is then broken down into two categories

a. The carbonate or temporary h

Hard ... nsible for the depos ... ivalent metal ion su ... agnesium are the tw

Satura

The satu ... e stability of the wate ... to be scale forming, ... thin 1.0 units from



What is sc

Scale is a h ... surfaces caused by the preci ... evaporates in a cooling tower or an evaporative ... is lost and the dissolved solids concentrate in the remaining water. If this concentration cycle is allowed to continue, the solubility of various solids will eventually be exceeded. The solids will then settle in pipelines or on heat exchange surfaces, where it frequently solidifies into a relatively soft, amorphous scale.

Problems