Water Purification & Treatment (BSC)

Course Outline with Outcomes

Content

1. Chemistry Fundamentals

Learning Outcome

Explain the fundamental principles in the structure, formation and interaction of chemical compounds and the importance of chemistry in industrial operations.

Learning Objectives

1. Define each term and explain the relationship between atoms, ions, elements, molecules, compounds, and mixtures.
2. Using the Periodic Table of the Elements determine the atomic numbers and the atomic masses of elements.
3. Explain the electro-negativity and the bonding of ions.
4. Explain the formation of chemical compounds, explain typical reaction equations and apply basic principles to the balancing of simple chemical reaction equations.
5. Apply basic principles to the balancing of simple chemical equations
6. Define acids, bases, and salts and explain their properties
7. Describe the sources of the impurities found in raw water.
8. Describe the effect of the listed water impurities on power plant equipment and processes.

2. Corrosion Principles & Processes

Learning Outcome

Explain the mechanisms that cause corrosion and the methods used to monitor and control corrosion as well as the chemistry and processes of corrosion mechanisms.

Learning Objectives

1. Define terms and explain the causes and characteristics of each of the following corrosion types: galvanic, atmospheric, stray current, biological, stress cracking, hydrogen induced, sulphide stress cracking and chloride stress cracking.
2. Explain the anodic and cathodic processes of corrosion.
3. Explain corrosion of single metals.
4. Explain the processes of crevice corrosion and pitting corrosion.
5. Explain the process of microbiologically influenced corrosion.
6. Explain the process of stress induced corrosion.
7. Explain the processes of erosion-corrosion.
8. Explain the mechanisms and significance of magnetite formation and magnetite depletion on boiler tube surfaces.
9. Explain the mechanisms and significance of Economizer and Superheater corrosion.

3. Internal Water Treatment

Learning Outcome

Describe boiler internal water treatment processes.

Learning Objectives

1. Explain the causes, effects and control of scale.
2. Explain the causes, effects, and control of foam in boiler water.
3. Explain the causes, effects, and control of caustic embrittlement.
4. Describe the methods by which silica is removed from feedwater and condensate.
5. Explain the use of chelating agents in boiler water.
6. Explain the principles, reactions, and control of chelation.
7. Explain the principles, reactions, and control of a coordinated phosphate program.
8. Explain the phenomenon of phosphate hideout.
9. Explain the principles, reactions and control of a congruent phosphate program.
10. Explain the principles, reactions and control of an equilibrium phosphate program.
11. Explain the principles, reactions and control of an all-volatile treatment program.
12. Explain the principles, reactions and control of a polymer treatment program.
13. Explain the principles, reactions and control of an oxygenated water treatment program.
14. Describe the mechanism of sludge conditioning.
15. Describe the mechanism of antifoam conditioning.
16. Explain the use of pH control in boiler water.
17. Explain the causes, effects, and control of carryover of boiler water.
18. Explain the use of blowdown from boiler water.

4. Water Pre-Treatment

Learning Outcome

Describe water pre-treatment processes for removal of suspended solids, oils and gases.

Learning Objectives

1. Explain the purpose, equipment, operation, and limitations of sedimentation.
2. Describe the mechanisms of coagulation and flocculation.
3. Describe the chemical processes and reactions of oxidation of organic contaminants.
4. Describe the chemical processes and reactions of iron and manganese removal from raw water.
5. Explain the purpose, equipment, operation, and limitations of filtration.
6. Explain the purpose, equipment, and operation of lime-soda softening.
7. Explain the purpose, equipment, operation and limitations of hot process phosphate softening.
8. Explain the purpose, equipment, operation and limitations of sodium zeolite softening.
9. Explain the purpose, equipment, and operation of hydrogen zeolite softening.
10. Describe the chemical processes and reactions in a dealkalizer.
11. Describe the mechanisms of membrane technology, including chemical and mechanical cleaning methods and clean-in-place design.
12. Explain the purpose, equipment, and operation of electrodialysis (ED) and electrodeionization (EDI).
13. Describe the chemical processes and reactions in a demineralizer.
14. Describe how oil is removed from water.
15. Explain the purpose, equipment, operation, and limitations of mechanical deaeration.
16. Explain the purpose, equipment, operation, and limitations of evaporation.
17. Explain the use of chemical deaeration in boiler water.

5. Steam Condensers

Learning Outcome

Discuss condenser principles, performance, operation and auxiliaries.

1. Describe the principles and design of jet, air cooled, and surface condensers.
2. Describe the purpose, principle and design of air ejectors and vacuum pumps.
3. Describe the purpose and flow of cooling water systems.
4. Describe the purpose, principle and design of cooling water intake screens, circulating pumps, cooling towers, and cooling ponds.
5. Describe the purpose, principle and design of condenser atmospheric exhaust (relief) valves.

6. Non-Boiler Water Treatment

Learning Outcome

Discuss water treatment applications for cooling water, wastewater, and potable water, as well as be able to explain the monitoring and management of potable water and cooling water treatment systems.

Learning Objectives

1. List the water impurities of concern in a cooling water system and the effects caused by each one.
2. Describe control methods for a cooling water system for control of corrosion, fouling and microbiological attack including chloride corrosion, and delignification.
3. Describe the potential effects of wastewater discharge.
4. Compare and contrast mechanical, chemical, and biological methods of wastewater treatment including the advantages and disadvantages of each.
5. Describe the use and chemistry of biocides in cooling water.
6. Describe the use of chemical inhibitor programs.
7. Explain the use of chelants in cooling water.
8. Explain the use of threshold scale inhibitors in cooling water.
9. Explain the use of surfactants, dispersants and biodispersants in cooling water.
10. Specify an appropriate method of wastewater treatment for a particular case study.
11. Describe the methods used for potable water treatment and analysis.
12. Describe the regulatory requirements for potable water quality and monitoring.
13. Describe the parameters and interpretation of potable water analyses.
14. Describe the selection and mechanism of oxidation agents.
15. Describe the mechanism of ultra-violet sterilization.

7. Wastewater Treatment

Learning Outcome

Describe the design, operation, and monitoring of processes and equipment used to treat wastewater.

Learning Objectives

1. Describe the processes that occur at each stage of treatment.
2. Describe the equipment and process involved in the removal of suspended solids from wastewater, including screening, flotation, and sedimentation.
3. Describe the equipment and process involved in the removal of colloidal solids from wastewater, including chemical coagulation, flocculation, and clarification.
4. Describe the equipment and process involved in the biological removal of solids from waste water, including activated sludge, rotating biological contactors, trickling filters.
5. Explain the financial management of the costs and benefits of water treatment.
6. Apply raw water analysis to the selection of a water treatment system.
7. Describe the troubleshooting process when a cycle chemistry parameter deviates from the acceptable range.