Material Properties and Corrosion for Nuclear Plants

An Online Continuing Education Course for Engineers

Course Number: MA-6001

Credit: 6 Hours / 6 PDH / 6 CPD

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1.0 OBJECTIVES

This course covers the following areas pertaining to Mechanical Properties:

- Mechanical and Thermal Stress
- Corrosion
- Pressure Tubes and Fuel Bundles

At the completion of training the participant will be able to:

Mechanical and Thermal Stress

- define terms as they relate to materials: mechanical stress and strain, hoop stress, thermal expansion, differential thermal expansion, thermal shock & residual stress
- describe factors which cause mechanical and thermal stress in a component
- explain the consequences of exceeding stress limits in materials
- explain why heating and cool down rates are limited
- define the following properties of materials: ductility, brittleness & nil-ductility transition
- explain the differences between ductile and brittle fracture
- explain why a material exhibiting a ductile/brittle transition temperature has operating limitations with respect to temperature
- define creep as it relates to materials
- explain why a large shaft becomes deformed when at rest
- explain why rolling a large shaft prior to operation reduces the deformation
- describe fatigue failure and work hardening

Corrosion

- describe the erosion of material
- describe wear or surface failure of materials
- given a plant system and associated chemical parameters with their normal operating ranges, explain the consequences of operating outside this range and the control methods used
- describe the following corrosion types: uniform, galvanic, pitting and crevice, stress corrosion cracking, erosion & microbiologically induced
- explain the importance of pH control in carbon steel based systems, including the significance of a magnetite layer, and describe the typical methods used to maintain proper control

- explain the importance of dissolved oxygen control in carbon steel based systems, and describe the typical methods used to maintain proper control
- explain the importance of conductivity control, and describe the typical methods used to maintain proper control
- define the term stress corrosion cracking (SCC), and state the conditions required to promote SCC
- explain the importance of pH control in stainless steel based systems, and describe the typical methods used to maintain proper control
- explain the importance of conductivity control, and describe the typical methods used to maintain proper control
- explain how scale can be formed on boiler tubes, state the adverse consequences of scale formation, and state the methods used to minimize scale formation

Pressure Tubes and Fuel Bundles

- state the effect of radiation on materials: oils and greases, plastics, metals & concrete
- describe the causes of creep in pressure tubes
- describe the process of hydrogen embrittlement and the occurrence of delayed hydride cracking and blistering of pressure tubes, including the factors affecting it
- explain how temperature cycling and reduced heat transport pressure can be used to minimize the potential for delayed hydride cracking in pressure tubes during start-up and cool-down

2.0 MATERIAL PROPERTIES

Notes:

2.1 INTRODUCTION

Materials of many types are important both in the design and operation of nuclear power plants. All materials may fail due to external or internal forces, such as mechanical and thermal stress, or to associated phenomena like creep, fatigue and erosion. In this module, we will discuss the main causes and consequences of mechanical f
materials commonly encountered and
control.

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