

# Piping Material Selection & Rating Classification

## INTRODUCTION

- Compared with other forms of transport, pipelines allow a more continuous, stable, and high-capacity supply of hydrocarbons to reach end-users. Pipeline transportation has the advantages of being well established, efficient, cost-effective, and readily expandable.
- The products carried in liquid pipelines include a wide range of materials. Process fluid systems gather production from onshore and offshore fields, while transmission lines transport them to terminals, interconnection points, and refineries.
- Materials selection plays an important role in piping systems. It is crucial to select a piping material that can cope with a variety of applications and damage mechanisms including corrosion, high/low temperatures, constant and cyclic loads, etc. Pipe inspection also plays an important role, making sure that optimal materials requirements are adhered to.
- This training course will combine the various disciplines of pipeline engineering, including design, structural integrity, hydraulic considerations, materials types and selection, inspection and maintenance as well as the applications of relevant codes such as ASME B31.3 and API 570.

This seminar will highlight:

- Main aspects of pipeline design and manufacturing considerations
- Knowledge of the governing principles, related to materials testing
- Relevant structural integrity, pipe failure and corrosion principles
- Main Types of pipeline materials and selection
- Relevant pipe inspection and maintenance techniques

## PROGRAMME OBJECTIVES

At the end of this seminar, the participants will,

- Develop deep understanding & familiarity basic principles of pipeline design for various industrial applications.
- Be familiar with the practical aspects of structural integrity, related to pipeline operation
- Have a knowledge of the various types structural and corrosion failure in relation to process pipes
- Have the necessary knowledge about pipeline materials and selection
- Understand aspects of pipe inspection and maintenance practices

## WHO SHOULD ATTEND?

- Process engineers
- Chemical engineers
- Mechanical and structural engineers
- Operation personnel
- Engineers and consultants dealing with planning of new production lines and retrofitting plants

## TRAINING METHODOLOGY

- The course will be conducted along workshop principles with formal lectures and interactive worked examples included in several workshops. The emphasis in the course will be on the explanation of all technical phenomena and providing answers to problems that are encountered in everyday industrial practice related to the design and materials selection of pipeline systems.
- Each learning point will be reinforced with practical examples. Computer simulations and videos will be used to illustrate the main aspects of the course. Delegates will receive electronic versions of the course material together with relevant computer simulations and videos.
- There will be ample opportunities for active discussion and sharing professional experiences and exchange that will help solidify the gained knowledge.

## PROGRAMME SUMMARY

The seminar will allow participants to:

- Have a sound understanding of the properties and applications of materials with particular emphases on the oil and gas industries
- Have a good knowledge, understanding and be able to select major types of engineering metals, including, carbon steels, alloy steels, stainless steels, cast irons, titanium and nickel-based alloys
- Be able to select heat treatment processes and mechanical strengthening techniques for metals, in order to optimise their use in a variety of engineering applications
- Appreciate the selection of non-metals, including polymers that are used for corrosion protection coatings and liners.
- Have a working knowledge of;
- Corrosion issues
- Various types of corrosion
- Good appreciation of material selection as a method of corrosion control and mitigation
- Explain the mechanisms behind corrosion resistant materials
- Be able to evaluate the performance and the selection of materials, coatings and inhibitors for various situations involving corrosion
- Have a working knowledge and selection of materials for major failure and degradation mechanisms, including different types of stress, fracture, fatigue and elevated temperature conditions.
- Be knowledgeable in Non-Destructive Techniques (NDT)

## PROGRAM OUTLINE

### Overview of Pipelines and Materials Testing

- Overview of main elements of oil and gas pipelines and systems
- Types of Metallic pipes and main manufacturing techniques, seamless, continuous welded, etc.
- Flanges and Gaskets
- Mechanical Test Requirements
- Tensile testing
- Charpy Impact test
- Hardness testing

### Pipeline Materials and Requirements

- Ferrous alloys - Classification of carbon steels, Low-Carbon Steels, Medium-Carbon Steels, High-Carbon and tool Steels, Alloy Steels
- Micro-structure of carbon steel
- Alloying selection
- Heat treatment of steel, hardening of carbon steel (by quenching), annealing, hot working, service temperature
- Stainless Steel, Ferritic, Austenitic, Martensitic, Duplex Stainless Steel, full stainless steel technical data
- Cast Irons – types and selection.
- Nickel based alloys, selection for corrosion and elevated service temperature
- Titanium alloys - types of titanium alloys ( $\alpha$ ,  $\beta$  and  $\alpha\beta$ ) and selection of titanium alloys for corrosion resistance

### Mechanical Design Considerations

- Temperature variations expansion loops and expansion joints
- Stress analysis examples, thermal expansion
- Maximum allowable pressure and wall thickness calculations and corrosion allowance
- Welding types and requirements
- Heat Affected Zone (HAZ)
- Alternative materials, Glass Fibre Reinforced (GRP), Polyethylene pipes, etc.
- ASME B31 and materials related considerations

### Failure Mechanisms, Corrosion Damage and Corrosion Mitigation

- Cyclic loading (Fatigue) damage of piping materials
- High temperature (Creep) failure of piping materials
- Corrosion principles and Electrochemical cell
- Types corrosion, uniform, bimetallic, hydrogen induced, erosion-corrosion, etc.
- Materials selection examples
- Cathodic Protection
- Coatings

## Pipeline Maintenance and Inspection

- Pigging methods for cleaning
- Pigging Inspection
- Hydro-testing
- Inspection (NDT) techniques, x-ray, ultrasonic, holiday detection, etc.
- Pipe repairs
- Overview of API 570 Pipe Inspection Code