Best Technology Solutions (BTS)

Industrial Welding and Fabrication Techniques Training program

Course Description

This training course is designed to give a comprehensive discussion of the subject of Applied Welding Metallurgy with emphasis on practical aspects. The course will concentrate on practical issues which are of interest to those who are in the field such as weld quality, properties of welded joints and weldability of different metals and alloys. The course will be delivered such that most of technical terms and concepts will be clarified by both scientific definition and examples. The course is divided into six main areas: Fusion welding processes, Development of the weld metal (fusion zone), Heat affected zone (HAZ), Fracture and cracking of welded joints, Weldability of steels and non ferrous alloys and Case examples of different industries. This course is designed to provide welding practitioners (engineers, technicians, etc.) with valuable knowledge for improving weld quality, understanding the origins of welding defects and avoid welding problems in future. The course can, also, be tailored for specific needs if required by certain participants.

Training Methodology

Training will be delivered mainly through lectures with emphasis on practical examples and case studies. Practical sessions would be provided when and wherever possible.

Who Should Attend

Welding engineers and technicians, inspection engineers and technicians process engineers, manufacturing engineers, product development engineers and managers, mechanical engineers, quality control engineers and technicians and people involved in welding, fabrication and heat treatment.

Course Objectives:

By the end of this course delegates will learn about:

- To familiarize participants with the scientific background of welding as a metallurgical process.
- To introduce participants to the role of weld thermal cycle in developing the weld metal.
- To explain to participants the effect of weld thermal cycle on the heat affected zone (HAZ).
- To explain to participants the origins of weld cracking and weld defects related to both weld zone and HAZ.
- To provide participants with the basic technical and scientific knowledge for choosing safe and effective pre-weld and post-welding heat treatments.
- To explain to participants weldability issues related to weld quality in both ferrous alloys (steels) and non-ferrous alloys.
- To explain to participants issues related to mechanical and corrosion properties of welded joints and weld joint performance under service conditions.
- To train participants to choose the right material-electrode combinations.
- To explain to participants how to conduct proper examinations of welded joints.

At Course Completion

Upon successful completion of this course, participants will be able to:

- Appreciate the meanings of different technical terms and concepts used in welding metallurgy
- Be able to choose the appropriate electrode and/or welding parameters for a certain welding application
- Understand the effect of weld thermal cycle on the development of different regions in the welded joint
- Understand the types and origins of different types of weld cracking and welding defects
- Choose the right pre-weld and post-weld heat treatments
- Predict some of the mechanical and/or corrosion properties of welded joints
- Understand weldability of different steels and non-ferrous alloys
- Choose the right metallographic examination

Course Outline

- **Fusion welding processes.**
    - Arc welding processes (SMA, TIG, MIG and SAW)
    - Process variables
    - Weld thermal cycle
    - Residual stresses in welds
    - Heat input rates
    - Shielding methods
    - Metallurgical effects of the weld thermal cycle
        - Metallurgical effects in the weld metal
        - Gas-metal reactions
        - Dilution and uniformity of weld deposit

        - Weld pool solidification
        - Weld cracking
    - Metallurgical effects in the parent metal
        - Microstructural changes in the HAZ
        - Precipitation and embitterment in the HAZ
        - Residual stresses

- **Development of the weld metal (fusion zone)**

    - Geometry of the weld melt
    - Solidification and crystal formation
    - Segregation
    - Refining weld structures
    - Phase transformation during cooling of the weld metal
        - Kinetics of phase transformations
        - Transformations in duplex stainless steel welds
        - Role of alloying in transformation
        - Role of slag inclusions in transformations
        - Predicting microstructure and properties of weld metal

- **The Heat Affected Zone (HAZ)**

    - The base material
    - The heating cycle
    - Grain growth
    - Reactions at the fusion-line
    - Transformations during cooling
    - Predicting microstructure and properties of HAZ
    - Multi-run (multi-pass) welds

- **Cracking and fracture in welds**
    - Fracture toughness
    - Solidification cracking
    - Liquation cracking
    - Lamellar tearing
    - Cold cracking
    - Reheat cracking

- **Weldability of carbon steels**
    - Metallurgy of the liquid weld metal
    - Gas-metal reactions
    - Slag-metal reactions
    - Transformations and microstructure of steel
    - The mechanical properties of welded joint
    - Stress concentration
    - Embitterment of fusion welds in steel
    - The Hydrogen embitterment and cracking of fusion welds in steel
        - Hydrogen attack
        - Hydrogen embitterment
        - Hydrogen-induced cold cracking
        - Measures to avoid hydrogen-induced cold cracking
    - Welding problems with iron and steel products
    - Cast iron
    - Steels used for their mechanical properties
        - Carbon and carbon-manganese steels
        - Micro-alloyed steels
        - Low-alloy steels
    - Steels for sub-zero temperature use
        - Low-alloy corrosion and heat resisting steels
        - Ferritic and austenitic stainless steels

- **Austenitic and high-alloy steels**
  - Metallurgy of the weld metal and heat affected zone
  - Carbide precipitation
  - Solidification cracking in the weld deposit
  - Hot cracking on the HAZ
  - Corrosion
    - Intergranular corrosion
    - Stress corrosion cracking
    - Preferential corrosion of welds
  - Corrosion resistant steels
  - Dissimilar weld joint
  - Heat resisting steels
  - Hardenable high-alloy steels
- **Non-ferrous alloys**
    - Aluminum and its alloys
    - Nickel and its alloys
    - Cupper and its alloys
- **Weld testing**
    - Non-Destructive testing
- **Destructive testing**

- **Case studies**

  - Case study I: Oil rig application
  - Case study II: Aerospace application
  - Case study III: Chemical industries application