Heat Treatment: Principles and Practice
1 Day Course

Key Learning Objectives:

- Understand the important structure-property relationships in ferrous and non-ferrous metals and how heat treatment is used to modify structure and properties.
- Appreciate the distinction between equilibrium phase, TTT and CCT diagrams (Fe-Fe3C phase diagram example).
- Understand how cooling rate influences steel hardness and gain familiarity with heat treatment regimes for steels and the microstructures that are developed.
- Learn about hardenability and how quench severity, carbon content, grain size and other alloying elements influence it.
- Know the important categories of non-ferrous alloys and the typical heat treatments used to develop the required microstructure/properties.
- Understand the basic principles of carburising/carbonitriding and nitriding/nitrocarburising and the effect these treatments have on surface structure and properties.
- Appreciate the different furnace types used in heat treatment and how they are monitored and controlled.

Who Should Attend:

This Course:

- This course suits managers and technicians working in QA and heat treatment of metals & metal products. It is also relevant to designers, specifiers & commercial people.
- The course aims to provide a grounding in the heat treatment regimes applied to common industrial metals and relates their properties to the microstructural changes induced by the treatments.
- Includes a comprehensive technical manual.

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BSSA
Section 1: Introduction to Underlying Metallurgical Principles
- Definition of heat treatment: commonly heat treated ferrous and non ferrous metals
- Structural relationships: atoms, crystals, grains and macroscopic shape
- Metallurgy primer: metal crystal structures (BCC, FCC, HCP), strengthening mechanisms, role of defects, binary phase diagrams
- Mechanical properties: strength, hardness, ductility and toughness

Section 2: Heat Treatment of Ferrous Metals
- Fe-Fe3C phase diagram - extended to TTT plot for eutectoid steel, effect of cooling rate on microstructural evolution
- TTT and CCT diagrams
- Common phases in steel: austenite, ferrite, pearlite, bainite and martensite
- Heat treatment regimes: conventional quench, martempering, austempering
- Hardenability concept – effect of section thickness and alloying

Section 3: Heat Treatment of Non Ferrous Metals
- Aluminium alloys: alloy designation, focus on 2000 and 7000 series, typical heat treatments—aging transformations
- Magnesium alloys: common designation of casting grades, major alloy groups, heat treatment and microstructure/properties
- Titanium alloys: α, α + β, β alloys and typical heat treatments
- Nickel based superalloys: role of alloying elements, heat treatments & evolution of gamma prime (γ')
### Section 4: Thermochemical Treatments
- **Definition of case hardening**
- **Carburising methods**: solid, liquid, gas and plasma based processes
- **Carburising procedure**: continuous line layout, case depth vs process time, hardness & residual stress profiles
- **Nitriding and nitrocarburising methods**: line layout, pre and post oxidation treatments
- **Properties of nitrided steel**: hardness profiles, adhesive wear, fatigue and corrosion data

![Carburising Treatment: (a) Hardness vs Carbon Content, (b) Typical Gas Carburising Cycle](image)

### Section 5: Furnaces: Batch, Continuous and Induction
- **Batch furnace types**: car bottom, tip-up, pit, bell and hood etc.
  - advantages and disadvantages
- **Continuous furnace types**: pusher-tray, mesh belt, roller hearth, walking beam etc.
  - advantages and disadvantages
- **Induction heat treatment**: skin depth and effect of frequency, coil design, applications
- **Cryogenic treatment for retained austenite**

![Batch Heat Treatment: Integral Quench Furnace](image)

### Section 6: Furnaces: Temperature Measurement, Atmospheres and Fuels
- **Temperature measurement**: thermocouples, pyrometers (optical/radiation) - measuring principle, types and applications
- **Manual and automated temperature control, zoning**: practical considerations
- **Furnace atmospheres**: metal carburisation, decarburisation, and oxidation
- **Characteristics of oil, gas & electric fuelled furnaces**

![Critical Requirements for Oxidation of Metals in Oxygen, H₂O and H₂ Containing Atmospheres](image)
Heat Treatment: Principles and Practice - Booking Form

Please reserve the following places on the Mechanical Testing Techniques course:
BSSA Member (£190 + VAT) / Non-Member (£250 + VAT) (delete as appropriate)

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N.B. All invoices and event information will be emailed to this address

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Name on card ___________________________   Signed ___________________   Date ___________________