

Carrying out heat treatment of engineering materials

Overview

This standard covers a broad range of basic competences that you need, to apply specified heat treatment processes to engineering materials/components. It will prepare you for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

You will be expected to prepare for the heat treatment activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how you intend to carry out the required heat treatment activities.

You will be required to prepare the appropriate equipment to use, based on the heat treatment process and materials to be treated. You will be expected to use the specified or appropriate techniques to prepare the materials and equipment in readiness for the application of the treatments. The heat treatment activities will include the application of treatments such as flame hardening, case hardening, carburising, tempering, annealing and normalising, as applicable to the task.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the heat treatment activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, and to seek appropriate help and advice in determining and implementing a suitable solution. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate heat treatment techniques and procedures safely. You will understand the heat treatment techniques used, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

You will understand the safety precautions required when carrying out the heat treatment operations, and when using the associated tools and equipment. You will be required to demonstrate safe working practices throughout, and will understand your responsibility for taking the necessary safeguards to protect yourself and others in the workplace.

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Performance criteria

You must be able to:

1. work safely at all times, complying with health and safety legislation, regulations, directives and other relevant guidelines
2. plan the heat treatment activities before you start them
3. prepare the materials in readiness to receive the appropriate heat treatment
4. check that the heat treatment equipment is set up and maintained at satisfactory operating conditions
5. carry out the heat treatment process, using appropriate techniques and procedures
6. check that the finished material achieves the required characteristics and meets the heat treatment specification
7. deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve
8. shut down the heat treatment equipment to a safe condition on completion of the activities
9. leave the work area in a safe condition on completion of the heat treatment activities

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Knowledge and understanding

You need to know and understand:

1. the specific health and safety precautions which must be taken when carrying out heat treatment processes (such as wearing protective clothing and protective equipment, using fume extraction equipment)
2. the hazards associated with carrying out heat treatment processes (such as handling hot materials, using heat treatment solutions, fume inhalation, splashes from hot oil or liquids, fire and explosive mixtures), and how they can be minimised
3. the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as leather aprons, eye protection, overalls, face masks, breathing equipment)
4. the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed
5. the importance of following job instructions and defined heat treatment procedures
6. how to obtain the required information on heat treatment temperatures, tempering colours, soak times and quenching/cooling methods to be used
7. the various types of material that can be flame hardened, case hardened, tempered, normalised and annealed
8. the material preparation methods and techniques to be undertaken prior to applying the heat treatments (such as removing scale, oil and dirt; masking surfaces to contain the case hardening or carburising deposits; polishing surfaces to be tempered; packing or coating the components with a carbon enriched material; pre-heating before immersion into a salt bath)
9. the specific heat treatment process to be carried out, and the types of application for which they are best suited (such as flame hardening, case hardening, carburising, annealing, tempering and normalising)
10. the basic principles of operation of the specific heat treatment process being carried out
11. how to prepare the equipment for the heat treatment activities (such as setting furnace or salt bath controls to give correct temperature; the procedure for lighting and extinguishing the blacksmith's forge; setting up gas torches; ensuring that suitable tongs/handling devices are available)
12. the visual checks to be made on the components prior to carrying out the surface treatment activities (such as checking that they are dry, have been pre-heated or are correctly masked up)
13. the need to make certain that all components and jigs are completely free of water or other solvents prior to immersing them in a hot solution, and the potential consequences of failing to check

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14. the methods used to hold/secure components in a heat treatment solution (such as wires, hooks, jigs)
 15. the importance of monitoring the equipment settings and process solutions during the heat treatment process
 16. heating the components to the correct temperature for the process being carried out (such as hardening temperatures for various carbon contents; soak times at set temperatures for carburising, annealing or normalising; temperatures and colours for various tempering applications), and why these must be adhered too
 17. the quenching and cooling methods to be used (such as fresh water, salt water, oil, sand, air and leaving the components in the furnace to cool naturally)
 18. the need to maintain quenching oil at a temperature below its flash point
 19. how to check the finished work after heat treatment (such as visual checks for cracks or distortion; using simple file or spark tests to check that hardening or annealing has been achieved; the use of dye penetrant and magnetic particle tests; the use of specialised hardness tests)
 20. the problems that can occur with the heat treatment operations, and how these can be overcome
 21. when to act on your own initiative and when to seek help and advice from others
 22. the importance of leaving the work area and equipment in a safe and clean condition on completion of the heat treatment activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

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Scope/range related to performance criteria

1. Carry out **all** of the following during the heat treatment activities:
 1. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 2. follow job instructions and heat treatment process specifications and procedures
 3. ensure that the equipment is correctly prepared for the heat treatment operations being performed
 4. store all tools and equipment on completion of the heat treatment activities
 5. dispose of waste and excess materials, in line with agreed organisational procedures
2. Carry out **three** of the following heat treatment processes:
 1. flame hardening
 2. carburising
 3. annealing
 4. case hardening
 5. tempering
 6. normalising/stress relieving
3. Apply heat treatments to **two** different types of material from the following:
 1. low carbon steel
 2. chilled cast iron
 3. copper
 4. high carbon steel
 5. welded fabrications
 6. silver/tool steel
 7. other materials (specify)
4. Prepare the components for the heat treatment activities, by carrying out **two** of the following:
 1. removing scale
 2. masking
 3. pre-heating
 4. degreasing/cleaning
 5. polishing area to be tempered

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5. Use **two** of the following methods of heating the components:
 1. furnace
 2. gas torches
 3. blacksmith's forge
 4. salt/chemical baths
6. Use **two** of the following methods of quenching/cooling the material:
 1. fresh water
 2. oil
 3. sand
 4. salt water
 5. air
 6. leave in the furnace to cool
7. Carry out the heat treatment activities to include **all** of the following:
 1. lighting up the furnace/forging or torch, using approved procedures
 2. setting the equipment to maintain the correct conditions (such as soak time, temperature)
 3. checking that the components are correctly prepared for the required heat treatment activities (such as dry, at the correct temperature, correctly polished or masked, packed with carbon enriched material)
 4. checking that there is sufficient cooling medium (so that it will not overheat or reach flash point)
 5. loading the components safely into the heat source/solution
 6. ensuring that components are left for the required induction period
 7. removing the components from the heat source/solution safely and correctly
 8. quenching/cooling the components, using the appropriate medium and technique
8. Carry out simple checks on the heat treated components, to include **two** of the following:
 1. visual checks for cracks or distortion
 2. NDT tests (such as dye penetrant, magnetic particle, ultrasonic)
 3. simple physical checks to confirm that hardening or annealing has been achieved (such as grinding wheel spark tests, file test)
 4. specific hardness tests (such as Vickers, Brinell)
9. Carry out heat treatment processes which comply with **all** of the

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following:

1. the final heat treated material is in line with the specification or job requirements
2. the heat treated material is free from defects
3. the heat treatment process meets customer/company requirements

Behaviours

Additional Information

You will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as:

- strong work ethic
- positive attitude
- team player
- dependability
- responsibility
- honesty
- integrity
- motivation
- commitment

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