SEMPEO249

Producing and preparing molten materials for casting

Overview

This standard covers a broad range of basic competences that you need to prepare and process the materials used in the production of molten materials, to produce cast components using moulds and shells. 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 melting activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how you intend to carry out the required activities and the sequence of operations you intend to use.

You will be required to prepare the appropriate equipment to use, based on the type and amount of molten material needed. This includes ferrous and non-ferrous alloys, plastic/polymers and liquid ceramics. You will prepare the base material for insertion into the melting furnace, and will start up the furnace, and charge the base material plus any other specified materials or additions into the melting vessel at the specified time. You will also adjust the furnace operating conditions to suit the molten material requirements. You will be expected to discharge the molten material into the receiving vessel or to other holding furnaces, as appropriate.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the preparation and control of the melting activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the base materials, additives or 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 preparation and control procedures safely for the production of molten materials for casting. You will understand the melting techniques used, and their application, and will know about the equipment, materials, consumables and tests that are used to confirm that the process is under control, 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 melting operations, and when using the associated tools and equipment, especially those involved in handling and pouring the molten material. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

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 material melting activities before you start them
3. set up the operating conditions of the melting furnace, making any necessary adjustments to maintain satisfactory operating conditions
4. obtain the required charge materials, and check that they are in a suitable condition to use
5. start up the furnace, using approved procedures, and add the materials at the appropriate time
6. carry out appropriate tests of the molten material at suitable intervals, in order to achieve the material 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. dispose of waste and excess materials safely and correctly
9. leave the work area in a safe and tidy condition on completion of the melting activities

Knowledge and understanding

You need to know and understand:

1. the specific safety precautions to be taken when working with melting furnaces and molten materials (such as wearing full protective clothing and protective equipment; minimisation of dust and fume, ensuring adequate ventilation/fume extraction, and the elimination of slipping or tripping hazards)
2. the COSHH regulations that apply when dealing with charge materials, furnace additions and additives
3. the hazards associated with working with melting furnaces and molten materials (such as splashes and spills of molten materials; dust and fumes; handling hot and heavy materials), and how they can be minimised
4. the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
5. the emergency procedures to be followed in the event of a malfunction of any melting furnace, holding ladle or pouring vessels in use
6. why it is important to keep the furnace and melting equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area
7. the importance of following job instructions and defined casting procedures
8. manual lifting techniques and requirements on acceptable weights to be handled by hand
9. the various types and applications of material melting furnace that are used (such as rotary and cupola types; crucible types such as lift out, push up, bale out, and tilting; electric furnaces such as induction arc and resistance)
10. how to check that the furnace and its linings are in a safe and serviceable condition
11. how to identify the various charge materials you are to use in producing the cast components
12. the various forms of materials used in the melting process (such as ingots, granules, powders, bought-in scrap and scrap components for re-melting)
13. why it is necessary to check the amounts of materials, prior to commencing melting operations
14. the effects on the melting operation and the molten material if the base materials are out of date, different in content from the specification requirements, added to the furnace/melt at the wrong time or temperature, or when wet or damp,

or if too little or too much is added to the melt
15. the reasons why furnace start-up procedures are performed, and why these must always be adhered to
16. the methods of charging the furnaces, and the precautions to be taken when adding materials to molten liquids
17. the reasons for preheating some materials prior to furnace charging
18. the additions that are made to the material/metals/alloys to aid the melt or produce and/or correct the material specification
19. how to establish melting and pouring temperatures and how to set the furnace/crucible controls to give the required melt conditions
20. the methods of checking when the molten material is at the required temperature (such as by visual means, by use of fixed and optical pyrometers)
21. the actions to take if the molten material is outside the specified temperature range
22. methods of checking chemical composition by spectrographic or chemical analysis of samples from the melt
23. the defects in castings which can be directly related to the use of molten material which is outside the specified temperature range, or which is untreated, or is treated but casting is delayed, or to the use of un- skimmed metal/material
24. when to act on your own initiative and when to seek help and advice from others
25. the importance of cleaning the furnace/crucible in accordance with the furnace/crucible manufacturer's instructions
26. the importance of leaving the work area in a safe and clean condition on completion of the melting activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Scope/range related to performance criteria

1.

Prepare the furnace for operation, to include **all** of the following, as appropriate to the equipment used:

1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.2 follow job instructions, melting specifications and procedures
1.3 ensure that services/power supplies are connected, and operational and start-up procedures are initiated
1.4 check that guards/screens are in position and operational
1.5 check that emergency stop controls are operational
1.6 check that visual display panels are operational
1.7 ensure that supply and discharge outlets are clear and operational
1.8 check that furnace linings and equipment are in a safe and usable condition
1.9 shut down the furnace to a safe condition on completion of the melting activities
1.10 return all tools and equipment to the correct location on completion of the melting activities

2.

Prepare the materials used in the casting process, and check that they are to the required specification, to include **all** of the following:

2.1 selection and preparation of the base charge materials (such as scrap, ingots, returns)
2.2 selection and preparation of any additives and additions (such as fluxes, alloys, trimming additions, inhibitors, de-oxidisers, colour – relevant for plastics and ceramics only)
2.3 selection and preparation of any fuel charge materials

3.

Produce molten materials, using **one** of the following types of furnace:

3.1 cupola
3.2 bale out
3.3 direct or indirect arc
3.4 induction (high or medium frequency)
3.5 lift out crucible
3.6 tilting crucible
3.7 rotary
3.8 other melting furnaces (specify)

4.

Produce molten material from **one** of the following:

4.1 ferrous alloys
4.2 non-ferrous alloys

4.3 plastic/polymers
4.4 liquid ceramics

5.

Monitor the melting process, to include **all** of the following:

5.1 measuring the melt temperature (such as visually, immersion pyrometer, visual display units)
5.2 adjusting the operating conditions of the melting furnace (such as melting rate by changing the power or fuel input)
5.3 making necessary additions to the melt
5.4 where applicable, informing appropriate people of non-conformance of the molten material
5.5 confirming that the melt is ready for casting

6.

Carry out treatment of the melting/molten material, to include **two** of the following:

6.1 adding deoxidising agents to charge material
6.2 adding oxidising agents to charge material
6.3 adding alloying elements
6.4 adding nucleants
6.5 deoxidising molten material
6.6 modification of molten material
6.7 adding cover fluxes to charge material
6.8 degassing molten material
6.9 grain refining of molten metal
6.10 removal of slag/oxide skins/impurities

7.

Take samples of the molten material, for **one** of the following types of test:

7.1 carbon equivalent measurement
7.2 chemical analysis
7.3 X-ray fluorescence spectrometry (XRF)
7.4 spark emission spectrometry
7.5 wedge tests
7.6 tensile tests
7.7 hydrogen gas content

8.

Discharge the molten material from the furnace into **one** of the following:

8.1 holding furnace
8.2 prepared pouring ladles
8.3 prepared treatment ladles
8.4 other holding/casting vessels/pigs

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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