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(54) Title: METHOD FOR THE MANUFACTURING OF ELEMENTS OF NON-FERROUS METAL ALLOYS, ADVANTAGEOUSLY ALUMINIUM ALLOYS

(57) Abstract: The subject of the invention is a method for the manufacturing of elements of non-ferrous metal alloys, advantageously aluminium alloys, used for the manufacturing of shaped elements, in particular rods, in thermal treatment of metal s. It is characterized in that the charge will be subjected to plastic working of at least 60% deformation, advantageously by pressing with the degree of processing exceeding the value of 2, at a temperature below the range of occurrence of a solid solution, after which the obtained element undergoes the supersaturation process by heating it up to the temperature of occurrence of a solid solution and keeping it at this temperature for a period of 2-25 minutes, advantageously 5 minutes, and then rapidly cooled, advantageously using water, to the ambient temperature, after which it is subjected to the ageing process.

Method for the manufacturing of elements of non-ferrous metal alloys, advantageously aluminium alloys

The subject of the invention is a method for the construction of elements of non-ferrous metal alloys, advantageously aluminium alloys, used for the manufacturing of shaped elements, in particular rods, in thermal treatment of metals.

In order to achieve high strength properties, alloys with different solubility when solid, in particular finished products or semi-finished products undergo thermal treatment, which consists of a supersaturation operation and ageing operation, or thermal and thermo-mechanical treatment, composed of, in the following order: supersaturation operation, plastic deformation and ageing operation.

The supersaturation operation consists of heating the alloy to temperature from the range of a solid solution, annealing it for a time necessary to dissolve the secondary phase particles and rapid cooling, as a result of which the alloy in the ambient temperature remains in a single-phase structure, which will be thermodynamically unstable and will transform during the ageing operation. This operation consists of the heating of the supersaturated alloy to the temperature below the solubility limit

and annealed for the time required for precipitation from the supersaturated solid solution of phases with a high degree of dispersion.

Usually, the thermal treatment is conducted on elements with initially or finally shaped geometry, as a result of casting, machining or plastic working. If plastic working is conducted in an appropriately high temperature, which guarantees the alloy will achieve the structure of a solid solution, rapid cooling of the deformed element will result in its supersaturation. In particular, in case of high-temperature pressing of the alloy, the supersaturation may be performed directly at the press delay route, through intensive cooling of the compact, usually with water. Single-phase structure of the alloy, which results from the supersaturation operation, increases its plastic properties and enables intense plastic working of the alloy, up to achieving a product with final geometry, and subsequently the used aging process, as well as the assumed mechanical properties.

Since the annealing of the alloy in an appropriately high temperature, which is an element of the supersaturation, is intended to dissolve the phases and obtain a solid solution, the time of annealing necessary for the full occurrence of the heat activated process of diffusion of alloy components amounts usually from 1 to a few hours. The conditions of alloy annealing are not differentiated depending on whether it was or was not subjected to initial plastic working.

In accordance with the method of aluminium alloy element manufacturing, a charge with dimensions of Ø40 x 40 mm, of a 7075 aluminium alloy, was pressed on a hydraulic press with a speed of 0.5 mm/s within a temperature of 450°C to which both the charge and the working tools

were heated, after which the charge was annealed within this temperature for 2 hours. The obtained rod with a diameter of 12 mm was immediately cooled with water. Then, the rod was aged by annealing at a temperature of 150°C for a time of 3 hours. As a result, the rod obtained a hardness of 160 HV.

In accordance with another used so far method of manufacturing of aluminium alloy elements, in particular of 7075 aluminium alloy, a charge with dimensions of Ø40 x 40 mm was pressed on a hydraulic press equipped with a mechanical system resulting in oscillating rotation of the die along its axis with an angle of ± 8° with a frequency of 5 Hz. The process of pressing was conducted at a speed of 0.5 mm/s at a temperature of 20°C, without initial heating of the charge and the tools, obtaining a rod with a diameter of 12 mm, which was immediately cooled in water. Then, the rod was aged by annealing at a temperature of 150°C for a time of 3 hours. As a result, the rod obtained a hardness of 137 HV.

The essence of the invention, which is a method of manufacturing non-ferrous metal alloy elements, with the use of plastic working and thermal treatment, advantageously aluminium alloys, consists of the metallic charge being subjected to a plastic deformation of at least 60%, advantageously by pressing with the extrusion ratio exceeding the value of 2, at a temperature below the range of occurrence of a solid solution, after which the obtained element undergoes the supersaturation process by heating it up to the temperature of occurrence of a solid solution and keeping it at this temperature for a period of 2-25 minutes, advantageously 5 minutes, and then rapidly cooled, advantageously using water, to the ambient temperature, after which it is subjected to the ageing process.

It is advantageous when plastic working is conducted by pressing with oscillating rotations of the die along its axis with an angle in the range of ±(4–25)° and a frequency in the range of 1–15 Hz.

It is also advantageous when plastic working is conducted by rolling, with at least one of the working rollers moving along its axis or an additional working tool, restricting the roll gap, whereas the movement range may not be higher than 10 mm, and the frequency may not be lower than 2 Hz.

The use of the solution presented in the invention obtains a technical and utility effect, which is the shortening of the time needed to anneal alloys during a supersaturation operation, while simultaneously increasing its strength properties. The higher the deformation obtained before the thermal or thermal and mechanical treatment is, the shorter the annealing time, whereas the minimum deformation value should be 60%. The most advantageous effects are obtained when the initial deformation of the alloy is conducted in condition of a variable deformation path, implemented by the change of the load scheme, which is obtained in the pressing process through the additional use of oscillating die rotations along its axis by an angle in the range of ±(4–25)° and a frequency in the range of 1–15 Hz.

Shortening the annealing time in the supersaturation operation with the method presented in the invention is possible due to the generation during the initial deformation of the alloy an above-equilibrium concentration of point defects, advantageously in the conditions of change of the path of deformation. On one hand, these defects along with the atoms of alloying elements in the temperature below the temperature of occurrence of a solid solution create relatively mechanically and thermally stable nano-sized

clusters, which hinder the diffusion, and thus the effectiveness of the aging operation. On the other hand, if the aging operation will be preceded by a classic supersaturation operation, including short-term annealing at the temperature from the range of a solid solution presence, the clusters dissolve and point defects are released, significantly accelerating the new phase precipitation. Thus, the higher the annealing temperature is in the super-saturation operation, the shorter the super-saturation time.

The method presented in the invention results in the increase of the strength properties of the products and the efficiency of technological processes including the thermal and thermo-mechanical treatment, is energy-saving and environmentally friendly.

Example

Charge of the 7075 aluminium alloy with dimensions of Ø40 x 40 mm was pressed on a hydraulic press equipped with a mechanical system resulting in oscillating rotation of the die along its axis with an angle of ± 8° with a frequency of 5 Hz. The process of pressing was conducted at a speed of 0.5 mm/s at a temperature of 20°C, without the initial heating of the charge and the tools, obtaining a rod with a diameter of 12 mm, which after air cooling was subjected to rod super-saturation operation, which includes 2 min long heating up to a temperature of 470°C, holding this temperature for 5 min, after which rapid cooling with water was conducted. Then, the rod was aged by annealing at a temperature of 150°C for a time of 3 hours. As a result, the rod obtained a hardness of 192 HV.

Claims

1. A method of manufacturing non-ferrous metal alloy elements, with the use of plastic working and thermal treatment, advantageously aluminium alloys, characterized in that the charge will be subjected to plastic working of at least 60% deformation, advantageously by pressing with the extrusion ratio exceeding the value of 2, at a temperature below the range of occurrence of a solid solution, after which the obtained element undergoes the supersaturation process by heating it up to the temperature of occurrence of a solid solution and keeping it at this temperature for a period of 2-25 minutes, advantageously 5 minutes, and then rapidly cooled, advantageously using water, to the ambient temperature, after which it is subjected to the ageing process.

2. A method in accordance with claim 1, characterized in that plastic working is conducted by pressing with oscillating rotations of the die along its axis with an angle in the range of ±(4–25)° and a frequency in the range of 1–15 Hz.

3. A method in accordance with claim 1, characterized in that plastic working is conducted by rolling, with an over the axis movement of at least one of the working rollers or an additional working tool, restricting the roll gap, whereas the movement range may not be higher than 10 mm, and the frequency may not be lower than 2 Hz.