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(54) **METHOD OF VERTICAL POURING LARGE-SIZE MASSIVE PLATE CASTINGS**

(57) The method involves preparing two mutually fitting parts of the mould, each of them in an independent moulding flask standing on a mould base with a pattern along with centering elements placed therein, provided with at least one active cooling segment fixed inside it, with a shape matching the casting and known heat capacity, wherein during the sprinkling of the pattern a gating system is formed and the process of vibratory compaction of the moulding sand is initiated, causing vibrations of the entire system with a near-resonance frequency. Once the moulding sand has set, both moulding flasks are clamped together, and subsequently raised to a vertical position, and a priming tank is installed on the upper wall of the flask, and hoses connecting the collector to active cooling segments are attached, upon which the mould is filled with liquid metal, and the process of cooling the casting with water mist is started.

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Description

[0001] The object of the invention is a method for vertical filling of the moulds of large-sized massive plate castings.

[0002] Large-sized castings, in particular massive flat castings, are typically prepared in a horizontal position. This is associated with the existence of multiple problems, such as, for example, nonuniform crystallisation or nonuniform solidification of the castings, which results in multiple defects of the final castings, difficult to avoid. The basic imperfections are the defects of the upper surface of the casting, matched by the upper part of the mould cavity, such as: local bulges, depressions, warps and twists of the casting, which occur as a result of heavy thermal radiation affecting the mould cavity. The thermal radiation of liquid metal towards the surface of the upper part of the mould causes numerous surface defects, such as pits, sinters or burns. On the other hand, metal structure porosities (called microshrinkages) and even the creation of the so-called shrinkage cavities can occur inside the castings.

[0003] The essence of the solution according to the invention is in that two mutually fitting parts of the mould are prepared, each of them in an independent moulding flask standing on a mould base with a pattern along with centering elements placed therein, provided with at least one active cooling segment fixed inside it, with a shape matching the casting and known heat capacity. Each pattern is first sprinkled with facing sand with an increased strength, and subsequently with filling material, wherein during the sprinkling of the pattern a gating system is formed and the process of vibratory compaction of the moulding sand is initiated, causing vibrations of the entire system with a near-resonance frequency, continuing for a further time corresponding to 10% of the total duration of filling the moulding flask.

[0004] Subsequently, once the moulding sand has set, the patterns are removed, and an isopropyl alcohol-based mould coating is applied onto the inner portions of the mould parts, upon which, after its evaporation from the mould coating, both mould parts placed in two moulding flasks are assembled and glued together by means of sealing glue, upon which both moulding flasks are clamped together by wedge-bolt clamping elements. When the sealing glue has set, the whole is raised to a vertical position, upon which a priming tank is installed on the upper wall of the flask, and hoses connecting the collector to active cooling segments are attached, upon which the mould is filled with liquid metal. Once the mould is filled with liquid metal, the process of cooling the casting with water mist is started.

[0005] Preferably, the degree of compaction of the filling material is no lower than 1.5 g/cm^2 , and its strength after 24 h is no lower than 260 N/mm^2 . Preferably, the deflection of the moulding flask over a length of 1 m does not exceed 0.5 mm.

[0006] In a preferable embodiment, the active cooling

segment consists of at least two steel plates with a shape matching the casting and known heat capacity, permanently connected to a tube coil connected by a flexible hose with a proper cross-section to a compressed air supply module, provided with a supply collector connected to a pneumatic network, a proportional air flow regulator, and an injector, which is connected to a proportional water flow regulator, connected to the water mains.

[0007] Preferably, the facing sand consists of fresh sand and a cement with resins containing furfuryl alcohol.

[0008] Preferably, the filling material consists of fresh sand or reclaimed rubber in an amount of no less than 85 parts by weight, and a cement with resins containing furfuryl alcohol in an amount of no more than 15 parts by weight.

[0009] Preferably, zircon flour is a component of the mould coating.

[0010] Preferably, vibrations with a near-resonance frequency are triggered by means of electric vibrators attached to the outer walls of the moulding flask in a manner ensuring the generation of a driving force in a horizontal direction, parallel to the plane of the mould base.

[0011] Preferably, the number and distribution of dampers depend on the mass and dimensions of the mould.

[0012] In a preferable embodiment, the dampers are distributed along the opposite sides of the mould base.

[0013] Preferably, the rotational speed of the electric vibrators is variable within a range from 0 to 12,000 rpm.

[0014] Preferably, the value of the maximum driving force is adjusted by changing the amount and magnitude of eccentric masses before starting the compaction process of the moulding sand.

[0015] Preferably, the value of accelerations of the vibrating set measured in every point thereof falls within a range from 80 to 120 m/s^2 .

[0016] Preferably, cooling with water mist proceeds in such a manner that compressed air is introduced into the tube coils, upon which its temperature is controlled in a continuous manner, and after reaching an air temperature of 105°C , water is introduced into the system and mixed with compressed air, generating water mist, which constitutes a cooling medium; further in the process, the pressure and flow of the coolant as well as the degree of saturation of air with water are controlled and adjusted, thus changing the intensity of heat extraction from the steel plates; on the other hand, when the temperature of the cooling medium drops below 105°C , the inflow of water is closed, and the cooling process ends when the temperature of the coolant drops below 80°C .

[0017] Most preferably, compressed air is introduced into the coils with a rate ranging from 300 to 1000 l/min.

[0018] The advantage of the solution according to the invention is the production of large-sized castings lacking defects such as slag inclusions, sand inclusions, and non-metallic inclusions. The responsible parts of the casting are present practically in the lower part of the mould. Preparation of castings according to the de-

scribed method limits technological allowances for mechanical treatment, due to which the weight of raw castings is reduced considerably, and the time of machining is shortened significantly. The use of the technology in question eliminates or considerably reduces geometrical defects of castings related to flatness or rectilinearity.

[0019] Due to the use of near-resonance frequencies originating from small vibrators, an optimally compacted moulding sand in the moulds of large-sized massive castings is produced in an uncomplicated and fully automated process.

[0020] The use of active cooling segments provides a stable process for cooling large-sized castings, the ability to precisely control this process, and to improve the microstructure of a casting undergoing solidification, as well as the geometrical, dimensional, utilitarian and qualitative properties of the final product.

[0021] The solution according to the invention is illustrated in an embodiment.

Embodiment I

[0022] A furan mass mould is prepared in a horizontal position. A gating system is made of ceramic moulds representing main, distribution and supply gates, in order to avoid possible inclusions originating from the gating system and mould erosion. The pattern is sprinkled using two layers of various moulding sands: a facing sand with a greater strength, whose function is to increase the rigidity of the mould in the metal-mould contact area, and a sand with a normal strength, filling the remaining space of the mould. The facing sand consists of fresh sand and a cement with resins containing furfuryl alcohol. The filling material consists in a proportion of 15 to 85 parts by weight of the following: fresh sand or reclaimed rubber in an amount of 15 parts by weight, as well as a cement with resins containing furfuryl alcohol. In order to improve the degree of compaction of the moulding sand, mechanical compaction by means of two electric asynchronous vibratory sets was used instead of manual compaction. For moulding in moulding flasks, tube installations (coils) were mounted for cooling with water mist along with active chills. The operating principle of the system has been formulated so as to direct the action of volumetric control elements (chills) towards specific surfaces of the casting, while the cooling coils are supposed to assist the chills, but primarily expedite the discharge of heat from the entire mould. The mould technology strictly regulates the type of moulding sand used to make the casting mould, its composition and parameters. Measurements of the binding kinetics of the sand use an innovative method of testing the sand by means of a portable device determining the degree of cure of the moulding sand produced using the technology of self-curing materials. Tests of the degree of compaction of the sand were performed by cutting a sample from a final casting mould, and the degree of compaction was determined based on the calculated density of the collected samples.

Claims

1. A method for vertical filling of the moulds of large-sized massive plate castings **characterised in that** two mutually fitting parts of the mould are prepared, each of them in an independent moulding flask standing on a mould base with a pattern along with centering elements placed therein, provided with at least one active cooling segment fixed inside it, with a shape matching the casting and known heat capacity; subsequently, each pattern is first sprinkled with facing sand with an increased strength, and subsequently with filling material, wherein during the sprinkling of the pattern a gating system is formed and the process of vibratory compaction of the moulding sand is initiated, causing vibrations of the entire system with a near-resonance frequency, continuing for a further time corresponding to 10% of the total duration of filling the moulding flask, and once the moulding sand has set, the patterns are removed, and an isopropyl alcohol-based mould coating is applied onto the inner portions of the mould parts, upon which, after its evaporation from the mould coating, both mould parts placed in two moulding flasks are assembled and glued together by means of sealing glue, upon which both moulding flasks are clamped together by wedge-bolt clamping elements; and subsequently, when the sealing glue has set, the whole is raised to a vertical position, upon which a priming tank is installed on the upper wall of the flask, and hoses connecting the collector to active cooling segments are attached, upon which the mould is filled with liquid metal, and the process of cooling the casting with water mist is started.
2. The method according to claim 1, **characterised in that** the degree of compaction of the filling material is no lower than 1.5 g/cm², and its strength after 24 h is no lower than 260 N/mm².
3. The method according to claim 1 or 2, **characterised in that** the deflection of the moulding flask over a length of 1 m does not exceed 0.5 mm.
4. The method according to claim 1, **characterised in that** the facing sand consists of fresh sand and a cement with resins containing furfuryl alcohol.
5. The method according to claim 1, **characterised in that** the filling material consists in a proportion of 15 to 85 parts by weight of the following: fresh sand and reclaimed rubber as well as a cement with resins containing furfuryl alcohol.
6. The method according to claim 1, **characterised in that** zircon flour is a component of the mould coating.
7. The method according to claim 1, **characterised in**

that vibrations with a near-resonance frequency are triggered by means of electric vibrators attached to the outer walls of the moulding flask in a manner ensuring the generation of a driving force in a horizontal direction, parallel to the plane of the mould base.

8. The method according to claim 1, **characterised in that** the number and distribution of dampers depend on the mass and dimensions of the mould. 5 10
9. The method according to claim 1 or 8, **characterised in that** the dampers are distributed along the opposite sides of the mould base. 15
10. The method according to claim 1 or 7, **characterised in that** the rotational speed of the electric vibrators is variable within a range from 0 to 12,000 rpm.
11. The method according to claim 1, **characterised in that** the value of the maximum driving force is adjusted by changing the amount and magnitude of eccentric masses before starting the compaction process of the moulding sand. 20 25
12. The method according to claim 1, **characterised in that** the value of accelerations of the vibrating set measured in every point thereof falls within a range from 80 to 120 m/s². 30
13. The method according to claim 1, **characterised in that** an active cooling segment consists of at least two steel plates with a shape matching the casting and known heat capacity, permanently connected to a tube coil connected by a flexible hose with a proper cross-section to a compressed air supply module, provided with a supply collector connected to a pneumatic network, a proportional air flow regulator, and an injector, which is connected to a proportional water flow regulator, connected to the water mains. 35 40
14. The method according to claim 1, **characterised in that** cooling with water mist proceeds in such a manner that compressed air is introduced into the tube coils, upon which its temperature is controlled in a continuous manner, and after reaching an air temperature of 105°C, water is introduced into the system and mixed with compressed air, generating water mist, which constitutes a cooling medium; further in the process, the pressure and flow of the coolant as well as the degree of saturation of air with water are controlled and adjusted, thus changing the intensity of heat extraction from the steel plates; on the other hand, when the temperature of the cooling medium drops below 105°C, the inflow of water is closed, and the cooling process ends when the temperature of the coolant drops below 80°C. 45 50 55

15. The method according to claim 14, **characterised in that** compressed air is introduced into the coils with a rate ranging from 300 to 1000 l/min.



EUROPEAN SEARCH REPORT

Application Number

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Examiner

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CATEGORY OF CITED DOCUMENTS

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ON EUROPEAN PATENT APPLICATION NO.**

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