A METHOD FOR BILAYER AND DOUBLE-SIDED IRON CASTINGS

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Of major importance for many industries is the increase of reliability, durability and performance of units, components of machinery and equipment with concurrent cost reduction.

To ensure these requirements is possible by replacing monometallic parts by bilayer or double-sided parts with different properties of some members.

The examples of bilayer components could be mill rolls, bushings, rollers, jaws crusher cheeks, armor plates, slide-ways for bulk materials; the examples of double-sided components are jackhammer bits, plowshares, excavator bucket teeth etc.

The work area or operating surface of such parts should possess high hardness and wear resistance, while the core or the mounting fastener should be resistant to impact, possess toughness and improved machinability, unlike the hard operating layer.

It is known that high hardness and wear resistance of materials can be provided by white cast iron with carbide inclusions of iron, chromium and other alloying elements, while improved ductility and impact strength can be provided by ferritic high-strength cast iron [1].

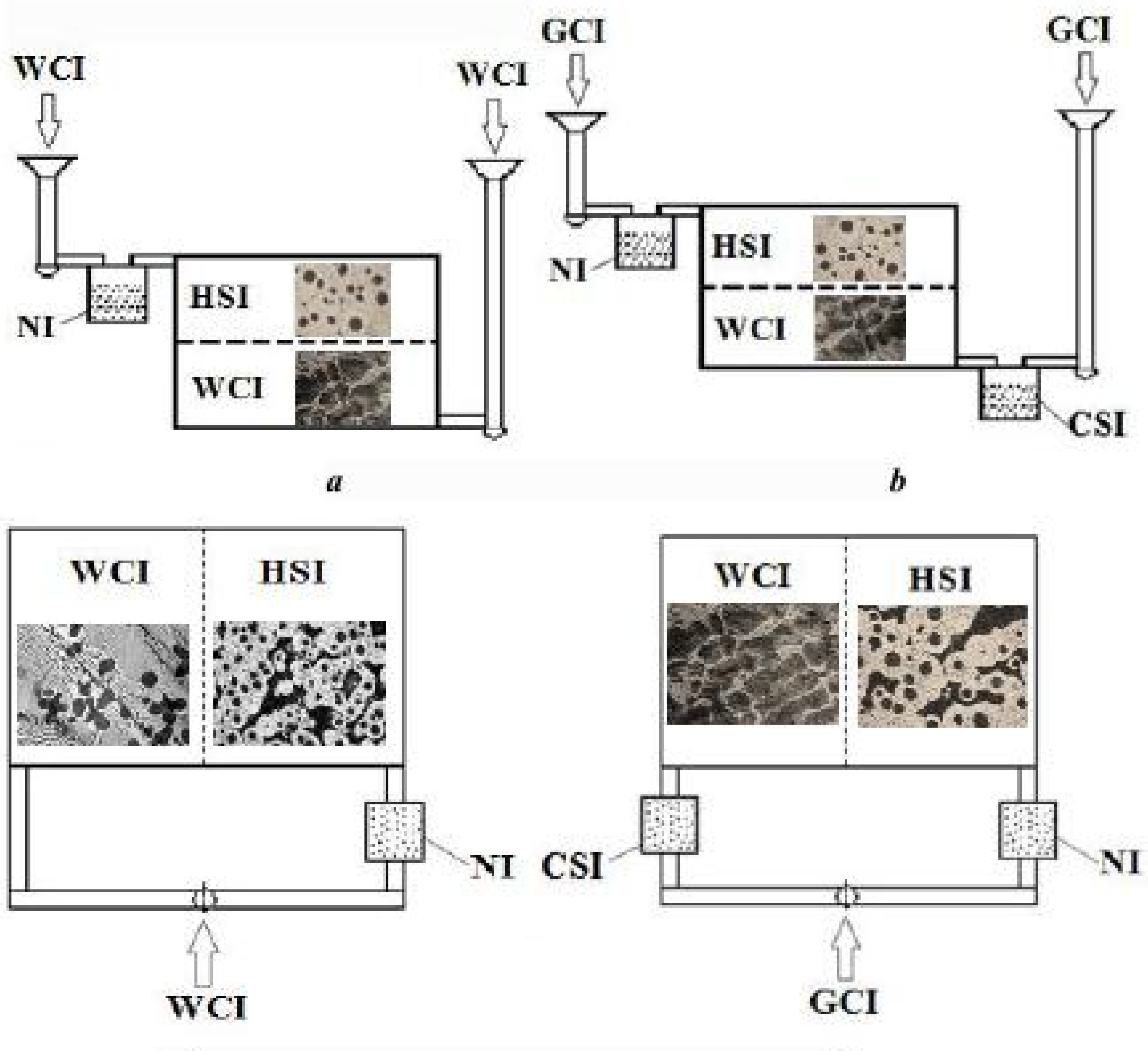
At present, the production of cast iron parts with differential properties in separate areas (zones) is accomplished by various ways. Of greatest interest are the methods for producing such parts via injection by successive pouring of heterogeneous cast iron into a shared mold [2,3].

However, the need for smelting, for example, of white iron, synchronously with smelting and nodularizing of high-strength cast iron in two independent furnaces increases the cost of technological process and complicates the production of castings with differentiated properties of their parts or layers, which is a significant inconvenience of the existing production methods of such castings.

Foundry departments of the National Technical University of Ukraine «KPI», (Kyiv) and of the Donbass State Machine-Building Academy (Kramatorsk) perfecta fundamentally new way of differentiating the structure and properties of cast iron in different parts of castings, devoid of these inconveniences [4-6].

The method is based on the technology of intra-mold treatment of the melt in areaction chamber of gating system, in other words it is the so-called inmold-process [7].

The idea of the new method lies in the smelting of the initial white cast iron in a melting furnace and pouring it into the bottom of the lower part of the mold cavity where the hard working layer of casting crystallizes. The remaining part of the mold cavity is filled with the same initial cast iron through a second independent gating system with a reaction chamber where the white cast iron is modified by nodularizingand graphitizing inoculants subsequently forming a soft matrix layer of ductile iron casting (Fig. 1,a).



a *b*

c *d*

Fig.1 Scheme of technological options for obtaining bilayer (*a*, *b*) and double-sided (*c*, *d*) castings of white cast iron (WCI) and high strength cast iron (HSI) on the basis of the initial white cast iron (WCI) or gray cast iron(GCI), with partial modification of metal in the mold by nodularizing (NI) or carbide-stabilizing (CSI) inoculants

Gating systems possessing two reaction chambers with nodularizingand carbide-stabilizing inoculants allow the mold to be filled with conventional gray cast iron of eutectic composition (Fig. 1, b).

For obtaining double-sided castings the mold is poured with the initial white cast iron via two independent gating systems, thus separating the melt by two streams. The first melt flow of the initial cast iron fills the mold cavity, where hard solid working layer crystallizes, and the second melt flow is modifiedin the reaction chamber by nodularizing inoculant and subsequently crystallizes in the mold, forming the second part of the casting with nodular graphite (Fig. 1, c). Fundamentally it is possible to fill in the mold with conventional gray cast iron with subsequent modification of two separate streams – one by nodularizing, and the other one by carbide-stabilizing inoculants (Fig. 1, d).

Early laboratory testing of the new method showed negative results. Instead of the expected bilayer or double-sided iron castings all experimental castings crystallized to yield plain conventional gray cast iron with flaked graphite. The reason for this was the hydrodynamic mixing of dissimilar flows when filling forms with liquid metal and subsequent convective and diffusive redistribution of inoculants between the layers in the liquid-solid alloy, which led to blending and homogenization of the structure and properties of cast iron throughout itsentire volume.

The issue of prevention the problem of hydrodynamic mixing and redistribution of elements when obtaining double-sided castings (Fig. 1, c, d) was solved by installation of a partition wall of galvanized iron sheet into the mold cavity. At a certain combination of the partition thickness and the cast melt temperature, the dissolution (fusion) time of the partition coincided with the time of cast iron in liquid and liquid-solid state, preventing mixing of the melt and providing obtaining castings with differentiated properties in different sections. In some cases, the partition is not completely melted, but is securely welded to the both parts of the casting (Fig.2).

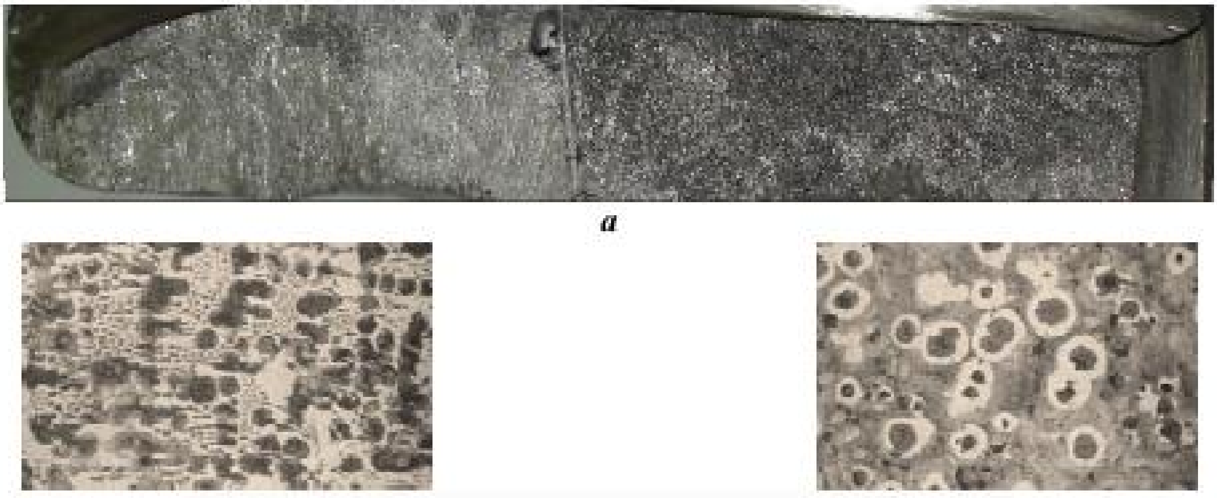


Fig. 2 –Fracture (*a*) and microstructure of the left (*b*) and right (*c*) parts of double-sided casting

The same problem with obtaining bilayer (Fig. 1, a, b) castings was solved by pausing time between the two phases of casting. At a certain pause, sufficient for the formation of a layer of separating solid crust on the surface of the lower plate, hydrodynamic mixing and diffusion redistribution of inoculant elements is prevented. As a result, white iron casting crystallizes in the lower layer and high-strength cast iron in the upper layer respectively (Fig.3).

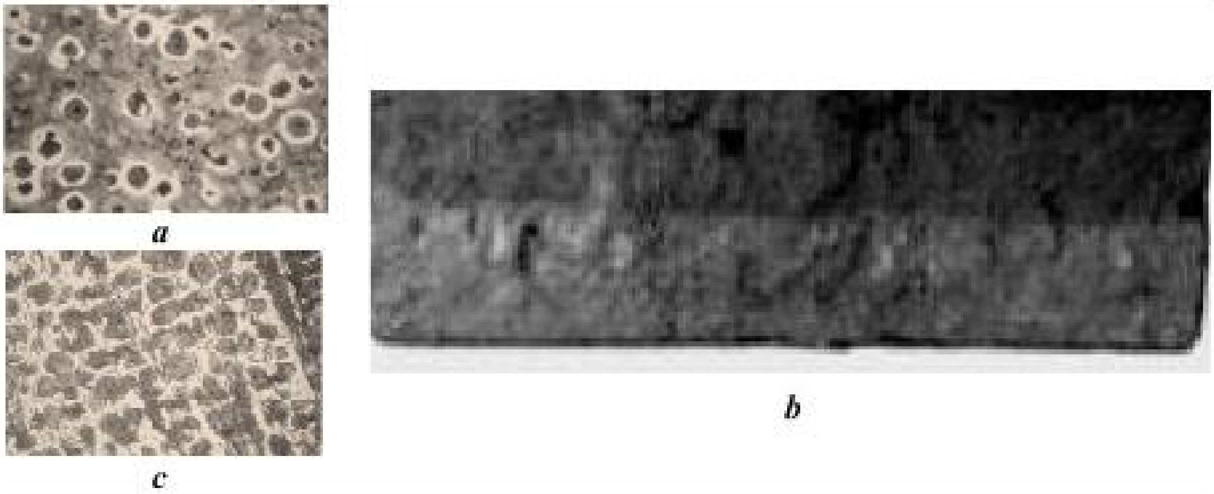


Fig. 3 – Fracture (*b*) and microstructure of the upper (*a*) and lower (*c*) parts of bilayer casting

Conclusion. Thus, this work confirms the possibility of implementation of the proposed method of cast iron structure and properties differentiation in local parts or layers of parts by using in-mold inoculation technology of the initial smelt melted in single melting furnace.

The results of numerous laboratory studies indicate the prospects of applying the proposed method at industrial enterprises for manufacturing parts, operating under unstressed-abrasive or impact-abrasive wear instead of steel castings, e.g. steels C120G13 (X120Mn12), or other high-alloy steels, as well as special alloyed cast irons.

The proposed method allows to considerably simplify the process of producing castings with differentiated properties, to reduce the consumption of scarce and expensive alloying elements, as well as to reduce the cost of casting; also it does not require installation of additional equipment in a foundry shop.

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INFLUENCE OF THE NATURE VEGETABLE OILS ON THEIR CHEMILUMINESCENCE IN OXIDATION PROCESS

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INTRODUCTION

Chemiluminescence method is widely used in experimental chemistry, in particular, to study the oxidation of organic matter (Shlyapintoch et al. 1996). It is known (Belyakov et al. 1983; Lisitsyn et al. 2005) that the oxidation of vegetable oils (RH) is a radical - chain process (Lisitsyn et al. 2005), which can be represented by a simplified set of reactions:

$$RH + O_2 \rightarrow R\bullet + HO_2^{\bullet} \qquad (1)$$

$$R\bullet + O_2 \rightarrow RO_2^{\bullet} \qquad (2)$$

$$RO_2^{\bullet} + RH \rightarrow ROOH + R\bullet \qquad (3)$$

$$RO_2^{\bullet} + RO_2^{\bullet} \rightarrow \text{products} + Q \qquad (4)$$

The latter of these reactions is the main and most often the only source of chemiluminescence (CL) in these processes. Recombination of peroxy radicals ($RO_2^{\bullet}$) is a two-stage and quite exothermic reaction that leads to the formation of an unstable product (tetroxide):

$$ROO^{\bullet} + ROO^{\bullet} \longrightarrow [ROOOOR] \longrightarrow R{=}O^{*} \qquad (5)$$

$$R{=}O^{*} \longrightarrow R{=}O + h\nu \qquad (6)$$

Schedule of tetroxides accompanied by the formation of carbonyl compounds in the system electronically excited state ($R = O^*$). Go past from the excited to the ground state accompanied by chemiluminescence ($h\nu$). Given the above, the kinetic curve of CL initiated during oxidation of organic matter should look like curve 1 (Fig. 1).

The presence of vegetable oils natural antioxidants (tocopherols) which are phenolic compounds (PhOH) and actively destroy peroxy radicals in the reaction:

$$PhOH + RO_2^{\bullet} \rightarrow PhO^{\bullet} + PhOOH \qquad (7)$$