LOW CORE MIXTURE OF HOT CURING

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This article discusses the creation of low-toxicity of mixtures of hot rod new generation curing, not containing resin. They allow you to make the process of manufacturing rods in heated snap improved techno-economic and health indicators. The basis for the development of such mixtures are modified technical lignosulfonates.

Keywords: core sand, heated / cold rig, low-toxic technical lignosulphonate binders, mould cores pattern-making, technological additions, breaking strength compounding.

In Russia the foundries at the machine-building plant produce a wide range of cores using toxic organic binders hardened by heat processing in the drying ovens. We should note that both heated and cold rigs are used in this process. The cores moulding technology in the heated rig uses some toxic synthetic resins and their combinations. The disadvantage of this technological process lies in the necessity of using some expensive and often scarce binders, that fact leading to increasing expenditures on core sand. Besides this fact, mould cores pattern-making throws out considerable amounts of phenol, formaldehyde, ammonia, cyanic hydrogen and other toxic compounds into the environment and surroundings. This becomes the reason of unfavorable sanitary and hygienic labour conditions appearance. That’s why the development of low-toxic binding compositions having the resins properties is very actual because it envisages the prospects of appearing new generation of core sands that will meet the ecological requirements of modern production.

The development of such mixtures relies on low-toxic technical lignosulphonates (LTTLS) binders containing a modifier. The mixture of vat residues of organic synthesis in water having volume relationship in the proportion of 6:1 was used as a modifier [1].

Bonding LTTLS [2] was prepared by mixing LTTLS with a modifier of vat residues of organic synthesis for 3–5 minutes to achieve a fluidity state. The modifier sharply decreases viscosity of technical lignosulphonate and that results in stabilizing a colloid system increasing binder covering properties.

Core sands were prepared in laboratory runners of LM-1 model made of three things: 1) quarts sand with 1K02A brand from Verkhne-Dneprovsk sand-pit; 2) technological additions and 3) low-toxic lignosulphonate binder.

Some samples in the form the eights and cylinders for conducting testing were produced from a mixture by its packing with three blows of laboratory impact testing machine of LU-type. Standard samples were dried at temperature of 250±10 ºC in the drying laboratory cabinet of SNOL-3,5.3,5.3,5/3-M2 type with an automatic temperature control. To define core strength in a hot state the standard sample in the form of an eight was, first, heated for 5 minutes at the temperature of 250 ºC, then, it was rapidly placed (during 10–15 seconds) into a clam device of a breakage machine of LRU-1 type. To research physical, mechanical and technological mixtures properties we have used laboratory equipment of «Tsentrozap» firm.

Finally, as a result of many experiments conducted we have found an effective set of technological additions looking like this: marshalit – boric acid – iron minium, this very sequence giving the possibility to the mixture characteristics based on LTTLS to approach the properties of resins compositions of hot hardening.

The created set of technological additions in the form of such sequence as functions effectively; if it includes «KO» binder, the latter, unfortunately, deteriorating the ecological significance of a developed compounding. That's why we had to continue the search of substances increasing strength of LTTLS containing moulding cores using molecules lacing of lignosulphonates.

The waste products of Novocherkassk synthetic mill in the form of zinc- chromium catalyst were used as a LTTLS lacing agent, the latter, in terms of oxides, having the following composition in percentage:

Zinc oxide	Basis
Chromium oxide (III)	29−31
Tungsten oxide	0,05−0,1
Alkali metals oxides, not more than	0,04

Zinc-chromium catalyst waste products in the form of grey powder obtained at methanol production comprise many tons. The powder participates in ion exchange reactions with LTTLS forming the element having a mesh structure that increases mould cores strength.

Table 1 introduces the compoudings of the developed mould cores mixtures №№ 1–5 in comparison with the composition of mixture № 6, all the mixtures being obtained using LTTLS without any technological additions.

Table 1

Mixtures based on LTTLS and a set of technological additions

Names of mixtures ingredients	Content of ingredients in mixtures in percentage					
	№ 1	№ 2	№ 3	№ 4	№ 5	№ 6
Quartz sand	94,8	93,3	91,2	89,1	87,6	95,0
Zinc-chromium catalyst waste products	0,7	0,8	1,0	1,2	1,3	–
Marshalit	0,5	1,0	1,5	2,0	2,5	–
Iron minium	0,1	0,3	0,5	0,7	0,9	–
Boric acid	0,4	0,6	0,8	1,0	1,2	–
LTTLS binder	3,5	4,0	5,0	6,0	6,5	5,0

Physical and mechanical properties of mixtures are given in table 2.

Table 2

Physical and mechanical properties of cores mixtures based on LTTLS

Names of mixtures properties	Mixtures properties indicators					
	№ 1	№ 2	№ 3	№ 4	№ 5	№ 6
Wet mixtures compression strength, kPa	4,5	4,7	5,1	5,6	6,0	4,4
Gas impermeability of wet mixture, units	163	156	146	143	134	163
Breaking strength, MPa, of standard samples in a hot state after 5-minute hardening at the temperature of 250±10° C	0,56	0,69	0,72	0,86	0,83	0,32
Breaking strength, MPa, of standard samples after drying at the temperature of 250±10° C for						
5 min	1,42	1,88	1,93	2,12	2,06	1,20
10 min	1,65	2,16	2,42	2,87	2,90	1,46
15 min	1,78	2,22	2,94	3,20	3,23	1,53

As we may conclude according to table 3 a mixture with the developed set of technological additions as compared to a mixture without them provides 2–2,27 as much increase of cores in a hot state strength. It is especially important that such increase of «hot» strength of cores has been achieved without resins application. Mould cores fabricated of brought forward mixture have «hot» strength close to that of resins cores, giving the possibility to carry out their hardening in the similar modes.

Table 2 shows as well that the developed mixture allows us to increase cores strength in a cold state 1,5–2,0 times as much.

In the process of mould cores fabricating in a heated rig the melt of boric acid, partially, dissolves the oxides of zinc-chromium catalyst waste producing the corresponding salts that lace them supplementary by means of the ion exchange reactions with the macromolecules of LTTLS. Such phenomenon results in the cores strength increase both in hot and cold states.

The put forward mixture compounding has the following composition in percentage:

LTTLS binder	4,0–6,0
Wasted zinc-chromium catalyst	0,8–1,2
Boric acid	0,6–1,0
Marshalit	1,0–2,0
Iron minium	0,3–0,7
Quarts sand	the rest

In addition to these positive moments the advanced mixtures compositions meet the ecological requirements in their application to modern foundry.

The optimal content of a wasted zinc-chromium catalyst in the mixture ranges over 0,8 to 1,2 %. If its content in the mixture is less than 0,8 % and higher than 1,2 % the cores strength in a hot state reduces.

The optimal boric acid content in the mixture is 0,6–1,0 %. If the boric acid content is less than 0,6 %, then the strength of the cores in a cold state reduces, but when it is higher than 1,0 %, then the compressive strength of a wet mixture increases, its sand-blast fluidity worsening.

The mixture based on LTTLS with the proposed technological additions was tested in the foundry of «Zaporozharmatura» PO with using on automaton of 4532 B model for moulding «Corpus DU-15» cores. The cores hardening mode did not change that is the hardening time was 60 seconds, hardening temperature – 270 ^{o}C. All cores were moulded according to the technological requirements and quality. They had smooth surface, they were sharp-edged and they demonstrated manipulation strength. To reduce cores hydroscopity we used a special coating on an organic basis that provided cores with a prolonged storage and reduced casting burnt-on sand.

Conclusion

The research stated the influence of wasted zinc-chromium catalyst, marshalit, boric acid and iron minium on the mixtures properties and presented a set of technological additions increasing LTTLS bonding properties up to those of the resins level. The worked out mixtures compositions are characterized by having physical and mechanical inticators typical to those of resins mixtures. In addition to these positive moments the advanced mixtures compositions meet the ecological requirements in their application to modern foundry.

References

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