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Effect of different additives on the physical and mechanical properties of liquid-glass core mixtures

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Abstract. The molding sands composition research of various compositions has been carried out. Quantitative dependences of the influence of additives on the physical and mechanical properties of core mixtures are obtained.

1 Introduction

The difficulty of knocking out cores from castings made from various mixtures is one of the important problems of foundry production. At different enterprises, there are different situations associated with knocking out cores from castings. If at one plant the rods are easily knocked out of the castings, at another there are difficulties with knocking out the rods; in some cases, knockout has proved so problematic, as there are serious complications in the use of the hydraulic knockout machine, which is a modern mechanized means of removing cores. To eliminate such problems and improve the knockout of rods, a lot of work has been done worldwide.

Many types of research have been carried out, and the effectiveness of various additives in a large number of organic and inorganic origins has been verified.

For example, in Russia, the influence of additives on the conditions for knocking out rods was tested: charcoal and coal, coke, black and silver graphite, wood pitch, bitumen, petroleum oils, molasses, dextrin, sulphite-alcohol stillage, pulverized bakelite, wood flour and sawdust, clay, cement, lime, fireclay, magnesite, phosphorite and others [1-4].

In European countries, research was carried out on the influence of not only the above but also other additives, such as sugar, iron oxide, naphthalene, proprietary additives, etc. Based on the results of this research, it was concluded that the optimal solution is to add organic additives in small quantities.

But the introduction of such additives did not always give positive results, and in some cases, it was not effective.

Some researchers proceeded from the idea of the need to destroy a strong film of liquid glass, cementing individual grains of quartz sand using a variety of additives, mainly of organic origin [5,6].

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2 Methods

The experiments did not yield any positive results in solving this problem. Of course, did not exclude the possibility of improving the knockout of rods from castings in individual cases. After production and in the scientific field, they understood how to achieve the expected positive results in increasing the knockout rates; it is only possible to explain the complex processes that occur in liquid glass mixtures when they are poured with metal; systematic research on this issue gradually began to work out.

The knockout of the mixture was mainly evaluated by many experts on the compressive strength of the samples, first heated to high temperatures and then cooled. However, many works do not explain the reasons for the chosen heating temperatures, i.e., does not explain the increase in the samples' strength when preheated to one temperature and the change in strength when heated to another temperature [7-10].

Experiments to study the composition of molding and core sands were carried out at the subsidiary " Casting and Mechanical factory", Tashkent. To study the rods, 4 variants of mixtures were prepared. The mixtures were prepared from quartz sand grade $2K_2O_2$, bentonite clay grade P1T2, liquid glass, lime, chalk ($CaCO_3$), and sugar.

The mixture was prepared by manual mixing in a special container; first, the powdered components were mixed, and then the amount of liquid glass was added.

3 Results and Discussion

The composition of the mixture with additives of lime, chalk, and sugar is presented in table 1.

Table 1 - Quantitative ratio of the components of the core mixture

Components		Mass fraction of components, %			
		№0	№1	№2	№3
Initial	Quartz sand	96	94	92	90
	Clay bentonite	4	4	4	4
	Liquid glass	6	6	6	6
Additives	Lime	0	2	4	6
	Chalk	0	2	4	6
	Sugar	0	2	4	6

For the knockout test, specimens 30 mm high and 50 mm in diameter were made and compacted by three blows on an automatic impact driver. After compaction, the samples were removed from the sleeve and transferred to the drying chamber. To carry out the gas permeability test, specimens 50 mm high and 50 mm in diameter and specimens of the "eight" type were made according to GOST 23409.7-78, which are shown in Figure 1, compacted by three blows on an automatic pile driver.

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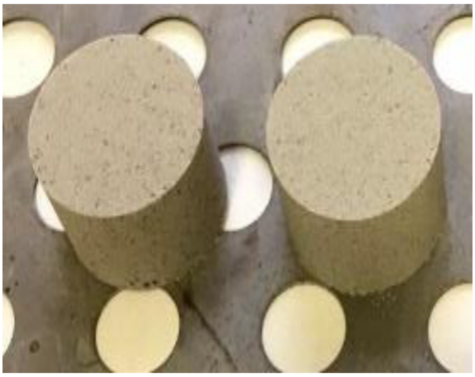
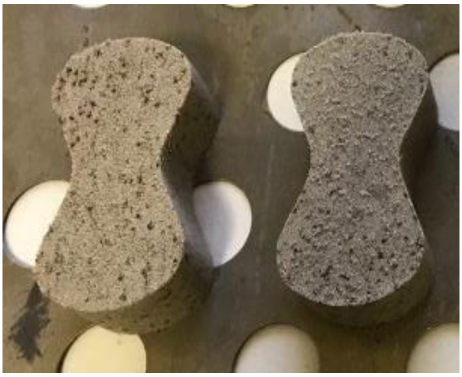




a) *b)*

Fig. 1. Samples for testing mechanical properties and gas permeability, (a) and (b).

Drying of the finished samples was carried out in an electric oven, after which the samples were tested. To acquire optimal strength, the prepared samples were dried in an electric oven at +200ºC for 30 minutes. Then, after cooling the samples to room temperature, they were heated to a temperature of +600 ± 10°C, kept at this temperature for 30 min, and slowly cooled in a furnace for 2 hours.

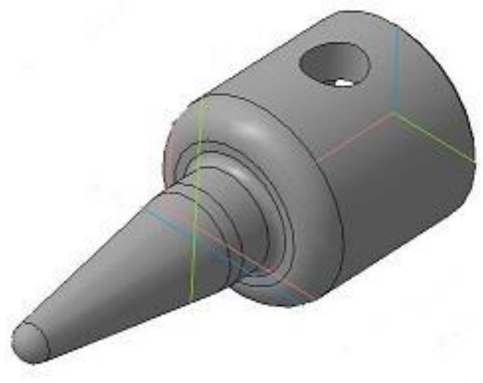
To determine the work expended on knocking out the mixture, the analytical dependence of the potential energy on the destroyed mass acting on the test sample was used.

The obtained samples were preliminarily weighed on a balance (GOST 24104-88, error ± 0.01 g), then tightly, without a gap, inserted into a metal sleeve (Fig. 2, b), which, in turn, was installed on a pallet (Fig. 2, in). At the bottom of the pallet, there was a hole with a diameter of 22 mm for the free exit of the striker (Fig. 2, d), which pierces the sample (Fig. 2, a).

a)

b)

c)



d)

Fig. 2. A device for assessing the knockout of mixtures: a) is test sample; b) is metal sleeve; c) is pallet; d) is striker.

Using automatic copra, 10 blows were applied to the samples. The samples' destroyed part was again weighed on the scales (GOST 24104-88, error ± 0.01 g), and the results were obtained.

In studying samples for the knockout, the mixture's physical and mechanical properties as gas permeability and tensile strength were studied in parallel.

When determining the gas permeability of a dry sample, it was placed in a special sleeve under a pressure of 980.7 Pa, and 2000 cm3 of air was passed through the sample.

To determine the tensile strength of molding and core sands, samples were made according to GOST 23409.7-78.

The work on the destruction of samples depending on the content of the additive after drying at a temperature of +200 ° C is presented in Table. 2 and in fig. 3.

Table 2. Work on the destruction of samples depending on the content of the additive

Additives	Spent work on destruction, J		
original	525.40		
Additives, %	**2**	**4**	**6**
Chalk	243.90	272.60	125.14
Lime	860.83	573.89	243.90
Sugar	860.83	478.24	358.68

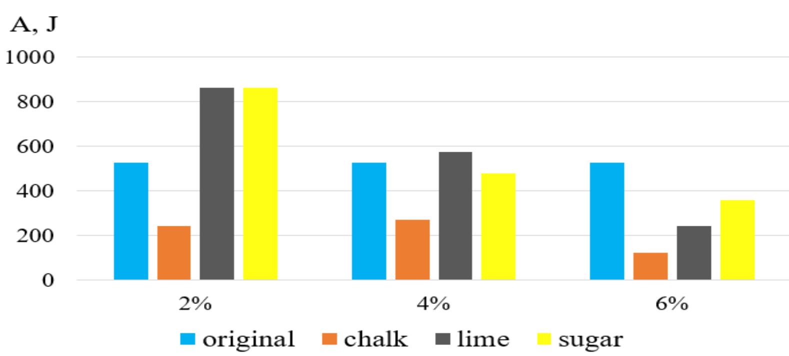


Fig. 3. Work expended on the destruction of samples

As can be seen from Figure 2, the addition of 2% lime to the mixture, as well as sugar, increases the amount of work on the destruction of samples, and the introduction of a mixture of 2% chalk made it possible to reduce the work on the destruction of samples by 2 times. The presence of 4% lime and the same amount of sugar in the mixture has practically no effect on the work on the destruction of samples, and the content of 4% chalk in the mixture reduces the amount of work by almost two times. The content of lime and sugar in the mixture increased to 6%, making it possible to reduce the work by half, and the addition of chalk reduced the work of destroying the sample by 3 times.

The results of testing samples for gas permeability are shown in Table 3 and Figure 4.

Table 3. Gas permeability of samples depending on the additive

Additives	The gas permeability of the mixture, units		
original	117.83		
Additives, %	**2**	**2**	**2**
Chalk	169.50	169.50	169.50
Lime	133.97	133.97	133.97
Sugar	192.00	192.00	192.00

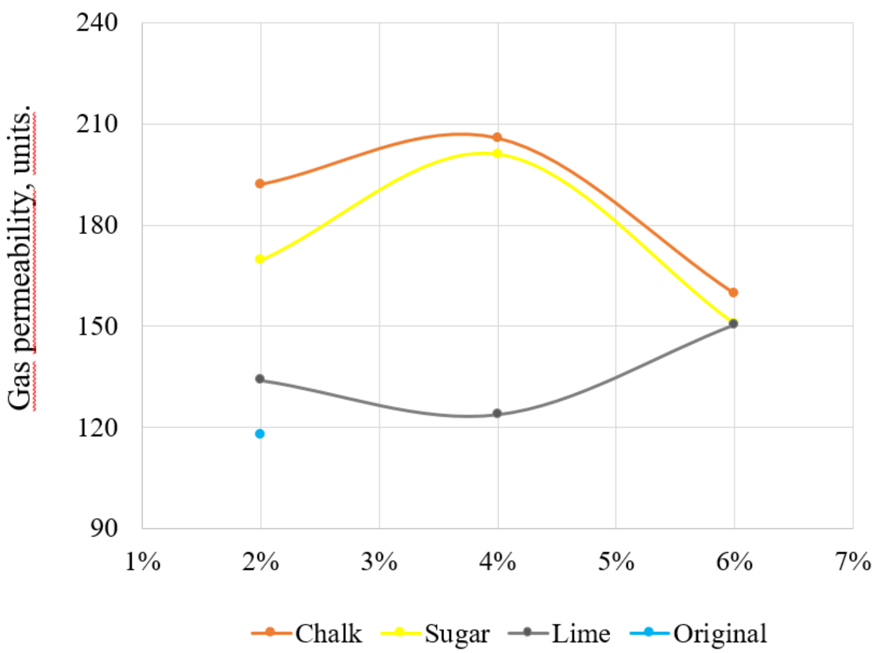


Fig.4. Change in gas permeability of samples depending on from the amount of additive

The experiments have shown that the gas permeability has better values with adding 2% chalk relative to other additives. Its values reached almost 200 units, which is two times higher than the gas permeability of the standard sample. In the case of using 2% sugar and lime as additives, the results were also 1.5 and 0.5 times higher, respectively, than the gas permeability value of the standard sample.

With an increase in the lime addition to 4%, the gas permeability values did not change significantly relative to standard samples. The content of sugar and chalk in the mixture increased to 4 percent, led to a twofold increase in gas permeability.

At the next stage, the experiment was carried out with the addition of 6 percent of each of these materials. Tests of the same properties of samples showed approximately the same values, which turned out to be much lower than samples with 2% and 4% additives.

The strength tests carried out on specimens of the "eight" type showed the following results following Table 4 and Figure 5.

Table 4. Tensile strength test results

Additives	Tensile strength, Pa		
original	184.00		
Additives, %	**2**	**2**	**2**
Chalk	134.10	134.10	134.10
Lime	80.58	80.58	80.58
Sugar	190.95	190.95	190.95

As can be seen from Figure 4, a 2% addition of sugar and lime reduces the strength indicators. When chalk is added, there is a slight increase in the strength indicators of the mixture, and a 6% addition of lime and chalk reduces the strength indicators, and sugar increases this indicator by almost 1 .5 times.

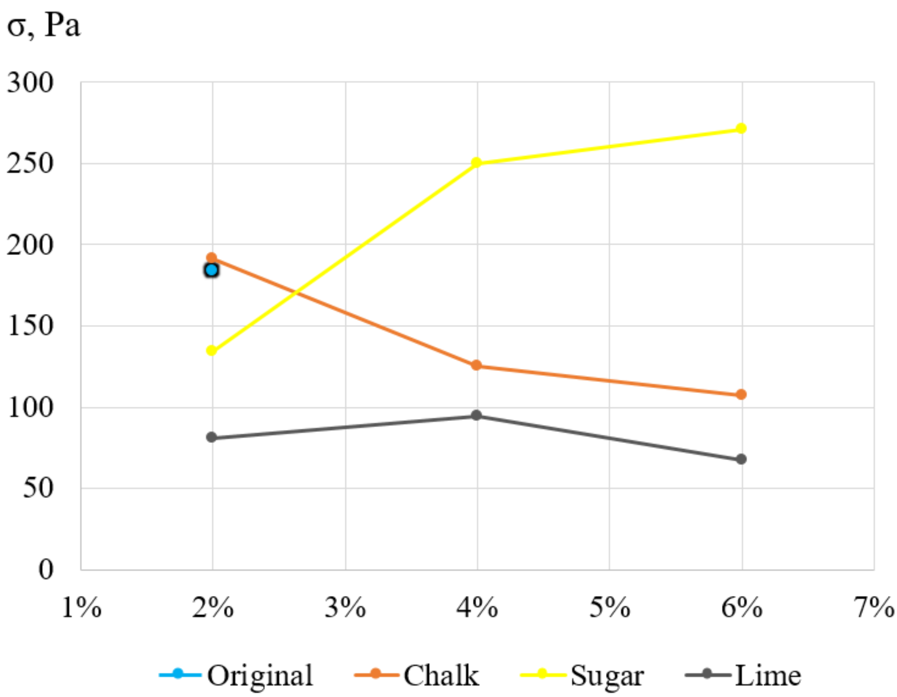


Fig.5. Tensile strength of samples depending on from the amount of additive

4 Conclusion

Technology with a reduced, i.e., less than 6%, the content of the liquid glass. Because liquid glass has exceptionally high adhesion to quartz, then the cohesive type of destruction of the mixture proceeds. As a result, the strength of the mixture will directly depend on the amount of binder introduced into it. The less liquid glass is introduced into the mixture, the easier it will be to knock out the rods from the castings.

The research on the influence of various factors on the conditions for the knockout of cores from castings showed the prospect of a direction for the search for materials and technologies that reduce the work during knockout.

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