ARCHIVES of FOUNDRY ENGINEERING

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

ISSN (1897-3310)
Volume 15
Special Issue
1/2015

115 – 120

24/1

Burrs from Cores Produced by Cold-Box-Amine Method and Possibility of their Elimination in Eurocast Košice s.r.o. Company

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Received 11.03.2015; accepted in revised form 05.05.2015

Abstract

Foundry industry belongs toward key branch with important meaning for different manufacturing industries. Liquid metal is casting in foundry, which makes cast stock with weight from several grams till several ton [1].
To achieve asking qualities of the product is needed know abundance technological a technical process and progress, but in spite of long – term development foundry industry there occur some question marks, that need answer [1].
Characteristic defect castings of ferrous alloys, which often accompanies the use of amine - Cold box cores are flash gutters. Survey, it was found that 77 % of those surveyed foundries have problems with burrs, 71 % foundries solves this problem (or try to tackle) protivýronkovými ingredients in nuclear and molding compounds , but only 29 % considered their "antivýronkovú" method for successful and favorable [2].

Keywords: Moulding mixture, Cold -box - amine, Casting error, Flash gutters

1. Introduction

Cold-Box-Amine method was founded in 1965 by Ashland company and in year 1968 it was introduced to the european foundry industry. After 35 years, this method finds its worldwide place and become most important method of cold hardening with gas. In Germany, the share of this method in comparison to other methods of core production is cca 60%. The share on all methods using the hardening with gas is cca 77% [3].

2. Theoretical part

Description and principle of cores production with the CBA method

Cold-Box-Amine method makes it possible to produce fast machine production up to middle sizes. This fast, cost-effective and automatic production provides good possibilities for on-line production. Just after production, the cores can be put into die or sand moulds which can be casted. This fast flow of production is only possible, when after painting of the cores with water paint are these cores immediately dried in the oven. Core production with the CBA method can be two times faster than the Croning method. The share of all methods for core production is described on Fig. 1, from which it can be seen, that in more than 60%, the Cold-Box method is used. [1]

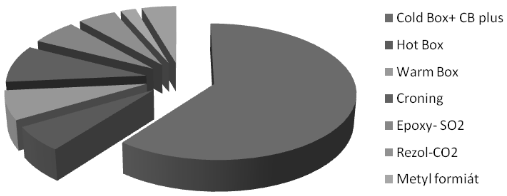

Fig. 1. The share of all core production methods

CBA method consists in the use of no-water dry silica opening material and:

– Liquid substance 1, which is the product created by condensation of phenol and formaldehyde on benzyl-ether resin in solvent
– Liquid substance 2, which is polyisocyanite component in solvent
– Catalyst, mostly tertiary amines, which influence the speed of reaction in determining way

Both substances create the core mixture together with opening material, which is hardened with the effect of gas catalys (Fig.2). Curious characteristics of phenol resin is its benzyl-ethere structure. Summary chemical equation je additing polymerization, which advantage is that no new dissociate product are created [3]

substance 1 + substance 2 → solid binder
phenol resin + polyisocyanite → polyurethane

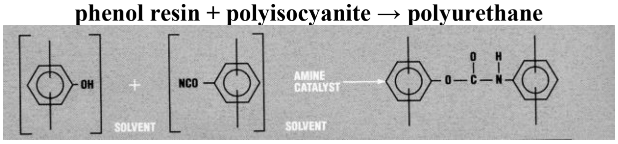

Fig. 2. Chemical equation [3]

Catalysts for Cold-Box method

As catalyst, amines are used – alkaline burning organic liquids with strong ammonia small, which after reaction come out in non-changed form and because of their hygroscopic properties need to be taken away or destroyed. Polymerization reaction takes places immediately during the contact with catalyst vapors. Another addition of catalyst does not influence the hardening process, so dosing of excess catalyst is not suitable [4].

Characteristic defect of casting surface with the use of Cold-Box-Amine method is the occurrence of burrs in the places created by real cores.

3. Experimental part, results, discussion

Characteristics of castings with burrs occurrence

Castings, on which experiments were made are wheel shaped, produced from gray cast iron EN GJL 250. Name of these castings is Reibscheibe – they are braking discs with diameter 642 mm, respectively 652 mm (Fig.3). [4]

Fig. 3. Core RC 131 530 [4]

Types of tested additives and binding compounds

During tests, additives from different producers had been tested. Type of additive and its amount had been changed. During tests, three types of binding compounds from different producers in combination with additives had been tested.

Binding compounds:

– Friodur 050B + Friodur 055A – Furtenbach GmbH
– Gasharz 6747 + Aktivator 8196 – Hüttenes – Albertus CZ, s.r.o.
– Askocure 366 + Askocure 666 – Ask – Chemicals – CZ s.r.o.

Additives:

– Furtol AD 15 – Furtenbach GmbH
– Antrapex P 115 – Furtenbach GmbH
– Veinseal I 35 – Hüttenes – Albertus CZ, s.r.o.
– Veinseal RB 30 – Hüttenes – Albertus CZ s.r.o.
– Furtol VPH 139 GKG – Furtenbach GmbH
– Furtol AD 50 – Furtenbach GmbH
– EP 4085 – ASK – Chemicals – CZ s.r.o.
– BR 4048 – ASK – Chemicals – CZ s.r.o.
– BR 955 – ASK – Chemicals – CZ s.r.o.
– Sphereox – ASK – Chemicals – CZ s.r.o. [4]

Methodology of experiments

During these experiments, more test 1 – 7 had been executed. Also there are described test, by which the percentage of burr occurrence on castings was below 2%.

During this experiment, the Cold-Box system from ASK – Chemicals company had been used. As binding compounds, ASKOCURE 366 (compound A) and ASKOCURE 666 (compound B) had been used. Additives BR 955 on wooden saw-dust basis, additives BR 4048 on mineral basis and additives Sphereox as ferrous oxides had been used. 5 combinations were tested. Test were executed on cores with the model nr. RC 56041.

a) The weight of new sand was 136 kg/mixing. Weight percentage of binding compounds was 0,66 and 0,66. Additive BR 4048 wasadded in the amount of 1,47 weight% (2 kg).

Result: cores were produced without problems, had a little bit higher abrasion. On some places could be seen non-shot places (Fig.4).


Fig. 4. Core with additive BR4048 [4]

By visual checking on non-cut castings, tested surface seemed to have minimal occurrence of burrs. Some signs of burrs could be seen on the „teeth“ of casting (Fig.5).


Fig. 5. Connectiones on castings with the use of additive BR 4048 [4]

The occurrence of burrs on connections was visible on some places. On some places were these errors caused by not complete shot of cores, as it can be seen on Fig. 6. On „teeth“, burrs occurred in minimum amount. [4].


Fig. 6. Burrs on connections on cut casting [4]

b) During this test, the weight of the sand had not been changed. Other additive had been tested, BR 955 with weight percentage 1,47. Volume of binding compounds had been increase to 0,73 + 0,73 – this step was suggested by the representative of ASK-Chemicals CZ, due to the fact, that additive BR 955 has the ability to bind the binding compounds to itself.

Result: cores by these experiment were stronger and had lower abrasion. By sight it could be seen, that these cores have more non-shot places than by previous test (Fig. 7) [4].
By visual checking of these castings, the test result was better than by previous test. Burrs were not much visible. Connections were smooth, without significant errors [4].
With the use of additive BR 955 final castings had minimum amount of burrs. On connections, burrs could hardly be seen, also on the „teeth“ of casting. The surface was smooth, without errors – as expected.


Fig. 7. Test result with additive BR 955

Next, the new additive Sphereox on ferrous oxide basis had been tested. Volume of binding compound had been again decreased to 0,66 weight % for compound A and B. Weight of new sand had been 136 kg/mixing. This additive was heavy, so to the mixture had been added 6 weight % - 8 kg of additive.
During this test, the combination with 6; 3 and 4,5 weight % of additive (respectively 8; 4 and 6 kg) had been tested.
Result: produced cores were strong, abrasion was minimal. Cores were produced without problems, processability of the mixture was good, same as fluidity of the mixture (Fig.8) [4]

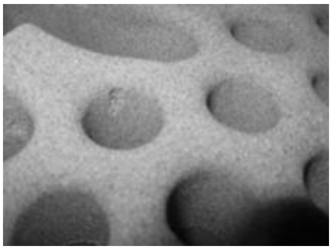
Fig. 8. Cores with the use of 6; 3 and 4,5 weight % of additive Sphereox [4]

The use of Sphereox additive had showed with minimum occurrence of burrs on casting. This test had very good results. With 6 weight % of additive, castings were without burrs, checking had been done visually on cut castings, so the places had been visible and open for precise checking. Surface of the casting was clean, without errors (Fig. 9) [4]


Fig. 9. Result of test with 6 weight % of additive Sphereox [4]

By the test with 3 weight % of additive, the surface was clean, burr occurrence was visible on some places on connections (minimum amount and size). No occurrence of burrs on „teeth“ was visible (Fig. 10) [4]

Fig. 10. Result of test with 3 weight % of additive Sphereox [4]

By the use of 4,5 weight % of additive Sphereox, the result was comparable with the 6 weight % of additive test. Casting surface was without errors, burrs did not occurr on connections, possibly there was minimum occurrence of very small burr on „tooth“ of the braking disc (Fig. 11) [4]

Fig. 11. Result of test with 4,5 weight % of additive Sphereox [4]

During this test, pouring temperature and pouring time had been measured. 4 ladles had been used for this experiment, from one ladle 6 moulds had been casted. Pouring temperature for first laddle had been 1393°C +/- 5. Pouring time was 22s. 5 cores with additive BR 4048 and one mould with core , where additive BR 955 was used, were casted.

Pouring temperature for second laddle had been 1389°C +/- 5. Pouring time was 22s. 3 cores with additive BR 955 and 3 mould with core , where additive Sphereox (6 weight %) was used, were casted.

Pouring temperature for third laddle had been 1388°C +/- 5. Pouring time was 25s. 1 core with additive Sphereox (6 weight %), 4 cores with additive Sphereox (3 weight %) and one mould with core , where additive Sphereox (4,5 weight %) was used, were casted.

Pouring temperature for fourth laddle had been 1388°C +/- 5. Pouring time was 22s. 3 cores with additive Sphereox (4,5 weight %) were casted. [4]

Present production: For cores S 83754: weight of new sand: 136 kg/mixing; binding compound: Gasharz 6747 (0,66 weight %) + Aktivator 8196 (0,66 weight %); additive: Veinseal I 35 (1,47 weight %) (Fig. 12) [4].

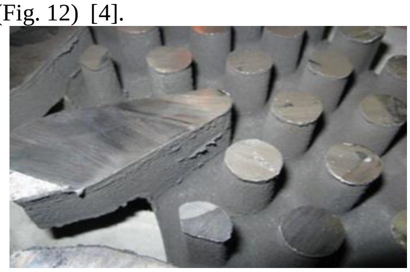

Fig. 12. Places of burrs occurrence by present production [4]

Evaluation

Table 1.
Test parameters and their results [4]

Experiment ID	NS (kg)	component A		component B		aditiv		result	assessment
		type	**Hm%**	**type**	**Hm%**	**type**	**Hm%**		
1.	92	Friodur 050B	0,98	Friodur 050B	0,98	Furtol AD 15	2,17	25%	5
2.	115	Gasharz 6747	0,78	Gasharz 6747	0,78	Furtol AD 15	1,74	20%	4
3.	115	Gasharz 6747	0,78	Gasharz 6747	0,78	Antrapex P 115	1,74	20%	5
4a	115	Friodur 050B	0,78	Friodur 050B	0,78	Antrapex P 115	1,74	25%	5
4b	127	Friodur 050B	0,70	Friodur 050B	0,70	Furtol AD 15	3,5	25%	3
4c	119	Friodur 050B	0,75	Friodur 050B	0,75	Furtol AD 15	3,5	5%	3
5	119	Gasharz 6747	0,75	Gasharz 6747	0,75	Veinseal I 35	3,5	5%	3
6a	136	Gasharz 6747	0,66	Gasharz 6747	0,66	Furtol AD 15	0,84	30%	6
6b	136	Gasharz 6747	0,66	Gasharz 6747	0,66	HP 4085	0,84	30%	6
7a	136	Askocure 366	0,66	Askocure 366	0,66	HP 4085	1,47	3%	2
7b	136	Askocure 366	0,73	Askocure 366	0,73	HP 4085	1,47	1%	1
7c	136	Askocure 366	0,66	Askocure 366	0,66	Sphereox	6	1%	1
7d	136	Askocure 366	0,66	Askocure 366	0,66	Sphereox	3	1%	1
7e	136	Askocure 366	0,66	Askocure 366	0,66	Sphereox	4,5	1%	1

4.Conclusion

During experiments, 3 binding compounds from 3 different producers in combination with different types of additives with different properties and different weight percentage had been tested. In some test also the amount of new sand had been changed, which caused the increase or decrease of the binding compounds amount according to the need of mixture, shot to the core-box. For first experiment, it was needed to do 4 mixings, because by first three mixings, it was not usable and able to shot the mixture. Experimentaly proven had been the binding compound from company Furtenbach and additive Furtol AD 15 from the same producer. Weight of the new sand by first mixing was 125 kg/mixing. Volume of binding compound was 0,72 weight % + 0,72 weight %. Mixed core mixture was dry, but was not able to be shot. It was needed to increase the volume of binding compound. The volume of binding compound had been changed through decrease of sand amount to 115 kg/mixing. This had to be repeated, because the mixture was again unusable. The weight of new sand had been decreased up to 92 kg/mixing, which increased the volume of binding compound to 0,92 weight %. The volume of added additive was 2,17 weight %. Core mixture had good fluidity and cores could be produced. But there had been greater volume of binding compound. Burrs occurrence on casting surface was determined by visual checking. Burrs occurred on the connections inside the casting – cca 20% of observed surface. Additive Furtol AD 15 had been also used in combination with binding compounds from Huttenes – Albertus company. By this test, the compounds were added to the 115 kg of new sand. Binding compound had been added in amount 0,78 weight % + 0,78 weight %, additive in amount 1,74 weight %. The mixture was usable, cores were shot without any big problems. Processability in this case was better. The burrs occurrence was still visible, cca on 20% of surface. Next, with binding compound from Huttenes – Albertus company, additive Antrapex P 115 from the same producer had been tested. The amount of compounds remained the same. Mixture had good fluidity, produced cores were strong. Processability of the mixture was 2 hours. Burrs were still visible – cca 25 % on observed surface [4].

This additive had been further tested with binding compound from Furtenbach company. We wanted to check the reaction and processability with different binder. We worked with the same amount of sand, the amount of binding compounds and additive had not been changed. Mixture properties were better as by first two tests, but worse as by third test. The abrasion had increased a little bit. Reaction of additive was better with the binding compound from the same producer. The burrs occurrence was set to cca 25%. During this experiment, also the additive Furtol VPH 139 GKG in amount 3,5 weight % had been tested. Amount of new sand had been changed to 127, respectively 119 kg/mixing. With decrease of the sand amount, the amount of binding compound had increased, because it was needed to modify the mixed core mixture. Burrs occurred in lower amount. Other experiments with binding compound from Furtenbach were not executed. By next experiment, additive Veinseal I 35 in the amount 3,5 weight % in combination with binding compound from the same producer Huttenes – Albertus had been tested. The volume of this compound was 0,75 + 0,75 weight %. Amount of new sand was 119 kg/mixing. Core production was without problems. Tested castings were compared with commonly produced castings of the same type. Observed surface of casting produced by core showed much less burr occurrence in comparison to commonly produced castings. It could be cca 5% of observed surface. In this experiment, the amount of additive had been increased to 5 weight %. The result was comparable with previous experiments, the burrs occurred on cca 5 % of observed surface. Also additive Veinseal RB 30 had been tested. Surface of cores was comparable with previous cores. Quality of observed surface was almost the same. It is clear, that these additives could be changed and used under the same conditions. [4].

By next experiment, the binding compound from Huttenes – Albertus company in combination with additives from two different producers had been tested. Additive Furtol AD 50 from company Furtenbach and additive EP 4085 from company ASK – Chemicals. As first, additive EP 4085 had been tested, which was added into mixture in amount 2 weight %. We have worked with 136 kg of new sand and this decreased the amount of binding compounds to 0,66 + 0,66 weight %. With such low amount of additives, the cores could not be shot. In this case, probably the low amount of binding compound was the reason. We have decided to decrease the amount of additive to 0,84 weight %. Cores were produced without problems, were strong. Similar, with the same amount of additive Furtol AD 50 the cores were produced without problems and were strong. But after pouring and visual checking of the casting, this experiment did not brought the wished result. Burrs occurrence was significant, on some places the burrs were in greater amount, they occurred also on „teeth“. By last experiment, the Cold-Box system from ASK – Chemicals had been tested. As binding compounds, ASKOCURE 366 (compound A) and ASKOCURE 666 (compound B) were used. Additives BR 955 on wooden saw-dust basis, additive BR 4048 on mineral basis and additive Sphereox on ferrous oxide basis were tested. 5 combinations had been tested, tests were executed on cores with model nr. RC 56 041. The weight of new sand had not been changed, we worked with 136 kg/mixing. As first, additive BR 4048 had been tested. Amount of binding compound was 0,66 + 0,66 weight %. Cores were produced without problems, they had bit higher abrasion. On some places, the cores were not completely shot. By visual checking of non-cut castings, the surface looked to be with minimal occurrence of burrs. On cut castings, the occurrence of burrs was visible, also on connections and also on „teeth“. It could be caused by non-shot cores. Additive BR 955 was tested as second. By this additive, the increased amount of binding compound to 0,73 + 0,73 weight % - according to the suggestion of ASK – Chemicals representative (this additive is more wetty) - was used. Cores were stronger and had lower abrasion. It could be seen that more places were not completely shot. Castings were checked visually. On non-cut castings, the surface seemed to be clean, without burrs occurrence. On cut castings, the observed surface was without burrs. Burrs did not occurred on connections, the surface was smooth. This test came out unexpectadly good. As last, the additive Sphereox was tested. This additive was added in three different amounts, 6 weight %, 3 weight % and 4,5 weight %. We wanted to check its influence with different amounts. Amount of binding compound had been decreased to 0,66 + 0,66 weight %.

Cores were produced without visible errors, had low abrasion and mixture had very good properties. [4]Observed surface was without errors. Burrs did not occurred on observed surface, possibly in minimal amount with minimal dimensions. The surface of castings was clean. It can be said, that use of Sphereox additive has brought desired results with all three charges of additive.

The results of experiments were compared with present production of Reibscheibe cores in foundry Eurocast s.r.o. Košice. They work with amount of 136 kg/mixture of new sand. Binding compounds are from Huttenes – Albertus company, their amount is 0,66 + 0,66 weight %. Used additive for prevention of burrs occurrence is Veinseal I 35 form same producer in amount 1,47 weight %. 7 experiments were executed, in which three binding compounds from three producers in combination with different types of additives from different producers added in different amounts into the mixture were tested. By experiment nr. 7 b,c,d,e in which the Cold-Box system from ASK – Chemicals company had been tested, the result of burrs occurrence was almost zero, which is the result we wanted to achieve. This system consists of binding compounds ASKOCURE 366 (compound A) and ASKOCURE 666 (compound B). The amount of these compounds for 136 kg of new sand was 0,66 + 0,66 weight %. Desired result was obtained with the use of additive BR 955, Sphereox. From the experiment results I propose to produce the Reibscheibe cores with Cold-Box system from ASK – Chemicals company in amound and dosing which were executed by experiment nr. 7b and 7d. [4].

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