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PRODUCTION OF DUCTILE CAST IRON FROM IRON BLAST FURNACE PIG IRON BY "IN MOLD" METHOD

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SUMMARY

A trial of ductile cast iron production with the use in 100% blast furnace pig iron has been undertaken. Norwegian pig iron OB and Polish pig iron from Steelworks Katowice have been used. Ductile cast iron has been produced by "IN MOLD" technology and some positive results have been obtained – they eliminate expensive charge materials and expensive technology of spheroidization.

1. INTRODUCTION

The problem of producing ductile cast iron has been known for many years. Methods of introducing magnesium into liquid metal have been changing for about 50 years. The most often method was pouring onto magnesium or magnesium preliminary alloy in a ladle. This method is simple but not very efficient; it may be dangerous, too, as it makes some fire when magnesium vapours burn. Some new closed and pressure methods have been rapidly developing. But they also have some disadvantages, e.g. cast iron temperature is considerably lowered. From the technological point of view these methods are good for small ladles – up to about 5 Mg. When big castings of ductile cast iron are produced, the method of pouring onto magnesium preliminary alloy in a ladle is used [1,2].
In Steelworks Katowice there is a very big technical equipment (ladles of capacity 350 tons), and thus technological and organisation problems are very special. Also the solutions to these problems must be suitable to the conditions in Steelworks Katowice.

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2. TRIAL OF PRODUCTION OF DUCTILE CAST IRON FROM STEELWORKS KATOWICE PIG IRON

Because of technological conditions in Steelworks Katowice "IN MOLD" method has been assumed to be a basic method for ductile cast iron production. This method must be modified a little due to dimensions and mass of the castings. It will be developed on future stage of the research which is already being carried out in Steelworks Katowice.

During laboratory tests some castings in a "step test" of mass 6.5 kg and different wall thickness from 10 – 20 – 30 – 40 to 50 mm were made. In this technology there is a reaction chamber in the system of pouring into moulds. Metal flows across the chamber and reacts with the magnesium preliminary alloy. Behind the chamber there is a filter which stops the pieces of preliminary alloy being in a liquid metal (Fig. 1.).

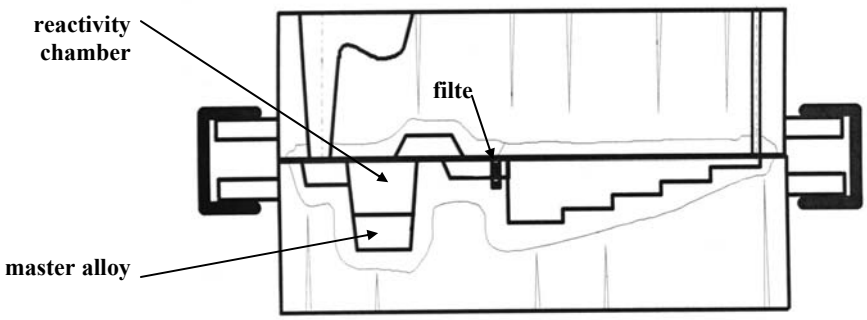

Fig.1. Casting mould with a reaction chamber ready for technological stepped test casting 10, 20, 30, 40 and 50 mm

Rys. 1. Forma odlewnicza z komorą reakcyjną gotowa do technologicznej próby schodkowej 10, 20, 30, 40 i 50 mm

To check usability of the pig iron coming from Steelworks Katowice some parallel tests with the use of the pig iron OB. were carried out. The latter pig iron is most often used for ductile cast iron production, but it is very expensive.

Chemical composition of both kinds of pig iron is following:

Composition in [%]:	C	Si	Mn	P	S
Pig iron OB:	3.65	1.75	0.01	0.02	0.01
Pig iron SK:	4.29	1.25	0.20	0.01	0.009

In the first test cycle pig iron without any additions was melted in an induction furnace. In the second test cycle about 1% Si was introduced into the pig iron. Thus, in the first test there was too little silicon while in the second test there was about 2.5% Si in initial cast iron.

Cast iron was modified with FeSiMg5 with ~ 5%Mg, ~50%Si, 0.8%Ca, 1.9%Al. Preliminary alloy in the amount 150 and 180 g was placed in the reaction chamber

through which liquid metal was flowing. Relative fraction of preliminary alloy was 2.0 – 2.5 % liquid metal mass. Temperature of pouring was about 1250 – 1300 ^{o}C.

3. METALLOGRAPHIC STUDIES

Metallographic studies were carried out on all castings. Figures 2 – 5 present microphotographs of ductile cast iron. Fig.2 presents structure of cast iron from pig iron OB with silicon small content (1.2% Si).

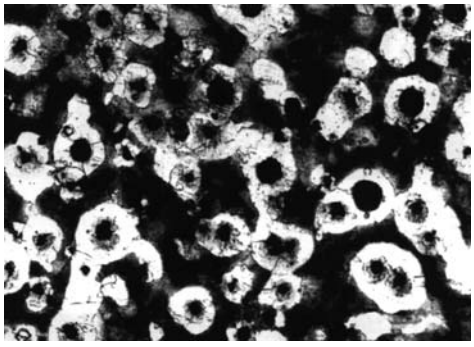

Fig.2. Ductile cast iron structures from 2 test obtained from OB(1,2% Si) pig iron charge only (description in the text), above 100 x

Rys. 2. Struktura żeliwa sferoidalnego z próby 2 uzyskanego wyłącznie z surówki OB(1.2% Si) (opis w tekście), pow. 100x

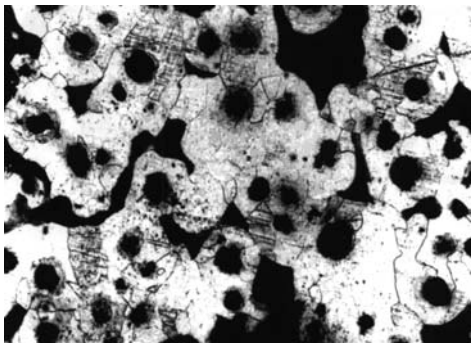

Fig.3. Ductile cast iron structures from 3 test obtained from OB(2.5% Si) pig iron charge only (description in the text), above 100 x

Rys. 3. Struktura żeliwa sferoidalnego z próby 3 uzyskanego wyłącznie z surówki OB(2.5% Si) (opis w tekście), pow. 100x

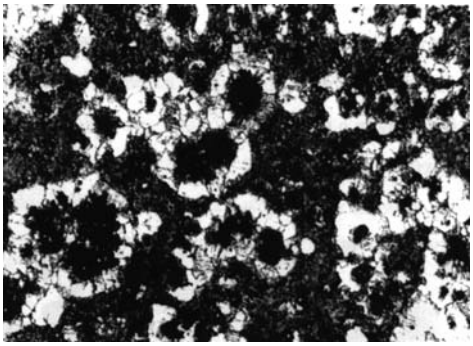

Fig.4**.** Ductile cast iron structures from 4 test obtained from SK(1,8%Si) pig iron charge only (description in the text), above 100 x

Rys. 4. Struktura żeliwa sferoidalnego z próby 4 uzyskanego wyłącznie z surówki SK(1.8% Si) (opis w tekście), pow. 100x

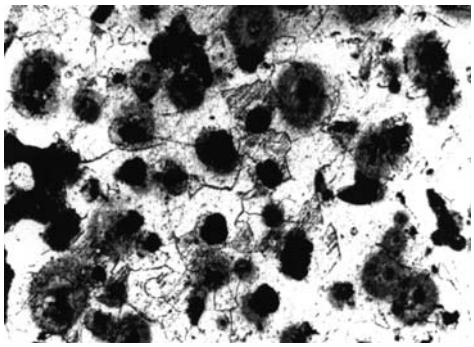

Fig.5. Ductile cast iron structures from 5 test obtained from SK(2.8% Si) pig iron charge only (description in the text), above 100 x

Rys. 5. Struktura żeliwa sferoidalnego z próby 5 uzyskanego wyłącznie z surówki SK(1.2% Si) (opis w tekście), pow. 100x

Pearlitic structure was achieved in that test. Ferrite grains formed around modular graphite. Fig.3 presents structure of ferrite ductile cast iron. In that test silicon content was increased to 2.5 %. The same tests were carried out for pig iron from Steelworks Katowice. The results were exactly the same as for pig iron OB Ductile cast iron with silicon small content (1.8% Si) has a pearlitic structure – Fig.4, while ductile cast iron with silicon content 2.8% has a ferritic structure – Fig.5.

4. CONCLUSIONS

1. Preliminary tests show that there is a possibility of producing ductile cast iron from pig iron from Steelworks Katowice.
2. Ductile cast iron produce test should be carried out on heavy castings in industrial conditions in Steelworks Katowice.
3. Steelworks Katowice has liquid pig iron in excess and it may be used for ferritic ductile cast iron castings, e.g. metallurgical accessories, mainly ductile cooling plates for iron blast furnaces, and even castings of vermiculite cast iron with the use of flexible conduit for spheroidization.
4. It has been found that ductile cast iron received by IN MOLD method can be received as ferritic cast iron both in thin and thick walls (10 and 50 mm), which is essential for machinery-castings.

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OTRZYMYWANIE ŻELIWA SFEROIDALNEGO Z SURÓWKI WIELKOPIECOWEJ METODĄ "IN MOLD"

STRESZCZENIE

Podjęto próbę wytworzenia żeliwa sferoidalnego z surówki wielkopiecowej. Użyto surówki norweskiej i surówki polskiej z Huty Katowice. Uzyskano pozytywne wyniki stosując do wytworzenia żeliwa sferoidalnego technologii „IN MOLD" technologia ta eliminuje drogie materiały wsadowe i kosztowną technologię sferoidyzacji.

Reviewed by prof. Zbigniew Piątkiewicz