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POLISH INSTALLATION FOR NEW ECOLOGICAL METHOD OF DUCTILE IRON MANUFACTURE

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Abstract

The paper gives characteristic of the installation for ecological production of ductile iron, designed and made under the Target Project No. 7 TO8 B 036 96C/2950 financed by the Committee of Scientific Research (KBN) and executed by F.M."GLINIK" S.A. and The T.Kościuszko Technical University of Cracow. The principle of the installation operation is that of an autoclave. The technical specification of the installation operation in single spheroidising treatment of 1 ton of cast iron was given, some design and technical solutions used in the installation were described, along with the flow charts and the expected outcome of practical application of the installation in production of ductile iron.

1. Introduction

The ductile iron, whose grades are given by Polish Standard PN-92/H-83123, is characterised by very high mechanical properties which result from the presence in its metallic matrix (ferritic, ferritic-pearlitic, pearlitic, bainitic-austenitic, martensitic or relevant tempered structure) of graphite in the form of spheroids [1-4, 6, 7,8].

The chemical composition of ductile iron is determined not only in respect of its grade but also in respect of the casting wall thickness; usually it is comprised in the following range of values : 3.2-3.8% C; 2.1-3.0% Si; 0.15-0.8% Mn; max 0.15% P, (in ferritic cast iron up to 0.10%), max 0.02% S, 0.05-0.12% Mg.

Magnesium, characterised by strong affinity to oxygen, in contact with molten iron burns rapidly, causing metal splashes, glare effects, and evolution of fumes, which seriously threaten the safety of workers and cause high losses of magnesium. To avoid this unfavourable effect, various methods to introduce magnesium „safely" to the melt have been developed and used; their aim is to avoid, to greater or smaller extent,

magnesium burning out and hence to improve its yield. In this respect the following new methods have become most popular [3, 4, 5, 7 – 16] :

- pouring with liquid metal the magnesium master alloys resting on the bottom of the ladle,
- introducing magnesium in the form of rods of 20-30 mm diameter to a drum ladle or cupola receiver,
- introducing magnesium to a converter ladle,
- introducing magnesium under the bell to a ladle placed in autoclave,
- introducing magnesium in the form of wire (flexible cord) of 13 mm diameter to the liquid iron in the ladle.

Due to very high mechanical and utilisation properties, ductile iron belongs to the group of iron and carbon alloys cast most frequently, and as such finds a wide-scale application as a material for parts used in vehicles, agricultural machines, pipes and fittings, and for castings operating at metallurgical plants, e.g. ingot moulds and rolls.

To maintain in western markets the strong position and competitiveness of castings made from ductile iron it is necessary to {5} : produce castings of high quality, reduce costs of production, and ensure just-in-time deliveries.

Among the numerous, well-known and previously discussed installations for the spheroidising treatment of cast iron not all of them can satisfy the imposed requirements, while other are characterised by some drawbacks, sometimes even so serious that they can be an obstacle in producing high-quality grades of ductile iron. The drawbacks encountered most often include [5,6] : low magnesium yield (low coefficient η), castings of inconsistent quality, pollution of natural environment, imminent threat to workers' health and safety.

The choice of a spherodising treatment and the design of a workstand for this treatment should be made no earlier than after careful evaluation of the production stability, costs of the spheroidising treatment, investment outlays, and operating costs.

The greatest savings combined with production of castings characterised by consistent and stable quality are ensured by the spheroidising treatment done with pure magnesium in an autoclave. This method is also safe for the workers and friendly to the environment [4, 5, 16].

2. Operating characteristic of the installation

The development in ductile iron castings production observed recently in the world and in Poland has fuelled the efforts in searching for such technologies of manufacture that can ensure the stable, efficient, flexible, economic, safe and environment-friendly production of this material.

The „GLINIK" Machines Factory S.A., Michalusa Str. 1, 38-200 Gorlice and The T.Kościuszko Technical University of Cracow, Warszawska Str. 24, 31-155 Kraków,

have requested and were granted a financial support from the Committee of Scientific Research (KBN) in Warsaw for the execution of Target Project No. 7 TO9B 036 96 C/2950 (KBN Agreement No. 1740/C O8-7/96).

The leader of the project entitled : „A modern method of producing ductile iron in a newly designed „GLINPOL" installation for the spheroidising treatment friendly to environment" is F.M. „GLINIK", Gorlice. The leader of the research and development part of the project entitled : „Elaboration of complete technical specification for the „GLINPOL" installation used in spheroidising treatment of iron with pure magnesium, designing a pilot model of this installation, and conducting trials on practical application of the technology of making ductile iron castings under the conditions of „GLINIK" Foundry" is the Department of Foundry Practice at the Institute of Materials Science and Metals Technology; Faculty of Mechanical Engineering at the T.Kościuszko Technical University of Cracow.

The technical project and the design of a pilot model of the „GLINPOL" installation as well as the design of a complete production stand with accompanying facilities were made by the Office for Design and Supply of Metallurgical Installations HpH – S.A., Kościuszki Str. 115, 32-650 Kęty.

2.1. Application

The installation is assigned for the manufacture of high-quality ductile iron directly in the foudry ladle, type KOZ-1, used for pouring of foundry moulds. The spheroidising treatment of cast iron is done with pure magnesium introduced to the ladle placed in a chamber of the „GLINPOL" installation; the chamber is designed in a way such as to enable maintaining of the assumed pressure within a range of 0.6-1.0 MPa.

2.2. Assembly parts of the installation (production stand) – Figure 1

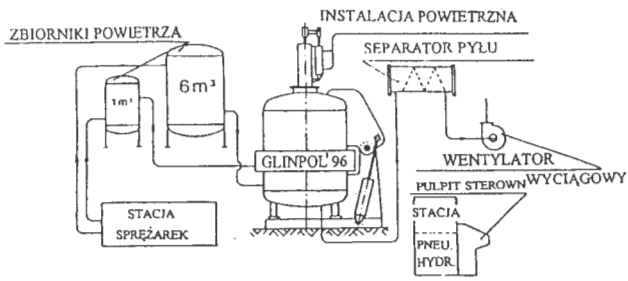

Fig. 1 The production stand for the spheroidising treatment of cast iron performed in „GLINPOL" installation [16, 18]

The whole facility (production stand) for the spheroidising treatment of cast iron comprises : „GLINPOL" installation – Figs. 1, 2, compressed air installation, sucking

device to empty the pressure chamber of the „GLINPOL" installation, power hydraulics installation, foundry ladle type KOZ-1 of special design, electric control system

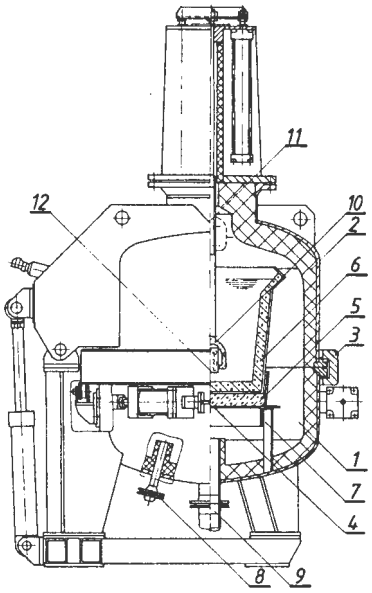

Fig. 2. Vertical section of the „GLINPOL" installation [18]: 1 – chamber, 2 – insulation, 3 – ring, 4 – ladle base, 5 – base insulation, 6 – ladle (lining), 7 – bracket, 8 – compressed air nozzle, 9 – sucking off nozzle, 10 – magnesium feeder (shaped element), 11 – drive, 12 – container for magnesium

2.3. Description of the installation

The pilot version of the „GLINPOL" installation has been made in the form of a two-part pressure vessel, the fixed part of which is resting on the carrying frame made of channel sections, connected to the foundation by means of foundation bolts.

Inside the fixed part there is a removable plate on which the foundry ladle filled with cast iron is placed. Under the plate are located outlets of the pipe nozzles connected to the air-sucking device and to the compressed air supply installation.

The upper part of the container (chamber) is connected to the lower part through an assembly of the supporting bearings, and it is deflected by means of a hydraulic C12W cylinder. Both parts are sealed by a sealing ring, type „O", and connected to each other through a set of flanges provided with segmented indentations on outer perimeter.

The segmented protrusions on flanges are pressed to each other by means of a lock ring, provided from the inside with splines which during revolution are superimposed on the ring segments.

The lock ring is put in movement by three servo-motors, mounted on the chamber outer perimeter under the ring.

The interior part of the installation (pressure chamber) is provided with thermal insulation made of a wet KAOWOOL filter, easy in moulding and well adjusted to the shape of the pressure chamber vessel of „GLINPOL" installation.

In the side wall of the deflected part there is a connecting pipe for fixing of a safety valve. The deflected part is provided with a flange which bears the supporting structure of the drive system for immersing the container with magnesium in cast iron melt.

The immersing and feeding system is composed of a ceramic shaped element (of a bell type) under which there is a perforated container with magnesium, a steel mandrel, and a ceramic insulation pipe.

3. Advantages of the „GLINPOL" installation

The main advantages of the designed and manufactured „GLINPOL" installation assigned for the spheroidising treatment of cast iron with pure magnesium include :

- the possiblity of using pure magnesium (scrap),
- maximum yield of magnesium,
- low magnesium consumption which makes the process economic,
- elimination of glare and fume effects which makes the process safe,
- fume and dust pollution in foundry reduced to minimum which makes the process ecological,
- easy and totally safe operation of the installation,
- simple construction,
- possibility of operating the installation in every foundry (no matter what type of the metallurgical process they use) which makes the process flexible,
- the drop in cast iron temperature very small (moulds are poured from the same ladle in which the spheroidising treatment has been carried out),
- short duration of technological cycle during the spheroidising treatment (max 220 s).

In conclusion it should be emphasized that, after redesigning of the installation, there are good chances for the spheroidising treatment of large batches of cast iron, e.g. 1.5 t, 2 t. The producer of the „GLINPOL" installation is F.M. „GLINIK" S.A., 38-320 Gorlice, Michalusa Str. 1, tel. (++48 18) 35-28-200, fax: (++48 18) 35-28-463. The availability is up to 6 months from the date of signing an appropriate agreement.

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POLSKIE URZĄDZENIE DO NOWEJ EKOLOGICZNEJ METODY OTRZYMYWANIA ŻELIWA SFEROIDALNEGO

Adam TABOR

Rozwój produkcji wyrobów z żeliwa sferoidalnego, jaki obserwuje się w ostatnich latach zarówno w świecie jak i w Polsce, spowodował poszukiwania takich technologii wytwarzania, które zapewniają stabilność, sprawność, elastyczność, ekonomiczność, bezpieczeństwo oraz ekologiczność produkcji tego tworzywa.

Fabryka maszyn „GLINIK" S.A. ul. Michalusa 1, 38-200 Gorlice i Politechnika Krakowska im. T. Kościuszki, ul. Warszawska 24, 31-155 Kraków uzyskały dofinansowanie z Komitetu Badań Naukowych w Warszawie do zgłoszenia Projektu Celowego Nr 7 T08B 036 96 C/2950 (Umowa KBN Nr 1740/C T08-7/96).

Projekt techniczny modelu badawczego „GLINPOL" oraz projekty całej instalacji gniazda produkcyjnego wraz z urządzeniami towarzyszącymi wykonało Biuro Projektów i Dostaw Urządzeń Hutniczych HpH – S.A., ul. Kościuszki 115, 32-650 Kęty.

Urządzenie przeznaczone jest do otrzymywania wysokiej jakości żeliwa sferoidalnego bezpośrednio w kadzi odlewniczej KOZ-1, przy pomocy której prowadzi się zalewanie form odlewniczych. Do sferoidyzacji żeliwa używa się czysty magnez, wprowadzany do żeliwa w kadzi, która umieszczana jest w komorze urządzenia „GLINPOL", która to komora umożliwia utrzymywanie stałego zakładanego ciśnienia w zakresie 0,6÷1,0 MPa.

W skład całej instalacji (gniazda) do sferoidyzacji żeliwa wchodzą: urządzenie „GLINPOL", rys.1, 2, stacja sprężonego powietrza, instalacja odpowietrzania komory ciśnieniowej urządzenia „GLINPOL", instalacja hydrauliki siłowej, kadź odlewnicza KOZ-1 w wykonaniu specjalnym, instalacja elektryczna sterowania.

Urządzenie (model badawczy „GLINPOL") wykonane jest w formie dwuczęściowego zbiornika ciśnieniowego, którego część stała spoczywa na ramie nośnej wykonanej z ceowników, połączonej z podłożem za pomocą śrub fundamentowych.

Wewnątrz części stałej znajduje się zdejmowana płyta, na której umieszczona jest kadź odlewnicza z żeliwem. Pod płytą zlokalizowane są wyloty króćców do podłączenia instalacji odpowietrzania oraz doprowadzania sprężonego powietrza. Obydwie części uszczelnione są pierścieniem uszczelniającym. Segmentowe występy na kołnierzach dociskane są do siebie za pomocą pierścienia blokującego. Pierścień blokujący wprowadzany jest w ruch trzema siłownikami, zamontowanymi na obwodzie zewnętrznym komory pod tym pierścieniem.

Komora ciśnieniowa posiada izolację termiczną, wykonaną z wilgotnego filtru KAOWOOL. W bocznej ścianie części odchylanej znajduje się króciec do zamontowania zaworu bezpieczeństwa. Część odchylana zaopatrzona jest w kołnierz, do którego mocowana jest konstrukcja nośna napędu zespołu zanurzania w żeliwie pojemnika z magnezem.

Zespół zanurzeniowo-dozujący składa się z kształtki ceramicznej pod którą umieszcza się perforowany pojemnik z magnezem, trzpienia stalowego oraz rury izolacyjnej ceramicznej.

Do głównych zalet zaprojektowanego i wykonanego urządzenia „GLINPOL" przeznaczonego do sferoidyzacji żeliwa czystym magnezem należy zaliczyć:
• możliwość stosowania czystego Mg (złom), • maksymalny stopień przyswajania Mg, • małe zużycie Mg – ekonomiczność, • eliminacja efektów świetlnych i piroefektów – bezpieczeństwo, • maksymalne ograniczenie zadymiania i zapylania w odlewni – ekologiczność, • łatwa i całkowicie bezpieczna obsługa urządzenia, • prosta konstrukcja, • możliwość stosowania w każdej odlewni (niezależnie od stosowanego procesu metalurgicznego) – elastyczność, • bardzo mały spadek temperatury żeliwa (zalewanie formy z kadzi w której przeprowadzany jest zabieg sferoidyzacji), • krótki czas trwania cyklu technologicznego podczas zabiegu sferoidyzacji (max 220 s.).