ARCHIVES of FOUNDRY ENGINEERING

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

ISSN (1897-3310)
Volume 14
Special Issue
1/2014
43-46

9/1

Aspects of Quality Assurance in Mechanization of Core Making Process

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Received 28.03.2014; accepted in revised form 14.04.2014

Abstract

The article presents conclusions drawn from analysis and research conducted in domestic foundries concerning currently used core shop equipment as well as determination of their needs within this area.
Works within mechanization of core making process, conducted together by Ferro-Masz company, Łódź and Faculty of Foundry Engineering of AGH, Kraków, included analysis of available technologies, applied materials and requirements for mechanization of core making process with the use of blowing methods.
Commercial offers from manufacturers of core making systems has been discussed together with presentation of own solution of universal core shooting/blowing machine, ensuring production of high-quality cores.

Keywords: Mechanization and automation of casting processes, Core making process, Core sand technologies, Universal core shooting/blowing machines

1. Introduction

Within the Framework of the project "Design, fabrication and manufacturing of a new-generation machines for core making from sands bonded by the newest, environment-friendly binding systems" [8] the analysis of available technologies and core shop equipment in polish as well as in foreign foundries, has been conducted.
Performed benchmarking enabled for evaluation of trends within the scope of casting production, and indirectly, for evaluation of demands for cores meeting the quality requirements.
Summary report concerning polish foundries was preceded by analysis of current situation of worldwide and polish foundry engineering (Figure no 1 and 2)

According to presented information the casting production is trending upwards after world economic crisis.
Production of high-quality castings requires also application of modern core making technologies. Modern technologies ensure mainly high functional properties of manufactured cores as well as environmental-friendly core sands, meeting the requirements of certain working conditions.
In case of core sands the development works concerned binding materials within the scope of environmental protection, technology (including i.e. extension of storage period of cores and moulds, increasing the dimension accuracy and improvement of quality) and possibility of mechanical manufacturing.

Mechanization of production of small to medium-sized casting cores includes application of core-blowing and core-making machines as basic equipment for core-box filling and core sand compaction.

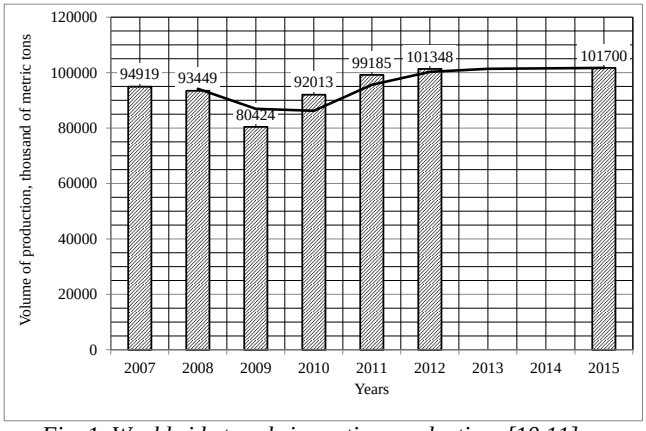

Fig. 1. Worldwide trends in casting production [10,11]

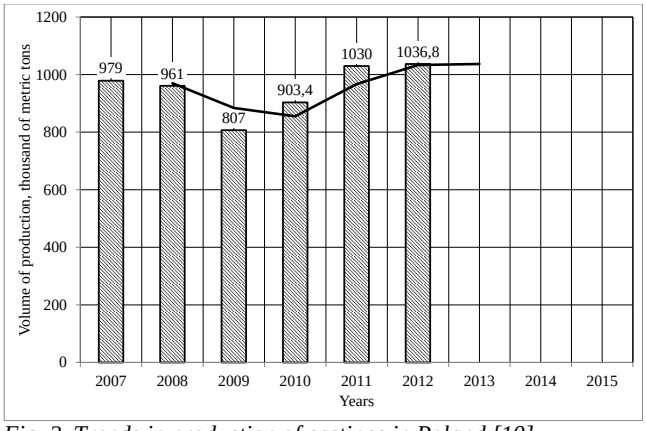

Fig. 2. Trends in production of castings in Poland [10]

Modern core-blowing machines meet the requirements of functionality i.e. it can be applied regardless of core making technology.

Currently offered core shooting/blowing machines includes, as a standard option, the possibility of adjustment to the demands of preferred core making technology and consequently to the current situation of the materials market.

2. Technology description and analysis of core shop equipment in domestic foundries

New technologies of core making are based on application of sand bonded by inorganic binders, mainly on waterglass [9]. Waterglass is modified with inorganic or organic additives. However these modification is minimal and it does not cause negative effect on the environment.

The following new technologies based on waterglass are mentioned: INOTEC (ASK Chemicals), CORDIS (Hüttenes Albertus) and AWB (Minelco).

Other type of inorganic binders are based on geopolymers (RUDAL binder), binders containing nanosilica and on inorganic salts [9].

Core sands containing inorganic binders are being constantly improved. Other interesting newly developed solutions are core sands based on biopolymer binders and furfuryl resins.

Continuous development concerns mainly binders for cold-box process with the use of amines (Ashland process).

New, modified binders have been developed. For several years inorganic solvents (esters of silicic acid) are being used in cold-box process (so called 4-th generation of binders) [9]. Considering the above, cold-box technology will be still essential for further development in the area of core sands.

Regardless of conducted analysis of available information, a survey have been carried out in 25 domestic foundries, manufacturing over 50% of total casting production in Poland. The scope of the survey included information regarding:

I. currently used core sands technologies
II. applied materials
III. core shop equipment

On the base of the survey results it has been determined that the most commonly used technologies of core sand are as follows: Croning/Hot-box (91% of respondents), CO_2 (73% of respondents),phenolic resins (36% of respondents), furan resins (9% of respondents), oil bonded sands (9% of respondents).

Commonly used core making machines in foundry practice are as follows: Ferro-Masz core shooting/blowing machines (FM12, FM20); year of production: 2010 and 2012, Laempe core shooters (LLKFZ 15, L 40, LL 10); year of production 1971, 1998 and 2007 ., Röperwerk (H 2,5, H 5, H 12, H 25) year of production 1970 ÷ 1980 and 2010, Hansberg (Shalco U 190, U 200, U 250) year of production: 1965 ÷ 1995, Fischer (25 MP) year of production 1971 ÷ 1998, Sintokogio (CBR 545) year of production 1971 ÷ 1998, IMR, PS.

Wide range of machines and especially their year of production deserves particular attention.

The above mentioned data shows great diversity of used technologies which is also a result of the character of work of the utilized core shooters.

3. Proposed solutions for mechanization of core making process

Presently offered core shooters are suitable for core production with the use of different technologies. This kind of machines are manufactured by the following European producers:

DISA (Norican Group) and LAEMPE [12]. These universal machines are used in various applications and consider the requirements of specific technology of core production.

DISA is a provider of the technological customized solutions. The company offers a number of conceptual possibilities related to quality, automation and capability.

DISA supplies core shooters meant for mass production of complicated high-quality cores. The basic series of core volumes of 10 dm^3 to 300 dm^3 can be designed for horizontal, vertical or

horizontal and vertical parting. DISA automatic core shooting machines can be easily adjusted to meet particular production requirements regarding automation degree, process technology and performance.

LAEMPE company offers core shooting machines (LHL-, LFB-, L-, LL-, LE-series and special solution machines based on Hottinger and Röperwerk technology) with different shoot volume ranges. All offered core shooters are adjusted to various technologies including: cold-box , hot-box , Croning (shell moulding), SO_2, inorganic.

The group of manufacturers includes also Ferro-Masz company specialising in mechanised core making equipment, particularly for the cold-box technology [12].

At the moment Ferro-Masz company developed and implemented universal core making system solutions (Fig. 3) [1,6]. Modular structure of core shooting machine with interchangeable units and auxiliary equipment have been developed. Interchangeability refers both to core blowing machine as well as auxiliary equipment.

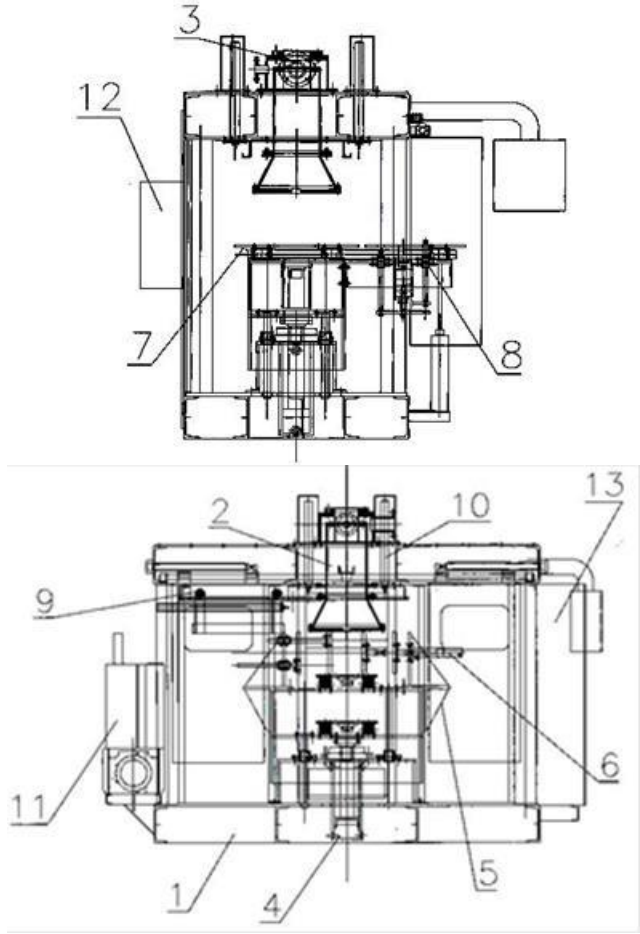

Fig. 3 Schematic diagram of a shooting machine: 1 – machine frame, 2 – shooting head, 3 – shoot valve, 4 – table-lifting cylinder, 5-core box table, 6 – core box opening, closing and clamping assembly, 7 – core removal mechanism, 8 – core push assembly, 9 – gas hood with ejection plate, 10 – clamping of horizontally split core box; 11 – hydraulic-pneumatic installation, 12 – hydraulic system, 13 – electric-powered supply and control system

Core blowing machine components are based on specially developed solutions of interchangeable units which enable realization of core blowing process with different dynamic. Auxiliary equipment also includes components related to the technology of core hardening, i.e. heating plates, gas preheater, gas hood, gas neutralizer, scrubber, exhaust hood etc.

Methods for determination of constructive and operational parameters have been developed as a result of cooperation between Ferro-Masz company and AGH [8]. Validation of calculations has been done on the basis of individual test results concerning production of cores with the use of sample core sand, typical for core making technologies with the use of blowing methods [5,7].

Sample core sand presented full range of properties typical for sands used for different technologies of core production. Commonly used core sands as well as newly-developed ecological friendly sands bonded by inorganic binders have been tested. The possibility of application of wide range of sands (loose self-hardened sand; quick-setting sand comprising organic and inorganic binders; loose quick-hardened sand and sands used in shell moulding (Croning), hot-box, warm-box, Thermoshock and warm-air processes) has been taken into consideration.

Depending on the type of the core-making process, the following parameters were determined:

- technological properties of core sand, pertaining to the core-filling with the sand-air mixture and indicators of the core mixing ability to fill the core box,
- level and quality of box filling and sand compaction, taking into account such parameters as: the type of core sand, intricacy of the core shape, air pressure, size of blowing and venting holes.

The obtained results allowed for confirmation of previously developed empirical formulas [3,4], calculating the average compaction level for the given type of the core sand, basing on the initial parameters of core blowing process.

Tests were performed on the base of testing procedure determining the evaluation of applicability of sand mix types to be used in shooting or blowing processes, similar to the approach suggested by D.Boenisch and Knauf [2].

Thus formulated criteria defining the degree of the box filling (box filling factor) allows for better insight into the behaviour of sand during the flow and box filling controlling the compaction level and structure, which in turn determines the durability and permeability of sand mix after hardening.

4. Conclusions

Information presented in this article reflects growing demand for high-quality castings. Meeting this demand requires implementation of mechanized methods of casting production.

High-quality castings require good-quality cores produced in stable conditions resulting from the requirements regarding functional properties and capability and efficiency of production.

Demanded quality of cores is ensured by the available core shooting/blowing machines of high technological quality; offering functional, practical, reliable, durable and safe

exploitation. High technological quality is ensured by the core shooting/blowing machine producers.

Results of the survey conducted in domestic foundries shown that a number of different technologies of core production is being used. However there is a very limited number of foundries using the environmental-friendly technologies. Core shop equipment also require implementation of modern solutions based on core shooting/blowing machines.

Most of the respondents in domestic foundries are determined for implementation of new, eco-friendly and efficient technologies together with installation of modern core shooting/blowing machines. These foundries are interested in universal core shooting machines which can be easily adjusted to meet particular production requirements regarding improvement of production flexibility (based upon current needs and situation in the material market).

The newly developed and successfully implemented into production series of types of core shooting/blowing machines, with the possibility of adaptation to different core making technologies, meet the requirements of polish foundries.

5. Acknowledgements

This study was completed within the framework of the project INNOTECH no K2/IN2/69/183139/NCBR/ 12 "Design, fabrication and manufacturing of a new-generation shooting machines for core making from sands bonded by the newest, environment-friendly binding systems".

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