PNEUMATIC POWDER INJECTION INTO LIQUID ALLOYS AS A TOOL OF QUALITY IMPROVING

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Abstract
In the paper has been presented the benefits of pneumatic reagents introduction (carburizers, alloy additions) into liquid alloy in aspect of profitability of castings production and quality of the made materials. There have been shown the advantages of grain materials blowing in but the disadvantages and risks of its, caused various furnaces usage for various metallurgical process too.

1. INTRODUCTION
The metallurgical processes of various alloys are the most energy consuming, thus are the most expensive parts of the whole production process. This is caused the long periods of any liquid bath treatment (refining, modification, alloys additions introduction etc.), that require a proper (high) bath temperature. Thus we have to pursue the shortest time of reagent introduction, with simultaneous its high yield (efficiency). One of the best method of metallurgical processes intensifying in this aspect is pneumatic powder injection, because of its short time and the biggest values of technological parameters such efficiency or process ratio.

Every metallurgical process requires at some stage that various components are added which are provided for specific purpose. Most frequently, due to different engineering and economic reasons they are materials in form of pieces. Utilisation of fine fractions of these materials which are wastes while in lump or piece form is manufactured is very limited because there is no effective method to enter them into liquid metal. In this connection, these materials are stored as wastes on dumps, increasing their number.

2. APPLICATIONS OF POWDER INJECTION
A method of powder injection has been since many years well known and appreciated method of liquid alloys treatment and it is use for:
- cast iron recarburization,
- slag foaming,
- alloys additions introduction,
- modification and spheroidizing of cast iron,
- desulphurization, deoxidation and non-metallic inclusions modification,
- furnace dusts blowing in etc.
The best results (the widest use in industry) give pneumatic recarburization of cast iron in EAF, when it is necessary to increase of carbon content before its spheroidizing. It is especially important, when the steel scrap with low carbon content is use instead of pig iron. On this field Department of Foundry has many successes, which are proven by many industrial applications.
ECONOMIC PARAMETERS OF CAST IRON MELTING PROCESS WITH POWDER INJECTION

Not long ago melting of high carbon cast iron required mainly a pig iron, mostly special sort. That was caused of problems in recarburization because of difficulties in carbon content increasing above its high values (more than 3.0 %). When the pneumatic injection of carburizer has been used instead of its traditional introduction, that problems disappeared. The typical installation for pneumatic recarburization of liquid cast iron is shown on the fig. 1.

Fig. 1. Scheme of pneumatic injection carburizing liquid metal stands.

The usefulness of pneumatic recarburization could be analyzed in many aspects, which depends on foundry conditions, where it is introduced. The use of this method make possible to eliminate a pig iron from charge and to substitute it with steel scrap, what gives results as follows:

- decreasing of melting process costs (the steel scrap is cheaper than pig iron),
- making use of steel scrap, which are normally not good charging materials for foundries,

In so-called “non-pig iron melting” (like in e.g. in WSK PZL Rzeszów S.A.) that method could possible:

- very quick and sure correction of carbon content afterwards the charge (cutting the time of recarburizing and a whole melting process),
- production of various cast iron grades, even nodular cast iron (require high carbon content) from steel and own scrap,
- decreasing of quantity of graphite materials dust comparing to traditional method (carburizer is directly introduced above liquid alloy surface),
- making easier the foundrymen work by elimination charging of carburizer by hand.

The advantages listed below show its usefulness in foundry practise.

The researches carried out in Odlewnia Staliwa “Labedy” show next advantages of pneumatic injection technique:

- even twenty times reducing of recarburization time,
- even five times reducing of carburizer quantity,
- possibility of using the graphite electrodes scrap (grinded) as a carburizer,

It is caused even twenty times increasing of recarburization rate and eight times increasing of carbon yield.
In the paper [10] are presented economic analyzes carried out in METAEXPORT Odlewnia Koluszki. Apart from that described above, carried our researches show that:

- the highest participation in melting costs has metallic charge,
- elimination of pig iron from metallic charge, with simultaneous using of pneumatic recarburization, significantly decreases cast iron melting costs, especially nodular cast iron,
- usage of pneumatic recarburization of liquid cast iron make possible the flexible production of many cast iron grades from the same charge.

Since many years a recarburization stand is mounted in “Teksid” Skoczów, where it is used for recarburization in EAF in nodular cast iron production process (mainly with usage of steel scrap). Long-term utilization of it confirmed very high effectiveness but the high economic benefits too. Very important is great sureness, repeatability and reliability of the pneumatic injection, what is a priority in quality aspects.

**USE OF FINE GRAIN SIZE FERROALLOYS AS THE ALLOYS ELEMENTS CARRIER**

It is well known that the yield of alloys elements introduced mostly depends on its grain size and a method of introducing. From among many methods of the grained material introduction into liquid alloy, the best is pneumatic blowing in.

With use of electric induction furnaces, because of melting conditions, the most profitable is “shooting” of powders with use of lance, with outlet above liquid surface. In that case a problem of sufficient grains kinetic energy appears, because the resistance of the liquid medium (alloy).

The development of injection technique is very essential, especially in aspect of usage fine particles of some materials (e.g. ferroalloys), which are the waste materials. Good results of the experiments with such materials can sell foundrymen on use that method, especially as producers of ferroalloys for metallurgy and founding want to sell it cheaply.

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**Fig. 2. Research stand of powder injection into induction furnace**

1-chamber feeder, 2-rubber hose, 3-injection lance, 4-buffer, 5- protective cover, 6-rotameter RDN-25, 7-supply gas pressure regulator, 8-cruicible electric induction furnace, 9-slidable arm, 10-transportation gas cylinder, 11-swivel damper
In Department of Foundry of Silesian Technical University since many years have been carried out researches which purpose is development of “powder shooting” (non-immersed lance) in aspects of its use in any furnace. They have been making on research stand shown on the fig. 2.

From industrial usage alloys addition pneumatic injection point of view, is important easily to get very high increasing of alloy elements content in liquid cast iron. The experiments convinced the usefulness of injection method in that aspect and also shown how easily we can get very high efficiency (yield) of the alloy additions introduction (over 90%).

THE INFLUENCE OF REAGENTS INTRODUCTION METHOD ON A QUALITY OF ALLOYS

On the basis of the many researches was stated that on the quality of melting alloys the methods of carried out treatment are very influent. On the usable properties (e.g. durability) of the castings significant influent has chemical composition and structure homogeneity in whole volume of the cast. The pneumatic method of grained materials introduction, thanks to its superb distributing are on this field almost unbeatable. For a homogeneity of the whole metal bath, the pneumatic parameters and a stand construction should be determined to achieve enough two-phase stream range in liquid bath.

BIBLIOGRAPHY