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ARCHIVES
of
FOUNDRY ENGINEERING

DOI: 10.24425/122512

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

ISSN (2299-2944)
Volume 18
Issue 2/2018

117 – 120

20/2

Characteristic of Weighing Process of Lump Charge Materials Using Electromagnet

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Received 14.01.2018; accepted in revised form 08.05.2018

Abstract

In cast iron foundries, used ferromagnetic batch materials can be transported and loaded into the furnace by lifting magnet. The precision of these operations by using electromagnetic grippers depends primarily on the variation in the mass of the batch material pieces. The article presents the characteristics of size of the batch materials used in the selected iron foundry. The obtained ranges mass values of individual pig iron ingots have been presented. It has been found that the mass of individual pig iron ingot may differ ± 25% from the declared by producer. The mass range of individual pieces of crushed or uncrushed return scrap was examined. Some pieces of uncrushed scrap have the mass more than three times the average weight of pieces of this scrap. Characteristics of the lifting capacity of these materials by a lifting magnet suspended to the crane was determined. Analysis of the obtained results indicates that for materials with less diversified mass of individual ferromagnetic pieces it is possible to use a gripper to weight a bigger portion with the same control setting. It was also found that there is a significant dispersion for a given gripper control, especially for materials with a wide range of individual pieces mass changes.

Keywords: Weighing process, Charge materials, Electromagnet using

1. Introduction

In many foundries producing cast iron castings, lifting magnet are used to assemble the charge material for foundry furnaces [1÷4]. These grippers are suspended to the gantry, additionally equipped with the electronic weighing scales. Ferromagnetic charge materials, such as various types of steel and iron scrap, pig iron or ferroalloys, are in the form of a charge with a diversified mass range of individual pieces [5, 6]. The article will present the influence of the different types of weighted bath materials on dispersion of weighted mass, for the adopted settings of the gripper's feeding system.

2. Abbreviated characteristics of weighted batch materials

In the selected cast iron foundry, two types of pig iron are used: processing and special [5, 6]. Both grades are delivered to the foundry in ingot. The pig iron (Fig. 1) has a chemical composition according to the certificate provided by the manufacturer: 4.11% C, 0.64% Si, 0.064% Mn, 0.052% P and 0.015% S. The weight of a single piece of ingot in the certificate is 12 kg. The special casting iron (Fig. 2) has the following chemical composition: 4.20% C, 0.17% Si, 0.007% Mn, 0.012% P and 0.008% S. The weight of one ingot of this pig iron, as per the certificate, is 12 kg.

In order to check the mass stability of individual pieces of ingot, several dozens of ingots have been weighed. Fig. 3 shows the results of weighing individual ingots special pig iron.

Fig. 1. Processing pig iron [7]

Fig. 2. Special low-phosphorous pig iron [7]

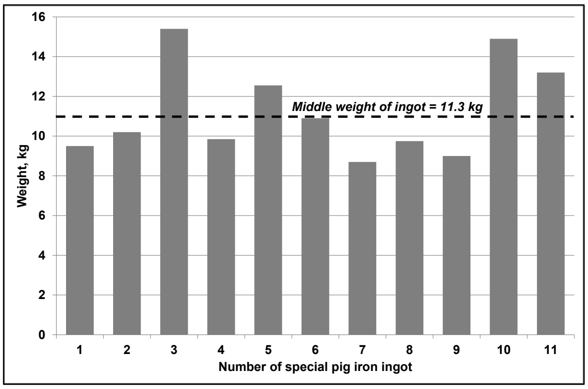

Fig. 3. Diagram of the mass of single ingots of a special pig iron

The analysis of the graph on Fig. 3 shows that the mass of weighed individual ingots in the range from 8.7 kg to 15.4 kg, i.e. it exceeds ± 25% of the middle weight of one piece of 12 kg according to the manufacturer of the ingots special pig iron. Fig. 4 shows a return scrap lump which is not previously crushed for remelting.

The graph analysis shows that some pieces of not crushed scrap have the mass more than three times the average weight of pieces of this scrap.

The crushed scrap used in the iron foundry (Fig. 6) has a smaller mass distribution of the individual pieces compared to the not crushed scrap as shown on Fig. 7.

The different mass and size of individual pieces of ferromagnetic materials affect the precision of weighing using a lifting magnet.

Fig. 4. View of uncrushed return scrap lump [7]

The mass of individual pieces of this scrap is very diverse, as shown on Fig. 5.

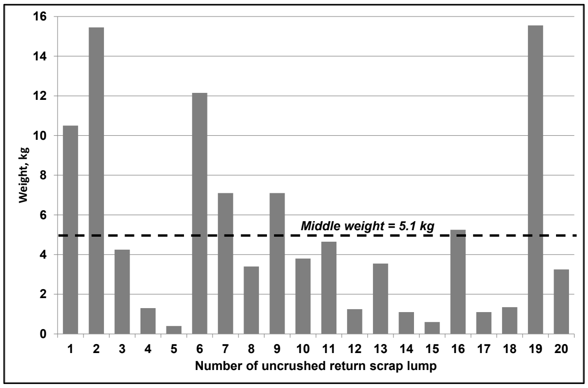

Fig. 5. Mass chart of individual pieces uncrushed return scrap lump

Fig. 6. View of crushed process scrap lump [7]

3. Characteristics of weighing using a lifting magnet

In the process of weighing and transporting in the foundry of such ferromagnetic materials as special or processing pig iron, crushed and uncrushed return scrap lifting magnet is used as shown on Fig. 8.

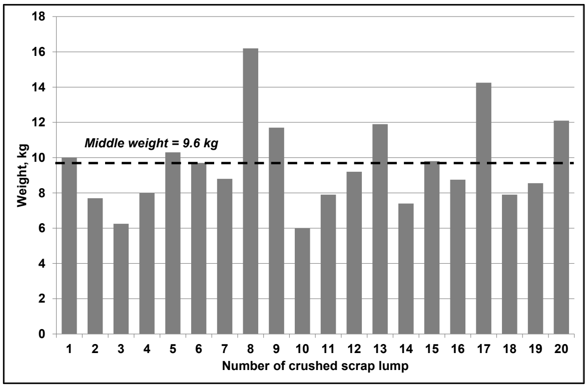

Fig. 7. Mass chart of individual pieces crushed return scrap lump

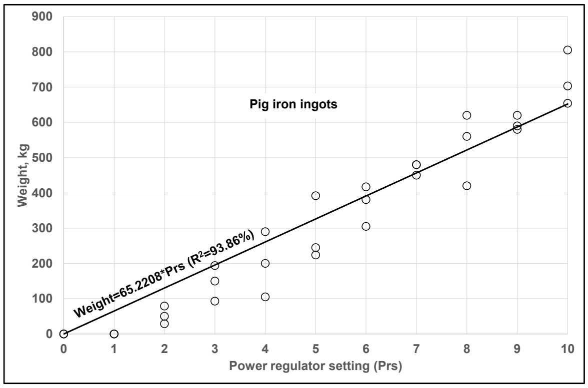

Fig. 9. Characteristics of weighing pig iron ingots using a lifting magnet

Fig. 8. View of lifting magnet [7]

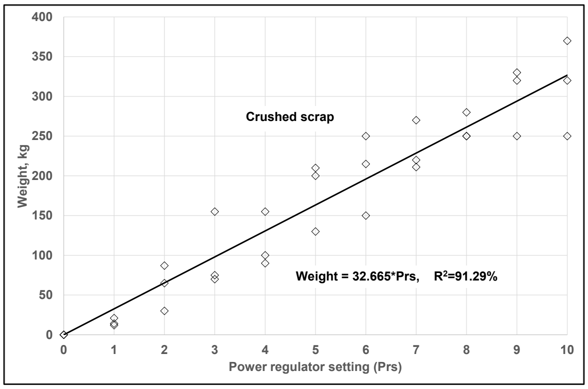

Fig. 10. Characteristics of weighing crushed return scrap using a lifting magnet

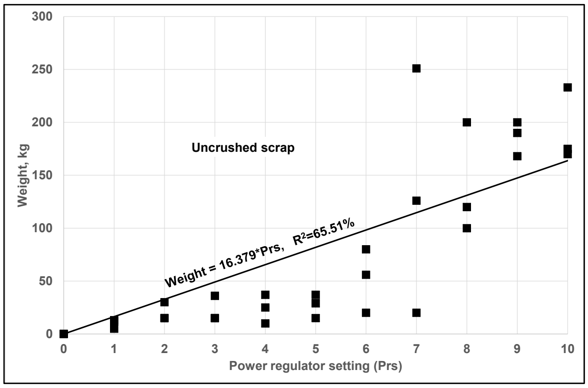

Fig. 11. Characteristics of weighing uncrushed return scrap using a lifting magnet

Value of the gripper's lifting force is controlled by setting the power supply of the electromagnets in the range between 0 ÷ 10, where "0" indicates the power supply switched off and "10" indicates the maximum power supply [7]. Fig. 9 shows the results of three weighings of cast ingots for each setting of the power supply regulator.

The maximum value of the weight distribution of weighed ingots equal to 200 kg was obtained for setting "8". Slightly smaller scatter values occurred for the "4", "5" and "10" settings.

Fig. 10 and Fig. 11 show the weighing characteristics of a scrap, correspondingly uncrushed and crushed.

The R^2 determination coefficient [8] for the linear dependence of the lifting weight on the lifting magnet regulator setpoint was 93.86% for weighing special pig iron ingots, 91.29% for crushed return scrap, and only 65.51% for uncrushed return scrap. In the last case, assuming a position the weight of the crushed return scrap weighed for a lifting magnet, depends linearly on the setting of the regulator, it may be burdened with a relatively large error.

Fig. 12 shows the linear characteristics of the mass of the weighed individual batch materials as a function of the controller setting.

The analysis of this graph shows that using a lifting magnet, for the same setting of the lift regulator, weigh a much larger mass of ingot pig iron than returning scrap. Returning crushed scrap can be weighed about twice as much at the same regulator setting than uncrushed scrap.

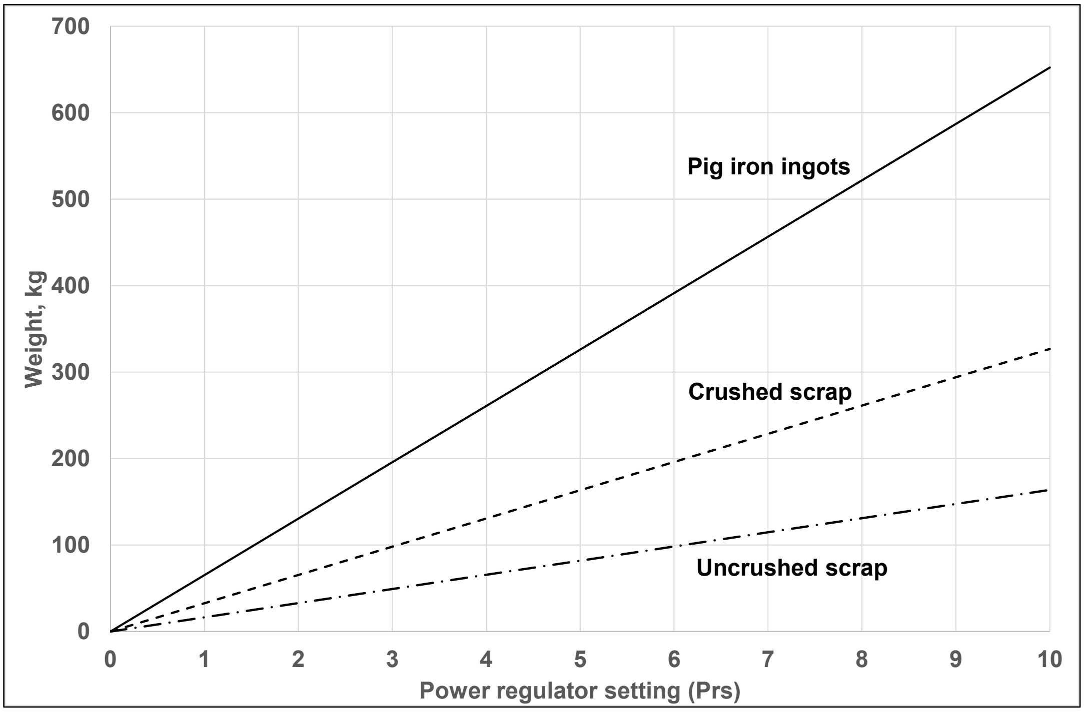

Fig. 12. Collate of weighing characteristics of a lifting magnet for ingot special pig iron, crushed and uncrushed return scrap

4. Conclusions

The carried out research tests mass of the ferromagnetic materials weighed using a lifting magnet allow us to develop appropriate weighing characteristics. The mass scatter of results values obtained for individual ferromagnetic materials, for the same settings of the regulator the strength of the lifting magnet, allows to estimate the precision of obtaining the assumed shares in the furnace feed. The developed weighing characteristics can be the basis for designing algorithms for controlling the batch assembly process together with the appropriate correction of weighing errors resulting from the use of a lifting magnet in the foundry [9].

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