Chiang Mai J. Sci. 2008; 35(1) : 196-198
www.science.cmu.ac.th/journal-science/josci.html
Contributed Paper

Applying of Aluminium Deoxidation in Iron Roll Casting

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Received : 15 September 2007
Accepted : 20 October 2007

ABSTRACT

In producing cast iron rolls for use in the hot rolling of billets, the furnace charge materials consist of bought in scrap, foundry returns and pig iron. Normally, to achieve acceptable casting quality, charges contain at least 30% pig iron. To meet increasingly tougher competition, foundries would like to reduce costs by using cheaper raw materials. To use greater proportions of steel scrap in place of the more expensive pig iron. However, castings might suffer from gas related defects such as pores. In general, aluminium is not used to deoxidize cast irons due to concerns that it may cause hydrogen pinholing. This study examines the potential for deoxidation with aluminium in producing iron castings free from gas related defects. The work suggests that only alloyed cast iron (Ni-Hard grade) can be considered for deoxidation because higher tapping temperatures to complete the oxidizing reaction of aluminium. The optimal amount of aluminium was found to be 0.05% by weight of the charge added as a ladle additive just before pouring.

Keywords: Iron casting, Deoxidation, Pores, Gas defect, Aluminium.

1. INTRODUCTION

In the manufacture of cast iron rolls for use in the hot rolling of billets, the furnace charge materials consist of bought in steel scrap, foundry returns and pig iron. Pig iron, used for at least 30% of the charge is a cleaner, more consistent material but it has become more expensive and its use results in higher costs. To meet increasingly higher competition, the manufacturer would like to reduce costs by using lower cost raw materials or using a greater proportion of steel scrap and reduced pig iron in charges. Although the cost is reduced, there is adversely affect on quality of casting.

Blowhole defects are typically found in the subsurface, which can result from chemical reaction [1]. Furthermore, the cast iron roll may be contaminated with forming oils, cutting fluids, rust and moisture. These contamination can lead to porosity due to the bubbles being trapped during solidification, dissolved gasses from melting and dross or slag containing gas porosity [2]. Aluminium is known to be a very strong deoxidizer and is commonly used in steelmaking. The advantage of aluminium deoxidation is the reduction of oxygen content in the melt thus preventing carbon monoxide formation during

solidification. Electrolytic cells were used for monitoring the aluminium concentration after the deoxidation [3]. However, too high addition of aluminium can lead to the problem of excess residual aluminium that may causes pinhole defects [4].

This study sets out to determine the suitable levels of aluminium additions to be used for deoxidation in iron castings production based on 100% steel scrap charges.

2. MATERIALS AND METHODS

This work has examined the using aluminium to determine whether deoxidation could be achieved. The used aluminium content are 0.04%, 0.05%, 0.06%, 0.07% and 0.08% by weight of charges. They were applied in Ni-Hard iron roll casting (the chemical composition of roll casting in the study is specified as a standard grade in ASTM A532 as shown in Table 1). The greensand mould casting process was used and all parameters involving casting properties were controlled. All castings for the experiment were produced from routine operation in the production line on which regular inspection is carried out for porosity defects.

Table 1. Chemical composition of indefinite-chill-roll casting (Ni-Hard iron).

Elements	% by weight	ASTM A532*
C	3.1-3.4	2.9-3.7
Si	0.5-0.8	0.8 max
Mn	1.0-1.2	1.3 max
Ni	2.7-3.0	2.7-4.0
Cr	0.8-1.5	1.1-1.5

*ASTM A532 is the specification covers a group of white cast irons. Alloying contents in ASTM A532 is varied according to each specific use.

3. RESULTS AND DISCUSSION

The results suggest that only alloyed cast iron, i.e., Ni-Hard cast iron, can be considered for deoxidation with aluminium because the higher tapping temperatures of around 1,450°C are high enough to complete the oxidizing reaction of aluminium and all dissolved oxygen without retaining excessive residual aluminium that could cause hydrogen gas to be picked-up in the moulds. The optimal amount of aluminium was found to be 0.05% by weight of the charge as shown in Table 2. Aluminium levels of around 0.06-0.08% can also be considered for deoxidation but may involve increased risks of excess residual aluminium that could then cause defects. Figure 1 shows the poor roll casting with insufficient treat (left) and sound surface of a good roll casting with adding aluminium 0.05% (right).

4. CONCLUSION

During the study, the cleanliness of the raw materials was a controlled parameter, only the level of aluminium deoxidizer was varied. The most effective aluminium level for this study is 0.05% by weight of the charge. For the most effective use, aluminium deoxidizer has to be dried and clean. The deoxidizer could be added into ladle before tapping molten metal and the upper level of tapping

Table 2. Result of varying aluminium levels in roll castings for porosity (visual checked on the rolls machined surface).

Aluminium level (wt% of charge)	Inspection for porosity on 4 rolls			
0.04	●	×	×	×
0.05	○	○	○	○
0.06	○	○	○	●
0.07	○	○	●	●
0.08	○	○	●	●

○: no porosity.
●: reduced porosity was found.
×: porosity was found and the casting was rejected.

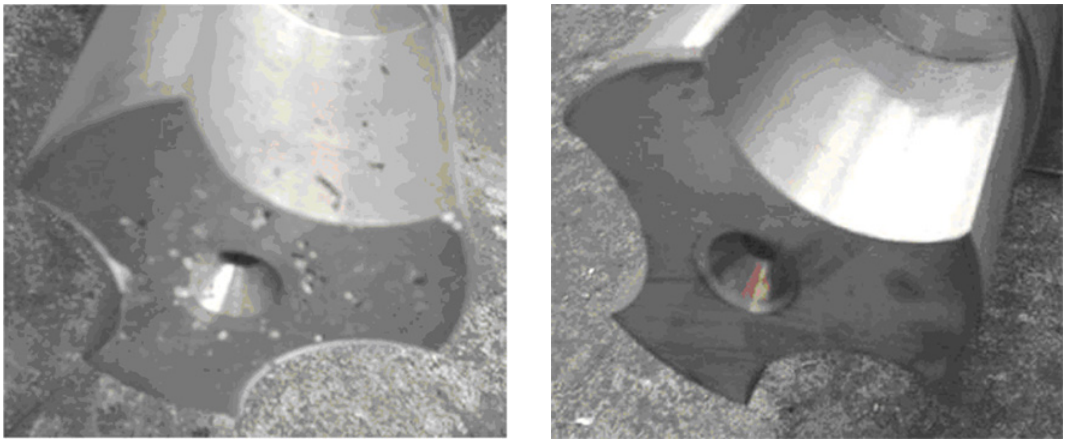

Figure 1. Before (left) and after (right) application of aluminium deoxidization for 0.2 m. diameter roll.

temperature should be considered to minimize risks of excess residual aluminium that could cause pinhole defects. Nevertheless, the deoxidizing technique by using aluminium level within an optimal range may risk porosity defects if the cleanliness of steel scrap is variable. Thus, the quality of all raw materials has to be consistent. The Aluminium deoxidation technique could be suitably be applied in manufacturing iron casting from 100% steel scrap charges which can significantly reduce raw material costs.

ACKNOLEDGEMENTS

This project was financial supported by a grant of Thai-German Institute and the special thanks is also extended to UCC industry Co.,Ltd for supporting all practical works with the kind cooperation.

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