Problems With and Solutions to Skull Formation in EBT Furnace for Tooling and Stainless Steel Production

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ABSTRACT

Bottom skull formation is a common problem in electric arc furnace for high-alloy steel production. Skull formation creates a number of process problems: reduced furnace volume capacity, lower tapping weight hit ratio and lower steel yield. The formation mechanism of bottom skull in an 85-ton eccentric bottom tapping (EBT) furnace for tool and stainless steel production in a steel plant in Korea has been investigated. The effect of bottom gas stirring and electromagnetic stirring (EMS) on the reduction of skull thickness has been compared. The results show that EMS is a more efficient way to reduce skull formation compared to gas stirring.

Keywords: Electric arc furnace (EAF); bottom gas purging; electromagnetic stirring (EMS); ArcSave; skull formation; stainless steel; tooling steel.

INTRODUCTION

Bottom skull formation is a common problem in electric arc furnaces used for high-alloy steel production, especially when a high percentage of FeCr is charged into the furnace together with short tap-to-tap time. Skull formation creates a number of process problems such as reduced furnace volume capacity, lower tapping weight hit ratio, lower steel yield, and reduced productivity etc. It has been reported that electromagnetic stirring could reduce skull formation for spout tapping furnaces used for stainless steel production[1]. Electromagnetic stirrers installed underneath the furnace bottom generates a mixing effect on the entire bath thus accelerating scrap melting and temperature homogenization which is helpful for skull removal. ABB Metallurgy has been committed to the development of new electromagnetic stirrers for improving steel quality and productivity for over 80 years, accumulating more than 1870 reference installations worldwide.

A new generation of electromagnetic stirrer for electric arc furnace (ArcSave®) was installed recently on a 70-ton EBT tapping furnace at SeAH’s steel plant in Changwon, Korea. SeAH CSS was founded in 1966 in the city of Changwon. The Changwon Plant produces 1.2 million tons of crude steel annually. SeAH CSS is the only seamless stainless-steel pipes and tubes manufacturer in Korea that uses the integrated steel manufacturing systems. The melt shop consists of an EAF, AOD/VOD, ladle furnace and continuous casting/ingot casting. The EAF has a capacity of 70 tons with a 72 MVA transformer and is equipped with a lance-manipulator consisting of four lances for injecting O₂, alumix and carbon. In combination with electrical power, three oxy-fuel wall burners are used for chemical energy input. Basic furnace data is listed in Table 1. Serious skull formation is the biggest operational problem with this EAF. In 2012, bottom gas stirring, consisting of 3 porous plugs installed in the bottom hearth of the furnace, was tested with the aim of eliminating the bottom skull problem but was unfortunately unsuccessful. Similarly, porous plug maintenance is a major challenge due to the high frequency of clogging caused by bottom skulls. After nearly one year of testing, the porous plugs were removed from the furnace due to lack of positive effects. In 2018, with the same objective in mind, electromagnetic stirring technology was introduced to SeAH as a new potential solution to the bottom skull problem. This paper will summarize the test results