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METHOD OF REMOVING LEAD FROM MOLTEN AUSTENITIC STAINLESS STEEL

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ABSTRACT OF THE DISCLOSURE

A method of reducing lead content in the molten bath of steel below 0.003% comprising substantially removing the slag cover from the molten bath, charging the melt with carbon, and oxidizing the melt to remove carbon and lead.

BACKGROUND OF THE INVENTION

This invention relates to a method of lowering the lead content of steels and more particularly to a process for reducing the lead content as low as 0.003% in a molten bath of austenitic stainless steel.

Lead is normally present in insignificant amounts in molten stainless steel. However, occasionally a significant amount of lead appears in scrap materials charged into the melt. When such a circumstance occurs, the lead is generally vaporized from the molten bath during the oxygen blow. In those instances where significant lead is still present in the bath after the oxygen blow it was heretofore customary to scrap the heat since lead in excess of 0.005% causes hot shortness and results in edge cracks during blooming, or if the ingot is successfully converted to slab, excessive conditioning is required to utilize the product.

Efforts currently utilized to remove excess lead from a molten bath are based on the belief that lead does not enter the slag during the melting operation but is either volatized or remains in the molten bath during the reduction process. Accordingly, various approaches are used to reduce or minimize the effect of unwanted lead to a level that precludes scrapping of the heat. Examples of such approaches are additons of rare earth metal or oxide to the bath to offset the hot shortness brought about by lead. This method is in lieu of eliminating lead and merely attempts to compensate for its undesirable effects by minimizing the hot shortness problem, is costly and results in dirty steels without being completely effective. Another approach is to maintain the heat at a high temperature for extended periods for the purpose of volatizing the lead. This approach has obvious production drawbacks and offers no assurance that lead content will be reduced to the desired level. Other approaches used include a combination of operations wherein the bath temperature is elevated and the melt is then subjected to a submerged blowing operation with a nonreactive gas. As in other approaches, lead content is difficult to control or anticipate when this operation is utilized and the results are not reliable. In any event all of these approaches are unsatisfactory either for economical reasons or from the production standpoint. Thus, prior to the present invention there has been no satisfactory method known to the steel industry to remove lead from a molten bath of stainless steel or to reduce it to a level consistent with hot working.

It is, therefore, a principal object of this invention to provide a method of removing lead from molten steel; and it is a more specific object of the invention to provide a method of removing lead from a molten bath of austenitic stainless steel to a level below 0.003%.

SUMMARY AND DESCRIPTION

In accordance with the invention, a process has been developed such that the lead in a molten bath of austenitic stainless steel can be reduced to a level as low as 0.003% or lower.

To accomplish this result, the slag cover is substantially removed from the molten steel bath contained within a furnace, high-carbon ferrochrome is charged, and oxygen is injected to effect removal of both carbon and lead.

In accordance with a preferred practice of the invention, a bath of austenitic stainless steel is prepared in a carbon electrode electric arc furnace under normal melting conditions. When it is determined that lead is present in undesirable amounts, the process of the invention is utilized to reduce the lead to acceptable amounts. Essentially the process comprises the following steps:

(a) removing the slag cover from the molten metal,
(b) charging the melt with carbon, and
(c) oxidizing the heat to remove carbon and lead.

The slag is removed in any conventional manner in accordance with the melting procedures utilized, such as by raking with wooden or steel rabbles, etc. It is, however, essential that substantially all slag be removed prior to proceeding with the next step of the process.

The melt is then charged with carbon which can be in any form provided that the slag cover has been completely removed. In the preferred embodiment of the invention the carbon is introduced in the form of high-carbon ferrochrome, having a carbon content of about 8%.

The oxidation step is preferably conducted by an oxygen blow immediately following the charge of carbon and serves the purpose of removing carbon and lead. The exact mechanism by which the lead removal is accomplished is not known; however, it has been established that the critical conditions for such removal are the steps of the invention process practiced in sequence. Further, while the process serves to remove lead to an acceptable level when utilized during any part of the melt, it is preferred to employ it immediately following the complete meltdown of the heat.

Reference is directed to Table I which tabulates a number of heats, treated in accordance with the invention, showing the effectiveness of the lead removal. Heat No. 56211 is a remelt of a previous heat which was scrapped due to high lead content. It is to be noted that no carbon additions were made to Heats 56037 and 56040 and the final lead content of these heats is unacceptable.

TABLE I.—LEAD REMOVAL

Heat No.	Steel type	Initial Pb (wt. percent)	Final Pb (wt. percent)	High C ferrochrome, lbs.
56037	316	.0052	.0034	None
56040	316	.0067	.0035	None
41504	316	.0033	.0023	2,000
41537	305	.008	.0014	3,000
41562	316	.0032	.0017	4,000
41564	316	.0019	.0017	4,000
41585	316	.0037	.0016	4,000
56211	304	.014	.0014	4,000
41584	316	.0034	.0014	4,000
56214	304	.0068	.0013	4,000
41593	316	.0023	.0012	4,000
56215	304	.020–.030	.0021	4,000

In an example of the invention, Heat No. 56215 having an aim analysis of: C—0.7; Cr—18.1–18.6; Pb—.003; Mn—.80–1.20; Ni—9.25–9.75; Sn—.015; P—.03; Mo—.30; Ti—.05; S—.025; Cu—.30; Co—.20; Si—.30–.60; was processed as follows:

70,800 pounds of scrap and metal was charged into the furnace and melted out 100% at which point lead content was .030. The slag was run off and 4000 pounds of 8% carbon ferrochrome was charged and entered the

melt during a 15 minute furnace run. An oxygen blow of 31 minutes at 120 pounds pressure was then conducted after which the lead content was read at .0016. Following the lead removal, the melt was completed in a normal manner and tapped. The final analysis being as follows: C—.070; Cr—18.50; Pb—.0021; Mn—1.07; Ni—9.37; Sn—.012; P—.024; Al—.007; Ti—.014; S—.010; Mo—.29; Co—.10; Si—.62; Cu—.18; B—.0006.

Although a preferred embodiment of this invention has been described, it is to be understood that various adaptations and modifications may be made without departing from the scope of the appended claims.

I claim:

1. In the melting of stainless steel in an electric arc furnace wherein a slag is used during melting, the improvement which comprises a method of lowering the lead content of a melt of said stainless steel having an initially higher lead content to a value less than 0.003% which comprises forming a melt of said steel at least in part of lead-containing stainless steel scrap, substantially removing said slag from the surface of said melt, adding carbon-containing material to the melt and immediately thereafter introducing oxygen-containing gas to the slag-free melt to remove carbon and lead.

2. A method as recited in claim 1 in which the carbon is charged in the form of high-carbon ferrochrome.

3. A method as recited in claim 1 in which the heat is oxidized by introducing oyygen into said bath.

4. A method as recited in claim 1 in which the carbon is charged in the form of high-carbon ferrochrome and the heat is oxidized by introducing oxygen into said bath.

5. A method as recited in claim 4 which is sequentially conducted immediately following the complete meltdown of the heat.

6. A method as recited in claim 5 in which the steel is austenitic stainless steel.

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