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John & Kernick

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71 Full Name(s) of applicant(s)

COUNCIL FOR MINERAL TECHNOLOGY
and
MIDDELBURG STEEL AND ALLOYS (PROPRIETARY) LIMITED

72 Full Name(s) of inventor(s)

THOMAS ROBERT CURR and
NICHOLAS ADRIAN BARCZA

54 Title of invention

"THE REFINING OF FERROCHROMIUM METAL"

ABSTRACT

A process for the refining of high carbon ferrochromium metal in which the ferrochromium metal is refined, in the liquid state, with liquid metal oxide, generally including oxide fines. The heating is carried out in a transferred arc thermal plasma with substantial exclusion of carbon; although a consumable carbon electrode can be employed to generate the plasma. The ferrochromium metal is preferably premixed with the required oxides and fluxes and the feed is added to the furnace bath at a rate controlled to ensure that the slag and metal remain molten and at a chosen temperature.

BACKGROUND TO THE INVENTION

THIS INVENTION relates to the refining of ferro-chromium metal and, more particularly, to the refining of high carbon ferrochromium metal to remove some carbon therefrom and also reduce the silicon content.

In the past, refining of silicon and carbon in ferrochromium metal by the addition of metal oxides has, apart from by gas injection processes such as Argon-oxygen decarburization (A.O.D.), only been achieved in the solid state under considerable vacuum in the so-called simplex process.

In this specification the term "fines" is intended to mean subdivided material having a size of less than 6mm and includes sizes of less than 2mm which is, in many cases, considered unsaleable in respect of certain materials such as ferrochromium, for example. It is the object of this invention to provide an improved refining process for ferrochromium metal.

Furthermore, a transferred arc thermal plasma is defined as an electrically generated plasma in which the ion temperature lies in the range 5000K to 60 000K and

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the molten bath forms a substantial part of the electrical circuit.

BRIEF SUMMARY OF THE INVENTION

In accordance with this invention there is provided a process for the refining of ferrochromium metal and a suitable metal oxide are heated in the presence of a transferred arc thermal plasma to effect a liquid slag to liquid metal refining in a substantially carbon free environment.

Further features of the invention provide for the heating to be carried out at atmospheric pressure or less than atmospheric pressure; for the high carbon ferrochromium metal to be in the form of fines (as herein defined) and to be preferably admixed, prior to melting, with oxide fines which may be agglomerated, or lumpy ore which may, in either case, be pre-reduced, pre-oxidized or otherwise pre-treated; for such fines to be, or to include, chromite fines; and for the feed materials to be preferably admixed with any required fluxes such as, for example, quartz or lime.

It will be understood that the expression "substantially carbon free environment" is intended to be interpreted as including the case where a consumable carbon electrode is employed to form the thermal plasma.

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The process can be run as a multi-stage process with varying degrees of refining dependant upon the metal oxide to metal ratio. Final alloy or metal additions could be made to produce any desired final metal composition, such as, starting material for direct stainless steel production.

The process can be run as a single continuous process. A further alternative is to run the process intermittently or with the intermittent tapping of slag and/or alloy or even the intermittent addition of ore or other refining medium. A batch process is also possible and within the scope of this invention.

DETAILED DESCRIPTION OF THE INVENTION

In order to test the invention experiments were carried out in a transferred precessing plasma arc furnace manufactured by Tetronics Research and Development Company Limited and substantially as described in their British Patent Nos. 1390351/2/3 and 1529526. The tests were carried out using a precessing speed of 50rpm and a non-consumable electrode in the plasma gun. In these tests 100 parts ferrochromium metal fines having the following composition were mixed with 28,6 parts of Winterveld Ore having the composition given below and, 4,3 parts of quartz, the composition of which is also given below.

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Composition of "Metal Fines" (slag to metal ratio = 0,129)

Metal component = 88,6% of total with composition given below:-		Slag component = 11,4% of total with composition given below:-	
Chromium	52,8%	Cr_2O_3	27,0%
Iron	36,2%	FeO	13,0%
Silicon	3,0%	CaO	2,2%
Carbon	6,55%	SiO_2	47,7%
		MgO	1,0%
		Al_2O_3	7,4%

Composition of Winterveld Chromite

Cr_2O_3	44,6%	FeO	23,3%	SiO_2	2,23%
CaO	0,20%	MgO	11,2%	Al_2O_3	13,7%

The quartz had a composition of 0,20%FeO, 99,5% SiO_2 and 0,06% Al_2O_3.

If required, limestone or dolomite could be used as a flux to effect the removal of sulphur from the metal. Likewise sodium carbonate could be used for the removal of phosphorus. Titanium removal occurs automatically as a feature of the process and this improves the quality of the metal.

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The above described mixture of raw materials was fed to the preheated furnace at a rate calculated to ensure that the metal and slag were maintained at a constant selected process temperature i.e. to maintain the required energy balance and maintain the slag and metal in a molten condition. The slag and metal were tapped after the addition of feed was complete.

The refining obtained was a reduction of the silicon content from 3 mass % to 0,84 mass % and a reduction of the carbon content from 6,55% to 4,10%. Thus an appreciable refining was achieved using the process of this invention. Lower silicon and carbon values are possible when the chromite ore or other suitable metal oxide to metal fines ratio is increased.

It is to be mentioned that the electrode used in the plasma gun can be either a non-consumable or a consumable graphite type of electrode. The use of an inert gas via the plasma gun was limited to the quantities required for operation of a stable thermal plasma and not specifically for any metallurgical purpose. Obviously more could be used, if desired. The furnace was not lined with any graphite or carbon layers which could contact the metal or molten slag. In this manner carbon was kept down to a minimum in the system and the stated degree of refining achieved.

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The following is an example of results obtained by the use of a consumable electrode for the process for refining ferrochromium metal.

The metallic fraction, which constituted 89,7 per cent of the mass of the material, had the following analysis by mass:

Chromium	51,2%
Iron	39,0%
Silicon	2,69%
Carbon	5,7%

The slag component had the analysis by mass:

Cr_2O_3	13,0%
FeO	3,87%
CaO	1,05%
SiO_2	55,3%
MgO	1,21%
Al_2O_3	18,3%

The analysis of the chromite was similar to that used for the tests done with the non-consumable electrode and described above. The analysis of the limestone used as flux had the analysis (mass %)

FeO : 0,46 SiO_2 : 2,07 CaO : 55,0

MgO : 0,53 Al_2O_3: 0,54

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In this test 100 parts of ferrochromium metal fines were mixed with 28,6 parts Winterveld ore and 11,5 parts limestone. The above mixture was again fed to a preheated furnace at a rate calculated to ensure that the metal and slag were maintained at a constant selected process temperature to maintain the required energy balance.

In this case the refining obtained was a reduction of silicon content from 2,69 mass per cent to 0,65 mass per cent and a reduction of the carbon content from 5,7 mass per cent to 5,2 mass per cent.

The construction of the furnace used was similar in concept to that used in the first described test in that an oxide refractory material was used as a lining.

It will be understood that the invention provides a simple yet effective process for the refining of ferro-chromium metal in which chromite ore can be used or, alternatively, any other oxide of a suitable nature. It is to be mentioned that the refining of the carbon and silicon automatically, in this method, results in a refining of the titanium content of the metal. This can be highly advantageous for certain applications of the metal.

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CLAIMS:-

1. A process for the refining of ferrochromium metal in which the ferrochromium metal and a suitable metal oxide are heated in the presence of a transferred arc thermal plasma to effect a liquid slag to liquid metal refining in a substantially carbon free environment.

2. A process as claimed in claim 1 in which the heating is carried out at or below atmospheric pressure.

3. A process as claimed in either of claims 1 or 2 in which the ferrochromium metal is in the form of fines as herein defined.

4. A process as claimed in claim 3 in which the "fines" have a size of less than about 2mm in diameter.

5. A process as claimed in any one of the preceeding claims in which the ferrochromium metal is mixed prior to feeding.

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6. A process as claimed in any one of the preceeding claims and which the metal oxide is fed to the furnace in the form of oxide fines which may optionally be agglomerated or in the form of lumpy oxide ore, or both.

7. A process as claimed in claim 6 in which the oxide fines or lumpy oxide ore is pre-reduced, pre-oxidized, or otherwise pre-treated.

8. A process as claimed in either of claims 6 or 7 in which the oxide fines or lumpy oxide ore comprises chromite.

9. A process as claimed in any one of the preceeding claims in which the ferrochromium metal and oxide are admixed with required fluxes.

10. A process as claimed in claim 9 in which the fluxes include quartz.

11. A process as claimed in either of claims 9 or 10 in which the fluxes include limestone or dolomite or both.

12. A process as claimed in any one of claims 9 to 11 in which the fluxes include sodium carbonate.

13. A process as claimed in any one of the preceeding claims in which the mixed solid ferrochromium metal and metal oxide are fed to a molten mass of metal and optionally slag.

14. A process as claimed in claim 13 in which the mixed solid ferrochromium metal and metal oxide is fed to the molten mass, at a rate controlled to maintain a predetermined temperature and molten state of such metal mass.

15. A process as claimed in any one of the preceeding claims in which the thermal plasma is generated using a non-consumable electrode.

16. A process as claimed in any one of claims 1 to 14 in which the thermal plasma is generated using a consumable electrode.

17. A process as claimed in claim 1 and substantially as herein described or exemplified in either of the examples.

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18. Ferrochromium metal whenever refined using a process as claimed in any one of the preceeding claims.

DATED THIS 11th DAY OF October 1982

JOHN & KERNICK

for the Applicant