The present invention relates to a process for the manufacture of low carbon and medium carbon ferromanganese, More particularly the invention relates to a process for the manufacture of low carbon and medium carbon ferromanganese in a fuel fired rotary furnace.

Ferromanganese is normally produced in an electric arc furnaces by a process which involves charging manganese ore, solid manganese silicide and burnt lime to the furnace and then melting and reacting the charge to produce ferromanganese and slag. This process can be carried out either as a one-slag process wherein the whole of the charge is added at the commencement, or as a two-slag process wherein portion only of the manganese ore and solid manganese silicide is added at the commencement, with the slag produced being thereafter tapped, and the remainder of the charge then added. This process suffers from the disadvantage that it is time consuming, requiring about 4 hours for completion, and consequently the wear on the refractory furnace lining is very high.

The object of the present invention is to provide a process for the manufacture of ferromanganese which can be carried out in a comparatively short time and which thereby considerably reduces the amount of wear on the refractory furnace lining with a consequential saving on the cost of replacing the lining.

Broadly, in accordance with the present invention, there is provided a process for the manufacture of ferromanganese which comprises charging limestone or burnt lime, manganese ore and steel scrap to a fuel fired rotary furnace, preheating the furnace and the contents thereof to a temperature of from 1,300° to 1,600° C., adding molten manganese silicide to the preheated furnace, rotating the furnace for a period of time to enable the reaction to be completed, and then tapping the ferromanganese produced from the furnace.

The charge should preferably be proportioned in such a manner that the ratio of the weight of manganese in the ore over the weight of silicon in the silicide is greater than 2.9.

The ore should contain at least 47% manganese. The limestone charge should be of such a weight that the final slag tapped should preferably have a CaO/SiO₂ ratio between 1.4 and 1.7.

The steel charge should be approximately 10% or less of the weight of manganese silicide charge the exact amount of steel charged depending on the manganese content of the manganese silicide and the desired manganese content of alloy to be produced.

The time required for completion of the reaction may vary from 2 minutes to 50 minutes, a time of from 5 to 20 minutes normally being sufficient to ensure satisfactory completion of the reaction. While the reaction is taking place the furnace must be rotated at a speed sufficient to ensure adequate mixing of the charge, speeds within the range of 2 to 50 revolutions per minute normally being satisfactory for this purpose.

During the period when the furnace is being rotated solid manganese silicide, manganese ore or steel may be added to the charge if desired.

The manganese silicide used in the process should preferably contain from 17 to 25% by weight silicon and more than 60% by weight manganese. If desired a portion of the limestone or burnt lime in the initial charge may be replaced by raw or burnt dolomite.

The carbon content of the ferromanganese produced depends primarily on the silicon content of the manganese silicide. Manganese silicides having a silicon content of from 17 to 18% by weight result in the production of a medium carbon ferromanganese, i.e., one having less than 1.5% by weight carbon, less than 1.5% by weight silicon and more than 75% by weight manganese, while manganese silicides having a silicon content of from 18 to 25% by weight result in the production of a low carbon ferromanganese, i.e., one having less than 1.0% by weight carbon, less than 1.5% by weight silicon and more than 75% by weight manganese.

The present process by enabling the reaction between the manganese silicide and the other components of the charge to be completed in a comparatively short period of time greatly reduces the erosion of the refractory furnace lining and thereby enables considerable savings to be made in the cost of replacement of the lining.

The invention is illustrated by the following examples.

**EXAMPLE 1**

**Low carbon ferromanganese**

The manganese ore and limestone charge used were as follows:

<table>
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<tr>
<th>Grade</th>
<th>SiO₂ (wt %)</th>
<th>Mn (wt %)</th>
<th>C (wt %)</th>
<th>CaO (wt %)</th>
<th>MgO (wt %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore</td>
<td>52.15%</td>
<td>11.0%</td>
<td>0.5%</td>
<td>9.4%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Limestone</td>
<td>94.9%</td>
<td>0.1%</td>
<td>0.5%</td>
<td>7.4%</td>
<td>0.1%</td>
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</tbody>
</table>

The ore, limestone and 25 pounds of steel scrap were preheated over a period of 1½ hours in a rotary furnace to a temperature of 1,500° to 1,550 °C. The furnace was rotated at 9 ½ r.p.m. during the preheating period.

After the furnace and contents had been preheated, 252 pounds of molten manganese silicide at a temperature of 1,400° C. were added and the furnace was then rotated for 7 minutes at 18 r.p.m. The rotation of the furnace was then stopped and the product and slag tapped from the furnace.

Manganese silicide analysis.—Mn, 67.2%; C, 0.5%; Si, 21.8%.

Product analysis.—Mn, 80.0%; C, 0.28%; Si, 0.35%.

Slag analysis.—Mn, 16.3%; CaO, 38.0%; SiO₂, 26.7%; MgO, 16.0%.

Weight of product.—329 pounds.

Weight of slag tapped.—508 pounds.

**EXAMPLE 2**

**Low carbon ferromanganese**

The procedure of Example 1 was repeated with the exception that the manganese silicide used was of a different composition.

Manganese silicide analysis.—Mn, 66.9%; C, 1.0%; Si, 18.4%.

Product analysis.—Mn, 80.8%; C, 0.54%; Si, 0.55%.

Slag analysis.—Mn, 12.2%; CaO, 36.0%; SiO₂, 23.5%; MgO, 14.0%.

Weight of product.—300 pounds.

Weight of slag tapped.—370 pounds.

**EXAMPLE 3**

**Medium carbon ferromanganese**

In this example, 262 pounds of limestone, 280 pounds of manganese ore and 20 pounds of steel scrap were preheated in the rotary furnace for 75 minutes to 1,550° C.
with the furnace being rotated at \( \frac{3}{4} \) r.p.m. during the preheating. The ore and limestone were of the same analysis and size as those used in Examples 1 and 2. 252 pounds of manganese silicide at 1,390° C. were then added to the preheated furnace and the furnace when rotated for 5 minutes at 18 r.p.m. The rotation of the furnace was then stopped and the product and slag tapped from the furnace.

Manganese silicide analysis.—Mn, 70.2%; C, 1.35%; Si, 17.1%.

Product analysis.—Mn, 78.2%; C, 0.92%; Si, 0.23%.

Slag analysis.—Mn, 19.0%; CaO, 42.0%; SiO_2, 27.7%; MgO, 5.2%.

Weight of product...—310 pounds.

Weight of slag tapped...—433 pounds.

What I claim is:

1. A process for the manufacture of ferromanganese which comprises charging manganese ore, steel scrap and a material selected from the group consisting of limestone and burnt lime to a fuel fired rotary furnace, preheating the furnace and the contents thereof to a temperature within the range of from 1,300° to 1,600° C., adding molten manganese silicide to the preheated furnace, rotating the furnace for a period of time sufficient to enable the reaction to be completed, and thereafter tapping the ferromanganese produced from the furnace.

2. A process according to claim 1, characterized in that the furnace is rotated at a speed within the range of 2 to 50 revolutions per minute during the reaction period.

3. A process according to claim 2, characterized in that a material selected from solid manganese silicide, manganese ore and steel is added to the charge in the furnace while said furnace is being rotated.

4. A process according to claim 3, characterized in that the molten manganese silicide added to the preheated furnace contains from 17 to 25% by weight silicon and more than 60% by weight manganese.

5. A process for the manufacture of low carbon ferromanganese which comprises charging manganese ore, steel scrap and a material selected from the group consisting of limestone and burnt lime to a fuel fired rotary furnace, preheating the furnace and the contents thereof to a temperature within the range of from 1,300° to 1,600° C., adding molten manganese silicide to the preheated furnace, said manganese silicide containing from 18 to 25% by weight silicon and more than 60% by weight manganese, rotating the furnace for a period of time sufficient to enable the reaction to be completed, and thereafter tapping the ferromanganese produced from the furnace.

6. A process according to claim 5, characterized in that the furnace is rotated at a speed within the range of 2 to 50 revolutions per minute for a period of time of from 2 to 50 minutes.

7. A process for the production of medium carbon ferromanganese which comprises charging manganese ore, steel scrap and a material selected from the group consisting of limestone and burnt lime to a fuel fired rotary furnace, preheating the furnace and the contents thereof to a temperature within the range of from 1,300° to 1,600° C., adding molten manganese silicide to the preheated furnace, said manganese silicide containing from 17 to 18% by weight silicon and more than 60% by weight manganese, rotating the furnace for a period of time sufficient to enable the reaction to be completed, and thereafter tapping the ferromanganese produced from the furnace.

8. A process according to claim 7, characterized in that the furnace is rotated at a speed within the range of 2 to 50 revolutions per minute for a period of time of from 2 to 50 minutes.

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U.S. Cl. X.R.