

1

2,797,988

PROCESS OF PRODUCING METAL ALLOYS OF
LOW IMPURITY CONTENT

John S. Barker, Jr., Charleston, S. C., and Norris B. McFarlane, Lewiston, N. Y., assignors to Pittsburgh Metallurgical Company, Inc., Niagara Falls, N. Y., a corporation of Delaware

No Drawing. Application January 18, 1956,
Serial No. 559,757

4 Claims. (Cl. 75—13)

This invention relates to a process of producing metals and improving the characteristics of the products made therefrom. More specifically the invention relates to a process of producing metal alloys of high purity and has particular reference to the process of producing ferroalloys very low in impurities, especially ferrosilicons, although the process may be utilized with equal benefits in the production of other metals and metal alloys.

A further object is the production of ferrosilicons which consist almost entirely of silicon and iron, the impurities both metallic and non-metallic having been reduced by this process to a very low content.

Other objects of the invention will become apparent from the following description and claims, it being understood that the description is given by way of example and that the invention is limited only in accordance with the scope of the claims.

The invention works well with all grades of ferrosilicon from 14% silicon content upward but will first be described with particular reference to its application in the production of high purity 65% ferrosilicon containing a maximum of 0.5% aluminum and a maximum of 0.50% total impurities. In describing this invention, impurities are defined as anything other than the major elements making up the alloy. In the case of 65% ferrosilicon, anything in the finished product except silicon and iron is to be considered as being an impurity. This alloy of approximately 65% silicon, 35% iron, and containing a maximum of only 0.05% aluminum was developed primarily for use, by steel producers, in the manufacture of electrical sheet steel, for making various electrical devices. In such devices, material of relatively low energy loss characteristics is highly desirable. Our process has been found to materially benefit the electric characteristics of the steel.

The ordinary process of producing ferrosilicon is to smelt a silica material such as quartz, quartzite, gannister, and the like, in an electric furnace, usually of the well known submerged arc type. The silica material together with reducing materials such as coke or coal, and iron in the form of scrap steel, and/or iron ore, mill scale, and the like, are charged at the top of the furnace, and as the charge moves downward in the furnace, the carbonaceous materials reduce the oxides. The resulting ferrosilicon is tapped periodically from near the bottom of the furnace. Reference to 65% ferrosilicon means 65% silicon content. Such ferrosilicon produced by the use of ordinary reducers such as coke and coal contains aluminum in the amount of approximately 0.75% to 1.20%. By using selected raw materials, as for example certain grades of petroleum coke, the aluminum content in the 65% ferrosilicon can be reduced to approximately 0.12%, but is more usually in the range of 0.15% to 0.25% aluminum.

In our process the 65%, or the 14% upward, silicon content ferrosilicon, or other metal susceptible to treatment by this process, is refined by treatment with a molten

2

slag of proper composition in an acid-lined electric furnace, usually of the open-arc type similar to those used by producers of steel. Our invention works well when the 65% ferrosilicon (or other percentage silicon content ferrosilicon, or other material as foregoing included) is charged to the furnace in the solid form but our usual procedure is to transfer the 65% ferrosilicon as tapped from the submerged arc furnace, and while still in a molten state, directly to an open-arc furnace having an acid lining. Sand and lime, in proper proportions is charged into the furnace to form a calcium silicate slag over the molten alloy.

While various proportions of sand and lime, ranging from sufficient of each material to form a slag consisting of one part of silica to one part of calcium oxide to a slag consisting almost entirely of silica work well, we have found that a slag which has approximately the eutectic composition of 65% silica and 35% calcium oxide gives best results. Occasionally fluorspar or alkali salts such as sodium silicate are added to control the viscosity of the slag. Also, we may vary the composition of the slag by the addition of an alkali salt, or the substitution of an alkali salt for a portion of, or all of the calcium oxide.

When the slag is formed and in proper working condition, a wooden pole inserted in the molten metal will agitate the bath and result in a more intimate contact between the slag and metal. The metal and slag is then tapped from the furnace into a ladle from which the metal and slag from one ladle into another ladle at a rapid rate will provide further intimate contact between the metal and slag and thus benefit the alloy. After this reladling process, the 65% ferrosilicon is cast in the usual manner.

Through the action of the slag on the 65% ferrosilicon and control of temperature as afforded by the electric furnace, non-metallic inclusions, being lighter than the metal, float to the top of the metal bath and enter and become a part of the slag. Elements such as aluminum are oxidized either by combining with residual oxygen in ferrosilicon, or by reduction of silica and likewise enter and become part of the slag. Gases are reduced by combining with an element as described above in the example given for aluminum or else through evolution to the atmosphere.

65% ferrosilicon refined in accordance with the specific procedure above described is remarkably low in aluminum content and can be readily reduced to a maximum 0.05% and frequently analyzes below 0.01%. Other contaminating elements are similarly and simultaneously eliminated. For example, the chrome content is often reduced by as much as 80%. We have further found, by means of metallographic studies and gas analyses, that non-metallic inclusions have been practically eliminated entirely and that objectionable gases such as nitrogen and hydrogen were substantially reduced. We have further found that the hardness and density are substantially improved.

Tests indicate that the ferrosilicon made according to our process contains a minimum of undesirable constituents. Comparative analysis of samples made by the ordinary process and those made by our process, shows as follows:

	Ordinary, percent	Ours, percent
Nitrogen.....	0.33	0.27
Oxygen.....	0.151	0.141
Hydrogen.....	0.014	0.010

We have prepared other grades of ferrosilicons in accordance with this invention, including 50%, 75% and

95% with equally as good results as those described in the above specific procedure.

We have described and illustrated our invention with particular reference to the making of high purity 65% ferrosilicon, although it is to be understood that the invention may be otherwise used and practiced.

As a partial summary thereof, in a broad sense, our invention includes:

(a) The process of refining ferrosilicon in an acid-lined electric furnace, using a silica-lime slag, or a variation thereof as indicated in the above description, in such a manner as to decrease and/or remove metallic impurities and non-metallic impurities from the alloy.

(b) The process of refining ferrosilicon in an acid-lined electric furnace, using a silica-lime slag, or a variation thereof as indicated in the above description, in such a manner as to increase the density and hardness of the alloy.

(c) The process of refining ferrosilicon in an acid-lined electric furnace, using a silica-lime slag, or a variation thereof as indicated in the above description, in such a manner as to materially decrease the gas content of the alloy.

(d) The process of refining ferrosilicon in an acid-lined electric furnace, using a silica-lime slag, or a variation thereof as indicated in the above description, in such a manner as to decrease the aluminum content to a maximum of 0.05%. Such a ferrosilicon is of particular advantage to the producers of electrical sheet steel.

(e) The process of refining ferrosilicon in an acid-lined electric furnace, using a silica-lime slag, or a variation thereof as indicated in the above description, in such a manner as to reduce the total impurities to a maximum of 0.50%.

What is claimed is:

1. The process of producing a ferrosilicon alloy with a low impurity content which comprises heating the ferrosilicon in an arc furnace to a molten state, delivering the molten mass into an arc furnace having an acid lining and adding sand and lime to the mass in the furnace to form a calcium silicate over the molten alloy.
2. The invention as claimed in claim 1 wherein the sand and lime added have the proportions of approximately 65% silica and 35% calcium oxide.
3. The process of producing a ferrosilicon alloy with a low impurity content which comprises heating the ferrosilicon in an arc furnace to a molten state, delivering the molten mass into an arc furnace having an acid lining and adding to the mass in the furnace a mixture of calcium oxide and an alkali salt in the proportions of approximately 65% and 35% respectively.
4. The process of producing a ferrosilicon alloy with a low impurity content which comprises heating the ferrosilicon in an arc furnace to a molten state, delivering the molten mass into an arc furnace having an acid lining, adding sand and lime to the mass in the furnace, stirring the molten mass to effect a thorough mixing, pouring the molten mass into a first ladle and then into a second ladle before delivering it to a mold where it is cast.

References Cited in the file of this patent

UNITED STATES PATENTS

30	873,328	Price	Dec. 10, 1907
	915,172	Goldschmidt	Mar. 16, 1909
	1,086,489	Walker	Feb. 10, 1914
	1,853,544	Browne	Apr. 12, 1932
	2,015,692	Perrin	Oct. 1, 1935
	2,098,176	Udy	Nov. 2, 1937
35	2,208,974	Haglund	July 23, 1940
	2,637,648	Udy	May 5, 1953