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METHOD FOR PRODUCING ALUMINUM-SILICON ALLOYS

Albert Regner, Praha-Smichov, Czechoslovakia, assignor to Spolek Pro Chemickou a Hutni Vyrobu, also named United Chemical and Metallurgical Works, Ltd., Praha, Czechoslovakia, a corporation of Czechoslovakia

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2 Claims. (Cl. 75—148)

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My invention relates to a method for producing industrially important aluminum-silicon alloys.

It has been proposed to prepare a eutectic or a supereutectic aluminum-silicon alloy by fractional crystallization of a crude alloy containing more than 12% Si and accompanying metallic impurities. Of these impurities, iron, titanium and carbides have an especially deleterious effect on the end products prepared from such alloys. However, inasmuch as the two last mentioned impurities can be adequately eliminated by such fractional crystallization, there is no further need to consider them hereinafter.

The crude alloy is prepared from oxides of aluminum and silicon, for instance either by electrothermic reduction of a mixture of kaolin and aluminum oxide with the aid of carbon, or by electrolysis of a fused bath of bauxite, to which may be added some earth. As is well known, the separation may be achieved in several different ways. According to one method, the crude alloy is subjected to fractional crystallization so that it is allowed to cool gradually from a completely fused state to a certain temperature which lies in the liquidus-solidus region and which temperature corresponds to the desired composition of the liquidus, whereupon the resulting crystals rich in silicon are separated, either by centrifuging or by vacuum or pressure filtration, from the mother melt which is concomitantly enriched in aluminum,

According to another method, the separation is achieved by filtration, whereby the crude alloy, previously treated thermally so as to yield as large silicon crystals as possible, is carefully heated above the eutectic temperature and the sieved out liquid part is separated from the solid phase, by filter-pressing for example.

The composition of the liquidus separated in such operations is controlled by the equilibrium diagram of the system concerned, according to which Al-Si-Fe alloys form a ternary eutectic which melts at 577° C. and which contains 11.6% Si, and 0.80% Fe, the balance being Al. However, as according to this diagram the technical crude alloys contain not only silicon, but also iron in a supereutectic amount, it is apparent that the liquidus separated from the crude alloy at a temperature slightly above the eutectical will contain the smallest amounts of these metals, whereas melts isolated at higher temperatures will contain not only more silicon, but also more iron. Experiments performed with this object in mind completely confirmed the correctness of the equilibrium diagram. Thus, a liquidus separated from the crude alloy at 579° C. showed practically an identical composition with that of the above said eutectic, whereas a separation performed at 588° C. yielded a product containing 13.6% Si and 0.90% Fe.

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Although according to some patents such products, isolated from crude and impure alloys at low temperatures, were considered to be equivalent to the so-called "silumin," a casting alloy of considerable technical importance and of precisely formulated composition, nevertheless in fact they merely complied with the specification regarding the required content of silicon, but did not satisfy the purity requirement because they contained about 0.85% Fe, representing an iron content almost twice as high as the admissible maximum. Experience teaches that an iron content in excess of 0.5% has a considerable harmful effect on the mechanical properties of silumin-type alloys. This circumstance, therefore, was the principal cause why the above described production method never became popular in industrial practice.

It has now been discovered that the iron content is reduced and mechanical properties are improved if a certain amount of chromium, cobalt or manganese is alloyed with the crude alloy beforehand, and only this adjusted alloy is then subjected to the separation process at a temperature just above the eutectical. However, it is equally advantageous to alloy the Cr, Co or Mn only into the liquidus which was first separated from crude alloys by known methods, without the addition of heavy metals, at a temperature close to the eutectical. This liquidus thus contained the prescribed amount of silicon but also had an inadmissibly high iron content. By the following separation of this intermediate product, at substantially the same temperature as that of the first operation, the iron content of the product is reduced to the desired extent without further changing the ratio of aluminum to silicon.

The said metals are alloyed either by themselves or in a mixture, and the added material advantageously amounts to 0.5 to 2 times the amount of iron present in the original alloy. Under such conditions the liquidus isolated at a temperature close to the eutectic temperature contains besides 12–13.5% Si only 0.25–0.40% Fe and 0.3–0.5% of those metals which were added to the original mixture in order to reduce the iron content. The presence of these small amounts of heavy metals is in no way harmful to the quality of the product, on the contrary, as is even illustrated by the more recent specifications for the composition of "silumin," such heavy metals have a very favorable effect in that they improve the corrosion resistance of such alloys, enhance the refining process by alkali metals and improve mechanical properties in general. The product obtained by the proposed process is therefore in all respects at least equivalent to alloys of the silumin type and represents a technically very valuable alloy.

Of course it is possible to use the discovered method also for reducing the iron content of supereutectic aluminum-silicon alloys which are prepared by separation of crude alloys at temperatures substantially higher than the eutectic temperature. Similarly as in the production of substantially eutectic alloys, here too the heavy metals can be added immediately to the crude alloys so that the iron is eliminated in the desired amount simultaneously with silicon, or they can be added only to the alloy of the finally desired silicon content but which still contains too much iron. This excessive iron is then eliminated in a separate process. Furthermore, the new process can be employed also for the regeneration of aluminum-silicon alloy scrap if such scrap is contaminated with an inadmissibly high content of iron which is dissolved in the alloy. Inasmuch as it is then usually desired to eliminate the iron only, but not to change the aluminum-silicon ratio, in such instances the separation is conducted at a temperature just sufficient to keep both principal metals of the alloy in a molten state.

It is possible to introduce the heavy metals into the original crude and impure alloys by direct alloying of the pure metals or of appropriate pre-alloys, or by an exchange reaction between chlorides or other convenient compounds of the heavy metals and a melt of the original alloy, or finally by the simultaneous reduction of the oxides of the heavy metals in the case of electrothermic or electrolytic processes.

My new method for reducing the iron content of aluminum-silicon alloys is entirely distinct from another known method which, by the addition of Mn, Co or Cr, merely reduces the harmful effect that an excessive iron content in aluminum-silicon alloys has on castings. Alloys modified by the old method are suited only for pressure injected die castings, but, in view of their high Fe content they are not usable for castings in moulds or in sand, because the iron has not been eliminated but merely transformed into a structurally less harmful form. Besides, in the old process the improving effect of the said heavy metals can be utilized only up to a certain maximum iron content and therefore the alloys of particularly high iron content were unusable even for die-castings.

The following examples are recited here in order to illustrate the present invention:

Examples

1. A crude aluminum alloy, which was prepared in an arc furnace and from which carbides were eliminated previously, and which contained 30.5% silicon and 1.3% iron, was gradually cooled after fusion so that the separating crystals, consisting predominantly of silicon, formed as large individual crystals as possible. As soon as the temperature dropped to 588° C., that is 11° C. above the eutectic temperature of the Al-Si-Fe system, the alloy was subjected to a pressure filtration. The isolated liquid phase had a composition of 0.9% Fe, 13.6% Si, and the balance Al.

2. The crude alloy of the above said composition was subjected to a further separation process in which, however, the temperature before filtration was allowed to drop as far as 579° C., i. e. 2° C. above the eutectic temperature. The isolated liquid phase contained 0.75% Fe, 11.6% Si, balance Al.

3. To this same alloy manganese was added in an amount corresponding to 1.3 times the amount of iron contained therein. By filtration at a temperature of 588° C. a fraction was obtained containing 0.48% Fe, 0.38% Mn, 13.5% Si, balance Al.

4. The process illustrated by Example 3 was repeated with the difference that the melt was cooled to 579° C. before filtration. The resulting liquidus contained then 0.36% Fe, 0.28% Mn, 11.6% Si, balance Al.

Although I have described certain specific embodiments of my new method, I am fully aware that many variations and modifications may be made in the details of procedure above set forth without departing from the spirit of my invention. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What I claim is:

1. A process for decreasing the impurity of iron in aluminum-silicon alloys to less than 0.5% said process comprising melting the impure aluminum-silicon alloy, adding thereto at least one metal selected from the group consisting of Mn, Co, and Cr, in amounts equal to about 0.5 to 2 times the total weight of iron present in the impure alloy, and thereafter slowly cooling said alloy and separating the solidus containing the major portion of iron from the liquid phase containing less than 0.5% iron at a temperature above the fusion point of the eutectic.

2. A process for decreasing the impurity of iron in aluminum-silicon alloys to less than 0.5% said process comprising melting the impure aluminum-silicon alloy, adding thereto at least one metal selected from the group consisting of Mn, Co, and Cr, in amounts equal to about 0.5 to 2 times the total weight of iron present in the impure alloy, and thereafter subjecting said alloy to fractional crystallization and separating the solidus containing the major portion of iron from the liquid phase containing less than 0.5% iron at a temperature above the fusion point of the eutectic.

ALBERT REGNER.

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