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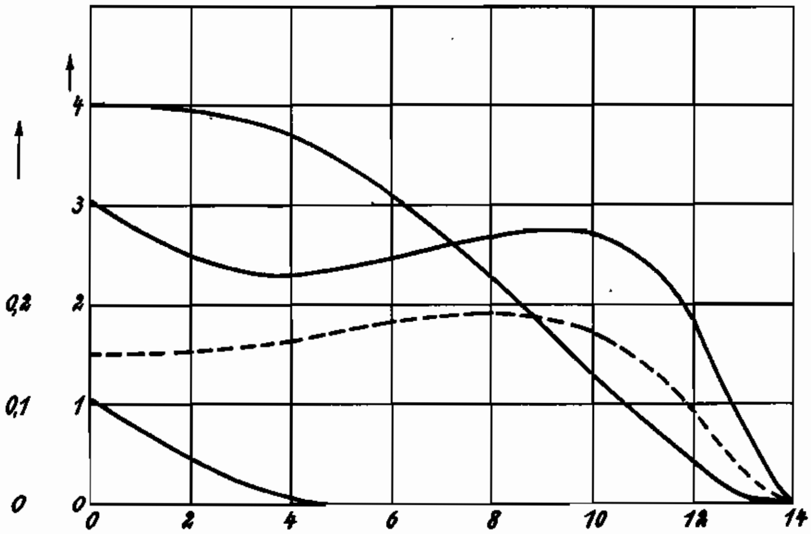

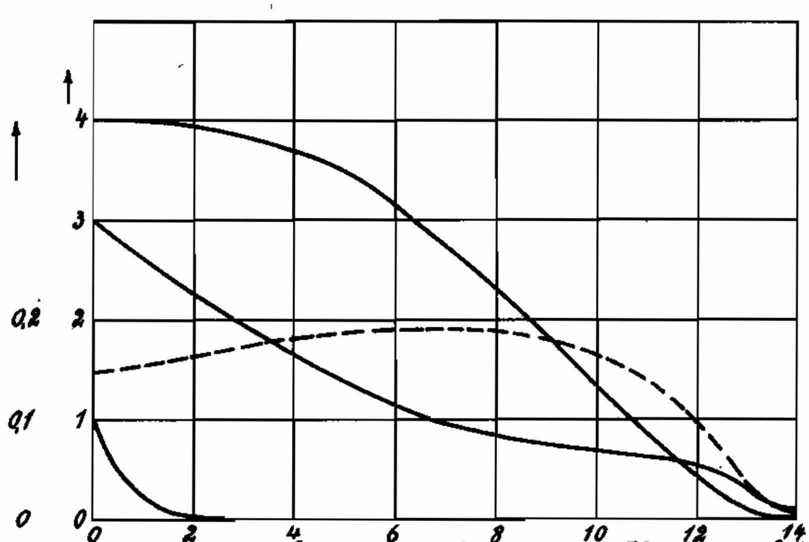

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PROCESS FOR THE PRODUCTION OF FIRST RUN METAL OR STEEL FROM STEEL PIG IRON OR OF A BESSEMER PIG IRON CONTAINING PHOSPHORUS

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Patent application Ser. No. 272,044 shows, that it is possible to blow steel iron from steel or first run metal in a basic converter. Recent investigations have shown that the analysis of the pig iron to be blown may vary within the widest limits. Thus, for example a steel iron with 0.15% Si; 2.5–3% Mn; 0.1–0.5% P or a steel iron with 0.5% Si; 0.5–1.5% Mn; 0.1–0.5% P can be perfectly blown to steel if the pig iron possesses sufficient physical heat. The possibility of carrying out the process from a metallurgical and technical point of view has no limit as regards the content of C, Mn and Si in the pig iron. Consequently, there is no difficulty to convert into steel a steel iron with for example 2% Si, more than 4% Mn and 4% C.

Other investigations have proved, that in the blowing of steel pig iron by the using in different quantities and for different periods of time the otherwise usual admixtures such as lime, scrap and ore, it is possible, contrary to the known state of the art, to influence the course of the charge to a far greater extent than in the conversion hitherto used. Thus, it has been unexpectedly discovered that by different lime additions the course of the charge can be influenced to a far higher degree than is known for example from the Thomas or Bessemer process.

Figs. 1 and 2 of the accompanying drawing are diagrams showing examples of this possibility of influencing the charge.

Fig. 1 shows a charge with high percentage of lime and/or high charge temperature and Fig. 2 shows a charge with small lime addition and intensive cooling. If ordinary steel iron with for example 4–4½% C; 2–3½% Mn; 0.8–1.2% Si and 0.1–0.3% P is blown at normal temperature with slag cooling with or without a small addition of lime, as shown in Fig. 1, it is possible, if the blast is interrupted at the proper time, to obtain a duplex metal with about 1.5 C and 0.8–1% Mn, and a slag with 30–35% Mn, 30–40% SiO_2; 5–10% MgO+CaO; 0.1–0.5% Fe and 0.0–0.5% P_2O_5, or if the charge is finished blown a steel is obtained with about 0.02% C, 0.2–0.3% Mn and 0.05–0.07% P and a slag with 25–35% Mn; 25–35% SiO_2; 10–20% CaO+Mgo and 10–15% Fe.

If, on the other hand, only lime is added instead of the cooling scrap and in such a quantity that the cooling effect of the lime corresponds to that of the scrap and the lime addition is greater than is necessary for the binding of SiO_2 and P_2O_5, it is possible, under suitable conditions, to obtain a first run metal with about 1.5% C and 2–2.5% Mn, and a corresponding slag with 10–15% Mn; 20–30% SiO_2 and 40–50% CaO, or a steel with 0.02% C; 0.6–1% Mn; 0.02–0.05% P and a corresponding slag with 20–25% Mn; 15–20% SiO_2, 35–45% CaO and 6–10% Fe.

It has also been found that, when blowing steel pig iron, the temperature has a considerably stronger effect on the course of the charge than is the case with other converting processes. If the temperature of a steel iron charge is increased with at the same time the highest possible addition of lime either by increasing the Si content in the pig iron or by increasing the physical heat of the pig iron, or by the omission of the usual cooling additions of scrap and the like, the manganese burning can be weakened to such an extent that when blowing to a first run metal with about 1.5% C the manganese content has only decreased slightly and amounts to 2.5–3% with a slag composition of 2–10% Mn; 1–5% Fe; 40–50% CaO and 30–40% SiO_2. When blowing to finished steel the Mn content under these conditions may attain 0.8–1.1% with 0.02% C and 0.02–0.05% P (see Fig. 1). The corresponding slag then contains 10–20% Mn; 25–35% SiO_2; 40–45% CaO and 8–10% Fe.

If, on the other hand, the charge is cooled by the addition of large quantities of scrap with or without a small lime addition, 0.6–0.8% Mn is obtained in the first run metal with about 1.5% C and in the corresponding slag 30–40% Mn; 30–40% SiO_2; 5–10% MgO+CaO and very small Fe and P contents, or in the steel 0.15–0.2 Mn with 0.02% C and 0.05–0.07% P and in the slag 30–40% Mn; 25–35% SiO_2; 10–20% MgO+CaO and 8–12% Fe (see Fig. 2). These two examples show that when blowing steel pig iron it is possible, contrary to the Thomas process, for example, with suitable treatment of the melting process, to produce both a steel with a Martin analysis and also one with a Thomas analysis. It must also be mentioned, and this constitutes part of the invention, that all addition of ferro manganese can be dispensed with when preparing the charge, if it is desired to produce a high Mn percentage in the finished steel.

It was further unexpectedly found that the above mentioned possibility of influencing, the extent of which was hitherto unknown in the blasting processes, can be assisted by an addition of ore, rolling scale or some other oxygen carrier, to an extent as was hitherto entirely unknown. If, for example with a steel iron charge which is blown exclusively with scrap cooling without or only with a small addition of lime, ore is added during the first minutes, such a strong Mn burning is attained that the manganese content of the first run metal with about 1.5% C, only amounts to about 0.5–0.6%, whereas the slag contains 30–40% Mn; 30–35% SiO_2; 5–10% CaO+MgO and about 5% Fe. If such a charge is blown to finished steel, the following result is obtained:—

In the case of 0.02% C the Mn content is 0.10–0.15% and the P content up to 0.07%.

The effect described can be increased, when blowing to steel, by again adding ore to the charge after the transition, that is in the dephosphorizing period, with the result that a considerable reduction of Mn and P is effected which in the finished steel leads to contents of 0.10–0.13% Mn and 0.02–0.05 P with 0.02% C, with a relatively smaller loss of iron from the bath than would be the case without this addition of ore.

If ore is added to a steel iron charge with a large lime addition, P is preferably oxidized in addition to Mn. If the ore is added to such a charge after the transition, the steel with a 0.02% C content has an Mn content of 0.4–0.5% and a P content of about 0.01–0.03%.

Ore therefore, in the case of highly basic slag, if added after the transition, accelerates preferably the oxidation of the phosphorus, whereas in the case of less basic slag, if added at the commencement of the charge or after the transition, the ore accelerates the burning of the manganese.

According to the invention all kinds of and desired intermediate analyses can be obtained in the first run metal, in the steel and in the slag by mutually varying the addition of lime, scrap and ore within and also beyond the anlysis values indicated, without affecting the scope of the invention, if the addition of lime, and/or of scrap and/or of ore is effected in stages during the course of the charge in order to change the influencing of the quantity and composition of metal and slag, same as of the temperature as desired within the widest limits which are technically possible. The favorable effect of cooling in stages for the production of uniform charge curves has already been described above.

In perfecting the steel iron blast process it has also been found that by tapping off a first run slag at a suitable time during the blasting process, which time may vary according to the local conditions, the slag quantity and concentration can be changed suddenly by introducing fresh additions which can also impart to the reactions an entirely new direction and intensity. This course is preferably chosen, if it is desired to obtain the slagged manganese at first in a state which is as valuable as possible for the production of ferro manganese or Spiegel iron, that is with the lowest possible percentage of SiO_2 and P_2O_5. In such an instance only a small amount of lime and scrap is added to the charge for example at the beginning, after about 3 minutes the slag rich in SiO_2 which is of no value is drawn off and the blowing is continued until the dephosphorizing commences, large quantities of scrap being added, that is at low temperatures, and with addition of but little lime. A slag is then obtained with 30–40% Mn; 35–45% CaO, 5–10% FeO and less than 0.5% P_2O_5. The metal produced by this process may be finish blown with a renewed addition of lime, but it is preferably used as duplex metal and finish converted in the Martin or electric furnace.

If the SiO_2 and P_2O_5 content are of no importance in the slag, and if it is mostly the metallic final product which matters, a considerable change can be produced in the composition of this final product by the process according to the invention for influencing a steel iron charge by tapping off the slag and changing the additions, as the two following examples show.

If, for example, a charge with a lime addition is blown up to a C content of 1.5%, and the slag formed up to this time with about 30–40% Mn; 40–50% SiO_2 and 10% MgO+CaO is tapped off, it is possible by continuing the blowing and by adding a small quantity of lime to obtain a finished steel with 0.5–0.7% Mn and 0.02–0.03% P. But if an ample quantity of lime is added at the beginning and the slag with about 40–50% CaO, 40–50% SiO_2 and 5–10% Mn is tapped after the blast has been on for about 3 minutes, and if after a fresh addition of lime with intensive scrap cooling the blowing is continued to a finish, a finished steel is obtained with about 0.2–0.3% Mn and 0.02–0.05% P and a slag with 40–50% CaO, 25–35% Mn, 5–10% SiO_2, 10–15% Fe and 1–2% P_2O_5.

It is evidently also possible to tap the slag before the burning of the phosphorus. The slag then has the following composition: 40–50% CaO; 30–40% Mn; up to 5% Fe and 5–10% SiO_2 and less than 0.5% P_2O_5 at which it would be suitable for the production of ferro manganese or Spiegel. The blowing of steel iron also resulted in an important and hitherto unknown discovery, i. e. that the iron of the bath only slags particularly strongly during the very last minutes of blowing. This discovery, however, renders it possible, according to the invention, to reduce losses of the charge thereby that during the blasting a first run metal or finished steel is blown only to a final manganese content of about 0.8%, a 1–1½% higher yield being then obtained owing to the slight loss of iron and manganese than occurs when blowing to 0.3–0.4% Mn.

The yield can be increased not only by this measure, but also by other measures coming within the scope of the invention. As has already been described it is possible, for example by increasing the addition of lime or by the hot working of the charge, (see Fig. 1) to protect the manganese from burning to such an extent that it burns substantially only after the transition. In this instance the loss of iron is evidently prevented to a far greater extent than if, as shown in Fig. 2, the working takes place at low temperature and with little lime. Furthermore, the loss of iron can, according to the invention, be considerably reduced by adding ore to the slag during the last minutes of blowing, a condition being that a quantity of CaO sufficient for the P_2O_5 combination must be present.

Another feature of the invention consists in providing during the blowing of steel iron measures which reduce the wear of the converter lining. Thus, it has been found that the wear can be kept relatively slight if, by adding cooling agents at intervals, the charge temperature is kept as low as the metallurgical condition for obtaining the desired final product will allow. It has also be found, that a steel pig iron with low Si content can be advantageously blown if the decomposition of the basic converter lining by the silicic acid formed has to be prevented. This discovery is new as regards the blasting of steel pig iron, as it could not be predicted that, in view of the high percentage of manganese in the pig iron and the manganese silicates which undoubtedly form, the silicic acid would attack the bases of the lining material. Investigation confirmed the fact known from the Thomas point of view that a high FeO content in the slag means considerable wear of the converter. It is therefore proposed, according to the invention, to interrupt the blast at a Mn content of about 0.8% wherever the purpose of use makes it appear advisable for the protection of the converter lining. By this means the wear of the lining is 25 to 35% less than when the charge is finish blown to 0.3–0.4% Mn.

The measures set forth above, and which are to be applied according to the invention when blowing steel pig iron or Bessemer pig iron containing phosphorus to first run metal or steel, may be employed singly or in any possible or desired combination without departing from the scope of the invention.

As the percentage of sulphur in the steel pig iron is mostly very low, it does not normally have any effect. But even a higher percentage of sulphur in the pig iron would be harmless because during the last minutes of blowing it would drop below the prescribed value.

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