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REPUBLIC OF SOUTH AFRICA

REPUBLIEK VAN SUID-AFRIKA

PATENTS ACT, 1978

CERTIFICATE

In accordance with section 44 (1) of the Patents Act, No. 57 of 1978, it is hereby certified that

MINTEK

has been granted a patent in respect of an invention described and claimed in complete specification deposited at the Patent Office under the number

2002/4091

A copy of the complete specification is annexed, together with the relevant Form P2.

In testimony thereof, the seal of the Patent Office has been affixed at Pretoria with effect from the **26th** day of **March 2003**

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FORM P2
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REPUBLIC OF SOUTH AFRICA

PATENTS ACT, 1978

REGISTRAR OF PATENTS

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Title of Invention:

54 AGGLOMERATION OF FERRO-ALLOY FINES

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FORM P7

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COMPLETE SPECIFICATION

(Section 30(1) Regulation 28)

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TITLE OF INVENTION

54	AGGLOMERATION OF FERRO-ALLOY FINES

BACKGROUND OF THE INVENTION

This invention relates to the agglomeration of ferro-alloy fines.

Ferro-alloy fines (less than about 5mm) have historically been worth less than lumpy pieces of the same alloy. During the production of ferro-alloys molten metal is usually cast into moulds. The hot metal is then allowed to cool whereafter it is crushed to a size which is acceptable for the client e.g. a stainless steel producer. During crushing, fines of the ferro-alloy are generated. These fines, together with fines recovered from slag reclamation, are usually sold at a discount or remelted by the ferro-alloy producers, since the fines are generally not sought after by end users.

Conventionally ferro-alloy fines are agglomerated by being mixed with a suitable binder and the mixture is then agglomerated e.g. by briquetting, blocking or a similar process. The agglomerates are cured to exhibit a suitable hardness. These hardened agglomerates are however often not suitable to be sold as a satisfactory end product since fines are again generated during subsequent handling, transport and furnace operations.

SUMMARY OF THE INVENTION

The invention is concerned with an agglomeration technique which substantially eliminates the generation of fines.

The invention provides a method of agglomerating ferro-alloy fines which includes the steps of:

(a) mixing the ferro-alloy fines with a binder to produce a mixture,

(b) agglomerating the mixture to produce an agglomerate,

(c) drying the agglomerate, and

(d) hardening the agglomerate by sintering the agglomerate at an elevated temperature under reducing or inert conditions.

Step (d) may be carried out by sintering the agglomerate in the presence of a solid or gaseous reductant.

If a solid reductant is used the temperature during sintering should be high enough to ensure the formation of a reducing atmosphere which, in turn, is dependent on the generation of CO and CO_2 by the reaction of carbon with oxygen. This process is dependent on the temperature, for the higher the sintering temperature, the greater is the concentration ratio of CO to CO_2. Specifically, to prevent oxidation of the ferro-alloy fines, the concentration of CO must be significantly higher than that of CO_2 (preferably at least 10 times higher, but more preferably 100 times higher).

Step (d) may be followed by the step of cooling the sintered agglomerate in a reducing or inert environment, or in a normal atmosphere. Characteristics of the specific ferro-alloy being treated dictate the nature of the cooling step. For example if oxidation of the ferro-alloy takes place during normal atmospheric

cooling then it is desirable to carry out the cooling in a reducing or inert environment.

More generally it can be said that step (d) is carried out under conditions which eliminate or substantially reduce oxide formation and ensure sufficient strength of the resulting briquettes.

Any appropriate mixing technique may be used in step (a) provided thorough mixing of the fines is achieved.

In step (b) it is preferably to make use of an agglomeration process wherein the mixture, produced in step (a), is compacted so that inter-particle contact occurs and the binder requirement is reduced. The agglomeration technique may be selected from conventional briquetting, pelletising, extruding or even block making techniques.

The binder which is used in the process of the invention should not contribute negatively to the end product. In this respect it is desirable to avoid phosphor and sulphur in the binder. Depending on requirement sodium silicate may be used as a binder. It is also possible to make use of one or more organic binders.

The binder may vary according to requirement of the particular product and specifications thereof. In most instances the binder may be present in an amount of less than 3% by weight.

The drying phase (step (c)) may be effected utilising any appropriate technique e.g. air drying or travelling grate drying.

BRIEF DESCRIPTION OF THE DRAWING

The invention is further described by way of example with reference to the accompanying drawings in which:

Figure 1 is a flow diagram representation of a prior art process used for the agglomeration of ferro-alloy fines,

Figure 2 is a flow diagram representation of an alternative prior art process used for the agglomeration of ferro-alloy fines, and

Figure 3 is a flow diagram representation of the process of the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

As has been noted in the preamble to this specification it is desirable to agglomerate ferro-alloy fines in a manner which produces strong durable agglomerates which are comparable in strength and quality to lumpy ferro-alloys.

A development of this type would effectively reduce the discount at which ferro-alloy fines are currently being sold. The need to remelt the fines in order to obtain lumpy sellable product would also be eliminated.

Figure 1 of the accompanying drawings illustrates in flow diagram form a conventional process for the agglomeration of ferro-alloy fines.

The ferro-alloy fines are mixed (step 10) with a binder and the mixture is then agglomerated (12) to form briquettes, blocks, pellets or any other agglomerated configuration. The agglomerates are then dried (14) using air curing or heat treatment e.g. on a travelling grate dryer.

In the process of Figure 2 the initial steps 16, 18 and 20 are respectively similar to the steps 10, 12 and 14 described in connection with Figure 1. However the dried agglomerates are treated further by sintering (22) in ambient atmosphere in order to achieve better physical strength. Temperatures of up to 1000°C, or even higher, are used during sintering. Thereafter the sintered agglomerates are cooled in an ambient atmosphere (24).

Figure 3 illustrates the process according to the invention. Similarly to the techniques described in connection with Figures 1 and 2 the ferro-alloy fines are initially mixed (26), agglomerated (28), and dried (30). The method of agglomeration is however important since the fines must be compacted in order to ensure that inter-particle contact is as close as possible. After drying the compacted fines are sintered (32) at a temperature which facilitates sintering of the ferro-alloy fines and in a reducing or inert atmosphere in order to prevent the oxidation of the ferro-alloy.

The reducing or inert environment is obtained by sintering the agglomerate in the presence of a solid reductant such as coke or a gaseous mixture. If a solid reductant is used the temperature during sintering should be high enough to

ensure the formation of a reducing atmosphere, as explained in detail hereinbefore.

After sintering the agglomerates are cooled in a step 34. This can be done either in a reducing or inert environment (34A) or in a normal atmosphere (34B). The characteristics of the specific ferro-alloy which is being treated dictate which of these options is employed. Thus if oxidation of the ferro-alloy takes place during normal atmospheric cooling it is important to conduct the cooling in a reducing or inert environment.

Test Results

The process of the invention as illustrated in Figure 3 has been applied on a test scale for the agglomeration of ferro-chromium fines and ferro-vanadium fines.

In each case the agglomerates were obtained by using a Komarek roll briquetter. The green (wet) briquettes were dried at a temperature of 200°C to 250°C.

The binder which is used during the mixing process should be chosen with care to avoid the addition of impurities to the agglomerate. In this respect the presence of phosphor and sulphur should be avoided. In the tests 3% by weight sodium silicate (grade 3379) was used as binder. Although this binder raises the silicon content of the resulting mixture the contribution is of such a nature that the increased silicon content remains generally acceptable. It is possible though to make use of one or more organic binders. This would imply that the binder

would contribute mainly to the green or wet strength of the agglomerate and would burn away during sintering, thereby diminishing any negative connotations associated with the organic binders.

In the treatment of the ferro-chromium fines the briquettes were sintered, in step 32, at a temperature of the order of 1200°C in the presence of an excessive amount of graphite, serving as a reductant. At this temperature the carbon from the graphite reacts with atmospheric oxygen to form CO and small quantities of CO_2, thereby creating a reducing environment. The briquettes obtained in this way were very strong with the colour of the alloy still prevailing, indicating that oxidation of the ferro-alloy was prevented. By way of contrast briquettes which were sintered at 1200°C without the reductant being present were dark in colour due to the briquettes being coated with a layer of metal oxide. Similarly ferro-chromium briquettes sintered at temperatures less than 1000°C were either dark, due to oxide formation, or were much weaker, due to the fact that sintering had not occurred. These factors indicate that the presence of the reductant is vital and that the sintering temperature should be high enough to ensure sintering (to obtain strength) and to prevent oxidation of the ferro-alloy (due to the formation of a reducing atmosphere).

In the treatment of ferro-vanadium fines the resulting briquettes were sintered in an H_2-reducing atmosphere at a temperature of the order of 1400°C. The briquettes obtained in this way were very strong and exhibited the colour typical for the alloy. Briquettes produced at temperatures of less than 1300°C in the

presence of graphite were either very dark, due to oxide formation, or were far weaker. Although an H_2 atmosphere would probably not be used in a commercial scale operation, a hydrogen-bearing gaseous mixture, e.g. natural gas, could well give positive results.

It is evident from the aforegoing examples that the process of the invention must be optimised for each type of ferro-alloy fines, in order to eliminate oxide formation and to ensure sufficient strength of the briquettes. Thus the actual sintering temperature and the specific reducing or inert environment, as well as the method of generating such environment, may differ from one application to another depending on the specific conditions and requirements. Nonetheless the general philosophy remains unaltered, namely to sinter the briquettes in a reducing or inert environment.

CLAIMS

1. A method of agglomerating ferro-alloy fines which includes the steps of:

   (a) mixing the ferro-alloy fines with a binder to produce a mixture,

   (b) agglomerating the mixture to produce an agglomerate,

   (c) drying the agglomerate, and

   (d) hardening the agglomerate by sintering the agglomerate at an elevated temperature under reducing or inert conditions.

2. A method according to claim 1 wherein step (d) is carried out by sintering the agglomerate in the presence of a solid or gaseous reductant.

3. A method according to claim 1 wherein, in step (d), a solid reductant is used and the temperature during sintering is high enough to ensure the formation of a reducing atmosphere.

4. A method according to claim 3 wherein, to prevent oxidation of the ferro-alloy fines, the concentration of CO is significantly higher than that of CO_2.

5. A method according to claim 3 wherein the concentration of CO is at least 100 times higher than the concentration of CO_2.

6. A method according to any one of claims 1 to 5 wherein step (d) is followed by the step of cooling the sintered agglomerate in a reducing or inert environment, or in a normal atmosphere.

7. A method according to any one of claims 1 to 6 wherein, in step (b), use is made of an agglomeration process wherein the mixture, produced in step (a), is compacted so that inter-particle contact occurs and the binder requirement is reduced.

8. A method according to claim 7 wherein the agglomeration process is selected from conventional briquetting, palletising, extruding and block making techniques.

9. A method according to any one of claims 1 to 8 wherein the binder is selected from sodium silicate and an organic binder.

10. A method according to any one of claims 1 to 9 wherein the binder is present in an amount of less than 3% by weight.

11. A method according to any of claims 1 to 10 wherein the agglomerate, in step (c), is dried using air drying or travelling grate drying.

12. A method of agglomerating ferro-alloy fines substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

DATED this 23rd day of May 2002.

McCALLUM RADEMEYER & FREIMOND
Patent Agents for the Applicant

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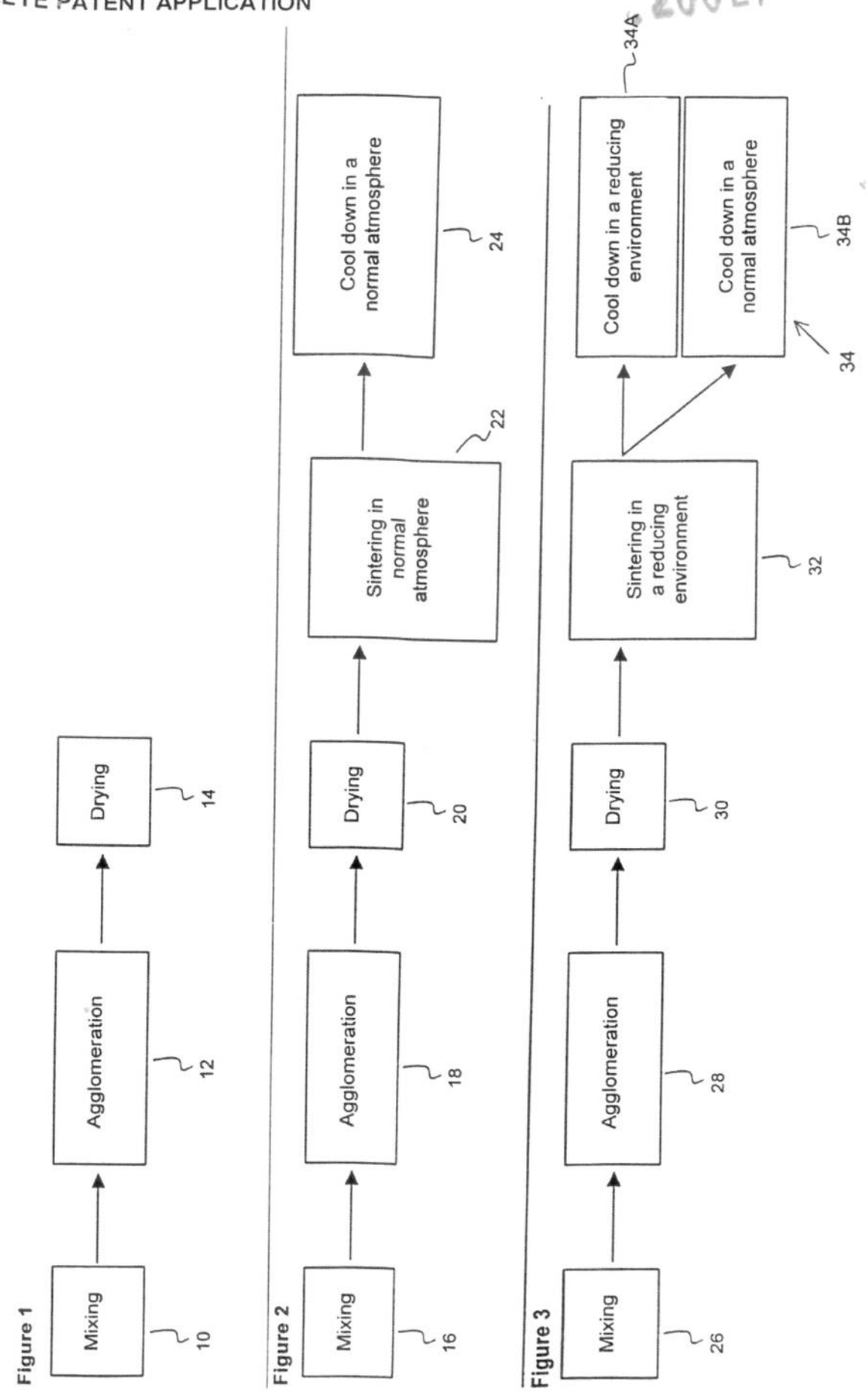

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