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D E C I S I O N
of 19 April 2001

Case Number: T 0622/98 - 3.2.2

Application Number: 92104620.7

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Language of the proceedings: EN

Title of invention:
Direct reduction process and apparatus

Applicant:
ZIA METALLURGICAL PROCESSES, INC

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty (yes) - after amendment"
"Inventive step (yes) - after amendment"

Decisions cited:
-

Catchword:
-

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Case Number: T 0622/98 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 19 April 2001

Appellant: ZIA METALLURGICAL PROCESSES, INC.
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Representative: Schoppe, Fritz, Dipl.-Ing.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 8 April 1998 refusing European patent application No. 92 104 620.7 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
J. C. M. De Preter

Summary of Facts and Submissions

I. The appeal is directed against the decision of the examining division to refuse European patent application No. 92 104 620.7. The reason given for the refusal was that the subject matter of independent method claims 1 and 18 lacked an inventive step and that the subject-matter of apparatus claim 19 lacked novelty. Reference was made in the decision to the documents

D1: Conservation and Recycling volume 8 No. 3/4, (1985), pages 363 to 375

D2: 44th Electric Arc Furnace Conference of AIME, 1986, pages 403 to 408

D3: Stahl und Eisen 110, (1990), Nr. 7, pages 99 to 106

D4: Stahl und Eisen 110, (1990), Nr. 7, pages 89 to 96

II. On appeal, the appellant filed an amended set of application documents and requested that the decision under appeal be set aside and a patent be granted therewith. In support of inventive step, the appellant drew attention to the features which relate to the transfer of waste gas having a significant heating value from the drying and coking zone to the reduction zone to improve the heat efficiency of the process. It was pointed out that the claims underlying the appealed decision did not comprise these technical features.

III. The Board of appeal issued a communication and referred to document D5 US-A-3 836 353 which was quoted in the description of the application. Subsequent to this communication the appellant filed an amended set of

claims 1 to 27 and requested grant of the patent based thereupon. Oral proceedings were requested, should a negative decision be contemplated by the Board. The wording of the independent claims 1, 18 and 19 of this request reads as follows:

"1. A method of recovering iron from steel mill wastes comprising the steps of:

(a) combining steel mill wastes, having metallic oxides therein, with carbonaceous material and an organic binder to form a mixture;

(b) mixing said mixture with water to form a wetted mixture;

(c) pelletizing said wetted mixture to form green pellets;

(d) charging said green pellets into a rotary hearth furnace;

(e) drying and coking said green pellets for 10 to 15 minutes at a temperature of 600°C (1112°F) to 900° C (1652° F) to form dried pellets and waste gas containing volatile matter;

(f) removing the waste gas of step (e) from said drying and coking zone and introducing same into the latter stage of the reduction zone through an air-gas burner;

(g) reducing said dried pellets for 20 to 30 minutes at a temperature not less than 1000°C (1832°F) and no higher than 1150° C (2102° F) to form reduced pellets; and

(h) discharging said reduced pellets from said rotary hearth furnace."

"18. A method of recovering iron from wastes generated from metallurgical processing of iron-containing materials, comprising the steps of:

(a) combining wastes having metallic oxides therein with carbonaceous material and an organic binder to form a mixture;

(b) mixing said mixture with water to form a wetted mixture;

(c) pelletizing said wetted mixture to form green pellets;

(d) depositing said green pellets onto the hearth of a rotary hearth furnace;

(e) drying and coking said green pellets for 10 to 15 minutes at a temperature of 600°(1112°F) to 900° C (1652° F) to form dried pellets and waste gas containing volatile matter;

(f) removing the waste gas of step (e) from said drying and coking zone and introducing same into the latter stage of the reduction zone through an air-gas burner;

(g) reducing said dried pellets for 20 to 30 minutes at a temperature not less than 1000°C (1832°F) and no higher than 1150° C (2102° F) to form reduced pellets; and

(g) discharging said reduced pellets from said rotary hearth furnace."

"19. Apparatus for recovering iron from steel mill wastes, comprising:

(a) means for combining steel mill wastes (12), having metallic oxides therein, with carbonaceous material (16) and an organic binder (22) to form a mixture (18);

(b) a mixer (24) for mixing said mixture (18) with water (20) to form a wetted mixture (18a);

(c) a pelletizer (28) for agglomerating said wetted mixture into green pellets (26);

(d) a rotary hearth furnace (30), having a hearth (32), side walls (30a), and a roof (30b), including:

(i) a charging and discharging zone (34) therein which occupies approximately 10% the surface area of said hearth (32),

(ii) a drying and coking zone (36) therein, adjacent to said charging and discharging zone (34), which occupies approximately 25% the surface area of said hearth, and

(iii) a reducing zone (38), adjacent to said drying and coking zone (36) and said charging and discharging zone (34), which occupies approximately 65% of the surface area of said hearth (32); and

(iv) means (43) for removing waste gas (45) from said drying and coking zone (36) and an air-gas burner (46) for injecting said waste gas (45) into the latter stage of said reducing zone (38);

(g) means (58) for removing reduced pellets from said rotary hearth furnace (30)."

Reasons for the Decision

1. The appeal complies with Rule 65(1) EPC and is, therefore, admissible.

2. *Amendments*

Independent method claims 1 and 18 derive from original claims 1 and 18, respectively, and dependent claims 11 and 12 as originally filed in combination with the technical features given on page 7, second paragraph of the description and Figure 2 as filed. Apparatus claim 19 is based on claim 19 and page 7, 2nd paragraph of the documents as filed. In order to satisfy Rule 29(7) EPC and to improve the intelligibility of the apparatus claims 19 to 27, the technical features in these claims are followed by reference signs corresponding to those given in Figures 2 to 6. The description which acknowledges the relevant prior art has been suitably adapted to the wording of the revised claims. An editorial amendment has been made to claim 12 by the Board in agreement with the appellant.

The amendments to the claims and the description, therefore, satisfy the requirements of Articles 123(2) and 84 EPC.

3. *The prior art*

Like the application, document D5 which is cited in the introductory part of the description discloses a method of recovering iron from steel mill wastes or wastes generated from metallurgical processing of iron

containing materials. This method permits the effective removal of contaminating impurities such as zinc, lead and cadmium from these wastes (cf. D5, column 1, lines 45 to 66, column 2, lines 42 to 44). Carbonaceous material is added to the wastes, and after mulling the wetted mixture is pelletized to form green pellets which are then charged into a rotary hearth furnace (RHF) (cf. D5, column 2, line 60 to column 3, line 58). This method which generally is called in the art the "INMETCO" process, is also dealt with in documents D1 to D4. The addition of an organic binder which is not explicitly mentioned in document D5 merely represents conventional practice in order to increase the pellet strength. Consequently, this feature is not regarded as representing a fundamental difference to the claimed method. It is, therefore, concluded that steps (a) to (d) of the claimed process are known from document D5. In addition, document D5 specifically mentions the process parameters to adhere to in the steps of:

- drying the pellets at 260 to 371°C for 10 to 15 min and oxidising (coking) the pellets between 815 to 871°C for 7 to 10 min (= step (e));

- reducing the pellets between 1093 to 1149°C for 7 to 10 min to vaporise the zinc, lead and sulfur (= step (g)); and

- reoxidising and hardening the pellets in a temperature range of 1260 to 1343°C for 7 to 15 min, (cf. D5. column 4, lines 9 to 67).

A comparison of the process parameters reveals that the temperature ranges and the duration for treating the pellets in the drying/coking step and in the reducing step given in document D5 essentially comply with those claimed in the present application. A difference to the claimed method may be seen in the final hardening

treatment for the pellets. Such a final treatment is, however, not fully excluded from the claimed process. Given that the remaining documents D1 to D4 do not disclose in detail all the process parameters to adhere to in the different zones, document D5 is regarded as representing the closest prior art.

4. *Novelty*

The method according to independent claims 1 and 18 is distinguished from this prior art (D5) essentially by step (f) of removing the waste gas generated in the drying and coking zone (36) from this zone and introducing it into the latter stage of the reduction zone (38) through an air-gas burner. This finding is also true for apparatus claim 19 which comprises a rotary hearth furnace including means (43) for removing waste gas from the drying/coking zone (36), and an air-gas burner (46) for injecting said waste gas into the latter stage of the reducing zone (38). None of the remaining documents D1 to D4 provides such a means for bypassing waste gas from the drying and coking zone to the reducing zone of a RHF (see in particular document D1, Figure 1, document D2, Figure 1, document D4, Figure 2).

Consequently, the subject matter of independent claims 1, 18 and 19 is novel.

5. *The problem to be solved*

Starting from the technical teaching given in document D5, the problem underlying the present application, therefore, resides in increasing the thermal efficiency of the known process, as is set out on page 2, lines 12 to 14 of the description.

The solution to this problem consists in collecting the waste gas that is created in the drying/coking zone and which comprises a high amount of volatile combustible components. The waste gas is then bypassed to and burned through an air-gas burner that is arranged in the latter stage of the reducing zone. In doing so, the significant heating value of the volatile combustible constituents contained in the off-gas is used to advantage in a latter stage of the process, thereby increasing its overall heat efficiency.

6. *Inventive step*

Although the problem of providing a good heat transfer and a high thermal efficiency of the RHF process is commonly addressed in the prior art, the remaining documents neither envisage the claimed solution to this problem nor does any of them render the claimed solution obvious.

Document D1 specifically refers to the "coal based INMETCO technology" which guarantees *inter alia* a good heat transfer (cf. D1, page 374, the last paragraph above Table 9 to page 375, point 6). The rotary hearth furnace and the operating parameters are described on page 364 and depicted in Figure 1, page 365. However, the exhaust gases are sucked off by an exhaust fan from the oxidising zone without recycling the waste gas to the reducing zone. Moreover, the gas phase temperature in the reducing zone of the RHF reaches temperatures as high as 1260°C (cf. D1, page 364, last paragraph) which is far above the maximum limit of 1150°C as specified in claims 1 and 18 of the present application. There is no suggestion anywhere in document D1 that would motivate a skilled person to use the energy potential of the volatile components in the off-gas that is produced when coking the coal or carbonaceous material contained in the pellets in the drying/coking zone.

A similar RHF arrangement is depicted in Figure 1 of document D2 which widely complies with the technical disclosure given in document D4, in particular Figure 2. On page 91, left hand column, lines 9 to 14, document D4 explicitly refers to the afterburning of the carbon monoxide that is generated when reducing the pellets in the reducing zone and which is identified to provide the major part of the energy supply required for the RHF process. Bypassing of the off-gases from the coking zone to the reducing zone is, however, envisaged neither in document D2 nor in document D4.

Document D3 concerns an investigation on a laboratory scale rather than on an industrial scale of the pellet behaviour at the drying and the reducing step. Moreover, the maximum temperature of the pellets in the reducing zone is preferably about 1300°C which is outside the range of 1000°C to 1150°C claimed in the present application. Due to the high temperature level in the reducing zone, the reduction period can be extremely short, i.e. 1 min to 12.5 min (cf. D3, page 103, right hand column, second paragraph: "Pellets aus Filterschlamm und Koksgrus", Figure 4, and page 106, left hand column: "Schlußfolgerungen"). No information or hint whatsoever is found in this document which would prompt a skilled person to use the heating value of the waste gas that is created in the coking zone in another zone of the furnace.

In summary, given that none of the cited documents discloses or suggests the claimed solution, namely to improve the heat efficiency of the RHF process by using the heat potential contained in the off-gas from the coking zone in the latter stage of the reducing zone, a

skilled person would have no incentive to do so. Consequently, the subject matter of method claims 1 and 18 and also of apparatus claim 19 is considered to involve an inventive step within the meaning Article 56 EPC.

The dependent claims 2 to 17 and 20 to 27 relate to preferred embodiments of the method given in claim 1 or of the apparatus given in claim 19, respectively. Therefore, these claims equally meet the requirements of the EPC.

7. Since the request for oral proceedings was conditional on the intention of the Board to issue a negative decision, which condition is not met, no oral proceedings are necessary.

8. Having regard to Article 111(1) EPC, the Board considers it appropriate for it to exercise favourably the powers of the examining division in the present case because it has reached the conclusion that the documents according to the request of the appellant meet the requirements of the Convention.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent in accordance with the request of the appellant as follows:

Claims:	1 to 27 as filed on 21 February 2001 with provision that in claim 12 "step (f)" is amended to "step (g)"
Description:	pages 1 to 4 as filed on 28 May 1998 page 10 as filed on 21 February 2001 pages 5 to 9 as originally filed
Drawings:	sheets 1/4 to 4/4 as originally filed

The Registrar:

V. Commare

The Chairman:

W. D. Weiß