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**Datasheet for the decision
of 15 November 2007**

Case Number: T 0165/05 - 3.2.02

Application Number: 98104712.9

Publication Number: 0866138

IPC: C21C 5/46

Language of the proceedings: EN

Title of invention:

Method for introducing gas into a liquid

Patentee:

PRAXAIR TECHNOLOGY, INC.

Opponent:

LINDE AKTIENGESELLSCHAFT
Air Products and Chemicals Inc.

Headword:

-

Relevant legal provisions:

EPC Art. 52(1), 56, 100(a)

Keyword:

"Inventive step (all requests, no)"

Decisions cited:

T 0386/89, T 0440/91

Catchword:

-



Case Number: T 0165/05 - 3.2.02

D E C I S I O N
of the Technical Board of Appeal 3.2.02
of 15 November 2007

Appellant: PRAXAIR TECHNOLOGY, INC.
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 16 December 2004
revoking European patent No. 0866138 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: S. Chowdhury
Members: R. Ries
M. Vogel

Summary of Facts and Submissions

- I. The appellant (patent proprietor) lodged an appeal against the decision of the opposition division to revoke European patent No. 0 866 138. The decision was dispatched on 16 December 2004.

The appeal was received on 2 February 2005 and the fee for the appeal was paid on the same day. The statement setting out the grounds of appeal was received on 26 April 2005.

The opposition was filed against the whole patent and based on Article 100 (a) EPC (lack of novelty and inventive step of the claimed subject-matter) and Article 100 (b) EPC. The opposition division decided that the subject-matter of claim 1 of the main and first and second auxiliary requests did not involve an inventive step, and revoked the patent, accordingly.

- II. The opponents had two main lines of attack under Article 100 (a) EPC, one comprising allegations of lack of novelty and inventive step based on documents published before the priority date of the patent in suit, and the second based on allegations of public prior use.

The following pre-published documents relevant to the first line of attack were of greatest interest in the appeal procedure:

D1: US-A-3 427 151

D2: WO-A-89/02051

D5: US-A-4 622 007

D14: BOF Steelmaking, Process Technology Division Iron and Steel Society of the American Institute of Mining, Metallurgical and Petroleum Engineers, Vol. 1, pp. 551, 578-590, 627, Second Printing of 1982

D27: Experimental data regarding gas jet coherency.

III. Oral proceedings were held on 15 November 2007.

The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of the main request or one of the first to sixth auxiliary requests, all filed on 13 November 2007.

The respondents (opponents) requested that the appeal be dismissed.

IV. Claim 1 of the main request reads as follows:

"A method for introducing oxygen gas into a liquid pool comprising molten metal, comprising:

- (A) ejecting oxygen gas from a lance having a converging and diverging nozzle with an exit diameter (d) and having a tip spaced from the surface of the liquid pool, and forming an oxygen gas stream having a supersonic initial jet axis velocity of at least 457 m/s (1500 fps) upon ejection from the lance tip;
- (B) surrounding the oxygen gas stream with a flame envelope having a velocity less than that of the oxygen gas stream, passing the oxygen gas stream from the lance tip to the liquid pool surface through a distance of at least 20d, and contacting the liquid pool surface with the oxygen gas stream having a supersonic jet axis velocity; and

(C) passing oxygen gas from the oxygen gas stream through the surface of the liquid pool and into the liquid pool, wherein the flame envelope is formed by ejecting fuel from the lance through an inner ring of holes surrounding the oxygen gas nozzle at the lance axis and oxidant through an outer ring of holes surrounding the oxygen gas nozzle at the lance axis and mixing and combusting fuel and oxidant exiting the two rings of holes, and wherein the flame envelope extends from the lance tip to the liquid pool surface".

Claim 1 of the first auxiliary request includes the additional feature "wherein the lance comprises a first annular passageway terminating in the inner ring of holes and a second annular passageway terminating in the outer ring of holes, wherein the first and second passageways are coaxial with and parallel to the central passageway".

Claim 1 of the second auxiliary request has the additional feature over claim 1 of the first auxiliary according to which the oxygen gas stream is passed from the lance tip to the liquid pool surface through a distance of within the range of from 30d to 60d.

Claim 1 of the third auxiliary request has the additional feature over claim 1 of the second auxiliary according to which the supersonic jet axis velocity is at least 75% of the initial jet axis velocity.

Claim 1 of the fourth auxiliary request has the additional feature over claim 1 of the third auxiliary according to which the method comprises a lancing mode

and a burner mode comprising: "significantly increasing the amount of fuel and oxidant provided for forming the flame envelope, so that the flame envelope not only serves to shield the main oxygen gas stream from entrainment of ambient gas but also serves to provide significant heat into the volume above the top surface of the liquid pool".

Claim 1 of the fifth auxiliary request has the additional feature over claim 1 of the third auxiliary according to which the flame envelope surrounding the oxygen gas stream has a velocity within the range of from 15.2 to 152 m/s (50 to 500 fps).

Claim 1 of the sixth auxiliary request has the additional feature over claim 1 of the third auxiliary according to which at least 85% of the oxygen gas ejected from the lance passes through the surface of the liquid pool and into the liquid pool.

Claim 1 of each request has its respective retinue of dependent claims.

V. The parties argued as follows:

The appellant's arguments may be summarised as follows:

The closest prior art document, D1, related to a lance in which an oxygen jet had a flame envelope produced by the combustion of fuel and secondary oxygen, but the configuration of holes for the fuel and oxygen was different to that of claim 1 of the patent in suit, and the oxygen jet velocity in D1 was sonic or below both

at the nozzle exit and at the surface of the molten bath.

The presently claimed arrangement of the rings of holes for fuel and oxygen gave rise to the surprising finding that it increased preservation of the coherency of the main oxygen jet so as to ensure deep penetration of oxygen into the bath. The experimental data verifying this finding was presented in document D27, which also showed that this effect was specific to oxygen as the main gas jet; it would not work with nitrogen, for example.

The technical problem originally disclosed (paragraph 7 of the patent in suit) was to provide a method for introducing gas into a liquid pool wherein essentially all of such gas ejected from the gas injection device entered the liquid pool, without need for submerged injection of the gas into the liquid, while avoiding significant damage to the gas injection device caused by contact with or proximity to the liquid pool.

This was achieved by the shielding effect of the flame envelope (paragraph 24). However, the effect of the rings of holes for fuel and oxygen was also to enhance the shielding effect of the flame, and this technical problem was closely related to the original problem. The presently claimed arrangement of fuel and oxygen holes was originally disclosed as a preferred arrangement so that these beneficial effects were foreshadowed in the application. The case law of the EPO stated that benefits not originally disclosed could be taken into account for assessment of inventive step, if the character of the invention was not altered.

There were various alternatives for generating a flame envelope; one could use a single ring with alternating fuel and oxygen holes, or a premixed gas, three concentric rings, an annular passage, etc, so the present arrangement was not simply a selection of one from two alternatives.

It was basic physics that gas laws alter drastically between sonic and supersonic flows. The person skilled in the art would not expect that shielding a central oxygen jet with a flame would be beneficial in the case of a supersonic jet. This was supported by D2 and D5, according to which an outer flame was detrimental to the operation of an oxygen lance in supersonic mode.

D14 related to an oxygen lance in a quiescent atmosphere and it taught that the ratio of densities of the central jet and the quiescent atmosphere was decisive for the jet quality. However, the behaviour of a supersonic jet in a flame envelope would be quite different owing to turbulence, so this document gave no incentive to surround a supersonic jet with a flame envelope.

The present situation was not a one-way-street situation since there were alternative ways of improving the penetration ability of a jet apart from adding a flame envelope, such as optimising the nozzle design, adjusting the density ratios, increasing nozzle diameter, increasing the supply pressure, etc.

At the priority date of the patent in suit oxygen lances in BOFs were known, as were supersonic lances

without a flame envelope. Nevertheless, the problem of bath penetration was ever present and the present patent fulfilled a long felt want, which was an indicator of inventive step.

The respondents' arguments may be summarised as follows:

The term "about sonic" in D1 included "above sonic", so that a gas jet with supersonic velocity was disclosed in D1. This was confirmed by calculations performed in D3. It was a routine matter to substitute the nozzle in D1 by the Laval nozzle of D2. D14 clearly taught the use of a supersonic jet and to preserve the jet speed in order to conserve momentum into the liquid bath.

The patent disclosed two alternative and equivalent arrangements of holes for the fuel and the secondary oxygen, and it was not inventive to choose the one or the other. Moreover, the technical effects of the selected arrangement was not disclosed in the patent and to invoke test results 10 years after the priority date thereof was not allowable. Furthermore, these results could not be used since all the parameters and variables of the experiment were not known.

D5 described a burner with different modes of operation, including one in which a supersonic jet for deep penetration was projected through a flame, and showed the same arrangement of channels for the fuel and oxygen as in the patent in suit. It was general knowledge that the flame should extend up to the pool surface. D14 also disclosed as an example that the supersonic jet was exhausted into and surrounded by a CO gas atmosphere, and owing to density effects even

better results would be expected with a hotter flame envelope.

Reasons for the decision

1. The appeal is admissible.
2. *Amendments*
3. The new claims of all requests include new features taken from the description and no objections arise under Article 123 (2) or (3) EPC.

4. *Novelty*

Novelty of the subject-matter of the amended claims was not disputed by the respondents. The Board concurs with this view.

4.1 Inventive step (main request)

- 4.2 The parties to the appeal proceedings and the Board concur that the closest prior art document is D1 because, like the patent in suit, this document discloses the use of a flame envelope to improve coherency of a central oxygen gas stream jet and hence the penetration capability of the jet into a molten metal, and to allow for a larger distance between the lance tip and the molten metal surface for increasing the lifetime of the lance (D1, column 3, lines 38 to 65 and column 4, lines 61 to 74).

4.3 The Board does not consider D1 to disclose the use of a gas jet at supersonic speed. It is the teaching of this document to use gas jet speeds up to sonic, and even the use of the phrase "about sonic" (D1, claim 2) does not clearly and unambiguously disclose a supersonic speed. The respondents have argued that the parameters in the table in column 8 of D1 inevitably result in a supersonic speed, and have produced mathematical calculations to support this, but the appellant has produced its own calculations "proving" the opposite. The only neutral evidence the Board can go by is the prior art, and in each and every prior art document in which supersonic jets are used a Laval nozzle is always employed, but the D1 nozzle is not a Laval nozzle.

4.4 The method of claim 1 differs from the method disclosed in D1 by the following steps, accordingly:

i) The velocity of the oxygen jet upon ejection from the lance tip is supersonic and at least 457 m/s (1500 fps) by virtue of the use of a lance having a converging and diverging nozzle.

ii) The velocity upon impingement of the jet at the surface of the bath is also supersonic.

iii) The flame envelope is formed by a supplying fuel through an inner ring of holes surrounding the oxygen gas nozzle at the lance axis and oxidant through an outer ring of holes surrounding the oxygen gas nozzle.

4.5 Given that it was known that a high momentum of the gas jet results in greater penetration into the molten bath

(see, for example, D14, page 581 last paragraph and 582 first paragraph), the person skilled in the art would undoubtedly consider increasing the jet velocity beyond sonic in D1 in order to achieve yet greater penetration.

The appellant argues that the skilled person, upon consideration of the effects of shock waves, turbulence, etc., would not expect any benefits from increasing the gas jet velocity in D1 from sonic to supersonic. However, this possibility was, in fact, already explored according to the description of the background art in column 1 of the patent. The fact that the use of a supersonic oxygen jet within a flame envelope was known in the prior art demonstrates that the skilled person would not be dissuaded from attempting to increase the jet velocity in the D1 device to above sonic in a flame envelope. Therefore, the appellant's argument, that the person skilled in the art would not consider this modification of the D1 apparatus, is not correct.

Moreover, the patent does not describe any difficulties associated with the use of a supersonic jet within a flame envelope, or how they were overcome. This also demonstrates that such difficulties belong more in the realm of theoretical considerations rather than practical realities.

For this reason, the step of increasing the velocity of the main oxygen jet velocity of D1 to supersonic, by means of a Laval nozzle, is not considered to involve an inventive step. Nor is the use of an initial jet axis velocity of at least 457 m/s (1500 fps) upon ejection from the lance tip considered to involve an

inventive step, since this has no technical effect associated with it, it is merely described as a preferred speed, i.e. it is merely a matter of optimisation.

4.6 It is evident from D14 (page 580, last paragraph to page 582, first paragraph) that the centreline velocity and momentum of the oxygen jet should be conserved as far as possible in order to achieve maximum penetration into the metal bath. This is a clear indication that it is desirable that the centreline velocity be supersonic also at the surface of the bath. This desideratum of claim 1 lacks an inventive step, accordingly.

4.7 Claim 1 contains the new features concerning the fuel/secondary oxygen arrangement of inner and outer rings of holes. Although these constructional features themselves were undoubtedly disclosed originally, the technical significance of these features was not originally disclosed. The appellant now invokes a surprising effect of this arrangement, supported by document D27, in order to justify inventive step.

It belongs to the well-established jurisprudence of the Boards of Appeal that where a specific problem is identified in the description, the applicant or patentee may be allowed to put forward a modified version of the problem particularly if the issue of inventiveness has to be considered on an objective basis against a new prior art which comes closer to the invention than that considered in the original patent application or granted patent specification.

However, in the present case the Board concludes that the alleged unexpected effects, which are not deducible from the application as originally filed, cannot be taken into account when determining the problem underlying the invention for the purpose of assessing the issue of inventive step. In this respect see T 0386/89, point 4 of the Reasons.

The appellant has argued that T 440/91 permits technical effects not mentioned in the original application to be taken into account for the assessment of inventive step, if these effects do not alter the character of the invention. The latter condition was fulfilled if the skilled person might consider the subsequently invoked advantages on account of their close technical relationship to the original problem. In T 440/91 it was pointed out that Rule 27 EPC did not rule out the possibility of additional advantages, not themselves mentioned in the application as filed but relating to a mentioned field of use, being filed subsequently in support of patentability.

The present situation is, however, different to that of T 440/91. In the latter case a patent application originally disclosed the problem of improving the solubility in water of a substance having therapeutic properties. Subsequently the question of inventive step was based on specific therapeutic properties of the substance which the skilled person would envisage. Thus the new problem remained nested within the original one.

In the present case, while the original technical problem related to maintaining gas jet coherency, the technical features for achieving this were the flame

envelope having a lower velocity than the main jet. Now, however, completely differently features are said to solve this problem and have been imported from the description into claim 1. There is no technical relationship between the original features for solving the problem and the new features for doing so.

The Board considers the character of the invention to have been altered by the fact that completely different features are now said to solve the stated problem. The appellant, in its letter of 24 July 2006 (Section 1.2.1), states that these newly disclosed effects were surprising, which is an admission that they could not have been envisaged by the skilled person.

The Board's doubts in this respect are further reinforced by the fact that there is a contradiction between the original disclosure and the newly presented effects. Originally, the two configurations of holes were said to be entirely equivalent (see the patent, column 5, lines 39 to 44 and column 6, lines 4 to 8), but now one of the two disclosed arrangements is said to be considerably more effective than the alternative arrangement.

The appellant's argument that the presently claimed arrangement was said to be the preferred one, and hence foreshadowed the newly presented effect, is not accepted. The word "preferred" is used liberally in the patent, even essential features as defined in claim 1 being said to be "preferred" (e.g. column 5, line 37 to 39 and column 6, lines 8 to 10), so as to dilute the impact of this word. Moreover, the presently claimed arrangement of holes is said to be a "usual"

arrangement (column 5, line 39 to 41), and there is no clear indication that it has advantages over the alternative arrangement of holes described in column 6.

Furthermore, not all the parameters and variables of the experiment underlying the results presented in D27 are known, so it is not clear that they correspond to the parameters underlying the patent in suit. The presently claimed arrangement of fuel and secondary oxygen holes is, therefore, regarded as the equivalent of the arrangement shown in D1, and not inventive.

- 4.8 For the reason that none of the distinguishing method steps of claim 1 is considered to involve an inventive step, the claim as a whole is devoid of an inventive step.

Therefore, the main request is not allowable.

5. *Auxiliary requests*

- 5.1 Claim 1 of the auxiliary requests import further features which, while having a bearing on gas penetration into the bath, do not technically interact with each other. For example, claim 1 of the fourth auxiliary request includes the features relating to the distance the oxygen gas stream passes (from 30d to 60d), the supersonic jet axis velocity is at least 75% of the initial jet axis velocity, the arrangement of the holes for fuel and oxygen, and the method comprising a lancing mode and a burner mode. All these features are technically unrelated so that they may be inspected individually for inventive step.

5.2 D1 also discloses the additional features of claim 1 (see point IV. above) of the first and second auxiliary requests (see Figure 2 of D1 and column 5, lines 3 to 6). These features cannot contribute to inventive step, accordingly.

5.3 It is clear, at least from D14, that it is desirable to maintain the gas jet momentum and coherency as much as possible. The additional feature of the third auxiliary request (the supersonic jet axis velocity is at least 75% of the initial jet axis velocity) merely expresses this desideratum and cannot support inventive step.

Similarly, claim 1 of the sixth auxiliary request simply expresses a known desideratum (at least 85% of the oxygen gas ejected from the lance passes through the surface of the liquid pool and into the liquid pool) and is not inventive.

5.4 The burner mode defined in claim 1 of the fourth auxiliary request is additional to the lancing mode defined in the first part of the claim and in claim 1 of the main request. It is known, for example from D5, that one and the same apparatus may be used in different modes, including a burner mode and a refining mode (D5, column 2, lines 30 to 55), and in each mode the parameters may be optimised for a given application. Therefore, the burner mode of this request does not endow the claim with an inventive step.

5.5 The additional feature of the fifth auxiliary request (the flame envelope surrounding the oxygen gas stream has a velocity within the range of from 15.2 to 152 m/s (50 to 500 fps)) is not associated with any particular

technical effect. Instead it is an optimising step which the person skilled in the art would carry out depending on a particular application of the claimed method. This claim does not involve an inventive step, accordingly.

6. From the foregoing it is seen that none of the requests on file is allowable.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar

The Chairman

V. Commare

S. Chowdhury