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Datasheet for the decision of 16 November 2007

Case Number: T 1228/05 - 3.3.06

Application Number: 98117323.0

Publication Number: 0901812

IPC: B01J 19/00

Language of the proceedings: EN

Title of invention:
Stationary vortex system for direct injection of supplemental reactor oxygen

Patentee:
PRAXAIR TECHNOLOGY, INC.

Opponent:
LINDE AKTIENGESELLSCHAFT

Headword:
Method for providing oxygen/PRAXAIR

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 100(b), 54, 56

Keyword:
"Sufficiency of disclosure: yes"
"Novelty: yes"
"Inventive step: non-obvious alternative to the prior art"

Decisions cited:
-

Catchword:
-

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Case Number: T 1228/05 - 3.3.06

D E C I S I O N
of the Technical Board of Appeal 3.3.06
of 16 November 2007

Appellant: (Patent Proprietor)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 15 July 2005 concerning maintenance of European patent No. 0901812 in amended form.

Composition of the Board:

Chairman: P.-P. Bracke
Members: P. Ammendola
A. Pignatelli

Summary of Facts and Submissions

I. This appeal is from the decision of the Opposition division concerning the maintenance in amended form of European patent No. 0 901 812 according to the then pending third auxiliary request of the Patent proprietor.

II. Claims 1 and 7 of the patent as granted read:

"*1. A method for providing supplemental oxygen to a reaction mixture comprising:*

(A) providing air into a reactor vessel containing a reaction mixture, and passing the air in the form of air bubbles within the reaction mixture;
(B) agitating the reaction mixture to create a stationary vortex;
(C) providing oxygen in the form of oxygen bubbles directly into the stationary vortex; and
(D) passing oxygen out from the oxygen bubbles and dissolving oxygen into the reaction mixture."

"*7. The method of claim 1 wherein substantially all of the air bubbles are kept from entering the stationary vortex into which the oxygen is injected.*"

The remaining granted claims 2 to 6 and 8 to 10 defined preferred embodiments of the method of claim 1.

III. The Opponent, in its notice of opposition, had sought revocation of the patent in suit on the grounds of insufficient disclosure (Article 100(b) EPC) and of

lack of novelty and of inventive step (Article 100(a) in combination with Articles 52(1), 54 and 56 EPC) in view of, *inter alia*, the following documents:

Document (1) = EP-A-0 477 818

and

Document (3) = "Ullmanns Encyklopädie der Technischen Chemie", volume 2, page 261, 1972.

IV. During the opposition proceedings the Patent proprietor filed under cover of a letter dated 6 September 2004 three sets of amended claims respectively labelled as first to third auxiliary request.

V. In its decision, the Opposition division found, *inter alia*, that the subject-matter of the granted claims was sufficiently disclosed in the patent and novel, but lacked an inventive step in view of document (1). In particular, the Opposition division found that the claimed method resulted from the optimization of the method for providing supplemental oxygen disclosed in document (1) and, thus, provided an obvious alternative thereto.

VI. The Patent proprietor (hereinafter "Appellant") lodged an appeal against this decision providing with the grounds of appeal comparative experimental data on the rate of oxygen uptake (hereinafter "the OUR data") that was achieved when injecting oxygen inside or outside several stationary vortices located throughout the whole length of two different reactor vessels. These

data included the figures 1 and 2 (hereinafter "the flow simulation figures") schematically depicting the flow patterns predictable in the used reactor vessels on the basis of a commercial computational fluid dynamic simulation program.

VII. The Opponent (hereinafter "Respondent") replied in writing to the grounds of appeal, refusing the Appellant's reasoning and disputing also the findings of the Opposition division in respect of novelty of the patented subject-matter and of the sufficiency of disclosure for the embodiment of the invention defined in claim 7 as granted.

VIII. Oral proceedings were held before the Board in the presence of both parties.

IX. In respect of the granted patent the Appellant argued in essence as follows:

- the description in paragraph 19 of the granted patent would implicitly suggest to its skilled reader that it was sufficient to inject air, for instance, in the longitudinally circulating reaction mixture to ensure that the air bubbles would remain outside the stationary vortices, thereby rendering possible to carry out the invention's embodiment defined in claim 7 as granted;

- the Respondent's attempt to consider the whole agitated liquid as a stationary vortex in the sense of the present invention, would amount to an unreasonable interpretation manifestly in contradiction with the patent description, which would instead explicitly

recognise the horizontal slow circulating "*stationary vortices*" as distinct from, for instance, the fast flowing "*longitudinally circulating reaction mixture*" passing through the impellers;

- nor were the schematic flow simulation figures or figure 4 of document (3) describing the formation of a stationary vortex in a reactor with a single impeller sufficient for proving that either the space below the lowermost impeller in figure 1 of the patent in suit or that between the first two impellers in figure 1 of document (1) were completely filled by stationary vortices;

- hence, the Respondent had proved neither that invention's embodiment described in claim 7 as granted could not be carried out by using the reactor whose design is schematically depicted in figure 1 of the patent in suit, nor that the injection of oxygen within stationary vortices had already necessarily occurred in the reactor vessel disclosed in figure 1 document (1);

- the claimed method differed from that of the prior art because of the additional requirement that the injection of oxygen had to take place within the stationary vortices;

- the OUR data would demonstrate the criticality of this feature on the oxygen uptake into the liquid filling the reactor;

- document (1) would in any case lead away from the invention, because it would expressly suggest that the oxygen injection should preferably occur in the down-

flowing liquid below the uppermost impeller so that the oxygen would be carried to the subsequent impellers, i.e. that the oxygen should be injected in the longitudinally circulating reaction mixture rather than in the stationary vortices.

X. The Respondent disputed the sufficiency of disclosure for claim 7 as granted by considering, on the one side, that the whole liquid phase in the reactor vessel could be considered a stationary vortex in the sense of the invention and, on the other side, that the only way for carrying out the invention disclosed in the patent, i.e. that of figure 1, required the air to be injected below the lowermost stationary vortex and, thus, in a portion of the reactor vessel which, according to the flow simulation figures filed by the Appellant itself and/or to the stationary vortex figure in document (3), would be substantially filled by a stationary vortex. Thus, the skilled person would not learn from the patent in suit how to possibly inject air in a reactor designed in accordance to figure 1, so as to keep the air from entering into the stationary vortices, as required by claim 7.

In respect of the novelty of the subject-matter of claim 1 as granted, the Respondent conceded that document (1) was totally silent as to the presence of stationary vortices, but argued again that the flow simulation figures provided by the Appellant and/or that of document (3) would allow to identify the positioning and the dimensions of the stationary vortices present in other reactors as well, and, thus, also between the impellers of the reactor depicted in figure 1 of document (1).

On this basis the Respondent concluded that the oxygen injection means described in figure 1 of document (1) would necessarily be located within a stationary vortex.

The Respondent disputed the presence of an inventive step for the patented subject-matter by maintaining that the provided OUR data would only prove that the oxygen was more efficiently adsorbed when injected in the space between the impellers rather than at the impellers. It argued that the instruction to inject oxygen between the impellers was already present in figure 1 of document (1) and that a skilled person, aiming at optimizing the method of the prior art, would in any case have arrived at positioning of the oxygen injection means within the stationary vortex by conventional optimization trial and error experiments, i.e. independently as to whether this person was aware or not of the existence of such stationary vortex.

XI. The Appellant requested that the decision of the first instance be set aside and the patent maintained as granted or on the basis of the claims of the first auxiliary request of 6 September 2004.

XII. The Respondent requested that the appeal be dismissed.

Reasons for the Decision

Main request: patent as granted

1. Interpretation of "*longitudinally circulating reaction mixture*"

1.1 The Respondent has argued that the "*longitudinally circulating reaction mixture*" disclosed in the patent in suit as flowing along the reactor central axis and the reactor walls, could also be considered as a "*stationary vortex*" in view of the definition given in the first two sentences of paragraph 12 of the patent description, reading "*As used herein, the term "stationary vortex" means a rotating body of liquid with little or no transverse or axial movements at the center point of the body. A stationary vortex is formed when a body of liquid is moved by a mechanical agitation system but is deflected into a steady rotational motion due to the restraining effect of reactor geometry.*".

1.2 The Board notes, however, that the patent description in paragraphs 12, 18 and 19 and the figure 1 makes clear that distinct flows are present in reactor vessels capable of producing stationary vortices. In particular, the patent description identifies as "*stationary vortices*" the slow rotating liquid flows (whose sectional view is schematically depicted by the pairs of small circles "7" below and above each impeller in figure 1 of the patent in suit) not bound onto the liquid surface, the impellers or the baffles of the reactor, as opposite to the fast "*longitudinally circulating reaction mixture*" going along the centre axis and the sides of the reactor vessel and, thus, necessarily passing through each impeller.

This is evident, in particular, from the wording "*The stationary vortex does rotate, but its linear or tangential speed is low compared to the fast moving fluid induced by the impeller immediately outside the*

stationary vortex. A stationary vortex differs from other types of vortices in that it does not bound onto the liquid surface, the impeller or the baffles." contained in paragraph 12 (in the part thereof of immediately following that cited by the Respondent) and which implies not only a difference in the flowing speed between the liquid circulating outside or inside the stationary vortices, but also that no stationary vortex is present at the impellers. The absence of stationary vortices of the liquid at the impellers represents already an evident difference vis-à-vis the fluid circulating longitudinally. As a matter of fact this latter must necessarily also circulate through the impeller region as well, as unambiguously defined in the last three sentences of paragraph 18, describing figure 1 and reading "*As the impellers rotate in a circular motion through the interior of the reaction vessel, the reaction mixture is pushed outward to the sides of the reactor vessel and inward toward the central axis of the reactor vessel. This lateral movement of the reaction mixture causes the formation of a small stationary vortex 7 above and below each impeller 6. The lateral movement of the reaction mixture also causes a longitudinal circulation of the reaction mixture, upward along the central axis and downward along the sides of reactor vessel 1.*". Consistent with such distinction is also the wording in paragraph 19 reading "*…The smaller air bubbles pass into the reaction mixture upflow along the reactor vessel central axis and around the periphery of each stationary vortex due to the peripheral reaction fluid flow around each stationary vortex illustrated by peripheral flow arrows 10, then into the reaction mixture longitudinal circulatory flow.…The entrainment*

of the air bubbles into the longitudinally circulating reaction mixture flowing at the center and the sides of the reactor vessel, and the peripheral flow 10 of the reaction mixture about each stationary vortex, keeps the majority, preferably substantially all, of the air bubbles from entering the stationary vortices.".

Hence, the Board concurs with the Appellant that the patent description expressly distinguishes the slowly flowing "*stationary vortex*" from the circular stream rapidly passing along the central axis and the reactor walls through the impellers, i.e. from the "*longitudinally circulating reaction mixture*".

1.3 Accordingly, the Respondent's interpretation of this latter (see above point 1.1) is found in open contradiction with the whole description of the patent in suit and, thus, discarded.

2. Sufficiency of disclosure: claim 7 as granted (Articles 100(b) and 83 EPC)

2.1 The Respondent has argued that the patent as granted did not teach to its skilled reader how to inject air so as to keep this latter from entering into the stationary vortices, as required by granted claim 7 (see section II of the Facts and Submissions).

2.2 In particular, the Respondent has maintained that any air injected in the reactor vessel of figure 1 would also unavoidably be injected into a stationary vortex, because also the "*longitudinally circulating reaction mixture*" could be considered a "*stationary vortex*" embracing the whole liquid phase.

However, this argument is based on the interpretation of the wording "*stationary vortex*" that has been found not convincing for the reasons already given in points 1.2 above and, thus, is also not convincing.

2.3 The Respondent has argued further that the only figure (i.e. figure 1) of the patent as granted would provide the sole specific disclosure as to how to carry out the invention and would require that the air is injected by means of a sparger located in a zone below the lowermost impeller. In the Respondent's opinion, this zone would substantially be filled by a stationary vortex produced by the lowermost impeller, as evident from the flow simulation figures (those provided by the appellant with the grounds of appeal) as well as from the figure depicting a single-impeller reactor forming a stationary vortex in document (3). Hence, the only way for carrying out the invention disclosed in the patent would not allow to realize the embodiment described in claim 7.

2.3.1 The Board notes initially that the patent disclosure relevant to embodiment of claim 7 embraces not just figure 1, but also the content of paragraphs 18 and 19 of the patent description.

In particular, the disclosure in paragraph 19 of the patent as granted cited above (see point 1.3) teaches implicitly, but directly and unamibiguously, that by injecting the air in the liquid flow moving longitudinally along the central axis and the sides of the reactor vessel, keeps substantially all air bubbles from entering the stationary vortices and, thus, also

from entering the stationary vortex into which the oxygen is injected.

The Board notes further that the Respondent has not disputed the availability of well-known means, such as the commercial computational fluid dynamic simulation program used by the Appellant for preparing the flow simulation figures, which allow the skilled person to identify the regions in a given reactor vessel certainly containing stationary vortices as well as the regions wherein the reaction mixture only flows longitudinally.

Hence, it appears that the skilled person not only learns from paragraph 19 of the patent description that it is sufficient to introduce the air e.g. into the longitudinally circulating reaction mixture in order for keeping the air from entering the stationary vortices, but is also able to localize the longitudinally circulating reaction mixture in which the air is to be injected.

Accordingly, the guidance provided by the description of the patent is already sufficient to realize the embodiment of the invention described in claim 7, independently on any consideration of the information provided by figure 1. Hence, the Respondent's reasoning given above is not convincing already for this reason.

2.3.2 Moreover, the Respondent's evaluation of this figure is not convincing because it implies the assumption that the flow simulation figures and/or the relevant figure of document (3) could allow to identify **also in other mixing processes**, i.e. independently of the reactor

design and of the setting of the reaction parameters, not only the approximate position but even the precise dimensions of the stationary vortices formed below and above each impeller (and, in particular, that formed below the lowermost impeller).

2.3.3 This assumption appears however unjustified in view of the common general knowledge recalled by the Appellant and undisputed by the Respondent, that the actual dimensions of the stationary vortices depend on a number of factors, such as the viscosity of the fluid filling the reactor, the shape and dimensions of the vessel, the positioning and the number of the baffles and of the impellers, as well as on the impeller rotation speed.

Already the dependence of the stationary vortex's dimensions on, for instance, the applied impeller rotation speed, implies a variability of these dimensions and, thus, is sufficient to deprive of credibility any generalization only based on the flow simulation figures and/or the figure of document (3). In other words, in the absence of supporting evidence, the dimensions of the vortices reported in these figures, rather than being representative of those possibly present in whatever reactor suitable for producing stationary vortices for whatever setting of the process conditions, appear only indicative of those present in the specific kinds of vessel considered and under certain rotation speeds of the impellers (in the case of the flow simulation figures, presumably the same impeller speed actually used in the examples to which they refer).

2.3.4 Accordingly, no reliable prediction as to the dimensions of the stationary vortices possibly present in the reactor of figure 1 of the patent in suit can be derived from the simulation figures and from the figure of document (3) only.

Hence, the Board has no reason to disbelieve that a routine adjustment of the mixing conditions in the reactor of figure 1 of the patent in suit - such as, for instance, an appropriate setting of the rotation speed of the impellers - would be sufficient for realizing the required condition (implied by the small size of the rings "7" in the same figure) that the stationary vortices must possess a limited size and, hence, must not extend into the region below the lowermost impeller wherein the air sparger is located.

2.3.5 Thus, the Board finds that the Respondent has not even rendered credible that a person skilled in the art, undisputedly also aware of the factors which influence the dimensions of the stationary vortices, would **not** be able to carry out the invention embodiment of claim 7 in a reactor whose design is consistent with that depicted in the schematic figure 1 of the patent in suit.

2.4 For all the above reasons, the Board concurs with the conclusion of the Opposition division that the Respondent has not succeeded in rendering credible that the ground of opposition under Article 100(b) EPC prejudice the maintenance of the patent as granted.

3. Novelty: claim 1 (Articles 100(a) EPC in combination with Articles 52(1) and 54 EPC)

3.1 This claim (see above section II of the Facts and Submissions) defines a method for providing supplemental oxygen to a reaction mixture characterised in that the oxygen is injected in stationary vortices created in the mixture.

3.2 The Respondent has argued that this method would be anticipated by the method disclosed in document (1) wherein the oxygen is injected between the uppermost and the second impeller.

In particular, it has maintained that even if this citation was completely silent as to the presence of stationary vortices, still the schematic flow simulation figures provided by the Appellant and/or the schematic figure in document (3) describing the stationary vortex formed in a single-impeller reactor would demonstrate that the oxygen injection means placed between the impellers in figure 1 of document (1) would necessarily be located in a region completely filled by a stationary vortex.

3.3 The Board observes, however, that this reasoning is based on substantially the same implicit assumption - as to the possibility of considering the dimensions of the vortices in the flow simulation figures and/or from the figure in document (3) representative of those possibly present in whatever reactor suitable for producing stationary vortices for whatever setting of the process conditions - that has already been

established to be unjustified for the reasons given in point 2.3.3 above.

3.4 Moreover, the Board notes that the description of document (1) given e.g. in column 4, lines 24 to 52, from column 6, line 52 to column 7, line 7 and from column 7, line 40 to column 8, line 22, discloses that the injection of oxygen bubbles in a reactor containing a Rashton impeller unit, i.e. in a reactor that undisputedly produce stationary vortices, leads to an optimized oxygen uptake either when resulting in a up-rising stream of these bubbles between curtains of similarly rising air bubbles or when carried in the down-flowing liquid between the two uppermost impellers, so that the oxygen bubbles are carried downwards to the lower of these two impellers and through its blades, thereby forming a fine oxygen bubble dispersion.

Hence, document (1) not only does not disclose directly and unambiguously any process wherein the oxygen is injected in a stationary vortex, but discloses explicitly the necessary existence **in the region between the impellers** (and, thus, also possibly in the zone of the schematic reactor of figure 1 wherein the oxygen is injected) of zones wherein the reaction mixture flows downwards through the impellers, rather than in the form of a stationary vortex, and which are sufficiently extended to allow the positioning therein of the oxygen injection means. This is in open contradiction with the Respondent's allegation that stationary vortices would fill substantially all the space between the impellers in the kind of reactors depicted in figure 1 of document (1).

3.5 Therefore, since the argument of the Respondent given above at point 3.2 is found not convincing and document (1) is undisputedly silent as to the possibility of injecting the supplemental oxygen within a stationary vortex, the Board concurs with the Opposition division that the Respondent has not succeeded in rendering credible that the subject-matter claim 1 of the patent as granted was anticipated by the prior art.

4. Inventive step: claim 1 (Articles 100(a) EPC in combination with Articles 52(1) and 56 EPC)

4.1 The Board notes that, as indicated at page 4, lines 6 to 11, of the patent in suit, the technical problem addressed by the claimed invention lies in the provision of an improved method for efficiently delivering oxygen to a reaction mixture. Since substantially the same technical problem has already been addressed in document (1) (see column 1, lines 53 to 54), the Board concurs with the finding of the Opposition division, undisputed by the parties, that the method disclosed in this citation represents an appropriate starting point for the inventive step assessment for the claimed subject-matter.

4.2 The claimed method differs from that disclosed in this citation in that the oxygen is injected within a stationary vortex, whereas in the prior art the oxygen injection is preferably carried out below the uppermost impeller in the down-flowing part of the longitudinally circulating reaction mixture in order to form a fine oxygen bubble dispersion (see above point 3.4).

4.3 The Appellant has attempted to prove that the method of the invention results in a superior oxygen uptake by filing the OUR data with the grounds of Appeal.

These additional comparative data, however, only prove that the oxygen uptake achieved by injecting the oxygen in any of the stationary vortices is superior to that achieved when oxygen is injected **at** the impeller itself, i.e. in a region where the reaction mixture flows horizontally towards the reactor walls (see the positions "V_{out}" in the flow simulation figures).

Since document (1) does not teach to preferably introduce the oxygen at the impeller in an horizontal flow, but rather as an up-rising bubble curtain intermediate between air curtains or in the down-flowing stream between the two uppermost impellers (see the portions of the description of document (1) already identified in point 3.4), it is apparent that the OUR data provide no comparison vis-à-vis the relevant prior art.

Moreover, the Board concurs with the Respondent that the provided OUR data could simply reflect the fact that the oxygen uptake is particularly limited when the gas is injected in the horizontal stream at the impeller. In other words, the OUR data could equally well be indicative of the superiority of the method of the invention or of the fact that the injection points at the impeller chosen for comparison are those providing the worst results, i.e. also worse of any of the embodiments of the method of document (1).

Hence, the Board finds that the OUR data do not allow any sound conclusion as to whether the oxygen uptake achieved by the claimed method is superior to, comparable or lower than that achieved in the prior art.

4.4 Under such circumstances, and since both the patent in suit and document (1) qualify as improving the respective method for providing supplemental oxygen, the Board concurs with the Opposition division and the Respondent that the only technical problem credibly solved by the method of claim 1 of the patent in suit vis-à-vis the prior art is that of providing a further method for providing supplemental oxygen to a reaction mixture characterized by an optimized oxygen uptake, i.e. the provision of an alternative to the prior art.

4.5 The Board finds, however, that the claimed method represents a non-obvious alternative to the prior art, because the person skilled in the art would be lead away from the invention by the disclosure of document (1) (recalled above at point 3.4) indicating as necessary to an optimized oxygen uptake the injection of the oxygen either as a up-rising stream located between curtains of similarly rising air bubbles or in the down-stream of the longitudinally circulating reaction mixture leading to the impeller.

4.6 The Respondent has argued instead that the skilled person would have arrived in any case at positioning the oxygen injection means within the vortex by conventional optimization of the prior art method also in view of the teaching derivable from the description of figure (1) given from column 7, line 40 to column 8, line 22 of document (1), that it is possible to

optimize the oxygen uptake by changing the position of the means injecting the oxygen and that these are, preferably, to be located in the region between the two uppermost impellers. Hence, in the Respondent's opinion, the skilled person would have arrived at locating the oxygen injection means within a stationary vortex by simple trial and error optimization experiments, regardless as to whether or not he would have also been aware that a stationary vortex was present at the location found providing the best results.

4.7 The Board finds however that the skilled reader of document (1) would have carried out the optimization experiments suggested in the portion of this citation referred to by the Respondent taking into account that, as indicated already above (see point 3.4), the same portion explicitly indicates not only that the oxygen is advantageously to be injected in the space between the two uppermost impellers, but also that this injection should occur in a down-flowing stream leading the gas bubbles through an impeller, in order to produce a fine bubble dispersion.

4.8 Since, as indicated already above (see point 2.3.1), the availability of conventional means for establishing the flow pattern in a reactor is undisputed, the skilled person attempting to optimize the embodiment of the method disclosed in document (1) identified by the Respondent, would have acted in accordance to the expectation that the most effective positions to inject the oxygen were to be found in the streams passing trough the impellers, i.e. would **not** have tested the positions wherein no longitudinal flow was predictable to be present and, thus, would also have never arrived

at locating the oxygen injection means within the stationary vortices.

Accordingly, the person skilled in the art would have not arrived at the method claimed in the patent in suit when simply optimizing the method of document (1).

4.9 Therefore, the Board finds that the subject-matter claim 1 of the patent as granted is based on an inventive step vis-à-vis the available prior art.

5. Novelty and inventive step: claims 2 to 8

The remaining claims define preferred embodiments of the method of claim 1 and, hence, their subject-matter is novel and based on an inventive step for the same reasons indicated above for the subject-matter of claim 1.

6. Hence, the Board concludes that the Respondent has not succeeded in rendering credible that the grounds of opposition under Article 100(a) EPC in combination with Articles 52(1), 54 and 56 EPC prejudice the maintenance of the patent as granted.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is maintained as granted.

The Registrar: The Chairman:

G. Rauh P.-P. Bracke