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Datasheet for the decision of 23 January 2020

Case Number: T 0452/17 - 3.3.05

Application Number: 04790745.6

Publication Number: 1680355

IPC: B01F5/00, B01F5/04, B01J8/02, C01B3/38, B01J8/04

Language of the proceedings: EN

Title of invention:
CATALYTIC SECONDARY REFORMING PROCESS AND REACTOR FOR SAID PROCESS

Patent Proprietor:
Casale SA

Opponents:
L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE
Haldor Topsoe A/S
thyssenkrupp Industrial Solutions AG
Linde AG

Headword:
Catalytic secondary reforming/Casale

Relevant legal provisions:
EPC Art. 54, 56
RPBA 2020 Art. 12(3), 25(2)
RPBA Art. 12(4)

Keyword:
Novelty - main request (no) - auxiliary request (no)
Inventive step - auxiliary request (no) - neighbouring field - obvious combination of known features
Statement of grounds of appeal - party's complete case
Late-filed request - submitted with the statement of grounds of appeal - admitted (no)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 0452/17 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 23 January 2020

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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted on 21 December 2016 revoking European patent No. 1680355 pursuant to Article 101(3)(b) EPC.

Composition of the Board:

Chairman E. Bendl
Members: T. Burkhardt
R. Winkelhofer

Summary of Facts and Submissions

I. Four oppositions had been filed against European patent EP 1 680 355 B.

II. The patent proprietor's appeal lies from the decision of the opposition division to revoke the patent.

III. The opposition division held, *inter alia*, that:
- the then main request did not fulfil the requirements of Article 123(2) EPC
- the then first and third auxiliary requests, as filed by submission dated 16 September 2016, did not fulfil the requirements of Articles 54 and 56 EPC, respectively

IV. The following documents were among those discussed at the opposition stage:

D7 US 5,492,649 A
D14 EP 0 997 433 A1
D22 EP 0 545 440 A2

V. In its statement setting out the grounds of appeal, the appellant maintained the main request and the first and third auxiliary requests as the main request and the first and second auxiliary requests, respectively. In addition, they filed a new third auxiliary request.

VI. Oral proceedings took place in the absence of opponent 4 (respondent 4), as had previously been announced.

VII. Independent claims 1 of the main request (patent as granted) and of auxiliary request 1 read both as follows:

"1. Catalytic secondary reforming process, for the production of synthesis gas, of the type comprising the successive steps of:
- feeding a first gas flow comprising hydrocarbons and a second gas flow comprising oxygen into a reforming reactor, at least one of said gas flows being fed into said reactor in a predetermined feed direction substantially parallel, preferably coaxial, to a longitudinal axis of said reactor,
- mixing said gas flows in said reactor, with substantially simultaneous oxidation of the hydrocarbons of said first gas flow by the oxygen of said second gas flow,
characterized in that said step of mixing said gas flows takes place by giving to said at least one of said gas flows a rotating swirling motion about said predetermined feed direction"

Claim 1 of auxiliary request 2 differs from claim 1 of the main request in the characterising part, which reads as follows:

"characterized in that said first gas flow comprising hydrocarbons and said second gas flow comprising oxygen are fed into a reaction chamber of said reactor in said predetermined feed direction keeping them separated for an initial portion of said reactor through a first cylindrical duct and a second cylindrical duct, respectively, said second gas flow comprising oxygen being inside and coaxial to said first gas flow comprising hydrocarbons and said second duct extending inside said reaction chamber and comprising an open end diverging towards the walls of said reaction chamber, and in that said mixing step takes place downstream of said portion, in said reaction chamber, giving to said

inner and coaxial flow a rotating swirling motion around said predetermined feed direction so that downstream of said portion said inner and coaxial flow deviates in a substantially radial direction towards the walls of said chamber."

Claim 1 of auxiliary request 3 differs from claim 1 of the main request in the characterising part, which reads as follows:

"characterized in that said first gas flow comprising hydrocarbons and said second gas flow comprising oxygen are fed into a reaction chamber of said reactor in said predetermined feed direction keeping them separated for an initial portion of said reactor through a first cylindrical duct and a second cylindrical duct, respectively, said second gas flow comprising oxygen being inside and coaxial to said first gas flow comprising hydrocarbons and said second duct extending inside said reaction chamber, said reaction chamber being defined at a frusto-conical upper end of a substantially cylindrical shell, with a substantially vertical axis, of said reactor, and said second duct comprising an open end diverging towards the walls of said reaction chamber, and in that said mixing step takes place downstream of said portion, in said reaction chamber, giving to said inner and coaxial flow a rotating swirling motion around said predetermined feed direction so that downstream of said portion said inner and coaxial flow deviates in a substantially radial direction towards the walls of said chamber."

VIII. The appellant's arguments, as far as relevant to the present decision, may be summarised as follows.

The main request and auxiliary request 1 fulfilled the requirements of Article 54 EPC since D7 did not disclose mixing by giving one of the gas flows a rotating swirling motion. The mixing was rather caused by a recirculation of the combustion products.

Auxiliary request 2 fulfilled the requirements of Article 56 EPC when starting from D7, which additionally failed to disclose a "second duct extending inside [the] reaction chamber". The skilled person would not have contemplated a combination with D14. Even if they did, they would not have arrived at the claimed subject-matter.

Auxiliary request 3 added a further feature which was not disclosed in the prior art.

IX. The respondents' arguments, as far as relevant to the present decision, may be summarised as follows.

The main request and auxiliary request 1 did not fulfil the requirements of Article 54 EPC over D7.

Auxiliary request 2 did not fulfil the requirements of Article 56 EPC in view of the combination of D7 with D14.

Auxiliary request 3 should not be admitted.

X. The appellant requests that the decision under appeal be set aside and that the oppositions be rejected (main request).

Alternatively, they request that the patent be maintained on the basis of one of three auxiliary requests:

- auxiliary request 1 or auxiliary request 2, both filed as then auxiliary requests 1 and 3, respectively, by submission of 16 September 2016
- auxiliary request 3 as filed with the grounds of appeal

Opponents 1 to 3 (respondents 1 to 3) request that the appeal be dismissed. Respondent 4 has not made any submissions as to the substance of the appeal.

Reasons for the Decision

Main request and auxiliary request 1

1. Novelty

For the following reasons, the subject-matter of claim 1 of these requests is anticipated by D7 (Article 54(1) and (2) EPC).

1.1 D7 discloses in Figure 1 a catalytic secondary reforming process for the production of synthesis gas (column 1, lines 5 to 9) comprising the successive steps of:

- feeding a first gas flow (12) comprising hydrocarbons and a second gas flow (10) comprising oxygen into a reforming reactor, at least one of said gas flows being fed into said reactor in a predetermined feed direction substantially parallel, preferably coaxial, to a longitudinal axis of said reactor (Figure 1)
- mixing said gas flows in said reactor, with substantially simultaneous oxidation of the hydrocarbons of said first gas flow by the oxygen

of said second gas flow (according to column 3, lines 56 to 61, mixing occurs in a "combustion zone")

characterised in that said step of mixing said gas flows takes place by giving to said at least one of said gas flows a rotating swirling motion about said predetermined feed direction (column 3, lines 56 to 61).

1.2 In the appellant's view, D7 does not disclose the feature "mixing said gas flows takes place by giving to said at least one of said gas flows a rotating swirling motion about said predetermined feed direction". The appellant refers to column 2, lines 58 to 63, of D7 and argues that the mixing in D7 is caused by a recirculation of the combustion products rather than by the swirling movement.

This argument is not convincing. According to claim 1 of D7, the "swirling motion" of "oxidizer gas" results in "a maximum number of *mixing* points for the process and oxidizer gas" (emphasis added by the board; see also column 2, lines 27 to 39, column 3, lines 56 to 61). Hence, the gas flows are well mixed by the "rotating swirling motion" as required by claim 1.

Even if the swirling motion *primarily* resulted in a recirculation, this recirculation would inevitably cause some mixing. As claim 1 does not require that the swirling motion is *the only and direct* cause for the mixing, even only indirect mixing caused by the swirling motion is encompassed by the wording of claim 1.

Thus, all the features of claims 1 of the main and first auxiliary request are disclosed in D7.

Auxiliary request 2

2. Inventive step

For the following reasons, the subject-matter of claim 1 of this request is rendered obvious by a combination of D7 with D14 (Article 56 EPC).

2.1 The claimed subject-matter relates to a catalytic secondary reforming process for the production of synthesis gas.

2.2 In the respondents' view, D7 is the closest prior art. This was not contested by the appellant. As shown in point 1 and below, D7 relates to the same technical field and has numerous features in common with the claimed subject-matter. Therefore, D7 is indeed a suitable starting point for assessing inventive step.

2.2.1 It is disputed among the parties which features distinguished D7 from the claim 1 at issue.

2.2.2 In addition to the interpretation of features mentioned in point 1, Figure 1 of D7 discloses that the oxygen and hydrocarbon comprising gas flows (10,12) are coaxial and remain separated for an initial portion of the reactor, with the oxygen comprising gas flow (10) being inside and being given a rotating swirling motion around the feed direction. Moreover, the arrows 8 in Figure 1 and the presence of a turbulent flow (column 2, lines 20 to 26, and column 3, lines 8 to 10) indicate that the gas flow has a radial component towards the walls of the reaction chamber.

2.2.3 The appellant holds that, contrary to claim 1, the "second duct" of D7 does not *extend inside* the reaction chamber. Due to the overall downward flow of the gases, oxidant could only be present *below* the tip of duct 10 in Figure 1. The appellant also points to the drawing of D22 where the "combustion zone" only started below the end of the tip.

2.2.4 There is, however, no geometric definition of the "reaction chamber" in the claim 1 at issue defining its boundaries and limiting its dimensions to the region below the end of the tip of duct 10 as shown in Figure 1 of D7, thus excluding the annular section above the tip.

2.2.5 Even if, *arguendo*, it was acknowledged that the "reaction chamber" is limited to the locations where reactions actually take place, this feature would still be anticipated by D7 because of the turbulence (column 2, lines 20 to 26, and column 3, lines 8 to 10; see also arrows 8 in Figure 1 of D7) and the inevitably resulting backmixing/recirculation effects. Moreover, the catalytic bed inevitably provides heat to the portion above the end of the tip 10, namely by radiation, conduction and/or convection. Accordingly, reactions (which do not necessarily involve the presence of a flame) inevitably take place above the end of the tip of duct 10, at least to some extent, and this location would thus form part of the "reaction chamber".

2.2.6 In the appellant's view, backmixing cannot occur in D7 since this would result in pyrolysis and damage the reactor. This view is not shared by the board since the extent of backmixing, while inevitable, is limited by the overall downward flow of the gases.

2.2.7 With regard to D22 as relied upon by the appellant, the drawing is only schematic. The combustion is not necessarily strictly limited to the "combustion zone" between the two limiting horizontal lines (the upper line corresponding to the end of the tip 12). Moreover, contrary to D7, there is not necessarily a turbulent flow in D22.

2.2.8 There is no apparent reason why the second duct 7 in Figure 1 of the patent in suit should *extend inside* the reaction chamber but not conduct 10 of Figure 1 of D7. In both cases, the inner tubes extend inside the reactor vessel. Claim 1 of the patent in suit is silent on any dimensions that might have an influence on the degree of backmixing.

2.2.9 On the other hand, it has not been contested by the respondents that D7 does *not* disclose a "second duct ... comprising an open end diverging towards the walls of said reaction chamber", which is consequently the sole distinguishing feature of claim 1 over D7.

2.3 According to the patent in suit, the problem to be solved is to provide a catalytic secondary reforming process with an efficacious mixing at the entry of the catalytic bed thus achieving a uniform temperature and composition at the entry of the catalytic bed and a uniform degree of conversion and advancement of the partial oxidation reaction (paragraphs [0006, 0009, 0010, 0032, 0033]).

2.4 The proposed solution to this problem is the process of claim 1 involving, amongst other elements, an inner coaxial second duct for a second gas comprising oxygen

with an "open end diverging towards the walls of said reaction chamber".

2.5 It has not been contested that this problem is solved, and there is no reason for the board to take a different stance.

2.6 It remains to be assessed whether it was obvious to solve the technical problem in the claimed manner when starting from D7.

D14 relates to a partial oxidation (POx) process. D14 discloses in Figure 1 an inner coaxial duct (5) for an oxygen comprising gas flow (3) that comprises an open end (expansion cone 5A) diverging towards the walls of the reaction chamber.

According to paragraph [0051], the use of expansion cone 5A promotes "an effective prompt mixing of the hydrocarbons with the free oxygen".

2.7 In the appellant's view, the skilled person would not contemplate D14 when starting from D7 since D7 and D14 relate to different technical fields and no catalyst was used in D14.

The board does not share this view. D7 relates to secondary steam or autothermal catalytic reforming (ATR) (column 1, lines 5 to 9). Both ATR and POx involve the production of a synthesis gas from a hydrocarbon feed and an oxygen containing gas. D7 itself explains that (emphasis added by the board) "[i]n autothermal catalytic reforming, the hydrocarbon feedstock is *partially* combusted with air, oxygen, or oxygen-riched air" (column 1, lines 29 to 30). This document also states that (emphasis added by the board)

"this invention provides an improved process for the preparation of hydrogen and carbon monoxide containing synthesis gas. The process comprises *partial oxidation* of a carbonaceous and steam containing process gas" (column 2, lines 27 to 39).

The skilled person moreover knows that uniform radial temperatures and concentration profiles are beneficial for increasing conversion in all kinds of tubular reactors, not only catalytic reactors.

For these reasons, D7 and D14 relate to at least neighbouring fields, and the skilled person would contemplate D14 when trying to solve the posed problem starting from D7.

Furthermore, because of the suggestion in paragraph [0051] of D14, the skilled person would replace the U-shaped nozzle (2) of the inner duct 10 of D7 with the expansion cone 5A of D14 to solve the posed problem.

Consequently, the subject-matter of claim 1 does not involve an inventive step within the meaning of Article 56 EPC.

2.8 The appellant's arguments to the contrary that the "mixing" of the gas flows was already part of the solution and should not be part of the technical problem to be solved and that the uniform temperature and composition should be used instead are not convincing.

The solution to the posed problem corresponds to the technical feature of an open end of the second duct that diverges towards the walls of the reaction chamber. Hence, the mixing is not the solution to the

technical problem but the effect that results from the distinguishing feature. Consequently, while there should be no pointer to the diverging open end, the mixing in the problem can be mentioned in this case.

2.9 The appellant is also of the opinion that the skilled person would not modify the U-shaped nozzle of D7 since this would go against one of the central objectives of D7, namely the reduction of wear. According to column 3, lines 44 to 51, only the U-shaped burner type of Figure 1 would achieve this. The appellant also refers to column 3, line 15, and claim 5.

However, the *main* objective of D7 is the reduction of soot as indicated in *independent* claim 1 ("Process for *soot-free* preparation of hydrogen and carbon monoxide containing synthesis gas"), and this is achieved by the improved mixing of the reactants ("to obtain a maximum number of mixing points for the process and oxidizer gas"). The reduction of wear is only an *additional* aspect, which is addressed in *dependent* claim 5.

2.10 The appellant further refers to the pre-mixing in Figures 3 and 4 of D14 (see reference numeral 22) that takes place before the reaction between the gases. It argued that D7 and D14 were incompatible since the gases in D7 reacted directly, i.e. without the pre-mixing.

This argument is not shared by the board. Paragraph [0051] of D14 hints at only the expansion cone 5A and not other features. This paragraph refers to the embodiment of Figure 1, which has no pre-mixing zone 22 (contrary to the embodiments of Figures 3 and 4). There is hence no contradiction between D7 and D14 in this regard.

Auxiliary request 3

3. Consideration/admission

The grounds of appeal of the present case and therefore also auxiliary request 3 were submitted before RPBA 2020 came into force. Thus, in accordance with Article 25(2) RPBA 2020, the provisions of Article 12(4) RPBA 2007 continue to apply to this case.

For the following reasons, and in exercising the board's discretion, auxiliary request 3 is not admitted into the current appeal proceedings.

3.1 Article 12(3) RPBA 2020 requires that the grounds of appeal contain a party's complete case and that it should expressly specify, amongst other elements, all the arguments relied upon.

This is not the case here since the grounds of appeal do not indicate the merits of auxiliary request 3, at least with regard to the assessment of inventive step. They do not set out how and why the newly added feature "reaction chamber being defined at a frusto-conical upper end of a substantially cylindrical shell" in claim 1 overcomes the objection under Article 56 EPC. The grounds are, for example, entirely silent on the technical problem to be solved and the reasons why the claimed solution was non obvious.

The grounds of appeal merely allege that none "of the prior art documents (for example D7 or D8) discloses oxidant conduit extending into the frusto-conical part of the shell" (last full paragraph on page 10) without

discussing the disclosure of the prior-art documents in this regard.

The admission of this request would put the board and the respondents in a situation where arguments on inventive step of the auxiliary requests would be presented and discussed for the first time during oral proceedings.

3.2 In particular the claim request should already have been presented and discussed in opposition procedure, as lack of novelty and inventive step were already objected with the grounds for opposition (Article 12(4) RPBA 2007).

3.3 Furthermore, for amended claims to be considered or admitted in appeal proceedings, they must not introduce, on a *prima facie* basis, new objections under the EPC (Case Law of the Boards of Appeal, 9th edition, V.A.4.12.1).

However, the new claims give rise to the following objections on a *prima facie* basis:

(1) The term "substantially" in the expression "substantially cylindrical shell, with a substantially vertical axis" in claim 1 is vague. Yet there are no explanations in the grounds of appeal why claim 1 is nonetheless clear (Article 84 EPC).

(2) The new feature "frusto-conical upper end" in claims 1 and 3 is allegedly based on page 5, lines 17-23, as originally filed.

However, this passage (which refers to the embodiment of Figure 1) also discloses the following features:

- a frusto-conical shape of the lower end
- an upper surface of the catalytic bed in the form of the horizontal "plane B" in Figure 1

However, there are no explanations in the grounds of appeal why the isolation of the "frusto-conical upper end" was allowable and did not result in an intermediate generalisation going beyond the original disclosure (Article 123(2) EPC).

3.4 Thus, according to Article 12(4) RPBA 2007 auxiliary request 3 is not considered or admitted.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated