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D E C I S I O N
of 1 June 2004

Case Number: T 0847/01 - 3.3.1.

Application Number: 92304881.3

Publication Number: 0516441

IPC: C07C 1/04

Language of the proceedings: EN

Title of invention:

Process for the conversion of natural gas into higher hydrocarbons

Patentee:

BP p.l.c.

Opponent:

Sasol Technology Ltd.

Headword:

Gas Conversion/BP

Relevant legal provisions:

EPC Art. 123(2)(3), 54(1)(2), 56

Keyword:

"Amendments: supported by the application as filed (yes) - extension of the protection conferred by the patent as granted (no)"

"Novelty (yes)"

"Inventive step (yes) - non obvious solution"

Decisions cited:

-

Catchword:

-



Case Number: T 0847/01 - 3.3.1.

D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 1 June 2004

Appellant:
(Proprietor of the patent)

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Respondent:
(Opponent)

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Representative:

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Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office posted
4 July 2001 concerning maintenance of European
patent No. 0516441 in amended form.

Composition of the Board:

Chairman: A. J. Nuss
Members: P. F. Ranguis
S. C. Perryman

Summary of Facts and Submissions

I. The Appellant (Proprietor of the patent) lodged an appeal against the decision of the Opposition Division to maintain the European patent 0 629 617 in the form of the first auxiliary request pursuant to Article 102(3) EPC.

II. Claim 1 of the main request before the Opposition Division read as follows:

"1. A process for the conversion of natural gas into higher hydrocarbons, which comprises the following steps:

(i) reacting natural gas with steam in at least one reforming zone containing a reforming catalyst to produce a first product stream containing carbon monoxide, carbon dioxide and hydrogen;

(ii) passing said first product stream, without separating said carbon dioxide, to a Fischer-Tropsch reactor containing a Fischer-Tropsch catalyst which is not cobalt or iron with titanium, zirconium, ruthenium or chromium on a silica or alumina or silica/alumina support, to produce a second product stream including hydrocarbons and carbon dioxide;

(iii) passing said second product stream to a recovery zone where the desired higher hydrocarbon products are recovered, the remaining components of said second product stream forming a gaseous third product stream comprising carbon dioxide;

(iv) passing at least a portion of said third product stream into the reforming zone of process step (i)."

III. The opposition sought revocation of the patent in suit on the ground that its subject-matter lacked novelty or did not involve an inventive step (Article 100(a) EPC). Several documents were cited including:

(1) US-A- 4 833 170

(4) EP-A- 142 887

IV. In its decision, the Opposition Division held that the subject-matter of Claim 1 of the main request (cf. point II above) was anticipated by the disclosure of document (1) and, therefore, this request did not fulfil the requirements of Article 54(1)(2) EPC.

V. Oral proceedings before the Board took place on 1 June 2004. In the appeal proceedings, the Appellant no longer relied upon the set of claims refused by the Opposition Division (cf. point II above) and submitted at the oral proceedings as sole request a set of seven claims. Claim 1, the sole independent claim, read as follows:

"1. A process for the conversion of natural gas into higher hydrocarbons, which comprises the following steps:

(i) reacting natural gas with steam in at least one reforming zone containing a reforming catalyst to produce a first product stream containing carbon monoxide, carbon dioxide and hydrogen;

(ii) passing said first product stream, without separating said carbon dioxide, to a Fischer-Tropsch reactor containing a Fischer-Tropsch catalyst which is cobalt or iron on a titania, ceria, zirconia or zinc

oxide support, to produce a second product stream including hydrocarbons and carbon dioxide;
(iii) passing said second product stream to a recovery zone where the desired higher hydrocarbon products are recovered, the remaining components of said second product stream forming a third product stream comprising carbon dioxide and methane;
(iv) recycling from 50 to 99%vol of the third product stream into the reforming zone of process step (i), such as to give a quantity of carbon dioxide of from 10 to 40%v based on the natural gas feed."

VI. In the written proceedings and during the oral proceedings, the Appellant argued that starting from document (1) as the closest state of the art, the technical problem to be solved was to provide a process for the conversion of natural gas into higher hydrocarbons while maintaining a favourable overall CO:H₂ balance within the whole process. Document (1) excluded the presence of carbon dioxide in the stream fed to the Fischer-Tropsch reactor. Although Document (4) disclosed a process wherein the product stream of the reforming reaction, which was fed to the Fischer-Tropsch reactor, comprised carbon dioxide, that was dependent on the use of very specific cobalt Fischer-Tropsch catalysts. Furthermore, that document warned against the use of other Fischer-Tropsch catalysts due to a loss of activity or stability of those catalysts.

VII. The Respondent (Opponent) did not raise any objection against the present request.

VIII. The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the claims of the sole request submitted at oral proceedings on 1 June 2004.

The Respondent made no request.

IX. At the end of the oral proceedings the decision of the Board was announced.

Reasons for the Decision

1. The appeal is admissible.

2. *Article 123(2)(3) EPC - Amendments*

2.1 The subject-matter of Claim 1 finds support in the application as originally filed (cf. page 2, line 24 to page 3, line 3; page 5, lines 7 to 10; page 5, lines 23 to 25 and page 6, lines 23 to 24). The subject-matter of Claims 2 to 7 corresponds respectively to the subject-matter of Claims 2 to 6 and 9 as originally filed. The Board is, therefore, satisfied that the main request complies with the requirements of Article 123(2) EPC.

2.2 The subject-matter of present Claim 1 recites a list of specific Fischer-Tropsch catalysts (cf. point V above), whereas Claim 1 as granted relates to a general definition of Fischer-Tropsch catalysts provided they are not cobalt or iron with titanium, zirconium, ruthenium or chromium on a silica or alumina or silica/alumina support. In addition, it was specified

that the third product stream comprised carbon dioxide and methane and 50 to 99%vol of the third product stream was recycled into the reforming zone such as to give a quantity of carbon dioxide of from 10 to 40%vol based on the natural gas feed. Those added features represent a restriction with respect to the subject-matter of Claim 1 as granted. The requirement of Article 123(3) EPC is, therefore, met.

3. *Article 54(1)(2) EPC - Novelty*

3.1 A claimed invention lacks novelty unless it includes at least one technical feature which distinguishes it from the state of the art.

3.2 In the present case, it is sufficient to observe that neither document (1) nor document (4) disclose a process for the conversion of natural gas into higher hydrocarbons involving Fischer-Tropsch catalysts as defined in Claim 1 (cf. point V above).

3.3 For this reason, the claimed subject-matter meets the requirements of Article 54(1)(2) EPC.

4. *Article 56 EPC - Inventive step*

4.1 The patent in suit as reflected by Claim 1 of the present request relates to a process for the conversion of natural gas into higher hydrocarbons. This process involves, in particular, reforming in a first step natural gas to produce a first product stream (synthesis gas) containing carbon monoxide, carbon dioxide and hydrogen, converting in a second step the synthesis gas into higher hydrocarbons using a specific

Fischer-Tropsch catalyst, then, in a third step, recycling into the reforming zone a part of the gaseous stream (50 to 99%vol) issuing from the Fischer-Tropsch reactor in order to obtain in the reforming zone a quantity of carbon dioxide of from 10 to 40%v based on the natural gas feed.

4.2 In order to determine the technical problem to be solved by the claimed invention, it is necessary to identify the closest state of the art.

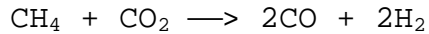
4.2.1 Document (1) discloses a process for the production of heavier hydrocarbons from one or more gaseous light hydrocarbons wherein the ratio of hydrogen to carbon monoxide in the synthesis gas is more efficiently controlled near the optimum ratio (cf. column 2, lines 20 to 27). This process comprises:

- (a) the autothermal reforming of the light hydrocarbons involving partial oxidation with air of the feed gas, followed by the steam reforming of the combusted gas with steam and carbon dioxide to produce a synthesis gas stream containing hydrogen and carbon monoxide in the desired proportion,
- (b) the reaction of the synthesis gas stream in the presence of a hydrocarbon synthesis catalyst containing cobalt to form heavier hydrocarbons and water from the hydrogen and carbon monoxide in the synthesis gas. The catalyst is preferably comprised of cobalt supported on silica, alumina or silica-alumina (cf. column 5, lines 58 to 60),

(c) the separation of the heavier hydrocarbons and water from the hydrocarbon product stream leaving a residue gas stream comprising nitrogen and unreacted hydrogen, carbon monoxide, light hydrocarbons and carbon dioxide. The residue gas stream is subjected to catalytic combustion with additional air to react the oxidizable components therein and form an oxidized product stream comprising carbon dioxide, water vapor and nitrogen. Carbon dioxide is separated from the oxidized stream producing a nitrogen product stream, and at least a portion of the separated carbon dioxide is utilized in the initial production of synthesis gas to control the proportions of hydrogen and carbon monoxide therein and to recycle the carbon in the carbon dioxide (cf. column 2, lines 30 to 62).

The critical issue discussed at length in the written proceedings was whether or not the synthesis gas stream issuing from the step a) contained carbon dioxide. It is true that carbon dioxide is fed to the reforming zone to achieve the steam reforming reaction. This presence of carbon dioxide is even one of the essential features of document (1). However, contrary to the view expressed by the Respondent in the written proceedings, that does not mean that the synthesis gas stream necessarily contains carbon dioxide. Such a finding would be at variance with the disclosure of document (1). Indeed, that document points out that the synthesis gas stream contains hydrogen and carbon monoxide in desired proportion. It is especially mentioned that the recycled carbon dioxide introduced in the reactor 28 reacts with unreacted light

hydrocarbons to produce additional carbon monoxide and hydrogen according to the following reaction:



(cf. column 5, lines 16 to 19 and column 3, lines 57 to 65) and that the resulting synthesis gas stream generated within generator 16 is comprised of hydrogen, carbon monoxide, nitrogen and unreacted light hydrocarbons (cf. column 5, lines 19 to 22). This is, furthermore, confirmed by the Example which states that the synthesis gas from the generator 16 contains hydrogen and carbon monoxide (cf. column 8, lines 8 to 18). In the absence of any material counter-evidence provided by the Respondent, it is to be concluded that the disclosure of document (1) does not teach passing the synthesis gas containing carbon dioxide into the Fischer-Tropsch reactor.

- 4.2.2 Document (4) aims at providing a process for the preparation of C_5^+ hydrocarbon from C_4^- hydrocarbon wherein the carbon dioxide formed in the steam reforming reaction is not separated until after the Fischer-Tropsch hydrocarbon synthesis (cf. page 4, lines 5 to 7 and page 3, lines 8 to 10). This purpose is achieved by a process in which, in the first step C_4^- hydrocarbons are converted by steam reforming into a mixture of carbon monoxide and hydrogen, which mixture is subsequently converted in a second step into a mixture of hydrocarbons consisting substantially of C_5^+ hydrocarbons by contacting it at elevated temperature and pressure with a catalyst comprising 3-60 pbw cobalt and 0.1-100 pbw of at least one other metal chosen from the group formed by zirconium, titanium, ruthenium and

chromium per 100 pbw silica, alumina or silica-alumina, in which the reaction product of the second step is divided into a gaseous fraction substantially consisting of unconverted hydrogen and carbon monoxide, C₄⁻hydrocarbons formed as by-product and carbon dioxide formed as by-product, and a liquid fraction substantially consisting of C₅⁺ hydrocarbons and water and in which the gaseous fraction is recycled to the first step (cf. page 6, line 18 to page 7, line 5).

The difference between the claimed process and that of document (4) resides in that the Fischer-Tropsch hydrocarbon synthesis is carried out in the presence of different catalysts. Furthermore, the quantity of carbon dioxide based on the natural gas feed recycled into the reforming zone is not clearly specified.

- 4.2.3 The Appellant argued that document (1) was to be considered as the closest prior art. However, the process according to document (1) provides that no carbon dioxide is present in the output of the reforming zone to be passed into the Fischer-Tropsch reactor (cf. point 4.2.1 above). In the Board's judgment, this represents an essential difference which disqualifies document (1) as the closest state of the art. Indeed, as explained in the patent in suit, an essential feature of the invention is that the output from the reformer includes carbon dioxide (cf. page 3, line 8). In document (4) however, it is clear that the synthesis gas fed to the hydrocarbon synthesis reactor does contain carbon dioxide (cf. point 4.2.2 above). That feature renders the process of document (4) closer to the claimed invention than is that of document (1).

4.2.4 Since according to the established jurisprudence, the "closest state of the art" is normally a prior art document disclosing subject-matter aiming at the same objective as the claimed invention and having the most relevant technical features in common, it is concluded that document (4) is the closest state of the art for determining the technical problem that the claimed invention addresses.

4.3 According to the patent in suit, in view of document (4), the claimed invention provides an improved natural gas process integrating a reforming process with a Fischer-Tropsch process (cf. page 2, lines 3 and 38). However, there is neither in the patent in suit nor in the opposition or appeal proceedings any evidence substantiating that alleged improvement.

It follows that the technical problem to be solved in view of document (4) can only be seen in the provision of an alternative process for the conversion of natural gas into higher hydrocarbons in the presence of carbon dioxide in the synthesis gas to be reacted.

4.4 In view of the evidence provided by the Appellant in the examining proceedings with the letter dated 18 May 1995, the Board is satisfied that the technical problem defined above is solved by the subject-matter of Claim 1.

4.5 It remains to be decided whether or not it would have been obvious for the person skilled in the art to solve the above technical problem in the claimed way.

4.5.1 The person skilled in the art would have noted that document (4) did not merely disclose cobalt and at least one other metal chosen from the group formed by zirconium, titanium, ruthenium and chromium as specific Fischer-Tropsch catalysts to achieve the Fischer-Tropsch reaction in the presence of carbon dioxide but **made** the satisfactory working of that reaction conditional on the use of such catalysts (cf. page 5, lines 4 to 16). That document indicated, furthermore, that the other Fischer-Tropsch catalysts (which were in that case not specified) suffered a decrease in their activity and a loss of stability upon the Fischer-Tropsch reaction in the presence of carbon dioxide (cf. page 4, lines 22 to 34 and page 5, lines 30 to 34). Although that statement by itself does not suffice to establish that there is a prejudice in the sense of the jurisprudence of the Boards of Appeal against the use of other Fischer-Tropsch catalysts than those expressly mentioned in document (4) to achieve the process, it nevertheless remains that the skilled person is given no indication that such other catalysts might work, either in document (4) or in any other literature put before the Board.

4.5.2 Document (1) cannot add anything relevant in that respect since it does not disclose the catalysts defined in Claim 1 and, furthermore, does not involve the Fischer-Tropsch reaction in the presence of carbon dioxide (cf. point 4.2.1 above).

4.5.3 No information available in the prior art cited are, therefore, liable to direct the skilled person to the use of the catalysts defined in Claim 1. Furthermore, those catalysts are used in combination with specific

conditions for recycling carbon dioxide also not derivable from that prior art. It follows that such a combination of features was not obvious for the skilled person and renders the subject-matter of Claim 1 inventive in the sense of Article 56 EPC. The same applies to dependent Claims 2 to 7 which represent particular embodiments of the subject-matter of Claim 1.

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 maintain the patent on the basis of the claim of the sole request submitted at oral proceedings on 1 June 2004 and a description to be adapted thereto.

The Registrar:

The Chairman:

D. Sauter

A. Nuss