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D E C I S I O N
of 9 March 1995

Case Number: T 0816/93 - 3.3.1

Application Number: 86302363.6

Publication Number: 0199475

IPC: C07C 1/06

Language of the proceedings: EN

Title of invention:
Fischer-Tropsch conversion of synthesis gas to hydrocarbons

Patentee:
The British Petroleum Company p.l.c.

Opponent:
Exxon Research and Engineering Company

Headword:
Fischer-Tropsch conversion/BRITISH PETROLEUM

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes, after amendment)"

Decisions cited:
-

Catchword:
-

Case Number: T 0816/93 - 3.3.1

D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 9 March 1995

Appellant: (Proprietor of the patent)
The British Petroleum Company p.l.c.
Britannic House
Moor Lane
London EC2Y 9BU (GB)

Representative:
Fawcett, Richard Fennelly
BP INTERNATIONAL LIMITED
Patents Division
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 7LN (GB)

Respondent: (Opponent)
Exxon Research and Engineering Company
P.O. Box 390
Florham Park
New Jersey 07932 (US)

Representative:
Somers, Harold Arnold
ESSO Engineering (Europe) Ltd.
Patents & Licences
Mailpoint 72
Esso House
Ermyn Way
Leatherhead
Surrey KT22 8XE (GB)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office pronounced orally on 24 June 1993, with written reasons posted on 16 July 1993, revoking European patent No. 0 199 475 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: R. K. Spangenberg
Members: J. M. Jonk
R. E. Teschemacher

Summary of Facts and Submissions

I. The Appellant (Proprietor of the patent) lodged an appeal against the decision of the Opposition Division by which European patent No. 0 199 475 was revoked in response to an opposition, based on Article 100(a) EPC, which had been filed against the patent as a whole.

The Opposition Division held that the grounds of opposition mentioned in Article 100(a) EPC, in particular lack of novelty with respect to the claims according to the then standing main request and lack of inventive step concerning the then standing auxiliary request, prejudiced the maintenance of the patent, having regard to the following documents:

(18A) US-A-2 738 360, and

(19) D.J. Dwyer et al, "Hydrogenation of CO and CO_2 on Clean Rhodium and Iron foils", Adv. Chem. Ser. 178 (1979), pages 65 to 92.

II. During the appeal proceedings the Board considered the following further documents on its own motion:

(10) EP-A-0 124 999,

(30) US-A-4 298 695, and

(32) EP-A-0 169 743 (Art. 54(3) and (4)).

III. Oral proceedings were held on 9 March 1995, which both parties, after having informed the Board accordingly, did not attend.

IV. Having regard to the reasons of the decision of the first instance and a communication of the Board, the Appellant requested that the decision under appeal be set aside and the patent maintained on the basis of

Claims 1 to 13 (main request) or Claims 1 to 6 (auxiliary request), both sets submitted on 23 February 1995.

V. The Opponent's requests corresponded to those of the Appellant.

VI. Claim 1 according to the main request reads as follows:

"A process for the production of a hydrocarbon product by contacting a gaseous mixture comprising carbon monoxide, hydrogen and ethene with a Fischer-Tropsch catalyst under Fischer-Tropsch conditions characterised in that the Fischer-Tropsch catalyst comprises one or more metals of Group VIII of the Periodic Table of the Elements or molybdenum, tungsten or rhenium, in the form of the elemental metal, an oxide or a sulphide and incorporates a solid acidic component, or comprises an oxide of either zinc, gallium or indium together with a porous crystalline tectometallosilicate, the ethene is present in an amount of from 2 to 15% by volume and the Fischer-Tropsch conditions are a temperature in the range from 175 to 450°C and a pressure in the range from 20 to 100 bar."

VII. The Appellant argued that the cited prior art documents did not give any incentive to the skilled person to perform the Fischer-Tropsch process using ethene containing synthesis gas in combination with an acidic catalyst as specified in the claims of both requests. Moreover, the advantages of obtaining increased productivity and selectivity to C_{5+} hydrocarbons and decreased amounts of undesirable by-products, particularly methane, was indicative of an inventive step.

VIII. The Respondent informed the Board that, having regard to the cited prior art documents, he agreed to the Appellant's submissions and, accordingly, had no objections to raise against the proposed amended claims of either the main request or the auxiliary request.

IX. At the conclusion of the oral proceedings the Board's decision to allow the Appellant's main request was pronounced.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 The amendments to Claim 1 as granted are based on granted Claims 2, 3, 4, 7 and 10 in combination with page 2, lines 40 to 58, and page 3, lines 2 to 5, of the specification of the disputed patent, and are also supported by Claims 3, 4, 7 and 10 in combination with page 2, line 32 to page 3, line 25, and page 3, line 32 to page 4, line 7, of the patent application as filed.

Present Claims 2 to 13 correspond essentially to Claims 5, 6, 8, 9 and 11 to 18 as granted, and are also supported by Claims 5, 6, 8, 9 and 11 to 18 of the originally filed patent application.

Thus, all amendments made according to the main request to the claims as granted comply with the requirements of Article 123 EPC.

2.2 Although both parties have submitted that the subject-matter of the present claims also meets the other requirements of the EPC, the Board can only set aside the decision under appeal and maintain the patent as requested, if it is satisfied that the ground of opposition according to Article 100(a) EPC initially raised by the Respondent does not prejudice the maintenance of the patent as amended.

2.3 After examination of the cited prior art, the Board has reached the conclusion that the subject-matter as defined in all claims is novel because none of the cited documents discloses a Fischer-Tropsch process using an acidic catalyst and an ethene containing synthesis gas.

2.4 The only remaining issue to be dealt with is whether the subject-matter of the present claims involves an inventive step, having regard to the objections raised in the decision under appeal.

2.4.1 The Board considers that documents (10) and (30), which are mentioned in the patent in suit (cf. page 3, lines 2 to 8) with respect to catalysts suitable for use in the claimed process and which disclose the catalysts applied in Examples 1 and 4 of the present patent, represent the closest state of the art. Both documents relate to a process for the conversion of synthesis gas under temperature and pressure conditions and in the presence of an acidic catalyst as indicated in present Claim 1 (cf. document (10), Claims 1 to 3 and 9, page 3, lines 18 to 30, page 6, line 30 to page 7, line 1, Comparative Test 3, the Table on page 11, and page 13, last paragraph; and Document (30), column 1, line 30 to column 2, line 52, column 4, line 20 to column 5, line 4, and column 7, lines 22 to 32).

2.4.2 The Appellant argued that by using Fischer-Tropsch catalysts, such as the catalysts described in documents (10) and (30) and also those disclosed in document (32) (mentioned on page 3, lines 5 to 7, of the patent in suit and representing state of the art in the sense of Article 54(3) and (4) EPC), a high productivity and selectivity to C_{3+} hydrocarbons and a reduced production of methane are not satisfactorily achieved.

2.4.3 Therefore, in the Board's judgment, the technical problem underlying the disputed patent, in the light of the closest state of the art as represented by documents (10) and (30), can be seen in providing a process for the production of a hydrocarbon product by contacting a gaseous mixture comprising carbon monoxide and hydrogen with a Fischer-Tropsch catalyst, e.g. the catalysts described in documents (10) and (30), wherein the productivity and selectivity to C_{3+} hydrocarbons is increased and at the same time the production of methane is decreased (see also the specification of the present patent, page 2, lines 7 to 18).

2.4.4 According to the present Claim 1 this technical problem is essentially solved by contacting a synthesis gas which comprises 2 to 15% by volume of ethene with particular acidic catalysts as defined in the claim.

2.4.5 Having regard to the Examples and Comparison Tests indicated in the patent in suit, the Board considers it plausible that the technical problem as defined above has been solved. Table 4 (cf. Comp. Tests 1, 3 and 4 compared with Examples 1, 3 and 4 respectively) not only shows that by using 9.5% by volume of ethene in the synthesis gas the productivity and selectivity to C_{3+} are increased and the selectivity to methane is decreased, but also that the acidic component of the catalysts provides important additional effects in these respects

[compare the effects of ethene using a $Ru/K/CeO_2$ catalyst, i.e. the effects shown by comparing Comparative Test 2 and Example 2 of the patent in suit (relating to subject-matter no longer claimed), with the effects of ethene using a $Ru/K/CeO_2/H$-MFI catalyst, i.e. the effects shown by comparing Comparative Test 3 and Example 3]. These test-results have never been disputed by the Respondent.

2.4.6 The question now is whether the cited prior art would have suggested to a person skilled in the art to solve the above-indicated technical problem in the proposed way.

2.4.7 As indicated above, documents (10) and (30) - like the claimed process of the disputed patent - are both related to the conversion of synthesis gas into valuable hydrocarbon products under temperature and pressure conditions and in the presence of acidic catalysts falling under the scope of present Claim 1. However, in the Board's judgment, both documents do not give any pointer to the skilled person that the production of C_{3+} hydrocarbons could be further improved and the synthesis of the methane by-product further reduced by including the claimed amount of ethene in the synthesis gas.

2.4.8 Document (32), which is - as indicated above - mentioned in the patent in suit (cf. page 3, lines 5 to 7) and relates to ruthenium/alkali metal/ceria catalysts as applied in Examples 2 and 3 and Comparative Tests 2 and 3 of the granted text of the present patent, concerns state of the art in the sense of Article 54(3) and (4) EPC and is, therefore, not relevant to the examination of inventive step.

2.4.9 Document (18A) discloses the conversion of synthesis gas ($CO+H_2$) in the presence of certain iron catalysts providing an improved yield of higher boiling hydrocarbons and at the same time a reduction of the formation of methane by adding to the synthesis gas acetylene in an amount of 0.5 to 10 % by volume (cf. column 1, lines 32 to 62). Moreover, it describes that part of the acetylene can be replaced by ethene (cf. column 2, lines 10 to 16, and Example 2 using synthesis gas comprising 1% by volume of acetylene and 9% by volume of ethene). However, both the Appellant and the Respondent had observed that this technical teaching only related to the conversion of synthesis gas in the presence of an **alkalised** iron catalyst (cf. column 1, lines 32 to 36, column 2, lines 5 to 9, and the examples), and that, therefore, the skilled person would not have inferred from it that such a beneficial effect of ethene would also be obtainable with other types of Fischer-Tropsch catalysts, such as the **acidic** catalysts mentioned in documents (10) and (30). In the absence of any evidence to the contrary, the Board accepts this point of view. On that basis, there was no reason for the skilled person to combine the technical teaching of document (18A) with that of documents (10) and/or (30). In addition, the fact that after the publication of document (18A) (in the year 1956) numerous efforts to improve the production of valuable higher hydrocarbons and to minimise the formation of methane have rather prompted the development of novel catalysts than attempts to achieve that goal on a technical scale by the addition of ethene to the synthesis gas, in the Board's judgment, confirms the above conclusion that the skilled person would not have considered that the effect of ethene described in document (18A) would be independent from the particular catalyst system used according to that document. Therefore, this document does not give any pointer to the skilled person that the

existing problem could be solved by the combined use of ethene in the gas mixture to be converted and an acidic catalyst as claimed.

2.4.10 Document (19) describes reactions of a gaseous mixture comprising CO, H_2 and ethene in an amount of 2.7 mol % in the presence of a low surface catalyst in the form of an iron foil (giving low conversions) at a temperature of 300°C and a pressure of 6 bar, showing that 80 to 90% of the incorporated ethene reacted, the predominant reaction of the ethene was the hydrogenation to ethane (cf. Figure 13) and approximately only 10% of the added ethene was incorporated into growing hydrocarbon chains (cf. page 84, lines 1 to 9, of the last paragraph and Figure 14). These experimental results would suggest that the straight-chain primary olefins initially produced can undergo readsorption and secondary reactions and that these secondary reactions not only produce the various hydrocarbons associated with the Fischer-Tropsch synthesis but also influence the size of the hydrocarbon chains (cf. page 85, last paragraph).

However, it is noted in this document that by using iron foil as a catalyst instead of a promoted industrial iron catalyst, a quite different product distribution is obtained, namely a distribution containing methane as the major product instead of liquid hydrocarbons (cf. page 84, second paragraph, lines 1 to 11, and Figure 12). This discrepancy is explained by the low surface area of the iron foil catalyst and, consequently, by the low reactivity of this catalyst resulting in extremely low conversions of less than 1% (cf. page 84, second paragraph, lines 12 to 21).

Therefore, having regard to the disclosure of this document as a whole, in the Board's judgment, a person skilled in the art would not have transferred the

teaching of this document with respect to the effect of the addition of ethene to the synthesis gas to Fischer-Tropsch conversions using highly reactive industrial catalysts, such as those described in documents (10) and (30). On the contrary, and in conformity with the unanimous opinion of the Appellant and the Respondent in this respect, the Board infers from the evidence submitted to it that the effects of the addition of ethene strongly depend on the catalyst and cannot be predicted for different types of catalysts. This finding is in the Board's judgment further confirmed by Table 4 of the patent in suit, which shows that by adding ethene in a process using a $Ru/K/CeO_2$ catalyst the total carbon conversion and the selectivity to the C_{3+} hydrocarbons are reduced, whereas the addition of ethene increases both the total carbon conversion and the selectivity to the C_{3+} hydrocarbons if a $Ru/K/CeO_2$/H-MFI catalyst falling under the scope of present Claim 1 is applied. Thus the Board holds that neither document (19) taken alone nor when considered in combination with document (18A) provided a hint to the skilled person that the existing problem could be solved by the claimed process, which comprises - as indicated above - the combined application of ethene and an acidic catalyst, i.e. a type of Fischer-Tropsch catalyst quite different from those described in the above documents.

2.4.11 In conclusion, the Board finds that the process according to Claim 1 involves an inventive step.

Since Claims 2 to 13 relate to preferred embodiments of the process claimed in Claim 1, they are also allowable.

3. The main request being allowable, there is no need to deal with the auxiliary request.

4. The Board observes that the description has not yet been brought into full conformity with the amended claims. However, since the Appellant has already expressed its willingness to perform any necessary amendments if an allowable set of claims were established, the Board has decided to exercise its power under Article 111(1) EPC and to leave the necessary adaptation of the description to the Opposition Division.

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 with Claims 1 to 13 filed on 23 February 1995, as main request, and a description yet to be adapted.

The Registrar: The Chairman:

E. Görgmaier R. K. Spangenberg