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**Datasheet for the decision  
of 6 November 2007**

**Case Number:** T 1262/05 - 3.3.06

**Application Number:** 98950676.1

**Publication Number:** 1025068

**IPC:** C07C 1/20

**Language of the proceedings:** EN

**Title of invention:**

Method for increasing light olefin yield by conversion of a heavy hydrocarbon fraction of a product to light olefins

**Patentee:**

ExxonMobil Chemical Patents Inc.

**Opponent:**

UOP LLC

**Headword:**

Production of light olefins/EXXON

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

Inventive step (no): main and auxiliary requests"

**Decisions cited:**

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**Catchword:**

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Case Number: T 1262/05 - 3.3.06

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.06  
of 6 November 2007

**Appellant:**  
(Opponent)

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**Decision under appeal:**

Interlocutory decision of the Opposition  
Division of the European Patent Office posted  
21 July 2005 concerning maintenance of European  
patent No. 1025068 in amended form.

**Composition of the Board:**

**Chairman:** P.-P. Bracke  
**Members:** G. Dischinger-Höppler  
U. Tronser

## Summary of Facts and Submissions

I. This appeal is from the interlocutory decision of the Opposition Division concerning maintenance of the European patent No. 1 025 068 in amended form on the basis of the then pending second auxiliary request, the independent Claim 1 reading:

"1. A method for increasing light olefin yield in an oxygenate to olefins conversion process, comprising:

contacting an oxygenate feed with catalyst comprising silicoaluminophosphate molecular sieve in a primary reaction zone at a temperature between 250°C and 600°C, thereby forming a product containing a C<sub>2</sub> and C<sub>3</sub> olefin-containing fraction and a C<sub>4+</sub> hydrocarbon-containing fraction; separating the C<sub>4+</sub> hydrocarbon-containing fraction from the C<sub>2</sub> and C<sub>3</sub> olefin-containing fraction; and contacting at least a portion of the separated C<sub>4+</sub> hydrocarbon-containing fraction with the catalyst in the primary reaction zone."

II. A notice of opposition had been filed against the granted patent, wherein the Opponent sought revocation of the patent inter alia on the grounds of Article 100(a) EPC for lack of inventive step (Articles 52(1) and 56 EPC). The opposition was based, amongst others, on the following documents

D1 GB-A-2 171 718,

D2 US-A-4 677 243 and

D3 US-A-4 527 001.

III. In its decision, the Opposition Division held that the subject-matter claimed in accordance with the second auxiliary request fulfilled the requirements of the EPC. The higher ranking requests were not allowed for the reason that Claim 4 thereof did not meet the requirements of Article 56 EPC.

IV. This decision was appealed by the Opponent, now Appellant.

The Patent Proprietor, now Respondent, maintained the claims held allowable by the Opposition Division as its main request.

V. Upon requests made by both parties, oral proceedings before the Board were held on 6 November 2007, in the course of which the Respondent filed an amended set of claims in an auxiliary request.

Claim 1 of this auxiliary request differs from Claim 1 of the main request by introducing the feature "along with additional oxygenate feed" between the terms "separated C<sub>4+</sub> hydrocarbon-containing fraction" and "with the catalyst".

VI. The Appellant objected to the amendment made in Claim 1 of the auxiliary request under Articles 123(2) and (3) EPC and submitted that the claimed subject-matter of both requests was not inventive over the prior art disclosed in document D1 in combination with the disclosure of documents D2 and D3. This was due to the fact that the subject-matter of Claim 1 differed from the prior art disclosed in document D1 only in that

another dual-functional catalyst was used, namely silicoaluminophosphate molecular sieve (SAPO) instead of dealuminated mordenite but no evidence was on file showing that a particular effect was obtained by that difference. However, it was known from document D2 that SAPO was a suitable catalyst in the catalytic conversion process of oxygenates into light olefins (OTO process) and from document D3 that SAPO was also suitable for conversion of butene into light olefins. Lack of inventive step resulted also in view of document D2 as the starting point when combined with the teaching of document D1 that recycling of higher olefins would increase the yield in propylene.

- VII. The Respondent, orally and in writing, submitted in essence that the examples of the patent in suit showed a surprising increase in the yield of light olefins if 1-butene and methanol were co-fed in accordance with Claim 1 as compared with separately feeding 1-butene and methanol.

Document D1 did not disclose the closest prior art since it pertained to the use of a different catalyst. If document D1 was still used as the starting point, a person skilled in the art would not consider documents D2 and D3 since they related to a different catalyst, namely SAPO instead of dealuminated mordenite and since it was not possible for a skilled person to predict the effect of a C<sub>4+</sub> hydrocarbon recycle on ethylene and propylene yields if the process of document D1 was catalysed with SAPO.

Document D2 contained the closest prior art since it related to an OTO process using SAPO as the catalyst.

The process disclosed therein differed from the claimed subject-matter in that no C<sub>4+</sub> fraction was separated from a C<sub>2</sub>/C<sub>3</sub> fraction and then at least partially recycled to the catalyst in the reaction zone and in that no C<sub>4+</sub> free C<sub>2</sub>/C<sub>3</sub> fraction was obtained. However, in order to increase the yield in ethylene and propylene, a skilled person would not consider document D1 due to the different catalyst used therein.

VIII. The Appellant requested that the decision under appeal be set aside and the patent be revoked.

The Respondent requested that the appeal be dismissed or, alternatively, that the patent be maintained on the basis of the set of claims submitted during oral proceedings as an auxiliary request.

## **Reasons for the Decision**

### 1. *Main Request*

The only point at issue regarding the main request is whether or not the subject-matter claimed therein is based on an inventive step.

1.1 The patent in suit is directed to a method for increasing the yield of light olefins, defined as ethylene and propylene, in an OTO process by recycling the heavy hydrocarbons produced during the conversion and after removing the light olefins. In particular, the patent in suit relates to a method wherein an oxygenate feed is contacted in a reactor with a SAPO catalyst under conditions effective to form a product

containing light olefins, specifically at a temperature between 250°C and 600°C. This product is separated into a fraction containing said light olefins and a heavy hydrocarbon-containing fraction and the heavy hydrocarbon-containing fraction is recycled to the reactor to convert at least a portion of the heavy hydrocarbons to light olefins (Claim 1, page 2, paragraphs [0001], [0002] and [0007]).

It is explained in the description of the patent in suit that light olefins, in particular ethylene and propylene, serve as feed for the production of numerous chemicals. As an alternative to the expensive traditional production of light olefins by petroleum cracking, production from oxygenates is said to be possible. However, due to the high demand, it was still necessary to provide new methods for increasing the yield of light olefin products and reduce the yield of unwanted products, such as hydrocarbons having molecular weights heavier than propane (page 2, paragraphs [0002] to [0004]).

Hence, the technical problem the patent in suit seeks to solve by the claimed subject-matter consists in the provision of an OTO process at increased yields of light olefins, i.e. ethylene and propylene.

- 1.2 There was a dispute between the parties whether document D1 (Appellant) or document D2 (Respondent) pertained to the closest prior art.

1.2.1 Document D1 relates to the manufacturing of light olefins, in particular propylene which is identified as one of the best known starting materials in the chemical industry (page 1, lines 5 to 8 and 28 to 30).

Specifically, document D1 discloses an OTO process wherein methanol and/or dimethyl ether are used as the oxygenate and dealuminated mordenite of particular characteristics (Si/Al ratio, Na<sub>2</sub>O content, specific surface area, pore diameter and pore volume) is used as the catalyst. In this process, the oxygenate together with a diluent is contacted in a reactor with the catalyst at a temperature of 300°C to 650°C to produce olefins. Thereafter, the olefins are separated from the reactant and the diluent and fractionated so as to recover a cut of high C<sub>2</sub>/C<sub>3</sub> olefinic hydrocarbon content and a cut containing a major part of higher olefins having at least 4 carbon atoms. At least a part of the higher olefins is then recycled to the reactor input, thereby increasing the yield in propylene noticeably (Claim 1, page 2, lines 9 to 12 and 17 to 28).

As a consequence, document D1 pertains to a similar purpose as the patent in suit, namely to the purpose of increasing the yields in propylene.

Considering that the presence of a diluent is not excluded in the claimed process (page 4, lines 5 to 6), the process of document D1 differs from the claimed one only in that another catalyst is used, namely a particular dealuminated mordenite instead of a SAPO catalyst. This was agreed by both parties.



1.2.2 The gist of document D2 consists in the finding that SAPO catalysts are particularly suitable in the OTO process (column 1, line 55 to column 2, line 14, column 3, lines 60 to 68 and column 5, lines 47 to 56). However, document D2 is not concerned with the problem of increasing specifically the yield in ethylene and/or propylene.

In particular, document D2 pertains to the production of olefins having up to 4 carbon atoms (column 1, lines 11 to 16 and column 5, lines 59 to 68). The feed is an oxygenate in the sense of the patent in suit (D2, Claim 19 and column 6, lines 48 to 66; patent in suit, paragraphs [0017] and [0018]), such as methanol and dimethyl ether (Examples 1 to 10) and the catalyst is a SAPO catalyst (Claim 1). The process consists in contacting in a reactor the oxygenate together with a stream of diluent with the catalyst at a temperature between 250°C and 600°C (Claim 22) and collecting the liquid and gaseous effluents (column 51, lines 33 to 40) which contain the light olefins and other hydrocarbons (Examples).

It is apparent and was agreed by the parties that the process of document D2 differs from the claimed one in that

- no C<sub>4+</sub> hydrocarbon-containing fraction is separated from a fraction containing C<sub>2</sub> and C<sub>3</sub> olefins;
- no C<sub>4+</sub> hydrocarbon-containing fraction is recycled to the catalyst in the reaction zone; and

- no C<sub>2</sub> and C<sub>3</sub> olefins-containing fraction freed from C<sub>4+</sub> hydrocarbons is obtained as the product.

- 1.2.3 According to the Case Law of the Boards of Appeal of the European Patent Office (see I.D.3.1), the most suitable starting point for the assessment of inventive step is normally a prior art document disclosing subject-matter conceived for the same or a similar purpose as the claimed invention and having the most relevant technical features in common, in the sense that a minimum of structural modifications is required.
- 1.2.4 Comparing the disclosures of documents D1 and D2 (points 1.2.1 and 1.2.2 above), the Board observes that a purpose similar to that for which the claimed invention is conceived is presented in document D1 only. Moreover, the process disclosed in that document differs from the claimed one only with regard to one essential technical feature, namely the catalyst used, whereas three essential technical features are missing in the process disclosed in document D2.
- 1.2.5 The Respondent argued that in a case where an invention related to an improvement of a catalytic process, the closest state of the art was a document which discloses a process using the same starting material and the same catalyst. In the process disclosed in document D1 a different catalyst was used. Therefore, document D2 represented the closest prior art.

In the Respondent's opinion, the above mentioned Case Law did not apply in the particular technical field of catalytic processes since it was impossible for a

skilled person to predict the effects when different catalysts are used.

- 1.2.6 However, the Respondent did not give any legal basis for these assumptions. Nor is the Board aware of any case law indicating that different criteria apply generally in the field of catalytic processes.

The Board has, therefore, no reason to deviate from the established case law and concludes that the disclosure of document D1 is the most suitable starting point for the assessment of inventive step of the claimed invention.

- 1.3 It is undisputed that no evidence is on file showing by comparison that the claimed process using SAPO as catalyst provides any advantage or effect over that disclosed in document D1 where dealuminated mordenite is used as the catalyst.

The Respondent argued, however, that the technical problem actually solved by the claimed invention in view of the disclosure of document D1 consisted in the provision of a process wherein more ethylene was formed since it was evident from the examples given in document D1 and in the patent in suit that the weight ratio of ethylene to propylene in the product obtained was about 1 : 1 (45.72 wt% : 41.46 wt%) when SAPO was used as the catalyst whereas it was about 1 : 20 (0.66 wt% : 12.09 wt%) when dealuminated mordenite was used.

- 1.4 The Board has strong doubts that the examples of the patent in suit are comparable with those in document D1 since they are conducted under different conditions.

However, the Board accepts this argument in the Respondent's favour because it is known in the art that the composition of a product derived from a particular process may depend on the catalyst used, hence a different ratio of ethylene to propylene may be obtained in an OTO process depending on the catalyst only (see D2, column 1, line 63 to column 2, line 21).

The Board agrees, therefore, with the Respondent that the technical problem solved by the claimed subject-matter over the disclosure of document D1 can be seen as providing a process forming higher amounts of ethylene.

- 1.5 It remains to be decided whether, in view of the available prior art documents, it was obvious for someone skilled in the art to solve the above stated technical problem by the means claimed, namely by using in the process disclosed in document D1 a SAPO catalyst instead of the particular dealuminated mordenite.
- 1.6 Document D1 does not contain any information as to how the ratio of the yields of ethylene and propylene in the product could be shifted towards an increase of the yield in ethylene.

As already indicated above, it is, however, known from document D2 that product ratios from an OTO process are tied to the catalyst used (column 1, lines 63 to 66). Specifically, it can be seen from the examples given in document D2 which all use SAPO catalysts in the OTO process that the products contain considerably higher amounts of ethylene when compared with the products obtained in the examples of document D1. Thus, it is

shown e.g. in Example 1 of document D2 that a product is obtained containing ethylene and propylene in molar ratio of between 0.8 and 2.3 (Table I-A). Considering the molecular weight of ethylene and propylene, this translates into a weight ratio of about 0.5 : 1 to 1.5 : 1, hence a ratio in the order obtained in the patent in suit if the oxygenate is methanol alone as an example of a process where no C<sub>4+</sub> fraction is separated and recycled (Example I: weight ratio ethylene : propylene is 51.06 : 34.19).

The Board is well aware of the fact that the examples of the patent in suit are not directly comparable with those of document D2 since they are conducted under different process conditions.

However, since it is taught in document D2 that different ratios of ethylene to propylene may be obtained in an OTO process depending on the catalyst only (see D2, column 1, line 63 to column 2, line 21), the Board holds that a skilled person seeking to increase the proportion of ethylene in the product obtained according to the process of document D1 would try a catalyst which already proved to be suitable to provide such a product. Therefore, he would try the SAPO catalyst used in document D2 in the process of document D1, even if the effect is not clearly predictable.

The Board further realises that the process of document D2 is different to the claimed one in that it does not include the steps required in accordance with the claimed process of separating a C<sub>4+</sub> fraction from a C<sub>2</sub>/C<sub>3</sub>

fraction, recycling at least apart of that C<sub>4+</sub> fraction and recovering a C<sub>4+</sub> free C<sub>2</sub>/C<sub>3</sub> fraction.

The Respondent argued in this respect that the catalysts used in documents D1 and D2 had completely different properties. In particular, the pore diameter in a SAPO catalyst was only up to 10 Å whereas the catalyst used in the process of document D1 had pores predominantly greater than 10 nm in diameter. Therefore, a person skilled in the art would not consider both catalysts for the same purpose.

However, it is known from document D3 that SAPO is also suitable for interconversion of light olefins, including conversion of butenes into ethylene and propylene (column 2, lines 55 to 63, Example 3 and Table III). Thus, SAPO is not only known to be suitable for converting oxygenates into olefins but also for interconverting the latter.

Therefore, the Board does not see any existing prejudice against the recycling of a C<sub>4+</sub> fraction and contacting it with the SAPO catalyst.

- 1.7 The Board concludes, therefore, that using a SAPO catalyst as disclosed in documents D2 and D3 in the process disclosed in document D1 is one option which a person skilled would try in order to shift the ratio of yields of ethylene and propylene towards an increase of the yield in ethylene.

- 1.8 For these reasons, the Board finds that the subject-matter of Claim 1 of the main request is not based on an inventive step and does not comply with the requirements of Articles 52(1) and 56 EPC.
2. No other result would be obtained, if - in accordance with the Respondent's view - document D2 was used as the starting point.
- 2.1 As pointed out above under point 1.2.2, the subject-matter of Claim 1 differs from the process disclosed in document D2 in that
- the C<sub>4+</sub> hydrocarbon-containing fraction is separated from a fraction containing C<sub>2</sub> and C<sub>3</sub> olefins;
  - the C<sub>4+</sub> hydrocarbon-containing fraction is recycled to the catalyst in the reaction zone; and
  - a C<sub>2</sub> and C<sub>3</sub> olefins-containing fraction freed from C<sub>4+</sub> hydrocarbons is obtained as the product.
- 2.2 The Respondent argued that an unexpected improvement of the yield of ethylene and propylene was achieved by the claimed process as compared with that disclosed in document D2. This was apparent from Example I of the patent in suit.

The Board observes again that it is doubtful whether the conversion of methanol conducted in accordance with Example I of the patent in suit is representative for the process disclosed in document D2, accepts, however, in favour of the Respondent that the technical effect

obtained by the claimed process in view of document D1 may be seen in that the amount of light olefins (ethylene and propylene) in the product is increased.

However, considering the teaching of document D1 that the yield of propylene may be increased if the separated C<sub>4+</sub> hydrocarbon-containing fraction is recycled to the catalyst (point 1.2.1 above) and considering further the teaching of document D3 that butenes may be converted into ethylene and propylene over a SAPO catalyst (point 1.6 above), a skilled person would expect that the yields in light olefins may also be increased if in the process of document D2 the C<sub>4+</sub> hydrocarbon-containing fraction was separated from a fraction containing C<sub>2</sub> and C<sub>3</sub> olefins and recycled to the catalyst.

The Board concludes, therefore, that it was obvious for those skilled in the art to recycle in the process of document D2 a C<sub>4+</sub> hydrocarbon-containing fraction in order to obtain a higher yield in light olefins.

### 3. *Auxiliary requests*

3.1 The amendment made to Claim 1 of the auxiliary request (see point V above) has the effect that Claim 1 is now restricted to an embodiment where the separated C<sub>4+</sub> hydrocarbon-containing fraction is necessarily contacted with the catalyst together with additional oxygenate feed.

3.2 However, this amendment does not imply subject-matter on which an inventive step could be based since the recycling of the C<sub>4+</sub> hydrocarbon-containing fraction to



the reactor input where it is jointly contacted with the catalyst together with the methanol is inherent in the process disclosed in document D1 (Claim 1, page 2, lines 24 to 26 and Examples).

Consequently, the reasoning given with respect to Claim 1 of the main request applies mutatis mutandis to Claim 1 of the auxiliary request.

3.3 In view of this finding of lack of inventive step, it is not necessary in the present case to decide on the Appellant's objections under Articles 123(2) and (3) EPC.

4. Since both of the Respondent's requests fail, the patent has to be revoked.

## **Order**

### **For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

The Chairman:

G. Rauh

P.-P Bracke