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**Datasheet for the decision
of 7 July 2023**

Case Number: T 0208/21 - 3.3.09

Application Number: 16862666.1

Publication Number: 3371138

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C07C5/373, C07C13/10,
C07C13/12, C07C13/15, B01J29/44

Language of the proceedings: EN

Title of invention:

PROCESS FOR CONVERSION OF ACYCLIC C5 COMPOUNDS TO CYCLIC C5
COMPOUNDS AND CATALYST COMPOSITION FOR USE THEREIN

Applicant:

ExxonMobil Chemical Patents Inc.

Headword:

Process for conversion of acyclic C5 compounds to cyclic C5
compounds/EXXONMOBIL

Relevant legal provisions:

EPC Art. 54(1), 56, 111(1), 123(2)
RPBA 2020 Art. 13(2)

Keyword:

Novelty - (yes)

Inventive step - (yes)

Amendment after summons - exceptional circumstances (yes)

Decisions cited:

T 0032/16



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Case Number: T 0208/21 - 3.3.09

D E C I S I O N
of Technical Board of Appeal 3.3.09
of 7 July 2023

Appellant: ExxonMobil Chemical Patents Inc.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted on 19 October 2020
refusing European patent application No.
16862666.1 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman A. Veronese
Members: C. Meiners
F. Blumer

Summary of Facts and Submissions

- I. The present decision concerns the appeal filed by the applicant (appellant) against the examining division's decision to refuse European patent application No. 16862666.1 (hereinafter "the application").
- II. That decision was taken on the basis of the state of the file by reference to the communication from the examining division pursuant to Article 94(3) EPC dated 2 April 2020. In its decision, the examining division found that the application did not meet the requirements of the EPC. In particular, the examining division concluded that none of the requests then on file met the requirement of Article 56 EPC.
- III. The following documents were cited in the examination proceedings:
- D1 US 4 886 926 A (DESSAU RALPH M [US] ET AL)
12 December 1989
 - D2 WO 89/04818 A1 (MOBIL OIL CORP [US]) 1 June 1989
 - D3 DE 25 35 809 A1 (SHELL INT RESEARCH)
4 March 1976
 - D4 US 2 438 400 A (HETZEL STANFORD J ET AL)
23 March 1948
 - D5 US 2 438 404 A (HETZEL STANFORD J ET AL)
23 March 1948
 - D6 V. SH. FELDBLYUM et al., "Cyclization and dehydrocyclization of C5 hydrocarbons over platinum nanocatalysts and in the presence of hydrogen sulfide", DOKLADY. CHEMISTRY, vol. 424, No. 2, February 2009 (2009-02), pages 27-30
 - D7 Y. ZHANG et al., "Sn-Modified ZSM-5 As Support for Platinum Catalyst in Propane

Dehydrogenation", INDUSTRIAL & ENGINEERING
CHEMISTRY RESEARCH, vol. 50, No. 13,
6 July 2011, pages 7896-7902

D8 S. VAEZIFAR et al.: "Dehydrogenation of
isobutane over Sn/Pt/Na-ZSM-5 catalysts: The
effect of SiO₂/Al₂O₃ ratio, amount and
distribution of Pt nanoparticles on the
catalytic behavior", KOREAN JOURNAL OF CHEMICAL
ENGINEERING, vol. 28, No. 2, February 2011,
pages 370-377

D9 US 4 927 525 A (CHU YUNG F [US]) 22 May 1990

- IV. With its statement of grounds of appeal, the appellant filed a main request (filed as "Set X") and auxiliary requests 1 to 7 (filed as "Set A" to "Set G").
- V. In a communication pursuant to Article 15(1) RPBA 2020 ("the communication"), the Board expressed the preliminary opinion that none of the claim requests pending at that time met the requirement of Article 56 EPC and that the dismissal of the appeal would be the likely outcome of the appeal proceedings.
- VI. With a letter dated 6 June 2023, the appellant made the claim request labelled "Set C" (previously re-filed with the statement of grounds of appeal) its new main request and filed auxiliary requests 1 to 4 ("Set C-1", "Set H", "Set I" and "Set K", in this order), thereby requesting that the auxiliary requests be admitted into the proceedings.
- VII. Together with its submission filed on 6 July 2023, the appellant submitted the document US 3,702,886 A, which is referred to in paragraph [0093] of the application as published (WO 2017/078896 A2) as well as in paragraph 3.6 of the Board's communication.

VIII. Oral proceedings were held before the Board. In the course of the oral proceedings, the appellant made auxiliary request 4 (labelled as "Set K"), filed on 6 June 2023, its sole claim request and withdrew all other claim requests then on file. The board concluded that the subject-matter of auxiliary request 4 / Set K was allowable.

IX. Claim 1 of Set K (sole claim request on file) reads:

"A process for conversion of n-pentane to a product comprising cyclopentadiene, said process comprising the steps of contacting said feedstock and optionally hydrogen under acyclic C₅ conversion conditions in the presence of a catalyst composition to form said product, wherein said catalyst composition consists of a microporous crystalline aluminosilicate, namely ZSM-5, a Group 10 metal, in combination with a Group 1 alkali metal and/or a Group 2 alkaline earth metal and, optionally, a Group 11 metal, wherein said ZSM-5 has a SiO₂/Al₂O₃ molar ratio in the range of 50 to 500, and wherein said Group 10 metal is platinum, and said Group 11 metal is copper or silver."

X. The appellant's arguments, where relevant to the present decision, can be summarised as follows:

Auxiliary request 4 ("Set K") should be admitted into the proceedings. This request met the requirements of Articles 123(2), 84, 54, and 56 EPC.

The additional experiments as detailed in the statement of grounds of appeal demonstrated that the prior-art Dessau catalysts were much less active in converting n-pentane to cyclic C₅ compounds than the claimed

catalysts under comparable process conditions. The prior-art catalysts deactivated at an unacceptable rate. The Pt/Sn-ZSM-5 catalyst of Example 1 of D1 was isostructural to ZSM-5 but was different from it.

Even if considering the objective technical problem in view of D1 or D2 to be the provision of an alternative (process), the claimed subject-matter was non-obvious to a skilled person. Both the increase of the aluminium content of the crystalline microporous material from less than 0.1 wt.% to about 0.2 wt.% or higher and the replacement of a tin ZSM-5 catalyst with a ZSM-5 catalyst went against the explicit teaching of D1 and D2. Hence, the prior art taught away from the subject-matter of claim set K, which thus met the requirement of Article 56 EPC.

XI. Final requests

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claim set K (claims 1 to 7), filed with its letter dated 6 June 2023.

Reasons for the Decision

1. *Admittance of claim set K (sole request)*

1.1 The filing of claim set K was occasioned by objections detailed for the first time in the Board's communication in points 3.4 and 3.8. When assessing inventive step, the Board had expressed the preliminary opinion that:

- the alleged improvements in catalytic activity had only been shown for the conversion of n-pentane to cyclopentadiene and that,

- due to the open wording of claim 1 of the previous requests, claim 1 encompassed catalysts including ZSM-5 zeolites comprising tin and/or other metals not specifically recited in that claim.

Whilst none of the requests submitted in the examination proceedings contained the amendments made in claim set K, the filing thereof can be regarded as a direct reaction to the objections set out for the first time in the Board's communication. Consequently, exceptional circumstances justified by cogent reasons apply in the present case. Furthermore, the Board held that claim set K suitably addressed the inventive-step objections raised by it and did not give rise to new objections.

1.2 Hence, although claim set K had been filed after notification of the summons, the Board took this request into account (Article 13(2) RPBA 2020).

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

2.1 Claim 1 is based on original claim 4, referring back to original claim 1, but the C₅ feedstock has been restricted to n-pentane (see, e.g., paragraphs [0070], [0083], [0084] and examples of the application as filed), and in which it has been specified that the product comprises cyclopentadiene instead of employing the generic term "cyclic C₅ compounds" as used in original claim 1 (see, e.g., paragraphs [0083], [0084] and examples as filed). Furthermore, in all the examples ZSM-5 is used as the microporous crystalline

aluminosilicate. The preference for ZSM-5 is also disclosed in paragraph [0092] of the application as filed. The preferred range for the molar ratio of the $\text{SiO}_2/\text{Al}_2\text{O}_3$ of 50 to 1000 in the microporous crystalline aluminosilicate, disclosed in paragraphs [0019] and [0095] as filed, has been narrowed to an upper endpoint of 500, also explicitly mentioned in paragraph [0095]. The chosen range thus corresponds to the range supported by the examples of the application (namely from 50 to about 500 - see Examples 1 to 8).

Paragraph [0157] of the application as filed discloses, *inter alia*, that a composition comprising a group of elements can equally consist of said elements. The limitation of the catalyst composition to the elements/components as recited in claim 1 (with the alkali and/or alkaline earth metal optionally being present as an oxide - see claim 4) is also supported by the examples. The latter describe the use of the (reduced) catalyst compositions for the conversion of n-pentane to a product comprising cyclopentadiene. Hence, there is a pointer to the feature combination of claim 1 in the original application documents.

2.2 Claims 2 to 6 correspond to original claims 3, 19, and 6 to 8, respectively. The narrower molar ratio of $\text{SiO}_2/\text{Al}_2\text{O}_3$ specified in claim 7 finds its basis in paragraph [0095] of the application as originally filed.

2.3 Thus, the subject-matter of claims 1 to 7 meets the requirement of Article 123(2) EPC.

3. *Novelty (Article 54 EPC)*

3.1 No novelty objections were raised by the examining division in the examination proceedings in relation to

the cited documents and the Board does not see any reason to raise any novelty objection of its own volition.

3.2 None of the cited documents discloses the conversion of n-pentane to a product comprising cyclopentadiene, using a ZSM-5 based catalyst composition limited to ingredients/components as called for in claim 1 that have a molar ratio of $\text{SiO}_2/\text{Al}_2\text{O}_3$ of 50 to 500 in the ZSM-5. Hence, the subject-matter of claims 1 to 7 is novel in view of the cited prior art and thus meets the requirement of Article 54(1) EPC.

4. *Inventive step (Article 56 EPC)*

4.1 The application

The application discloses a process for the conversion of n-pentane to a product comprising cyclopentadiene, using a catalyst composition consisting of the components as specified in claim 1, including ZSM-5. The Board takes the view that the wording of claim 1 excludes the presence of further metal species (such as tin) in the catalyst composition. Such additional metal species are also excluded from the "crystal framework" (see point 9.2 of the appellant's submission of 6 June 2023 in this regard). This limitation of the metals to silicon and aluminium, making up - together with oxygen - the "crystal framework" of ZSM-5, is in line with the usual understanding of the terms "aluminosilicate" and "ZSM-5" as an aluminosilicate having a specific crystal structure.

4.2 Closest prior art

In its communication dated 2 April 2020, which formed the basis for the decision under appeal, the examining division considered that document D1, or alternatively document D2, constituted the closest prior art for the claimed subject-matter. In particular, Example 1 of D1 and Example 39 of D2 were each considered as the starting point for the discussion. This choice was not disputed by the appellant. These documents relate to the provision of, *inter alia*, cyclopentadiene, by means of dehydrocyclisation of n-pentane in the presence of a catalyst composition comprising platinum (a Group 10 metal) and a zeolite containing tin and sodium, designated "Pt/Sn-ZSM-5". The Board sees no reason to diverge from this choice of closest prior art.

4.3 Distinguishing features

4.3.1 Firstly, the subject-matter of claim 1 of claim set K differs from the mentioned embodiments of documents D1 and D2 in the ratio of silica to alumina. In Example 1 of D1, this ratio exceeds the upper end-point value of 500 by far (see the appellant's corresponding calculation in section 8.1 of its statement of grounds of appeal, referring to a molar ratio of silica to alumina ratio of 3154). This holds equally true for Example 39 of D2, using the same catalyst.

4.3.2 Secondly, the ZSM-5 zeolites of the aforementioned examples of D1 and D2 contain tin (which belongs to Group 14 of the periodic table), in addition to platinum (which belongs to Group 10) and sodium (which belongs to Group 1). Claim 1 mentions neither tin nor Group 14. As set out above, the claimed catalyst composition consists of the components stipulated in

claim 1 and does not comprise other metals, such as tin, which are not recited in that claim. Hence, the presence of tin in the zeolite materials of D1 and D2 constitutes a second difference in relation to the subject-matter of claim 1.

4.4 Technical effect and objective technical problem

4.4.1 The data submitted in section 7 of the appellant's letter dated 6 June 2023 show that catalysts according to claim 1 induce a significant increase in the rate of dehydrocyclisation of n-pentane to a product comprising cyclopentadiene, when compared with a tin-containing "Dessau catalyst" as described in D1 and D2, under identical reaction conditions. Furthermore, the catalysts according to the invention are subject to lower deactivation rates.

4.4.2 Hence, the objective technical problem is to provide an improved process for the conversion of n-pentane to a product comprising cyclopentadiene. There is no evidence that this problem is not solved across the entire scope claimed.

4.5 Obviousness

4.5.1 Neither D1 nor D2 provides any incentive to modify the tin-modified zeolitic catalysts employed therein or to replace them with the those claimed. Furthermore, neither D1 and D2 nor the other cited documents contain any technical teaching that using a catalyst composition comprising platinum and a "conventional" ZSM-5 zeolite as called for in claim 1 and working within a molar ratio of silica to alumina as called for in claim 1 would bring about the aforementioned improvements in catalytic activity.

4.5.2 Even if considering the objective technical problem to be the provision of alternative processes, the following considerations would apply: D1 and D2 require the presence of further metals in the dehydrogenation catalyst compositions described therein. The presence of these metals is excluded from the scope of claim 1, e.g. tin (see claim 1 and Example 1 of D1; claim 1 and Examples 36 and 39 of D2). Furthermore, the catalysts of D1 and D2 typically comprise much higher molar ratios of silica to alumina than called for in claim 1.

Hence, D1 and D2 teach away from the subject-matter of claim 1, which - for this reason alone - is thus non-obvious to a skilled person in view of D1 or D2 as the closest prior art.

4.5.3 Consequently, the subject-matter of claim 1 is not obvious to a skilled person and therefore meets the requirement of Article 56 EPC. This conclusion applies equally to the subject-matter of dependent claims 2 to 7, which is more limited in scope.

5. *Remittal for adaptation of the description*

5.1 Article 11 RPBA 2020 only applies to cases that are remitted "for further prosecution". In particular, it does not apply to cases that are remitted with an order by the Board to grant a patent or to maintain a patent in amended form, be it with or without adaptation of the description (see Case Law of the Boards of Appeal, 10th edition, 2022, V.A.9.9; T 32/16, Reasons 5).

5.2 In the case in hand, the required amendments to the description were seen to be of not inconsiderable scope. Under these circumstances, the Board thus

decided to remit the case to the opposition division under Article 111(1) EPC for the description to be adapted to the claims that were found to be allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 7 of the main request (sole request), filed as claim set K with letter dated 6 June 2023, and a description adapted thereto.

The Registrar:

The Chairman:



M. Schalow

A. Veronese

Decision electronically authenticated