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**Datasheet for the decision  
of 9 February 2021**

**Case Number:** T 2392/16 - 3.3.06

**Application Number:** 09777387.3

**Publication Number:** 2334757

**IPC:** C10G3/00, C10G45/02, C10G45/58

**Language of the proceedings:** EN

**Title of invention:**  
Hydroconversion process and catalyst

**Patent Proprietor:**  
Haldor Topsøe A/S

**Opponent:**  
Neste Oil Oyj

**Headword:**  
Fuel from renewable organic material/HALDOR TOPSØE

**Relevant legal provisions:**  
EPC Art. 54, 56, 83, 123(2), 123(3)  
RPBA 2020 Art. 13(2)

**Keyword:**

Admissibility of the new main request filed during oral proceedings (yes) - reaction to an objection raised by the board for the first time during oral proceedings

Amendments - broadening of claim - (no)

Added subject-matter - (no)

Sufficiency of disclosure - (yes)

Novelty - (yes)

Inventive step - (yes)

**Decisions cited:**

**Catchword:**



**Beschwerdekammern**  
**Boards of Appeal**  
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Case Number: T 2392/16 - 3.3.06

**D E C I S I O N**  
**of Technical Board of Appeal 3.3.06**  
**of 9 February 2021**

**Appellant:** Neste Oil Oyj  
(Opponent) Keilaranta 21  
02150 Espoo (FI)

**Representative:** Zacco Denmark A/S  
Arne Jacobsens Allé 15  
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**Respondent:** Haldor Topsøe A/S  
(Patent Proprietor) Haldor Topsøes Allé 1  
2800 Kgs. Lyngby (DK)

**Decision under appeal:** **Interlocutory decision of the Opposition  
Division of the European Patent Office posted on  
16 September 2016 maintaining European Patent  
No. 2334757 in amended form.**

**Composition of the Board:**

**Chairman** J.-M. Schwaller  
**Members:** L. Li Voti  
J. Hoppe

## Summary of Facts and Submissions

- I. The appeal of the opponent (the **appellant**) is against the decision of the opposition division to maintain European patent no. 2 334 757 in amended form on the basis of the claims according to auxiliary request 1 filed on 7 June 2016.
- II. With its statement of grounds the appellant raised objections under articles 83, 123(2), 54 and 56 EPC based inter alia on the following documents:
- D1: US 2009/0163744 A1;  
D2: EP 1 741 768 A1;  
D3: "*An Introduction to Chemical Engineering Kinetics & Reactor Design*", C. Hill, 1977, pages 195-196;  
D8a: English translation of CN101029245 A (D8);  
D12: "*Hydrodeoxygenation of furan by carbon supported molybdenum sulphide catalysts*", K. Chary et al., *Carbon*, 29, 3, 1991, pages 478-479;  
D13: US 4,499,203 A.
- III. With its reply the patent proprietor (the respondent) submitted nine auxiliary requests.
- IV. Following the board's preliminary opinion, the respondent filed new requests and documents and a copy of a set of slides.
- V. During the oral proceedings held on 9 February 2021 the respondent, after the board had raised a new objection under Article 123(3) EPC, withdrew all the requests then on file and submitted a new main request, with independent claims 1 and 13 reading:

"1. Process for production of a hydrocarbon fuel from renewable organic material of biological origin comprising the steps:

(a) forming a feedstock by combining a fossil hydrocarbon fuel with a renewable organic material taken from the group consisting of vegetable oils, animal fats, tall oil, and of oxygen containing materials derived therefrom as well as combinations hereof wherein the content of renewable organic material is 1 to 35 vol%;

(b) mixing the feedstock of step (a) with a hydrogen-rich gas and conducting the combined stream to a hydrodeoxygenation stage by contacting said combined stream with a supported hydrodeoxygenation catalyst, wherein the metal component of the hydrodeoxygenation catalyst is Mo only, said catalyst having Mo content of 0.1 to 20 wt%, the support being selected from alumina, silica, titania and combinations thereof, and said support having a bimodal porous structure with pores with a diameter as measured by mercury intrusion porosimetry larger than 50 nm that constitute at least 2 vol% of the total pore volume."

"13. Use of a supported hydrodeoxygenation catalyst wherein the metal component of the hydrodeoxygenation catalyst is Mo only, said catalyst having Mo content of 0.1 to 20 wt%, the support being selected from alumina, silica, titania, and combinations thereof, and said support having a bimodal porous structure with pores with a diameter as measured by mercury intrusion porosimetry larger than 50 nm that constitute at least 2 vol% of the total pore volume, as hydrodeoxygenation (HDO) catalyst for the treatment in the presence of hydrogen of feedstocks combining a fossil hydrocarbon fuel with a renewable organic material taken from the group consisting of vegetable oils, animal fats, tall

*oil, and of oxygen containing materials derived therefrom as well as combinations thereof, wherein the content of renewable organic material is 1 to 35 vol%."*

Dependent claims 2 to 12 concern particular embodiments of the claimed process.

VI. The final requests of the parties were the following:

The appellant (opponent) requested that the decision under appeal be set aside and that the European patent be revoked.

The respondent (patent proprietor) requested that the patent be maintained in amended form based on the new main request filed during these oral proceedings.

### **Reasons for the Decision**

1. *New main request - Admittance*

1.1 This request, which is a slightly amended version of auxiliary request 2 filed with the proprietor's reply to the grounds of appeal, was filed in response to an objection under Article 123(3) EPC raised by the board for the first time during oral proceedings. Its filing was thus indeed due to exceptional circumstances and justified. Moreover it overcame prima facie the objection raised by the board without giving rise to new objections, since the expression present in granted claim 1 has been reintroduced.

1.2 The board thus exercised its discretion to admit this request under Articles 13(2) and 25(1) RPBA 2020.

2. *New main request - Compliance with the requirements of Article 123(2) and (3) EPC*

2.1 Since the expression "oxygen containing" present in granted claim 1 and defining the so-called "materials derived therefrom" has been reintroduced into claim 1, the objection under Article 123(3) EPC is thereby overcome and the claimed subject-matter no longer extends the protection of the patent as granted.

2.2 The only objection under Article 123(2) EPC maintained by the appellant concerned the wording of the hydrodeoxygenation (**HDO**) catalyst in claims 1 and 13, which contains as a metal component Mo only.

In the appellant's view the application as filed (reference is made in the following to the version published as WO 2010/028717) contained only support for an "unpromoted" catalyst, as specified in the passage on page 6, lines 1-2 reading: *"Surprisingly, it has been found that an unpromoted catalyst being impregnated only with Mo (and not Co or Ni) is effective ..."*. Since claims 1 and 13 at issue were not limited to the use of an unpromoted catalyst, their subject-matter thus extended to catalysts comprising non-metallic promoters, which however were not disclosed in the application as filed.

2.3 For the board, the application as filed does not disclose that the catalyst has to be unpromoted (see e.g. claim 1 and its corresponding passage of the description on page 6, lines 16-31 as well as dependent claim 3). A similar disclosure regarding the use in claim 13 is found in original claim 13 and page 15, lines 6-16 as filed. Further, in the explicit disclosure at page 9, lines 10-11 of a catalyst

containing as a metal Mo only (thus not containing metallic promoters) it is not specified that the catalyst has to be unpromoted in the sense that it does not contain non-metallic promoters.

- 2.3.1 It follows that the question whether the claimed catalyst may be understood to potentially contain non-metallic promoters concerns rather the clarity, which issue cannot be raised here since the granted claims did not specify either whether the catalyst had to be promoted or not. It follows that appellant's objection is of no relevance as regards the compliance of the claims with the requirements of Article 123(2) EPC.
- 2.4 The board thus concludes that the wording of the claims at issue does not infringe Article 123(2) EPC.
3. *Sufficiency of disclosure of the invention*
- 3.1 As regards this issue the appellant maintained during oral proceedings only the arguments put forward under points 6.1-6.7 of its grounds of appeal, namely that *"The patent does not sufficiently disclose how to achieve 50% conversion"*.
- 3.2 The board agrees in this respect with the decision under appeal (points 4.3-4.5) that claim 1 does not require a minimum conversion rate for the HDO processing stage. Therefore, it is irrelevant if any of the chosen conditions allows at least 50% conversion of the feedstock or not.
- 3.3 The board furthermore is convinced that a process as currently defined in the claims can easily be realised by a skilled person following the teaching of the description. It thus follows that the claimed invention



is sufficiently disclosed and meets the requirements of Article 83 EPC.

4. *New main request - Novelty*

4.1 As regards this issue the appellant declared at the oral proceedings to rely on its written submissions. The board has thus no reason to depart from its preliminary opinion that the claimed subject-matter is novel over documents D1, D2 and D8/D8a.

4.1.1 D1, which was published after the priority date of the patent in suit, does not disclose the feedstock to comprise a mixture of fossil hydrocarbon fuel and renewable organic materials, as required in claims 1 or 13 at issue.

4.1.2 D2 discloses (claim 14 and paragraph [0061]) the use of a hydrogenation catalyst containing a metal from the Group VIII and/or VIB. D2 however does not directly and unambiguously disclose that the catalyst has to comprise as a metal **Mo only**, as required in claims 1 or 13 at issue.

4.1.3 D8/D8a discloses (claim 1) the use of a catalyst of W, Mo, Co, Ni, Pt, Pd oxides or sulfides supported on one or more of alumina, activated carbon, diatomaceous earth, neutral or weakly acidic "bear body" (*i.e.* a support) and aluminium silicate, magnesium silicate, activated clay or a zeolite acidity "bear body". This document thus does not directly and unambiguously disclose a catalyst comprising as a metal **Mo only** and **alumina, silica and/or titania** as a supporting material.

4.2 It follows that none of the above documents takes away the novelty of the claimed subject-matter, which thus meets the requirements of Article 54 EPC.

5. *New main request - Inventive step*

5.1 Claim 1 at issue relates to a process for producing a hydrocarbon fuel from material of biological origin taken from the group consisting of vegetable oils, animal fats, tall oil and/or oxygen containing materials derived therefrom.

5.2 As explained in the patent (paragraph [0005]), for using feedstocks derived from renewable organic material in conventional automobile engines, it is desirable to convert the material into hydrocarbons that are similar to those present in fossil derived transportation fuels. In this respect, it is already known to convert vegetable oils into normal paraffins in the gasoline or diesel boiling range by hydroprocessing.

However, as stated in paragraph [0014], the prior art suffers from a lack of reaction control in the top part of the hydroprocessing reactor. As the reaction of vegetable and/or animal oils with hydrogen is highly exothermic and consumes high amounts of hydrogen, the temperature can rise very rapidly in the top of the reactor and the hydrogen partial pressure may be very low at the active reaction sites on the catalyst. These conditions will lead to coke formation, plugging up of the catalyst and cause a high pressure drop as well as increased deactivation rate of the catalyst.

Hence, the purpose of the invention (paragraph [0015]) is the provision of an improved process that enables to

convert renewable organic material into hydrocarbons boiling in the diesel range with low pressure drop over the catalyst bed and low catalyst deactivation rate. This goal is achieved by using a HDO catalyst having as a metal Mo only supported on an alumina carrier with a bimodal pore distribution.

- 5.3 The further objectives described in paragraphs [0016]-[0017] of the patent, namely *"the provision of a process that allows a gradual conversion of the vegetable and/or animal oils, thereby extending the effective reaction zone and suppressing the formation of carbonaceous deposits on the catalyst"* or *"the use of a catalyst that is effective in converting the oxygenates in the feed into hydrocarbons in the diesel boiling range and being more resistant than the prior art catalysts to the deposition of carbonaceous materials within the catalyst"*, concern more specific aspects. The same consideration applies to those effects mentioned in paragraphs [0031]-[0032], namely the reduced hydrogen consumption due to the low catalyst activity in possible hydrodearomatisation and hydrodesulfurisation, but these additional effects cannot be considered to represent separate goals of the invention either.

The Board thus cannot agree with the decision under appeal and the appellant that the low activity for hydrodesulphurisation should be considered in the formulation of the technical problem either.

- 5.4 Notwithstanding, all parties agreed that D2 represented the starting point for the evaluation of inventive step, as it concerns (paragraphs [0001], [0006]-[0007] and [0022]-[0024]) a process for the manufacture of diesel range hydrocarbons from bio oils

and fats with high selectivity and with high diesel yield, with the formation of high molecular weight compounds during hydrotreating being reduced and the stability of the catalyst increased. D2 addresses in particular the control of the reaction temperature and the reduction of catalyst plugging. Thus D2 has a similar goal as the patent in suit. As indicated in the board's preliminary opinion, example 5 of D2 moreover represents the closest prior art.

- 5.5 Since D2 already provides a successful solution to the technical problem dealt with in the patent in suit and as no evidence has been provided for a technical improvement over the process known from this prior art document, the technical problem underlying the claimed invention has to be reformulated in less ambitious terms, namely in the provision of a further process which enables the manufacture of diesel range hydrocarbons from bio oils and fats with high diesel yield and increased stability of the catalyst used.

It is noted that the appellant acknowledged this formulation of the technical problem during the oral proceedings before the board.

- 5.6 Example 1 of the patent, in which a feedstock consisting of 85% by volume straight run fossil LGO and 15% by volume rapeseed oil was treated with hydrogen over a Mo only catalyst supported on a bimodal alumina, is illustrative of the claimed process.

- 5.6.1 The appellant argued in its grounds of appeal (point 10/Annex C) that the data in the patent were insufficient and inconclusive and that it was "at least equally likely that example 1 actually shows conversion into fatty acids" (point 10.7). Moreover it has

submitted (point 10.10) that the gas chromatograms submitted by the patent proprietor during opposition (see letter dated 7 June 2016) "did not confirm that fatty acids are not formed and that the peak at 12 min retention time is exclusively octadecane".

- 5.6.2 In this respect the board notes that the appellant has also not submitted any conclusive evidence that the triglycerides of the feedstock of example 1 were not successfully converted into hydrocarbons as stated in the patent (paragraphs [0053] and [0055]). Therefore its allegations cannot be accepted either.
- 5.6.3 In any case there is no doubt that the catalyst used in the process of example 1 is clearly more stable against coking than conventional NiMo (nickel/molybdenum) catalysts, such as the one used in comparative example 2 (see also in this respect paragraph [0060] of the patent).
- 5.6.4 It follows from the above considerations that example 1 of the patent convincingly shows that the triglycerides used as feedstock are successfully converted into hydrocarbons and that the catalyst has increased stability.

For the board there is here no reason to assume, in particular in the absence of evidence to the contrary, that similar results would not be achieved with lower or greater amounts of renewable material in the feedstock as encompassed by claim 1 at issue (1 to 35 volume %) or with a catalyst having silica or titania as a support instead of alumina.

- 5.6.5 The board thus concludes that the technical problem posed has been convincingly solved by means of the process of claim 1.
- 5.7 The closest prior art (example 5 of D2) differs from the subject-matter of claim 1 in that the HDO catalyst is not one having as a metal component Mo only, with the metal content being 1-20 wt%, and being supported on alumina, silica and/or titania, and the carrier having a bimodal pore distribution with pores with a diameter larger than 50 nm constituting at least 2 vol. % of the total pore volume. Even though example 5 of D2 does not explicitly define the catalyst, it is reasonable to assume that it is one of those preferred in D2 which has been used, namely a nickel/molybdenum (NiMo) or a cobalt/molybdenum (CoMo) on alumina, since NiMo catalysts are also used in comparative examples 1, 2 and 6 and in example 7 of D2.
- 5.7.1 In example 5 of D2, rapeseed oil is mixed at a ratio of 1 to 5 with n-paraffins (the HDO product), which simulate a product recycle. For the board, even if this HDO product is not equivalent to a fossil hydrocarbon fuel, it is evident from page 5, line 42 of D2 that any hydrocarbon from biological or non-biological origin can be used as diluent with the feedstock of renewable material.

Therefore, even though the presence of a fossil hydrocarbon fuel in the feedstock might be considered to represent a further difference over the closest prior art, the board holds this feature to be at least suggested by D2.

- 5.8 It remains thus to decide if it was obvious for the skilled person, faced with the technical problem posed,

to use at the priority date of the patent a catalyst as claimed instead of that used in D2 in order to convert the feedstock, in particular the triglycerides, into hydrocarbons.

- 5.8.1 D2 (paragraph [0061] and claim 14) in this respect refers in generic terms to catalysts containing a metal belonging to the group VIB, without however disclosing explicitly any catalyst containing Mo as the only metal. It is thus not possible to derive from the teaching of D2 that the skilled person would have considered a catalyst containing only Mo as the metal as a suitable alternative to those commonly used and explicitly suggested in D2, namely NiMo or CoMo on alumina (see D2, page 7, lines 29-30).

The board observes that, owing to the teaching of D2, the skilled person would even have found other valid alternatives in D2 for solving the technical problem underlying the invention. For instance, as suggested in paragraphs [0072] - [0074] of D2, rather than looking for a different catalyst, he might have modified the operating temperature or the dilution ratio.

- 5.9 The appellant, by referring to the patent in suit, argued that alumina supported Mo catalysts were known to be suitable for HDO. The board remarks however that the prior art discussion in the patent concerns rather:
- Mo catalysts supported on bimodal alumina for hydrodemetallation and hydrodesulphurisation of heavy hydrocarbons (paragraph [0008]),
  - NiMo or CoMo catalysts for the hydrogenation of vegetable oil into normal paraffins (paragraphs [0010] and [0013]),
  - Pd (palladium), Pt (platinum), Ni, NiMo or CoMo catalysts in an HDO step (paragraph [0011]), or

- the HDO of an oxygenated feedstock such as triglycerides with a catalyst containing Group VIB **and** VIII metals such as Mo **and** Ni on a bimodal alumina support (paragraph [0012]).

Thus even if the patent acknowledges that Mo catalysts supported on bimodal alumina were known, it however clearly indicates that their use concerned hydrodemetallation and hydrodesulphurisation of heavy hydrocarbons, not the hydrodeoxygenation of a feedstock including biological renewable material, for which purpose Mo was used only in combination with other metals such as Ni and Co, as disclosed e.g. in D2.

5.10 The appellant further argued that it was known from D13 that a catalyst as claimed was suitable for HDO.

In fact, D13 (column 2, lines 20-36) teaches to improve the efficiency and the life time of catalysts subjected to poisoning by pore mouth plugging by making use of bimodal carriers which have their porosity distributed over two different pore diameters, namely micropores with a mean diameter of conventional (monomodal) carriers (3-10 nanometers) and macropores having a 100 to 10000 times greater mean diameter.

The board notes that this teaching is in agreement with the common general knowledge cited in D3 (page 196, left column, line 16 onwards), but D13 rather concerns **a new type** of catalyst (column 2, lines 54-55), namely the one identified (A) in its figure 1, therein compared with prior art bimodal and monomodal catalysts (B) and (C).



According to column 3, lines 47-55 of D13, this new catalyst (A) shows a relatively continuous pore distribution between two extreme values.

The appellant alleged that the skilled person would have been considered the catalyst of type (A) to have bimodal characteristics at the priority date of the patent, but since no evidence for this allegation has been provided, it is concluded that its pore size distribution is not bimodal, as required by claim 1 at issue.

- 5.10.1 Example 6 of D13 (column 14, lines 42-40) shows that a bimodal catalyst (B) containing Co and Mo performs better than a monomodal catalyst (C) but somewhat worse than catalyst (A). Moreover, examples 8 to 13 of D13 (column 15, lines 63-64 in combination with column 16, lines 4-7) state that a catalyst of type (A) having Mo only as a metal has substantially the same performance as the catalyst (A) of example 6.

The board nevertheless emphasises that all the examples of D13 refer to the use of catalysts for hydrodemetallating heavy fossil fuels (such as deasphalted oils; see tables 2 and 4 and figure 11), i.e. for a reaction implying heavy hydrocarbon feedstocks which are very different from those supposed to undergo HDO in claim 1 at issue. Furthermore D13 does not at all suggest the possible hydrotreatment of biological renewable material as required by claim 1 at issue.

- 5.10.2 It follows that even though D13 (column 2, lines 54-61) discloses that catalysts of type (A) may be used in any type of hydrotreatment including HDO, it does not at all suggest that known bimodal catalysts of type (B)

could also be suitable for all these different types of hydrotreatment.

Therefore D13 neither discloses nor suggests that a catalyst containing Mo as the only metal on a bimodal support could be successfully used in an HDO process of a feedstock containing biological renewable material.

Hence, starting from the closest prior art D2, the skilled person would not have found in D13 any motivation for using a catalyst as required in claim 1 at issue instead of the preferred NiMo or CoMo catalysts used in D2.

5.11 The appellant further referred in writing to document D12, which concerns (page 478, left column, lines 30-44) the HDO of organooxygen compounds contained in coal derived liquids, shale oil and petroleum feedstocks, but not the HDO processing of biological renewable materials.

In particular, D12 states that commonly used catalysts are molybdenum/tungsten sulphided catalysts promoted with cobalt/nickel and that no studies were available for carbon supported Mo or Co-Mo catalysts. Therefore it was attempted for the first time to use carbon supported sulphided Mo in the HDO of furan, an organooxygen compound found in fossil feedstocks.

In D12 various catalysts were tested as to their HDO rate on furan, including alumina supported NiMo or CoMo - the preferred catalysts of D2 - and alumina supported Mo (a catalyst at least similar to that of claim 1 at issue).

It is however apparent from Table 1 that the activity of the alumina supported Mo catalyst has the worst HDO rate of all those tested in D12. Its HDO rate is about four times lower than that of alumina supported NiMo or CoMo catalysts.

D12 (page 478, right column, last full paragraph) further discloses that in another study (the hydrodesulphurisation of thiophene) a similar Mo catalyst was found to be even 5 to 6 times worse than the CoMo catalyst. D12 moreover clearly shows in Table 1 that carbon supported catalysts are much better than alumina supported ones.

For the board, it follows that D12 does not contain any information that would have prompted the skilled person to use with a reasonable expectation of success a Mo only catalyst supported on alumina, let alone a Mo only catalyst supported on a bimodal alumina, as an alternative to the preferred NiMo or CoMo catalysts disclosed in D2 for the HDO of a feedstock including biological renewable material.

- 5.12 For the board it was just not common general knowledge to use a supported catalyst having Mo as the only metal in an HDO reaction of renewable material and that the skilled person would not have derived from the above quoted prior art documents any suggestion that such a catalyst could have been a suitable substitute for the preferred NiMo or CoMo of D2 in order to provide a further process which enables the manufacture of diesel range hydrocarbons from bio oils and fats with high diesel yield and increased stability of the catalyst used.

5.13 The board thus concludes that the subject-matter of claim 1 was not obvious from the known prior art documents and involves an inventive step within the meaning of Article 56 EPC. The same arguments apply mutatis mutandis to the dependent claims 2 to 12 and to the use claim 13.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the opposition division with the order to maintain the patent in amended form based on the claims of the new main request filed in the oral proceedings on 9 February 2021 and a description to be adapted where appropriate.

The Registrar:

The Chairman:



A. Pinna

J.-M. Schwaller

Decision electronically authenticated