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Datasheet for the decision of 14 December 2021

Case Number: T 0469/19 - 3.3.10

Application Number: 10793225.3

Publication Number: 2513025

IPC: C07C45/00, C07C29/20, C07C49/403, C07C35/08

Language of the proceedings: EN

Title of invention:
CATALYSED PHENOL HYDROGENATION

Patent Proprietor:
CAP III B.V.

Opponent:
versalis S.p.A.

Headword:

Relevant legal provisions:
EPC Art. 100(a), 123(2), 123(3), 83, 54(2), 56
RPBA Art. 12(4)

Keyword:
Grounds for opposition - lack of patentability (yes)
First auxiliary request - allowed

This datasheet is not part of the Decision
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Decisions cited:

Catchword:

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Case Number: T 0469/19 - 3.3.10

D E C I S I O N
of Technical Board of Appeal 3.3.10
of 14 December 2021

Appellant: (Opponent)	versalis S.p.A. Piazza Boldrini 1 20097 San Donato Milanese (IT)
Representative:	De Gregori, Antonella Studio Legale Bird & Bird Via Borgogna, 8 20122 Milano (IT)
Respondent: (Patent Proprietor)	CAP III B.V. Poststraat 1 6135 KR Sittard (NL)
Representative:	Cohausz & Florack Patent- & Rechtsanwälte Partnerschaftsgesellschaft mbB Bleichstraße 14 40211 Düsseldorf (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 13 December 2018 rejecting the opposition filed against European patent No. 2513025 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chair	P. Gryczka
Members:	R. Pérez Carlón
	K. Kerber-Zubrzycka

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the opposition division rejecting the opposition against European patent No. 2 513 025.

II. Notice of opposition was filed on the grounds of added subject-matter (Article 100(c) EPC), insufficiency of disclosure (Article 100(b) EPC), and lack of novelty and inventive step (Article 100(a) EPC).

III. The documents filed during the proceedings were labelled by the parties as "S" followed by a number. The present decision uses the labelling "D", instead. These documents include the following:

D1 WO 2009/146794 A1
D2 EP 1 050 339 A1
D4 Submission during examination proceedings of the patent, dated 4 February 2013
D5 Experimental section performed by opponent
D6 A. C. Dimian and C. S. Bildea "Chemical Process Design. Computer-Aided case studies" Wiley-VCH, 2008, Contents, Preface and Chapter 5
D7 M. T. Musser, "Cyclohexanol and Cyclohexanone", Ullmann's Encyclopedia of Industrial Chemistry, 2005
D8 "Cyclohexanol and Cyclohexanone" Kirk-Othmer Encyclopedia of Chemical Technology, 1979, 3rd Edition, volume 7
D9 DE 197 27 712 A1
D10 US 3,998,884
D19 C. Park and M. A. Keane "Catalyst support effects: gas-phase hydrogenation of phenol over

palladium" Journal of Colloid and Interface Science (266), 2003, pp. 183-194

D22 Additional experimental section performed by opponent

D37 Experimental Report by Dr Johan T. Tinge, 5 September 2019

IV. Claim 1 of the patent as granted, which is the respondent's (patent proprietor) main request, reads as follows:

"Method for preparing cyclohexanone, cyclohexanol or a mixture thereof in a continuous process, comprising catalytically hydrogenating phenol fed into a reactor comprising a hydrogenation catalyst,
wherein the hydrogenation catalyst is a supported catalyst, comprising (i) palladium; (ii) a support selected from the group of alumina and activated carbon; and (iii) a dopant selected from the group of alkali metal hydroxides, alkaline earth metal hydroxides, alkaline earth metal oxides, carbonates of alkali metals and carbonates of alkaline earth metals; and wherein during the hydrogenation of phenol continuously or intermittently water is fed into the reactor, the weight to weight ratio of water fed into the reactor to phenol fed into the reactor on average being in the range of from 0.0010 to 0.10."

V. The opposition division concluded that claim 1 of the patent as granted found the required basis in the application as originally filed. The claimed invention could be carried out by a person skilled in the art. Neither D1 nor D2 disclosed a process adding the amount of water required by claim 1. The claimed process was thus novel. Both documents D1 and D6 were suitable starting points for examining inventive step. Neither

of them disclosed adding the relative amount of water required by claim 1. The problem underlying the claimed invention was to provide a process for the preparation of cyclohexanone, cyclohexanol or a mixture of these with higher conversion and selectivity towards cyclohexanone. The claimed solution, characterised by adding water at the relative amount set, would not have been obvious for a person skilled in the art and was thus inventive.

VI. At the oral proceedings before the board, which took place on 14 December 2021, the respondent made auxiliary request 8 filed with the reply to the grounds of appeal its first auxiliary request. Claim 1 differs from claim 1 as granted in that it relates only to a process for preparing cyclohexanone or a mixture of cyclohexanone and cyclohexanol.

VII. The arguments of the appellant were as follows.

The application as originally filed did not disclose a relative amount of water in the range of from 0.0010 to 0.10 as "on average". For this reason, claim 1 lacked the required basis in the application as originally filed.

The claimed invention was not sufficiently disclosed for it to be carried out by a person skilled in the art. Examples 1 to 5 of the patent were not detailed enough and were made under untypical conditions. In addition, the term "on average" was not clear as it could refer to a time or space average.

D1 and D2 implicitly disclosed a method by adding the relative amount of water required by claim 1. D1 disclosed water as an impurity and did not disclose the

recycling of the phenol feed. D3 and D17 disclosed that phenol typically contained water in the required amount. D18 disclosed that hydrogen also inevitably contained water. The appellant calculated the resulting relative amount of water and concluded that it must have been within the boundaries set by claim 1.

If the method of claim 1 were to be considered novel, document D1 or D6 were the closest prior art. The problem of enhancing the selectivity towards cyclohexanone could not be invoked as the problem to be solved if the synthesis of cyclohexanol was intended. The problem of increasing conversion was not credibly solved having regard to the available evidence. The sole problem solved by the claimed method was the provision of an alternative. The claimed solution, characterised by the amount of water, would have been obvious for a skilled person in view of D1. It was thus not inventive.

Document D10 had been filed during the nine-month opposition period. Thus, arguments on inventive step taking D10 as the closest prior art should be admitted into the proceedings.

With respect to the method of claim 1 of the first auxiliary request, the problem of providing enhanced selectivity towards cyclohexanone could not have been considered solved. In fact, examples 1 to 5 of the patent showed the opposite. In addition, the key point was whether yield, not selectivity, could be improved. Even if an improvement were seen to be achieved, the claimed solution would have been obvious in view of D10, D9 or D19 and was thus not inventive.

VIII. The arguments of the respondent were as follows.

The amount of water set by claim 1 found the required basis on page 5, lines 27 to 32 of the application as originally filed.

The claimed invention was sufficiently disclosed, as proven by the appellant's own experimental data.

D1 and D2 did not disclose the amount of water required by claim 1. The claimed method was thus novel.

D1 or D6 were the closest prior art because the arguments starting from D10 should not be admitted into the proceedings.

The skilled reader knew that the hydrogenation of phenol inevitably led to a mixture of cyclohexanone and cyclohexanol. Reading the claim as directed only to the preparation of the latter was thus artificial. Be that as it may, the claimed method provided enhanced conversion. Even if it were to be seen as a mere alternative, the claimed method was inventive as the skilled person would not have considered adding water to the process.

Claim 1 of the first auxiliary request related to a method for preparing cyclohexanone or a mixture of cyclohexanone and cyclohexanol. The problem underlying the claimed invention was to provide a process with enhanced conversion towards cyclohexanone. The solution was characterised by adding a defined relative amount of water. Since it would not have been obvious for the skilled person, the claimed solution was inventive.

IX. The final requests of the parties were as follows:

- The appellant requested that the decision under appeal be set aside and that the patent be revoked.

- The respondent requested that the appeal be dismissed, subsidiarily that the decision under appeal be set aside and that the patent be maintained on the basis of one of the auxiliary requests 1 to 17 (filed as auxiliary requests 8, 1 to 7 and 9 to 17, respectively, with the reply to the grounds of appeal dated 9 September 2021) or on the basis of the auxiliary requests 18 and 19 filed with the letter dated 23 November 2021.

X. At the end of the oral proceedings, the decision was announced.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. Amendments

2.1 Claim 1 of the patent as granted results from the combination of claims 1 and 11 as originally filed with the relative amount of water "on average being in the range of from 0.0010 to 0.10". The appellant argued that this feature could not be found in the application as originally filed.

2.2 This feature finds the required basis on page 5, lines 27 to 32 of the application as originally filed. This passage reads:

"Usually, the weight to weight ratio of water to the compound to be hydrogenated - in particular phenol - on average is at least 0.0005, in particular 0.0010 or more, i.e. in the range of from 0.0010 to 0.10. In a preferred method of the invention, said ratio on average is [...]. In a particularly preferred method [...] said ratio is on average [...]."

The range of from 0.0010 to 0.10 is not explicitly disclosed as "on average". However, both in the same sentence before the mention of the range and in the next sentence, "on average" is used to describe the ratio. If the water amount of 0.0010 to 0.10 were not on average, this should have been indicated. As it stands, the passage quoted refers only to average values and thus provides the required basis.

2.3 The ground for opposition under Article 100(c) EPC does not preclude the maintenance of the patent as granted.

3. Sufficiency of disclosure

3.1 The appellant argues that the disclosure of the patent is not detailed enough to allow the claimed invention to be reproduced.

3.2 Claim 1 only requires hydrogenating phenol to obtain cyclohexanone, cyclohexanol or a mixture of these. The process is known in the art (D6, D7). Adding water to it is not technically complicated. As the technology is well known, the skilled person thus faces no unsurmountable difficulty. In fact, the appellant has filed experimental evidence reproducing embodiments of the claimed invention, proving it to be sufficiently disclosed to be carried out by a skilled person.

The appellant's arguments focus on the lack of detail of the specific examples of the patent. The issue under sufficiency of disclosure is, however, whether the claimed invention can be carried out by a person skilled in the art. This is the case here, regardless of whether some examples in the patent are detailed enough to be reproduced.

3.3 The appellant further argued that it was not disclosed whether the term "on average" referred to space average or time average. Also for that reason, the claimed invention could not be put into practise.

However, the appellant could reliably obtain embodiments of the claimed invention (D5) by using the information in the patent and the common general knowledge, regardless of the alleged lack of clarity of the feature "on average". This argument is thus not convincing.

3.4 The ground for opposition set out in Article 100(b) does not preclude the maintenance of the patent as granted.

4. Novelty

4.1 It was undisputed that D1 and D2 disclose a continuous hydrogenation of phenol over a catalyst as defined in claim 1. The issue to be examined is whether these documents also implicitly disclose a process in the presence of the amount of water set by claim 1.

4.2 Document D1 discloses (page 4, lines 3 to 10) that the hydrogenation process is carried out with a phenol feed having 95-100% phenol and a hydrogen feed containing 95-100% hydrogen.

D1 further discloses (page 4, lines 11 to 14) that the reaction media can contain other components, such as nitrogen, carbon dioxide, cyclohexanol and water. No amounts are given.

The example of D1 is carried out with "pure phenol" and "pure hydrogen".

4.3 The appellant argues that refined phenol usually contains less than 0.10% water (D3, D17). This is the lowest threshold set by claim 1 (0.0010). D1 would thus inevitably have been carried out with that relative amount of water.

However, there is no reason to conclude that the process of D1 was inevitably carried out with that amount of water. This argument is thus not convincing.

4.4 The appellant argued that the highest purity disclosed in D1 (100%) included 99.5% molar, with the same significant figures. The appellant calculated the relative amount of water if:

- purity of phenol was
  - 95% (page 4, line 5 of D1)
  - 99.5%, as a proxy for 100%, and
- phenol only contained water as a further component.

The same calculations were made for hydrogen. The appellant thus concluded that D1 inevitably disclosed a process with the amount of water required by claim 1.

4.5 However, these features are not disclosed in D1, let alone in combination. Even if 99.5% could be considered equivalent to 100%, D1 discloses only the latter, not the former. In addition, D1 does not disclose a phenol

feed or an hydrogen feed containing only water as an impurity, either.

4.6 The appellant argued that the example of D1 did not disclose any recycling. This excluded from the feed other impurities disclosed on page 4, lines 13 to 14 of D1 because unrecycled phenol would not contain any of them. Thus, only water could have been present.

On the one hand, D1 discloses that the list of impurities is non-exhaustive. It could not thus be concluded that only water could have been present. On the other hand, the example of D1 discloses the use of pure feeds, i.e. 100% pure. No further information is provided. The feed could have contained 99.5% phenol, as argued by the appellant, but also 99.9%. This information is not provided.

4.7 The appellant argued that the example of D1 did not disclose that the feeds used were anhydrous. The skilled reader would thus understand that water was not excluded from the process.

However, even if the skilled person were to conclude that water had inevitably been present, there is no reason why its amount should inevitably have been as required by claim 1.

4.8 The appellant also argued that hydrogen can have 0.45 mol% of water and relied on D18 in this respect.

Document D18 is a comprehensive review on hydrogen preparation. Throughout 250 pages, D18 discloses a considerable number of processes for obtaining hydrogen (see index). The appellant refers to only one of them. There is no reason to conclude that the process of D1

used exactly that type of hydrogen, let alone that every process disclosed in D18 would have led to hydrogen having that amount of water. This argument is thus also not convincing.

4.9 The board thus concludes that D1 does not clearly and unambiguously disclose a process in which the required amount of water was fed.

4.10 It has not been disputed that the arguments with respect to D1 apply analogously to the disclosure of document D2.

4.11 The method of claim 1 is thus novel (Article 54(2) EPC).

5. Inventive step

5.1 Claim 1 relates to a method for preparing cyclohexanone, cyclohexanol or a mixture thereof. The process is catalytic and continuous. Claim 1 requires a specific catalyst containing palladium and a dopant on a support. The process is carried out by feeding water at a weight to weight ratio of water to phenol on average in the range of from 0.0010 to 0.10.

The hydrogenation of phenol is a known process. It allows the synthesis of the partially hydrogenated product cyclohexanone and the fully hydrogenated cyclohexanol (D6, Figure 5.1 on page 132).

5.2 Document D1 discloses a method silent on the amount of water fed to the reactor. The parties agreed with the opposition division's conclusion that D1 was a suitable starting point for examining inventive step. The board sees no reason to differ.

The sole example of D1 discloses a conversion of phenol of 100%.

5.3 Technical problem underlying the invention

5.3.1 The respondent argued that the technical problem underlying the claimed invention was to provide a method which allowed phenol conversion and selectivity towards cyclohexanone to be improved.

However, the method of claim 1 is also directed to the preparation of cyclohexanol. It cannot be considered inventive to obtain as little as possible of the desired compound. Thus, the part of the problem relating to enhancing selectivity towards cyclohexanone cannot be taken into consideration for a part of the subject-matter claimed.

5.3.2 The respondent argued in this respect that phenol hydrogenation was known. The preamble of a claim was merely intended to define the field of the invention. The skilled reader would have considered the product of the process to be inevitably a mixture of cyclohexanone and cyclohexanol, regardless of the wording of the claim. Interpreting claim 1 as directed to the preparation of cyclohexanol was thus artificial and based on a purely linguistic analysis.

However, the preparation of cyclohexanol is explicitly claimed. The hydrogenation of phenol produces it; this embodiment of claim 1 is thus not incoherent. If the wording of a claim is, as in the case at hand, clear and sensible, the skilled reader would not interpret it differently.

This argument is thus not convincing.

5.3.3 Inventive step will thus be examined in the following considering the technical problem underlying the claimed invention to be the provision of a method for the hydrogenation of phenol with enhanced phenol conversion.

5.4 Solution

The solution to this technical problem is the claimed method of continuous catalytic hydrogenation of phenol over a palladium catalyst, characterised in that water is fed continuously or intermittently into the reactor, the weight to weight ratio of water fed into the reactor to phenol fed into the reactor on average being in the range of from 0.0010 to 0.10.

5.5 Success

The respondent relied on the experimental evidence on file to show that the problem of providing a method with enhanced conversion was credibly solved by the features of claim 1.

The respondent did not dispute that D1 disclosed complete conversion of phenol. The claimed method thus could not increase conversion beyond that. It argued, however, that the claimed method allowed enhancing the conversion if the catalyst was aged and the conversion dropped.

5.6 Experimental evidence available

5.6.1 The patent contains six pairs of examples and comparative examples. The first five pairs are

laboratory scale tests. Example 6 and comparative example F, which are the last pair, were carried out in a commercial plant. A summary of the results obtained can be found on page 3 of D4, which is a submission of the respondent during the examination of the patent.

Comparison of example F (without water) and example 6 (with water) shows an increase of conversion.

5.6.2 Further evidence was filed by the appellant as document D5. It contains two series of experiments with increasing amounts of water added. Examples 1 to 4 are carried out at about 170°C, examples 5 to 8 at 160°C. Examples 1 and 5 are comparative in which less water than required by claim 1 is used.

In both series 1 to 4 and 5 to 8, the conversion was lower if water was added.

5.6.3 Experimental evidence D22 was filed by the appellant shortly before the oral proceedings before the opposition division and was not admitted into the proceedings.

The board sees no reason to overturn the opposition division's discretionary decision on the conversion data which were filed with D22. It notes that even if these data were admitted, they do not show a difference in conversion between processes carried out with the required amount of water and those with less.

5.6.4 The appellant filed data linked to the experiments of D22 on page 33 of its grounds of appeal. These data included the selectivity of the process. Both parties relied on it at the oral proceedings before the board. These results are relevant in the part of this decision

dealing with the method of the first auxiliary request.

5.6.5 Lastly, the respondent filed in appeal experimental evidence as D37.

The appellant requested in writing that D37 not be admitted. However, the request was not pursued at the oral proceedings before the board, and the appellant relied on the content of D37.

D37 contains three sets of experiments. The first set shows better conversion if water is added. The second shows a small reduction in conversion by stopping water addition, with conversion slightly increasing by feeding water again into the process. The third set shows no effect on conversion.

5.7 The appellant acknowledges that conversion cannot be enhanced over that disclosed in D1. It argues, nevertheless, that an effect is achieved after catalyst ageing reduces conversion.

Comparative Example New3 of document D37 is carried out in a plant, re-started after replacement of the catalyst after 360 days of continuous production (D37, page 3, penultimate paragraph). Conversion after almost one year's operation was 99.1% and did not increase by adding water (Example New4). This catalyst was thus not deactivated by the respondent's own definition, despite the long production time.

The same conversion, 99.1%, could be increased by adding water in the Example New3/Comparative Example New2 series. This catalyst was thus already deactivated by the appellant's own definition.

Thus, aged and unaged catalysts can lead to the same conversion. This conversion is not always increased by adding water.

In addition, the data provided as D5 by the appellant show a decrease of conversion by adding water to the reaction.

The available data thus do not allow concluding that an increase in conversion is achieved by the distinguishing feature of the claimed invention.

5.8 Having regard to the available evidence, it is not credibly shown that the problem of providing a hydrogenation process with enhanced conversion has been credibly solved by the method of claim 1.

5.9 Reformulation of the technical problem

In accordance with the case law, alleged but unsupported advantages cannot be taken into consideration in determining the problem underlying the invention (see e.g. decision T 20/81, OJ EPO 1982, 217, Reasons 3, last paragraph).

As the alleged improvement in terms of better conversion has not been proven, the technical problem as defined above needs to be reformulated as to provide an alternative method for preparing cyclohexanone, cyclohexanol or a mixture of these.

5.10 The claimed solution is the method of claim 1, characterised by the relative amount of water added to the reactor.

5.11 This problem is credibly solved by the claimed method. Having regard to the available evidence, the hydrogenation of phenol can be carried out if the required relative amount of water is fed to the reactor.

5.12 It thus remains to be decided whether the proposed solution to the objective problem defined above would have been obvious for the skilled person in view of the prior art.

Water is known to be an impurity of phenol (D3), which is hygroscopic. D1 discloses water as an impurity in the hydrogenation of phenol (page 4, lines 12 to 14). Water can be a side-product if cyclohexanol is dehydrated in the process (D6, page 132, Figure 5.1). The skilled person would thus have concluded that water can be present in the process. Adding a small amount of water, such as required by claim 1, would thus have been an obvious option when seeking an alternative.

5.13 The respondent argued that the skilled person would have concluded that water was detrimental as it could interact with the alumina support and the dopants, which were alkali or alkali metal salts.

However, D10 discloses that water is not detrimental in a hydrogenation process carried out over a catalyst which, although different, is also supported on alumina. There is thus no reason to expect any detrimental effect on the support.

It is undisputed that hydrogenation of phenol on doped palladium catalysts was the method of choice for obtaining cyclohexanone at the filing date of the patent (D6, page 137, point 5.2.3.1). Water is known to

be a component of the reaction, and this is also acknowledged in the patent [0030]. Any detrimental effect of water, on the dopant or of any other kind, would have been reported in the art before the filing date. There is, however, nothing in the prior art on this.

These arguments are thus not convincing.

5.14 The respondent also argued that water needed to be separated from the reaction products. For this reason alone, the skilled person would not have added it to the process unless it would have provided some benefit.

Document D8 discloses on page 414, Table 2, the specification of "two typical cyclohexanones". Both commercial grade and high purity cyclohexanone may contain up to 0.2% water. This is above the threshold set in claim 1, taking into account that the molar mass of phenol (94.11 g/mol) and cyclohexanone (98.15 g/mol) do not differ much. Water thus does not necessarily have to be removed.

5.15 The method of claim 1 is thus not inventive (Article 56 EPC), and the ground for opposition set out in Article 100(a) EPC precludes the maintenance of the patent as grated.

First auxiliary request

6. The issues on amendments, sufficiency of disclosure and novelty do not differ from those examined above for the main request. The conclusions on those matters thus apply.

No objection under Article 123(3) EPC was raised or is

apparent to the board.

7. Admissibility

The appellant requested that this auxiliary request, filed as auxiliary request 8 with the respondent's reply to the grounds of appeal, not be admitted. The number of auxiliary requests was too large, and they were not convergent, it argued.

The first auxiliary request merely limits the method of claim 1 to two of the three embodiments of claim 1 of the patent as granted. The arguments in point 5.3 above on the preparation of cyclohexanol, which is the embodiment deleted from claim 1, have been raised in appeal for the first time. The respondent should thus have the opportunity to react to them.

Thus, the first auxiliary request is admitted into the proceedings.

8. Inventive step

Claim 1 of the first auxiliary request relates to a method for preparing cyclohexanone, or a mixture of cyclohexanone and cyclohexanol, over a palladium catalyst with the addition of water.

8.1 D10 as closest prior art

8.1.1 The appellant argued that D10 was also a suitable springboard for examining inventive step. These arguments were filed with the appellant's statement of grounds and had not been raised before the opposition division.

The appellant argued that D10 had nevertheless been filed during the opposition period; inventive step was a ground its case relied upon. The objection was filed with the notice of appeal and was thus admissible.

8.1.2 The respondent requested that this objection not be admitted. D10 had been cited in examination proceedings of the patent. It had been filed with the notice of opposition. The appellant was thus well aware of this document and should have filed any objection before the opposition division. Delaying the filing until appeal could be a tactical decision of the appellant.

8.1.3 The decision under appeal bases its conclusions on inventive step on a number of comparative data filed by the parties, summarised in point 5.6 above. The data aimed to show the effect of water in the claimed method.

The arguments taking D10 as the closest prior art are, however, completely different. The distinguishing feature with respect to D10 is the catalyst. Regardless of the definition of the problem underlying the claimed invention, the solution, characterised by the type of catalyst, inevitably differs. The sizeable evidence on file would thus serve no purpose. The board and the respondent would be facing in appeal the issue of inventive step from a totally different angle. This runs contrary to the review purpose at the core of appeal proceedings.

Whether document D10 was already filed during opposition does not change the situation. It was not cited as a possible starting point for examining inventive step by the appellant.

The board made use of its discretion under Article 114(2) EPC and Article 12(4) RPBA (2007) not to admit this submission.

8.1.4 For completeness, even if D10 were to be admitted, it would not have questioned the inventiveness of the claimed solution.

Documents D6 and D7 review the relevant prior art shortly before the patent's filing date. The penultimate paragraph on page 130 of D6 discloses that phenol hydrogenation "today" (in 2008) employed palladium catalysts. The following paragraph discloses that processes based on nickel catalysts such as that of D10 were older and required two steps. The state-of-the-art technique at the patent's filing date was the use of palladium catalysts, more selective towards the desired product and requiring a single reactor. The skilled person would thus not have turned to an outdated technology.

The appellant argued that the age of a document was not relevant in the context of inventive step. However, the issue here is not the age of the document, but the lack of practical relevance of that technology at the filing date of the patent.

8.2 The appellant further considered document D1 to be a suitable starting point for examining inventive step of the method of claim 1 of the first auxiliary request. The respondent and the opposition division also took this view, and the board sees no reason to differ.

The appellant also considered document D6 as a suitable starting point. It acknowledged, however, that the analysis of inventive step would not differ from that

with respect to D1.

8.3 Problem underlying the claimed invention

The respondent formulated the problem underlying the claimed invention as to provide a method for preparing cyclohexanone or a mixture of cyclohexanone and cyclohexanone with higher selectivity towards cyclohexanone.

8.4 Solution

The claimed solution is the method for preparing cyclohexanone or a mixture of cyclohexanone and cyclohexanol in a continuous process over doped, supported palladium, characterised in that water is fed continuously or intermittently into the reactor, the weight to weight ratio of water fed into the reactor to phenol fed into the reactor on average being in the range of from 0.0010 to 0.10.

8.5 Success

8.5.1 The parties have different views on whether the problem of enhancing selectivity towards cyclohexanone was credibly solved by the claimed method.

8.5.2 The available data in this respect is summarised as follows.

All the data provided by the appellant show an increase in selectivity towards cyclohexanone if water is added.

The same effect is seen in the results of D37, filed by the respondent.

The patent, however, contains five pairs of examples in which the opposite result was obtained. These are examples 1 to 5, with respect to comparative examples A to E. The appellant argues that the problem of increasing the selectivity towards cyclohexanone has not been credibly solved for this reason alone.

8.5.3 The board considers, however, that these results should be disregarded. This is in line with the appellant's arguments, for example in the third paragraph of page 33 of the statements of grounds of appeal.

The appellant argued at length, with reference to scientific evidence, that these examples were not representative of a real industrial process. Most of them are carried out over a broken catalyst. The conversions provided are very low and do not represent those disclosed in the prior art (D1 and D6). Neither the number of tubes of the reactor nor the catalyst's density are provided. The weight hourly space velocity (WHSV) used is untypical.

There is ample evidence that selectivity towards cyclohexanone is increased by using water in the relative amount required by claim 1 under usual hydrogenation conditions over palladium. There is evidence obtained in non-representative conditions that it does not. Evidence obtained under conditions which the skilled person would never have chosen does not represent the subject-matter claimed, even if formally embraced by it. It thus cannot outweigh solid evidence to the contrary.

8.5.4 The appellant also argued that the available data did not prove an improvement by every amount of water added. The data available only tested a fivefold

increase of water, from 0.007 to 0.036. Claim 1, however, required a relative amount of from 0.0010 to 0.10. This was an interval of two orders of magnitude.

The board considers, however, that the amount of water in the available evidence is representative of that required by claim 1. There is no proof that water at the lower or higher end of the relative amount set by claim 1 would not follow the general trend of the data on file. This argument is thus not convincing.

8.5.5 The appellant argued that the available data were carried out with catalysts supported on alumina. Any effect shown would not necessarily be obtained if the catalyst was supported on activated carbon.

However, there is no evidence on file on this respect. As a rule, the support is inert and is not expected to influence the catalytic properties of the metal in any way. Thus, this argument is also not convincing.

8.5.6 The appellant argued that the claim encompassed a method in which water was added intermittently. Such a mode of addition could not lead to any improvement if the addition of water was made during very short intervals and interrupted for a long time.

However, such a method would nevertheless lead to an increase in selectivity, albeit a small one, over a method in which water is not added at any point. Thus, this argument is also not convincing.

8.5.7 The appellant raised a number of objections by comparing different results obtained in the experimental evidence filed as D37.

However, the appellant was comparing results obtained in different series, different reactors and carried out under different conditions (temperature, dilution and WHSV). Thus, no conclusion can be obtained on the effect of the distinguishing feature of the claimed invention.

8.5.8 The appellant argued that the increase in selectivity towards cyclohexanone shown by experimental evidence D5 was the consequence of a kinetic effect due to the lower conversion.

If lower conversion would inevitably be linked to a higher selectivity towards cyclohexanone, this effect should have always been obtained. However, the pair Example New2 and Comparative Example New2 of experimental evidence D37 shows a decrease both of conversion and selectivity, contrary to the appellant's argument. This argument is thus not convincing.

8.5.9 The appellant argued that an improvement was only possible if both conversion and selectivity (i.e. yield) were enhanced. An increase of selectivity towards cyclohexanone was not enough on its own.

However, there is no example of a worse yield of cyclohexanone if water is added. This could also be the case for examples 1 to 5 of the patent if the lack of indication of any side-product meant that none was formed. This argument is thus also not convincing.

8.5.10 The appellant argued extensively that it was not apparent whether the data in D4, filed by the respondent during examination and summarising the data in the patent, disclosed selectivity or yields of cyclohexanone and cyclohexanol.

Examples F and 6 of the patent clearly provide the mol percent of the products. D4 is a summary of the data in the patent, not additional evidence. Be that as it may, comparison of the results of examples F and 6 show a higher relative amount of cyclohexanone produced if water is added. This is regardless of whether D4 provided yields or selectivities.

8.5.11 The board concludes that, having regard to the available evidence, the problem of enhancing selectivity towards cyclohexanone has been credibly solved by the method of claim 1.

8.6 It thus remains to be decided whether the proposed solution to the objective problem defined above would have been obvious for the skilled person in view of the prior art.

The appellant argued that the claimed solution would have been obvious having regard to D10.

Document D10 relates to a technology outdated at the filing date, as disclosed in D6 (see 8.1.4 above). For this reason alone, the skilled person seeking to improve selectivity would not have taken its teaching into account.

In addition, any conclusion on selectivity by adding water to a process over supported nickel would not be considered as directly applicable to a process over palladium. The process on nickel is by its own nature less selective and requires a second step to hydrogenate the cyclohexanol produced (D6, page 130, last paragraph; D10, column 5, line 39; and D10, figure). Thus, also for this reason, the argument is

not convincing.

D10 discloses that the increase in cyclohexanone selectivity is due to diluting with an inert gas, preferably methane (column 6, lines 42 to 45; and claims 1 and 2). Water is considered to increase efficiency, which refers to the selectivity to the desired products (cyclohexanone and cyclohexanol). From the results "OL to ONE ration" in Table I for the pairs with and without water, the change in selectivity towards cyclohexanone is very small, and the trend is not consistent (compare entries 21 and 32 and entries 26 and 30).

This argument is thus not convincing.

8.7 The appellant argued that the priority document of the patent referred to nickel and palladium catalysts on the same footing. This, it argued, proved that the skilled person would have considered these catalysts as equivalents.

This argument cannot be accepted. The priority document is not prior art for the claimed invention.

8.8 The appellant also relied on the disclosure of documents D9 and D19, which show that the claimed process could be carried out over palladium catalysts in the presence of water.

However, neither D9 nor D19 links water to selectivity. This argument is thus also not convincing.

8.9 The appellant argued that it was obvious for the skilled person that adding water would inevitably displace the reaction equilibrium towards the reagents.

The consequence was to favour the kinetically favourable product, cyclohexanone, over the thermodynamic product.

Even if this kinetic effect could underlie the effect achieved, it does not necessarily render the claimed solution obvious.

In addition, the arguments provided by the appellant are not accurate. Water is not a by-product of the hydrogenation. It is produced if the reaction temperature is too high, in small amounts, by dehydration of cyclohexanol (see Figure 5.1 on page 132 of D6). Water does not thus directly affect the chemical equilibrium of the hydrogenation of phenol to cyclohexanone and cyclohexanol. At the most, its presence could decrease the amount of cyclohexane produced, but this is not an effect on which the patent relies.

8.10 Therefore, the board arrives at the conclusion that the method of claim 1 of the first auxiliary request is inventive (Article 56 EPC). The respondent's first auxiliary request is thus allowed.

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 on the basis of claims 1 to 9 of the auxiliary request 1, filed as auxiliary request 8 with the reply to the grounds of appeal dated 9 September 2019, and a description yet to be adapted.

The Registrar: The Chair:

C. Rodríguez Rodríguez P. Gryczka

Decision electronically authenticated