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Datasheet for the decision of 16 September 2021

Case Number:	T 2340/16 - 3.3.02
Application Number:	09815514.6
Publication Number:	2328905
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Language of the proceedings:	EN

Title of invention:
ETHYLENE TETRAMERIZATION CATALYSTS COMPRISING P-N-P LIGANDS

Patent Proprietor:
Nova Chemicals (International) S.A.

Opponent:
Sasol Technology (Pty) Limited

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:

Inventive step
Non-enabling disclosure
Erroneous disclosure

Decisions cited:

T 2260/16

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 2340/16 - 3.3.02

DECISION
of Technical Board of Appeal 3.3.02
of 16 September 2021

Appellant: (Opponent)	Sasol Technology (Pty) Limited Baker Square West 33 Baker Street Rosebank 2196 (ZA)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Respondent: (Patent Proprietor)	Nova Chemicals (International) S.A. Avenue de la Gare 14 1700 Fribourg (CH)
Representative:	Mewburn Ellis LLP Aurora Building Counterslip Bristol BS1 6BX (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 12 August 2016 rejecting the opposition filed against European patent No. 2328905 pursuant to Article 101(2) EPC.**

Composition of the Board:

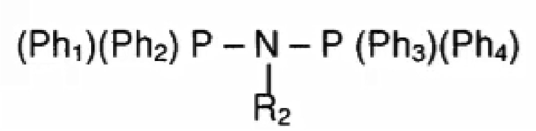
Chairman	M. O. Müller
Members:	S. Bertrand
	P. de Heij

Summary of Facts and Submissions

I. The appeal by the opponent ("appellant") lies from the decision of the opposition division to reject the opposition filed against European patent No. 2 328 905.

II. The contested patent contained a set of nine claims, independent claims 1, 5 and 6 of which read as follows:

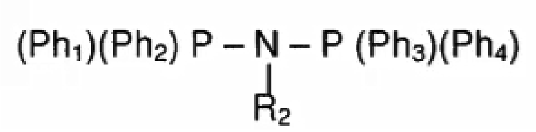
"*1. A ligand defined by the formula:*



$$(Ph_1)(Ph_2)P-\underset{R_2}{\underset{|}{N}}-P(Ph_3)(Ph_4)$$

wherein each of Ph_1, Ph_2, Ph_3 and Ph_4 is a phenyl group bonded to a phosphorus atom, with the provisos that
i) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 is ortho substituted with a halogen selected from the group consisting of fluorine, bromine and chlorine;
ii) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 has only hydrogen bonded to each ortho carbon; and
iii) R_2 is selected from the group consisting of hydrogen, C_{1-20} hydrocarbyl and silyl."

"5. *A catalyst system comprising:*
a) a transition metal selected from the group consisting of Cr, V, Ti, Ni, and W;
b) A ligand defined by the formula:



$$(Ph_1)(Ph_2)P-\underset{R_2}{\underset{|}{N}}-P(Ph_3)(Ph_4)$$

wherein each of Ph_1, Ph_2, Ph_3 and Ph_4 is a phenyl group bonded to a phosphorus atom, with the provisos that

i) at least one of Ph_1, Ph_2, Ph_3 *and* Ph_4 *is ortho substituted with a halogen selected from the group consisting of fluorine, bromine and chlorine;*
ii) at least one of Ph_1, Ph_2, Ph_3 *and* Ph_4 *has only hydrogen bonded to each ortho carbon; and*
iii) R_2 *is selected from the group consisting of hydrogen,* C_{1-20} *hydrocarbyl and silyl, and*
c) an activator."

"6. *A process for the oligomerization of ethylene comprising contacting the catalyst system of claim 5 with ethylene under oligomerization conditions.*"

III. The following documents are referred to in the present decision:

D1	WO 2004/056478 A1
D2	WO 2004/056480 A1
D3	US 2006/0293546 A1
D5	US 2007/0185357 A1
D6	WO 2004/056479 A1
D8	K. Blann *et al*, Chem. Commun., 2005, 620-1
D9	M. J. Overett *et al*, Chem. Commun., 2005, 622-624
D12	Excerpt from file history of US 10/539,237
D13	Excerpt from file history of US 10/538,088
D14	G. Ewart *et al*, J. Chem. Soc. 1964, 1543-7
D15	A. L. Casalnuovo *et al*, J. Am. Chem. Soc. (116), 1994, 9869-82
D16	T.V. RajanBabu *et al*, J. Org. Chem. (62), 1997, 6012-28
D21	Annex 1 and annex 2 submitted with the statement of grounds of appeal

IV. In its decision, the opposition division came to the conclusion that the claims according to the main request (patent as granted) involved an inventive step considering D1 or D2 as the closest prior art and in particular any of ligands:

- A [(2-fluorophenyl)$_2$P-N(methyl)-P(2-fluorophenyl)$_2$],
- C [(4-methoxyphenyl)$_2$P-N(isopropyl)-P(4-methoxyphenyl)$_2$], or
- E [(2-methoxyphenyl)$_2$P-N(isopropyl)-P(phenyl)$_2$].

V. In its statement setting out the grounds of appeal, the appellant contested the reasoning of the opposition division and submitted that the subject-matter of the claims as granted did not involve an inventive step considering D1 or D2 as the closest prior art, particularly in view of ligand E. Furthermore, it submitted document D21, comprising additional experimental data.

VI. The patent proprietor ("respondent") filed a reply to the statement of grounds of appeal, contested the appellant's objections and filed fourth to ninth auxiliary requests and D22 as an experimental report in response to D21.

VII. On 28 November 2019, the board issued a communication in preparation for the oral proceedings, which were to be arranged as per the parties' request.

VIII. Oral proceedings were cancelled and rescheduled to be held by videoconference.

IX. With a letter dated 14 April 2021, the respondent submitted a copy of decision T 2260/16 and further arguments regarding the non-enabling disclosure of ligand A in D1 and D2. It requested the board to issue a further communication, taking into account the last arguments which the respondent had submitted.

X. In a communication dated 7 July 2021, the board informed the parties that it saw no reason to issue a second communication under Article 15(1) RPBA 2020.

XI. In its letter of 23 August 2021, the appellant informed the board and the respondent that it would not be attending the oral proceedings.

XII. Oral proceedings before the board were held by videoconference on 16 September 2021 in the appellant's absence in accordance with Rule 115(2) EPC and Article 15(3) RPBA 2020.

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

Main request - inventive step

- Any of the ligands A, C and E as disclosed in documents D1 and D2 could be selected as the closest prior art. In first instance, the respondent had argued that the disclosure of ligand A was not an enabling disclosure. However, the opposition division had correctly acknowledged that the disclosure was enabling.

- The opposition division had erred in the conclusion that the ligands of the patent provided a superior productivity compared to the prior art ligands. Document D21 comprised experimental results comparing ligand E (according to D1 and D2) to ligand 1 according to the invention. Ligand 1 showed no improved productivity in comparison with ligand E.

- Productivity could in any case not be taken into consideration in the formulation of the objective technical problem because this effect was not derivable form the application as filed. The patent focused on maximisation of the yield of 1-hexene and 1-octene. There was no disclosure or suggestion in the original application that the ligand was associated with an improvement in the productivity of an ethylene oligomerisation reaction.

- The productivity parameter was open to manipulation or misinterpretation in that the ethylene oligomerisation reaction might be deliberately terminated before the rate of production fell, even though the catalyst remained active.

- The claims were broadly formulated. The productivity advantage was not achieved across the full scope of the process claims. The productivity was heavily influenced by the temperature and pressure as shown for instance by examples 4 and 6 of the patent. However, temperature and pressure were not part of the process claim. In addition, any advantageous productivity could only be acknowledged for the use of the claimed ligand in combination with chromium.

- Therefore the objective technical problem was no more than the provision of a process of oligomerisation of ethylene which employed an alternative catalyst ligand.

- D1 disclosed that, in case the ligand contained four aromatic groups, it was preferred that a least one of the aromatic groups had no ortho substituent and D1 indicated a preference for no more than two ortho-substituted aromatic groups. Based on the disclosure in D1, it would have been obvious to the skilled person to remove one or two of the ortho-fluoro substituents thereby arriving at a ligand according to the patent. This would also have been obvious in view of the disclosure of ligand A in D1. Ligand A had ortho-fluoro substituents and the skilled person would have foreseen that incorporating one such substituent into ligand C and E would provide a ligand which is active in the oligomerisation of ethylene.

- The claimed alternative catalyst ligand was also obvious in the light of documents D2, D3, D5, D6, D8 and D9.

- The opposition division had therefore erred in the finding that the claims of the patent involved an inventive step.

XIV. The respondent's arguments, where relevant to the present decision, may be summarised as follows:

Main request - inventive step - claim 6

- Considering the disclosure of example 16 of D1, using a catalyst system comprising ligand E, as the closest prior art, the distinguishing feature of claim 6 was the ligand comprising at least one of Ph_1, Ph_2, Ph_3 and Ph_4 which was ortho substituted with a halogen selected from the group consisting of fluorine, bromine and chlorine.

- As explained in paragraph [0009] of the patent, the technical problem underlying the subject-matter of claim 6 of the main request was the provision of a process which provided a more productive ethylene oligomerisation process with a greater quantity of useful 1-hexene and 1-octene products.

- None of the prior art cited by the appellant, i.e. any of D1, D2, D3, D5, D6, D8 and D9, taught how to solve this problem.

- Even if the objective technical problem was the provision of an alternative ligand, the solution of the invention was not obvious as the disclosure of ligands comprising a phenyl group ortho substituted with a halogen in documents D1 and D2 was not an enabling one. The synthetic route described in D1 was never applied to ligands comprising a phenyl group ortho substituted with a halogen, since this was not exemplified in D1. There was insufficient information in D1 to enable the skilled person to prepare these ligands. The synthetic route of D1 (one-step process) was very different to that described in the patent for preparing such ligands (two-step process).

- This was in line with T 2260/16, which acknowledged that the disclosure in documents D1 and D2 of ligand A, a P-N-P ligand comprising phenyl rings ortho substituted with a halogen, was a non-enabling disclosure.

- A halogen atom was not listed among the preferred polar groups on page 6 of D1.

- Furthermore, the disclosure in D1 of P-N-P ligands comprising phenyl rings ortho substituted with a halogen was erroneous. This was evidenced by the US equivalents D12 and D13, in which P-N-P ligands comprising at least one phenyl ring being ortho substituted with one halogen had been amended or deleted during the examination proceedings.

- Finally, D8 and D9 would point the skilled person away from substituting a halogen at the ortho position on the phenyl rings of the ligands disclosed in D1.

First to seventh auxiliary requests - inventive step

- The same reasoning as for claim 6 of the main request applied to the process claims of any of the first to seventh auxiliary requests.

Eighth auxiliary request - inventive step - claim 6

- Claim 6 of the eighth auxiliary request was restricted to processes for which the solvent was an aliphatic hydrocarbon solvent.

- The experimental data of document D21 were based on experiments performed with toluene, which was not a solvent in accordance with claim 6 of the eighth auxiliary request. For that reason, the comparison made in D21 was not relevant to the evaluation of inventive step of the subject-matter of claim 6 of the eighth auxiliary request.

- D19 and annex 3 submitted with the notice of opposition showed that ligands 1 and 2 (ligands used in the process according to claim 6 of the eighth auxiliary request) had superior productivity in comparison to ligands A, C and E (in accordance with D1 or D2).

- The objective technical problem was the provision of a process which provided a more productive ethylene oligomerisation process in an aliphatic hydrocarbon solvent.

- None of the prior art cited by the appellant taught how to solve this problem.

- The appellant's submissions on productivity were incorrect. Productivity was explicitly mentioned in table 1 of the application as filed, and these values were correct. Furthermore, the skilled person would have understood from paragraph [0004] of the patent that P-N-P ligands influenced the productivity of the catalysts used in the oligomerisation of ethylene. Productivity was a parameter which quantified the amount of product prepared per unit of time and thus characterised the performance of a catalyst.

- The same effect would be achieved by metals known to be used as a catalytic centre and under any conventional process conditions.

- Finally, the burden of proof was with the appellant to show by technical evidence that any other catalytic metal or conventional conditions of temperature and pressure would not have provided advantages over the prior-art ligands.

Eighth auxiliary request - inventive step - claim 1

- For the same reasons as for the process of claim 6 of the eighth auxiliary request, the objective technical problem underlying the subject-matter of claim 1 of the eighth auxiliary request was the provision of a ligand which provided a more productive ethylene oligomerisation catalyst when used in an aliphatic hydrocarbon solvent.

- For the same reasons as given for claim 6 of the eighth auxiliary request, the solution proposed by claim 1 of the eighth auxiliary request was not obvious.

XV. The parties' final requests were as follows:

The appellant requested in writing that the decision under appeal be set aside and that the patent be revoked in its entirety.

The respondent requested:

- that the appeal be dismissed, implying that the opposition division's decision to reject the opposition be upheld (main request);

- alternatively, that the patent be maintained on the basis of the claims of one of the first to third auxiliary requests submitted before the opposition division on 27 May 2016, or of one of the fourth to ninth auxiliary requests filed with its reply to the statement of grounds of appeal; and

- that decision T 2260/16 be admitted into the proceedings.

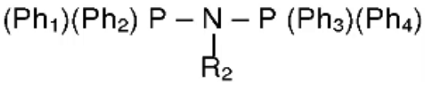
Reasons for the Decision

Main request (patent as granted)

1. Inventive step

1.1 In its statement of grounds of appeal, the appellant only raised an objection of lack of inventive step against the subject-matter of *inter alia* claim 6 of the main request in view of D1 or D2 as the closest prior art.

1.2 Claim 6 of the main request relates to a process for the oligomerisation of ethylene, comprising contacting ethylene with the catalyst system of claim 5 comprising a transition metal (Cr, V, Ti, Ni or W), a ligand and an activator.
The ligand has the following formula:



$$(Ph_1)(Ph_2)P-\underset{\displaystyle R_2}{\underset{|}{N}}-P(Ph_3)(Ph_4)$$

wherein each of Ph_1, Ph_2, Ph_3 and Ph_4 is a phenyl group bonded to a phosphorus atom, with the provisos that
i) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 is ortho substituted with a halogen selected from the group consisting of fluorine, bromine and chlorine;
ii) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 has only hydrogen bonded to each ortho carbon; and
iii) R_2 is selected from the group consisting of hydrogen, C_{1-20} hydrocarbyl and silyl.

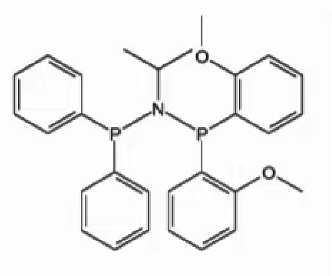
The ligand used in the process of claim 6 of the main request belongs to the group of P-N-P ligands.

The aim of the invention is to provide a process which selectively produces a mixture of 1-hexene and 1-octene with high levels of alpha olefins (paragraph [0009] of the patent).

1.3 Closest prior art

The appellant *inter alia* considered D1 as the closest prior art, and *inter alia* referred to ligand E as an appropriate starting point within D1.

Ligand E is a P-N-P ligand having the following formula:



E

Ligand E is disclosed in example 16 of D1. This example refers to a process for the oligomerisation of ethylene. This process uses a solution of ligand E, a solution of chromium (III) acetylacetonate and a solution of MAO (methylaluminoxane). Table 1 of D1 shows that mainly hexene ("C6") and octene ("C8") are produced. In the C8 fraction, 98.5 wt.% of 1-octene is present, meaning that the level of alpha olefins is high. This thus represents the same aim as the present invention.

Therefore the board sees no reason to deviate from the selection of D1 and ligand E as the closest prior art.

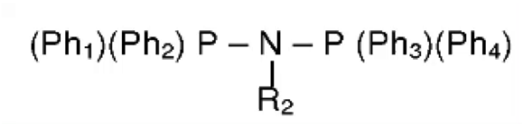
1.4 Distinguishing features

As set out above, the process disclosed in example 16 of D1 is a process for the oligomerisation of ethylene comprising the step of contacting ethylene with a catalyst system comprising chromium, ligand E and MAO.

Chromium and MAO are a transition metal and an activator respectively, as required by claim 6 of the main request by reference to the catalyst system of claim 5.

The process of example 16 of D1 provides ethylene oligomerisation products and is considered a process for the oligomerisation of ethylene comprising the step of contacting ethylene under oligomerisation conditions, as required by claim 6 of the main request.

Ligand E is a P-N-P ligand of the following formula:



$$(Ph_1)(Ph_2)\,P-\underset{\substack{| \\ R_2}}{N}-P\,(Ph_3)(Ph_4)$$

in which Ph_1 and Ph_2 are phenyl, Ph_3 and Ph_4 are 4-methoxyphenyl and R_2 is isopropyl.

As set out above (point 1.2), the ligand defined in the catalyst system referred to in claim 6 of the main request requires that:
i) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 be ortho substituted with a halogen selected from the group consisting of fluorine, bromine and chlorine;
ii) at least one of Ph_1, Ph_2, Ph_3 and Ph_4 have only hydrogen bonded to each ortho carbon;

Ligand E complies with requirement ii) but not with i): the ligand does not comprise at least one of Ph_1, Ph_2, Ph_3 and Ph_4 being ortho substituted with one halogen selected from the group consisting of fluorine, bromine and chlorine.

The subject-matter of claim 6 of the main request therefore differs from the disclosure of example 16 in the ligand used in the catalyst system, namely in that the P-N-P ligand comprises at least one of Ph_1, Ph_2, Ph_3 and Ph_4 being ortho substituted with one halogen selected from the group consisting of fluorine, bromine and chlorine.

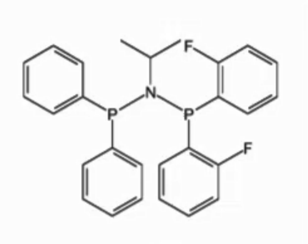
1.5 Formulation of the technical problem

The respondent in its reply to the grounds of appeal submitted that the technical problem underlying the subject-matter of claim 6 of the main request was the provision of a process which provided a more productive ethylene oligomerisation process with a larger quantity of useful 1-hexene and 1-octene products.

The board does not agree for the following reasons:

Document D21 was submitted by the appellant and comprises experimental results. It compares ligand 1 (according to the invention) with ligand E (according to D1, point 1.3 above).

Ligand 1 has the following formula:



1

In the table of D21, ligand 1 exhibits a productivity of 60,924 gram of product per gram of chromium and per hour ($g_{product}/g_{Cr}$.hr). Ligand E (according to D1) exhibits a productivity of 72,140 $g_{product}/g_{Cr}$.hr. The selectivity for 1-hexene/1-octene is the same for ligand 1 and ligand E (84.1 wt.%, column "1-C_6 + 1-C_8").

It follows that ligand 1 does not have improved productivity in comparison to ligand E under the conditions used in D21, while the selectivity for 1-hexene/1-octene is the same for both ligands. This conclusion was not disputed by the respondent.

Therefore the data of D21 show that the technical problem as formulated by the respondent (increased productivity over D1) is not solved over the whole scope of claim 6 of the main request, i.e. at least by ligand 1 in comparison to ligand E.

It should be noted that this conclusion is not invalidated by D22 filed by and relied on by the respondent.

D22 is a document comprising comparative data on the same ligands as those compared in D21 (ligand 1 and ligand E). In D22, two series of experiments are carried out and show that ligand 1 (304,286 and 512,686

$g_{product}/g_{Cr}$.hr) has an improved selectivity in comparison to ligand E (188,006 and 79,196 $g_{product}/g_{Cr}$.hr). The board notes that the experiments in D22 were not carried out under the same conditions as those of D21: in D22 the pressure is 40 bar and the temperature is 45°C, whereas in D21 the pressure is 20 bar and the temperature is 70°C. Therefore the experimental results of D22 cannot invalidate the comparison in D21 since the experimental conditions are not identical.

Consequently, the objective technical problem as submitted by the respondent has to be reformulated and can be seen only as the provision of a process for the oligomerisation of ethylene which employs an alternative ligand.

1.6 Obviousness of the solution

D1 teaches that the ligands disclosed in the document, including P-N-P ligands, comprise aromatic radicals ("R_1, R_2, R_3 and R_4") (first paragraph on page 6 of D1). In the same passage, D1 further discloses that preferably not all these aromatic radicals may be substituted by any substituent on an atom adjacent to the atom bound to the phosphorus atom.

Selecting a halogen from fluorine, bromine and chlorine as required for this substituent by claim 6 represents an arbitrary choice from the list of potential candidates encompassed by the term "substituent". Such an arbitrary choice does not contribute to inventive step.

Hence the skilled person would have arrived at the subject-matter of claim 6 of the main request without exercising inventive skill.

1.6.1 The respondent disputed this conclusion. First, it submitted that D1 did not disclose any ligands comprising at least one phenyl ring being ortho substituted with one halogen in an enabling manner. The synthetic route described in D1 was never applied to P-N-P ligands comprising at least one phenyl ring being ortho substituted with one halogen, since this was not exemplified in D1. There was insufficient information in D1 to enable the skilled person to prepare these ligands. The synthetic route of D1, which was a one-step process, was very different from the two-step process described in the patent for preparing such ligands. The respondent further referred to T 2260/16, which, in a case dealing with the same document D1, acknowledged that the disclosure of ligand A, a ligand comprising at least one phenyl ring being ortho substituted with one halogen, was a non-enabling disclosure in D1. Since D1 hence did not disclose any ligands with phenyl rings being ortho substituted with one halogen in an enabling manner, D1 could not render the claimed subject-matter, which required exactly this type of phenyl rings, obvious.

The board is not convinced.

In D1 (example 1d)) the process for preparing the P-N-P ligands in a one-step process involves the reaction of a primary amine with a substituted phosphine chloride (Ar_2PCl). As set out above, the P-N-P ligands disclosed in D1 cover ligands comprising at least one phenyl ring being ortho substituted with one halogen.

Furthermore, the top of page 8 and the first sentence of the second paragraph on page 16 of D1 disclose that the ligands disclosed therein can be prepared using procedures known to a person skilled in the art and procedures disclosed in published literature. D14, D15 and D16 were published in 1964, 1994 and 1997, respectively, i.e. before the priority date of D1 (20 December 2002). D14, D15 and D16 were thus available to the skilled person when reading D1. As reasoned by the opposition division (point 8.3.8 of the decision), D14 (paragraph bridging pages 1545 and 1546) discloses how to prepare P-N-P ligands from the reaction of a primary amine with diphenylphosphino-chloride. Furthermore, D15 (page 9878, left-hand column and top of right-hand column, "Preparation of Ligands") and D16 (page 6023) disclose the synthesis of substituted diphenylphosphino-chloride, the precursor of the substituted P-N-P ligands. The substituted diphenylphosphino-chloride is synthesised by reacting dibutyl phosphite with a Grignard reagent of formula RMgBr wherein R is a substituted phenyl, followed by treatment of the intermediate product with phosphorus trichloride. Therefore, by analogy with the method disclosed in D14, a P-N-P ligand comprising at least one phenyl ring being ortho substituted with one halogen can be prepared by selecting the appropriate halogen ortho substituted diphenylphosphino-chloride, which is to be prepared according to D15 and D16. There is no reason apparent to the board why this method would not have worked when applied in analogy to that described in D14 in order to prepare ligands comprising at least one phenyl ring being ortho substituted with one halogen.

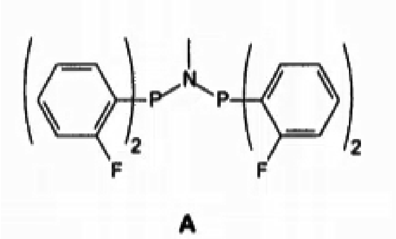
The board acknowledges that, in contrast to the process disclosed in D1, the patent uses a two-step process. In the first step (e.g. paragraphs [0074] to [0076] of the patent), the substituted phosphine chloride (e.g. (ortho $F-C_6H_4)_2PCl$) is reacted with a primary amine to provide an aminophosphine intermediate (e.g. (ortho F $-C_6H_4)_2PNHR$). This intermediate is then reacted in the presence of a base (n-BuLi) with a second phosphine chloride (Ph_2PCl) to give ligand 1 (see the formula in point 1.5 above). However, the fact that the patent uses a process of preparation different from the processes of the prior art does not provide evidence that the process of D1 or a process of the prior art available at the priority date of D1 could not yield the P-N-P ligands comprising at least one phenyl ring being ortho substituted with one halogen.

The board further acknowledges that paragraph [0012] of the patent mentions that "*Attempts to produce the new ligands by conventional condensation reactions ... were* ***unsuccessful***" (emphasis added by the board). This however does not necessarily mean that the production of these new ligands was not possible at all but may simply mean that the yield was not satisfactory. Furthermore, it cannot be deduced that the attempts to produce the new ligands mentioned therein refer to production of these ligands with the process of D1.

In the absence of any evidence to the contrary, the board concludes that there is no reason to assume that the information given in D1 was insufficient to enable the skilled person at the relevant date of D1 to prepare a P-N-P ligand comprising at least one phenyl ring being ortho substituted with one halogen, taking into account the common general knowledge represented by D14, D15 and D16 at that relevant date.

This conclusion does not contradict the finding of a non-enabling disclosure of ligand A in T 2260/16.

Ligand A has the following formula:



A

In T 2260/16 (reasons 1.4 to 1.7) it was concluded that ligand A was not disclosed in an enabling manner in D1. However, the situation in the case at hand is different from the situation in T 2260/16. In the case at hand, the question to be answered is whether it is possible to prepare a P-N-P ligand comprising **at least one** phenyl ring being ortho substituted with one halogen, rather than a specific P-N-P ligand A comprising **four** phenyl rings being ortho substituted with one halogen. In addition, the board in case T 2260/16 could not take into account the above mentioned documents D14, D15 and D16 that were submitted by the appellant in the present case in support of enablement. The appellant in case T 2260/16 after all had not rebutted the respondent's submissions regarding absence of an enabling disclosure.

Regardless of this, it is noted that the law does not preclude a board from deciding a case in a different way from another board, even though the facts underlying the case may be highly similar. Each board must make up its own mind and arrive at a legal conclusion that it considers to be the correct one.

1.6.2 According to the respondent, D1 could not render the claimed subject-matter obvious for the further reason that a halogen atom was not listed in the preferred polar groups on page 6 of D1 for substitution of the phenyl rings. These polar groups were limited only to multiatomic groups wherein a permanent dipole moment occurred between at least three different atoms. Thus the skilled person would not have considered a halogen atom a suitable polar group for the P-N-P ligands disclosed in D1. The skilled person would therefore not have arrived at the claimed subject-matter.

The board does not agree.

The board first notes that the first paragraph on page 6 of D1 does not refer to **any polar group** as a substituent on an atom at the ortho position but to **any substituent** ("...a*ny substituent on an atom adjacent to the atom bound to A or C.*"). The second paragraph makes a distinction between "a polar substituent" on at least one of R^1, R^2, R^3 and R^4 and "any substituent" at the ortho position by using the expression "In **addition**..." .

Even if it were accepted that the substituents at the ortho position were polar groups according to page 6 of D1, the board considers that halogen atoms would not be excluded from the list of polar groups. Contrary to the appellant's submissions, the polar groups listed on page 6 (sixth full paragraph) are not limited only to multiatomic groups wherein a permanent dipole moment occurs between at least three different atoms, since hydroxy and amino groups, which are in the list of polar groups on page 6 of D1, are not groups with a permanent dipole moment occurring between at least three different atoms. Thus the skilled person would not exclude polar groups such as halogens from the potential polar groups as taught by D1.

1.6.3 As a further argument, the respondent, relying on the prosecution of a US family member of the patent in suit, submitted that the disclosure in D1 of P-N-P ligands comprising at least one phenyl ring being ortho substituted with one halogen was erroneous.

The board is of the view that P-N-P ligands comprising at least one phenyl ring being ortho substituted with one halogen are an embodiment of the general term "heteroatomic ligand" in claim 2 of D1. As reasoned by the opposition division (8.4.3 of the decision), the skilled person would not see these ligands as an erroneous embodiment in D1. More specifically, the fact that some of these ligands have been amended in the US equivalents D12 and D13 is considered a response of the applicant to the rejection of certain claims in the US proceedings (see page 16 of D12 and page 17 of D13) and is not evidence of an erroneous disclosure. Therefore the amendments made in D12 and D13 cannot be used for determining the content of the disclosure of D1 and D2 as such.

1.6.4 Finally, the respondent argued that D8 and D9 would point the skilled person away from substituting with a halogen at the ortho position on the phenyl rings of the ligands disclosed in D1 and D2. The documents only disclosed alkyl groups as substituents at the ortho position of the phenyl groups of P-N-P ligands. There was no disclosure of halogen atoms as substituents on the phenyl groups of P-N-P ligands in these documents. More specifically, D8 and D9 taught that the steric nature of the substituent at the ortho position of the phenyl groups of P-N-P ligands influenced the ethylene oligomerisation selectivity, so the skilled person would not have introduced a halogen atom at the ortho position of the phenyl groups of P-N-P ligands.

The board does not agree. What the respondent in fact tries to argue is that a prejudice exists in the art against the selection of halogen for the ortho substitution of the phenyl rings of the ligands in D1. This argument cannot succeed. The mere fact that some prior art documents, such as D8 or D9, do not disclose halogen substitution as such cannot create any such prejudice. Otherwise a prejudice could always be argued to be present since there will always be prior art documents not disclosing a certain feature of a claim. Furthermore, the teaching in D8 or D9 that the nature of the ortho substituent has an influence on oligomerisation cannot be equated with a prejudice against ortho substitution with halogen either. In fact, there is no teaching at all in either D8 or D9 about any influence of halogen substitution at the ortho position, let alone that it is disclosed that the influence of such a substitution would be such that the objective technical problem cannot be solved. In fact, any influence on selectivity as referred to in D8 and D9 achieved during oligomerisation is irrelevant since the objective technical problem is not concerned with selectivity.

1.7 Therefore the subject-matter of claim 6 of the main request does not involve an inventive step.

2. For this reason, the main request is not allowable.

First to seventh auxiliary requests

3. Claim 5 of the first auxiliary request differs from claim 6 of the main request in that the list of halogens for the definition of the ortho substituent in the ligand of the catalyst system used in the claimed process was restricted to fluorine.

As already set out for the main request, the selection of any halogen, and thus also of fluorine, for the ortho substituent is arbitrary. No inventive step can thus be recognised for the subject-matter of claim 5 of the first auxiliary request for the same reasons as given for the subject-matter of claim 6 of the main request.

4. Claim 4 of the second auxiliary request differs from claim 5 of the first auxiliary request in that the R_2 group of the ligand of the catalyst system used in the claimed process is limited to a "simple" alkyl group having from 1 to 12 carbon atoms.

The group in ligand E of D1 corresponding to R_2 is isopropyl and is thus a simple alkyl group having from 1 to 12 carbon atoms. Hence the restriction in claim 4 of the second auxiliary request does not lead to any additional distinguishing feature. Thus the same reasons as given for the main request apply to the subject-matter of claim 4 of the second auxiliary request.

5. Claim 3 of the third auxiliary request differs from claim 4 of the second auxiliary request in that the R_2 group of the ligand of the catalyst system used in the claimed process is limited to isopropyl.

As set out above, the group in ligand E of D1, corresponding to R_2, is isopropyl, so the restriction of the definition of R_2 in claim 3 of the third auxiliary request does not lead to any additional distinguishing feature. The subject-matter of claim 3 of the third auxiliary request therefore does not involve an inventive step for the same reasons as given for the main request.

6. Claim 6 of the fourth auxiliary request corresponds to claim 6 of the main request, except that the list of transition metals of the catalyst system used in the claimed process has been restricted to chromium.

As set out above (1.3, *supra*), example 16 of D1 discloses chromium as the transition metal in the catalyst used for the oligomerisation of ethylene. Hence the restriction in claim 6 of the fourth auxiliary request does not lead to any additional distinguishing feature. The subject-matter of claim 6 of the fourth auxiliary request therefore does not involve an inventive step for the same reasons as given for the main request.

7. Claim 5 of the fifth auxiliary request is a combination of claim 5 of the first auxiliary request and claim 6 of the fourth auxiliary request (the halogen of the ligand is fluorine and the transition metal of the catalyst is chromium). For the same reasons as given for the first and fourth auxiliary requests, the subject-matter of claim 5 of the fifth auxiliary request does not involve an inventive step.

8. Claim 4 of the sixth auxiliary request is a combination of claim 4 of the second auxiliary request and claim 6 of the fourth auxiliary request (the halogen of the

ligand is fluorine, the R_2 group of the ligand is a simple alkyl group having from 1 to 12 carbon atoms and the transition metal of the catalyst is chromium). For the same reasons as given for the second and fourth auxiliary requests, the subject-matter of claim 4 of the sixth auxiliary request does not involve an inventive step.

9. Claim 3 of the seventh auxiliary request is a combination of claim 3 of the third auxiliary request and claim 6 of the fourth auxiliary request (the halogen of the ligand is fluorine, the R_2 group of the ligand is isopropyl and the transition metal of the catalyst is chromium). For the same reasons as given for the third and fourth auxiliary requests, the subject-matter of claim 3 of the seventh auxiliary request does not involve an inventive step.

10. For these reasons, the first to seventh auxiliary requests are not allowable.

Eighth auxiliary request

11. The claims of the eighth auxiliary request differ from those of the main request in that the solvent used in the process of claim 6 of the eighth auxiliary request has been restricted to an aliphatic hydrocarbon solvent.

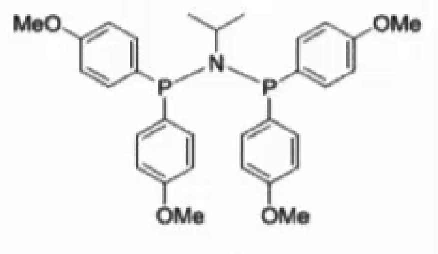
12. Inventive step - claim 6

12.1 In relation to the main request, the appellant referred to any of ligands A, C and E disclosed in D1 and D2 as the closest prior art. As each of these ligands is a suitable starting point, inventive step will be assessed considering not only ligand E, but also ligands A and C.

12.2 Closest prior art

Ligand A ("(2-fluorophenyl)$_2$P-N(methyl)-P(2-fluorophenyl)$_2$" or "(o-fluorophenyl)$_2$P-N(methyl)-P(o-fluorophenyl)$_2$") is of the formula depicted in point 1.7 above, and is disclosed in D1 (page 8, lines 15 and 16; page 16, lines 24-25; claims 28 and 65) and D2 (page 10, lines 14-15; claim 25).

Ligand C ("(p-methoxyphenyl)$_2$P-N(isopropyl)-P(p-methoxyphenyl)$_2$") is disclosed in D1 (examples 1, 2 and 4-15) and D2 (claim 25) and has the following formula:



C

Ligand E ("(phenyl)$_2$P-N(isopropyl)-P(4-methoxyphenyl)$_2$", formula in point 1.3 above) is disclosed in D1 (example 16) and D2 (claim 25).

12.3 Distinguishing feature

Like claim 6 of the main request, the distinguishing feature of claim 6 of the eighth auxiliary request over ligands C and E is that the P-N-P ligand comprises at least one of Ph_1, Ph_2, Ph_3 and Ph_4 being ortho substituted with one halogen selected from the group consisting of fluorine, bromine and chlorine. With regard to ligand A, the distinguishing feature of claim

6 of the eighth auxiliary request is that the P-N-P ligand comprises at least one of Ph_1, Ph_2, Ph_3 and Ph_4 having only hydrogen bonded to each ortho carbon.

12.4 Formulation of the technical problem

12.4.1 As set out above in the context of the main request, the appellant relied on D21 to argue that no effect was achieved by the ligands of the invention over ligand E.

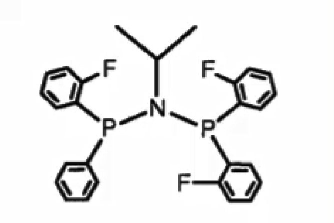
The experimental results submitted by the appellant in document D21 and considered for the process of claim 6 of the main request are no longer relevant for assessing the technical effect achieved by the ligands used in the process according to claim 6 of the eighth auxiliary request, since the solvent used in the experiments of D21 is toluene. This solvent is not an aliphatic hydrocarbon solvent as required by claim 6 of the eighth auxiliary request. Thus the experimental results of D21 do not compare the closest prior art with an embodiment according to claim 6 of the eighth auxiliary request, and for that reason cannot be taken into account when formulating the objective technical problem.

The same consideration applies with document D22 relied on by the respondent in the context of the process of claim 6 of the main request. The experiments in D22 were carried out in toluene. Toluene, as set out above, is not a solvent as required by claim 6 of the eighth auxiliary request.

12.4.2 The respondent relied on D19 during the oral proceedings for assessing the effect achieved by the ligands used in the process of claim 6 of the eighth auxiliary request.

In D19, ligands 1 and 2 are compared with ligands C and E of D1 in a process of oligomerisation of ethylene. The process of D19 is carried out in cyclohexane. Cyclohexane is an aliphatic hydrocarbon solvent, as required by claim 6 of the eighth auxiliary request.

Ligand 1 has a formula as depicted in point 1.5 above. Ligand 2 has the following formula:

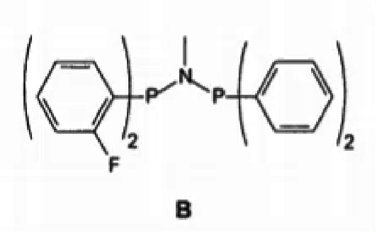


Ligands 1 and 2 are thus as defined in claim 6 of the eighth auxiliary request.

Ligands 1 and 2 ("isopropyl-(o-F)$_2$" and "isopropyl-(o-F)$_3$") have a productivity of 5.99 x 10^6 and 5.34 x 10^6 $g_{product}/g_{Cr}$.hr, respectively. Ligands C and E ("isopropyl-(p-OMe)$_4$" and "isopropyl-(o-OMe)$_2$") have a productivity of 1.57 x 10^6 and 0.29 x 10^6 $g_{product}/g_{Cr}$.hr, repectively. Thus D19 shows that ligands 1 and 2 (ligands used in the process according to claim 6 of the eighth auxiliary request) have increased productivity in comparison to ligands C and E (according to D1).

Annex 3 submitted with the notice of opposition shows comparative data for ligand B and ligand A (see formula in point 1.7 above) of D1 and D2 in a process of oligomerisation of ethylene carried out in 2,2,4-trimethylpentane (see last paragraph in annex 2 submitted with the notice of opposition). 2,2,4-trimethylpentane is an aliphatic hydrocarbon solvent as required by claim 6 of the eighth auxiliary request.

Ligand B has the following formula:



B

Ligand B is thus as defined in claim 6 of the eighth auxiliary request.

Ligand B has a productivity of 7.2 x 10^6 and 5.6 x 10^6 $g_{product}/g_{Cr}$.hr, while ligand A has a productivity of 5.3 x 10^6 and 5.2 x 10^6 $g_{product}/g_{Cr}$.hr (see second to fifth rows of the table of annex 3). Thus this annex shows that ligand B in accordance with claim 6 has superior productivity in comparison to ligand A in accordance with D1 or D2.

In view of the above technical effect achieved by the ligands used in the process of claim 6 of the eighth auxiliary request, the objective technical problem can be seen as the provision of a process which provides a more productive ethylene oligomerisation process in an aliphatic hydrocarbon solvent.

12.4.3 The appellant disputed the definition of the objective technical problem as set out above. It submitted that there was no disclosure or suggestion in the original application that the ligand was associated with an improvement in the productivity of an ethylene oligomerisation reaction. A link between the ligands used in the process and improved productivity was not derivable from the original application, so the objective technical problem could not be formulated taking this improvement into consideration.

The board does not agree. Table 1 of the application as filed explicitly mentions "productivity", and such productivity was measured for each of the examples referred to in the table. Different values of productivity are obtained for ligands 1 and 2, showing that the productivity also depends on the nature of the ligands. Furthermore, the passage on page 1, lines 28-30 of the application as filed explicitly discloses "*As described in the Chem. Comm. paper, these catalysts preferably comprise a diphosphine ligand in which both phosphine atoms are bonded to two phenyl groups that are each substituted with an ortho-methoxy group. Hexene-1 is produced with high activity and high selectivity by these catalysts*". It is thus recognised in the application as filed that the P-N-P ligands influence the productivity of the catalysts used in the oligomerisation of ethylene.

Thus the application as filed, by reference to the above article, suggests and by the results set forth in the examples even shows, the direct link between P-N-P ligands and productivity. Productivity as a technical effect is thus derivable from the application as filed.

12.4.4 The appellant further submitted that the productivity parameter was open to manipulation or misinterpretation in that the ethylene oligomerisation reaction might be deliberately terminated before the rate of production fell, even though the catalyst remained active. In other words, the calculated productivity value was highly dependent on the point in time at which the reaction was terminated or the monitoring of the amount of product was stopped.

The appellant's argument essentially implies that the respondent has intentionally manipulated the experiments on catalyst performance. This is a mere allegation, and without any substantiation of this allegation the board does not see any reason to doubt that the values given in D19 and annex 3 correctly reflect the catalyst performance.

12.4.5 Finally, the appellant argued that the process was broadly defined since the catalyst was not limited to chromium, the only metal tested in the examples of the patent and the technical data submitted during the proceedings. Furthermore, reaction temperature and pressure were conditions not defined in the claim. Hence the objective technical problem had not been solved over the entire scope of the claim.

The board does not agree.

The burden of proof was with the appellant to show by technical evidence that the improved productivity shown in D19 and annex 3 would not be obtained for any metal other than chromium (the metal used in the respondent's evidence D19 and annex 3) or any conventional conditions of temperature and pressure. In the absence of such technical evidence, the appellant's argument must fail.

12.5 Obviousness of the solution starting from ligands C and E

In its statement of grounds of appeal, the appellant relied on documents D1 to D3, D5, D6, D8 and D9 for the obviousness of the solution proposed by claim 6 of the main request.

As set out above, D1 teaches that the ligand disclosed in the document, including P-N-P ligands, comprises aromatic radicals ("R_1, R_2, R_3 and R_4") that may be substituted by any substituent on an atom adjacent to the atom bound to the phosphorus atom (first paragraph on page 6 of D1). In view of this statement, and in the light of the objective technical problem having been merely the provision of a process for the oligomerisation of ethylene which employed an **alternative** catalyst ligand, the subject-matter of claim 6 of the main request has been regarded as representing an arbitrary selection from the disclosure of D1.

However, the situation is different with regard to claim 6 of the eighth auxiliary request, since now the objective technical problem has to be defined more ambitiously as the provision of a process which provides a **more productive** ethylene oligomerisation process in an aliphatic hydrocarbon solvent. As it has not been argued by the appellant that the claimed process would be obvious for the skilled person attempting to provide a more productive process, it must be held to involve an inventive step.

In fact, D1 does not teach how to improve the productivity, let alone that substituting a halogen atom at the ortho position on the phenyl rings would increase the productivity of the catalyst in the process of claim 6 of the eighth auxiliary request.

The same conclusion is to be drawn in view of D2 (page 7, first and eighth paragraphs) and D6 (page 6, first paragraph), which essentially contain the same teaching as D1, namely P-N-P ligands comprising aromatic radicals ("R_1, R_2, R_3 and R_4") that may be substituted by any substituent on an atom adjacent to the atom bound to the phosphorus atom. There is however no teaching in D2 or D6 to substitute at said ortho position to increase the productivity of the catalyst for the oligomerisation of ethylene.

D3 teaches P-N-P ligands with substituted phenyl groups, among which a 2-fluorophenyl group (i.e. a phenyl ring substituted with fluorine at the ortho position) is mentioned (paragraph [0035] of D3) for the preparation of catalysts for producing an olefin oligomer with high productivity (paragraph [0001] of D3). There is however no teaching to use a P-N-P ligand with the 2-fluorophenyl group disclosed in D3 to increase the productivity.

D5 discloses a process for oligomerisation of ethylene and the preparation of C_6 and C_8 implying the use of a catalyst system comprising chromium, molybdenum or tungsten, and a P-N-P ligand (claims 1 and 14 of D5). Paragraph [0071] of D5 discloses a P-N-P ligand with a fluorine atom at the para position of one phenyl group ("(2-methoxyphenyl)2PN(methyl)P(2-methoxyphenyl)(4-fluorophenyl)"). However, D5 does not suggest substituting a halogen atom on one or more of the phenyl rings at the ortho position, let alone doing so to increase productivity.

D8 and D9 discloses P-N-P ligands for the preparation of ethylene trimerisation and/or tetramerisation catalysts. The P-N-P ligands comprise substituted phenyl groups. No teaching how to improve the productivity of catalysts used in the oligomerisation of ethylene is available in these documents.

Thus none of D1 to D3, D5, D6, D8 and D9 teaches introducing one halogen substituent at the ortho position on at least one of the phenyl rings of the ligands disclosed in D1 or D2 to improve the productivity of catalysts used in the oligomerisation of ethylene in an aliphatic hydrocarbon solvent.

Hence, starting from ligands C or E, the subject-matter of claim 6 of the eighth auxiliary request, and by the same token of dependent claims 7-9, involves an inventive step in view of the cited prior art.

12.6 Obviousness of the solution starting from ligand A

As with the reasoning given for the obviousness of the solution starting from ligands C and E, the cited prior art does not teach how to improve the productivity, let alone removing one to three fluoro substituents of ligand A to increase the productivity of the catalyst comprising this ligand.

13. Inventive step - claim 1

13.1 Claim 1 of the eighth auxiliary request corresponds to claim 1 of the main request. It relates to P-N-P ligands bearing four phenyl groups wherein at least one of them is ortho substituted with a halogen (F, Br, Cl), and at least one of the phenyl groups has only hydrogen bonded to each ortho carbon.

13.2 The appellant objected to inventive step of the subject-matter of claim 1 of the main request in view of ligand A, C and E as the closest prior-art ligand. This objection applies to the subject-matter of claim 1 of the eighth auxiliary request.

13.3 Closest prior art

As for claim 6 of the eighth auxiliary request, D1 and D2 disclosing ligands A, C and E represent the closest prior art.

13.4 Distinguishing feature

Like claim 6 of both the main request and the eighth auxiliary request, the distinguishing feature of claim 1 of the eighth auxiliary request over ligands C and E remains that the ligand comprises at least one halogen selected from the group consisting of fluorine, bromine and chlorine at the ortho position of at least one of Ph_1, Ph_2, Ph_3 and Ph_4. Furthermore, as set out above, the distinguishing feature over ligand A is that the ligand comprises at least one of Ph_1, Ph_2, Ph_3 and Ph_4 which has only hydrogen bonded to each ortho carbon.

13.5 Formulation of the technical problem

The respondent relied on the same effect achieved by the process of claim 6 of the eighth auxiliary request, i.e. the increased productivity of the catalyst prepared with the ligands of claim 1 in comparison to ligands A, C and E as shown in document D19 and in annex 3 (point 12.4.2 above).

For the same reasons as the process of claim 6 of the eighth auxiliary request, the objective technical problem can be seen as the provision of a ligand which provides a more productive ethylene oligomerisation catalyst when used in an aliphatic hydrocarbon solvent.

13.6 Obviousness

As set out above in the context of claim 6 of the eighth auxiliary request, none of the cited prior art teaches introducing one halogen substituent at the ortho position on at least one of the phenyl rings of ligand C or E as disclosed in D1 to improve the productivity of catalysts used in the oligomerisation of ethylene.

Nor is there any teaching in the cited prior art to remove one to three fluoro substituents of ligand A as disclosed in D1 to improve the productivity of catalysts used in the oligomerisation of ethylene.

Thus the subject-matter of claim 1 of the eighth auxiliary request, and by the same token of claims 2 to 5, involves an inventive step within the meaning of Article 56 EPC.

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 eighth auxiliary request, submitted with the reply to the statement of grounds of appeal, and a description to be adapted thereto.

The Registrar: The Chairman:

Beschwerdekammern des Europäischen Patentamts
Boards of Appeal of the European Patent Office
Chambres de recours de l'Office européen des brevets

N. Maslin M. O. Müller

Decision electronically authenticated