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**Datasheet for the decision  
of 22 June 2021**

**Case Number:** T 0869/18 - 3.3.10

**Application Number:** 11802160.9

**Publication Number:** 2632882

**IPC:** C07C17/20, C07C17/25, C07C21/18

**Language of the proceedings:** EN

**Title of invention:**  
PROCESS FOR PRODUCING 2,3,3,3-TETRAFLUOROPROPENE

**Patent Proprietor:**  
Daikin Industries, Ltd.

**Opponent:**  
ARKEMA FRANCE

**Headword:**  
PROCESS FOR PRODUCING 2,3,3,3-TETRAFLUOROPROPENE/DAIKIN

**Relevant legal provisions:**  
EPC Art. 100(b), 56, 83

**Keyword:**  
Sufficiency of disclosure - (yes)  
main and auxiliary request 1 - inventive step (no)  
auxiliary request 2 - inventive step (yes)

**Decisions cited:**

**Catchword:**



**Beschwerdekammern**

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**Chambres de recours**

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Case Number: T 0869/18 - 3.3.10

**D E C I S I O N**  
**of Technical Board of Appeal 3.3.10**  
**of 22 June 2021**

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**Decision under appeal:** **Decision of the Opposition Division of the European Patent Office posted on 1 February 2018 rejecting the opposition filed against European patent No. 2632882 pursuant to Article 101(2) EPC.**

**Composition of the Board:**

**Chairman**            P. Gryczka  
**Members:**            J.-C. Schmid  
                              W. Van der Eijk

## 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 EP-B-2 632 882. Claim 1 of the patent as granted reads as follows:

"1. A process for producing 2,3,3,3-tetrafluoropropene, the process comprising:

(1) a first reaction step of reacting hydrogen fluoride with at least one chlorine-containing compound selected from the group consisting of a chloropropane represented by Formula (1):  $\text{CClX}_2\text{CHClCH}_2\text{Cl}$ , wherein each X is the same or different and is Cl or F, a chloropropene represented by Formula (2):  $\text{CClY}_2\text{CCl}=\text{CH}_2$ , wherein each Y is the same or different and is Cl or F, and a chloropropene represented by Formula (3):  $\text{CZ}_2=\text{CClCH}_2\text{Cl}$ , wherein each Z is the same or different and is Cl or F in a gas phase in the absence of a catalyst while heating; and

(2) a second reaction step of reacting a reaction product obtained in the first reaction step with hydrogen fluoride in a gas phase in the presence of a fluorination catalyst while heating."

II. The Appellant had filed an opposition requesting revocation of the patent-in-suit in its entirety on the grounds of lack of novelty and inventive step (Article 100(a) EPC) and insufficiency of disclosure of the invention (Article 100(b) EPC). *Inter alia*, the following documents were cited in the opposition proceedings

- (A1) WO-A-2008/054781,
- (A2) WO-A-2009/003084,
- (A3) US-A-3 436 430 and
- (A4) EP-A-2 103 587.

III. According to the Opposition Division, it was clear that heating was performed during the first and the second reaction steps. Heating took place within the reactor as indicated in the patent in suit for the general procedure in paragraphs 26, 31 and 50 as well as in the examples in paragraphs 66 and 71. It was routine practice for the skilled person to measure the temperature for a hydrofluorination process depending on the type of reactor used. The process of the patent in suit consisted of performing steps (1) and (2) consecutively. The starting materials for step (1) were identified in claim 1 of the patent in suit as well as the reaction conditions for both steps and the sought product. The products in the intermediate stage were not indicated in claim 1 of the patent in suit, but had to be product(s) obtained from the first step. The process of the patent in suit was exemplified for a specific intermediate mixture leading to HFO-1234yf. There was no substantiated proof to question the feasibility of the claimed process over the whole claimed scope of protection. The Opponent's arguments that HFO-1234yf could not be obtained from any product(s) recovered from the first step were mere allegations. Accordingly, the Opposition Division came to the conclusion that the claimed invention was sufficiently disclosed in the patent in suit to be carried out by the skilled person and that the requirements of Article 83 EPC were fulfilled.

Claim 1 of document A1 disclosed a fluorination reaction of (a)  $CX_3-CHCl-CH_2X$ , (b)  $CCLX_2-CCL=CH_2$  or

(c)  $CX_2=CCl-CH_2X$  with HF, in the liquid or vapor phase, with or without a catalyst to produce at least one product selected from HFC-245cb, HFO-1234yf and/or HCFO-1233xf. The scope of document A1 overlapped with that of claim 1 of the patent in suit in the case where compounds (b) or (c) were taken as starting materials. To arrive at the process of claim 1 of the patent as granted, multiple selections had to be made from the disclosure of document A1, i.e. two mandatory steps, both in vapor phase, the first one without catalyst and the second one with catalyst. There was no example in document A1 relating to the production of HFO-1234yf from HCC-240db. There was no hint in document A1 to combine different pieces of information gathered throughout this document leading to the production of HFO-1234yf from HCC-240db, since document A1 was primarily directed to the fluorination of HCFC-243db, which was not a starting material for the present invention. Hence, the subject-matter of the claims of the patent as granted was novel over document A1.

The closest prior art to the invention was document A2. This document disclosed a two-step process for producing HFO-1234yf, which differed from the claimed process in that the first step was performed in a liquid phase. The technical problem was to improve selectivity toward HFO-1234yf. Even if the problem to be solved were only the provision of an alternative process, the phase change in the first hydrofluorination in the context of the overall production of HFO-1234yf would not be obvious. Document A3 was directed to a non-catalytic fluorination of propylene with HF under vapor phase conditions for the production of chlorofluorohydrocarbons, i.e. products with a very high degree of halogenation with no hydrogen atom left. Document A3 required the presence

of chlorine as a reactant, which was not the case in the contested patent. Document A3 could not be combined with document A2, since these documents did not relate to the preparation of the same product. The process described in document A4 for the production of HFO-1234yf comprised three steps. HCFO-1233xf was the intermediate for the production of HCFC-244bb via fluorination with a catalyst. Hence, the proposed solution to carry out the first stage in a gas phase was not obvious in the light of the cited documents. Even starting from document A1 as the closest prior art to the invention, the skilled person would find no hint to combine the different pieces of information spread throughout this document to arrive at the claimed process. The subject-matter of the claims of the patent as granted involved therefore an inventive step.

IV. During the oral proceedings before the Board, the Respondent defended its patent on the basis of the patent as granted (main request) and on the basis of auxiliary requests 1 to 4 filed with a letter dated 15 October 2018.

Claim 1 of auxiliary request 1 differs from claim 1 of the main request in that the product obtained in the first reaction step is optionally supplied in the second reaction step after removing hydrogen chloride contained therein.

Claim 1 of auxiliary request 2 differs from claim 1 of the main request in that the second reaction step uses, as a starting material, at least one chlorine-containing compound selected from the group consisting of a chloropropane represented by Formula (4) :  $\text{CClX}_2\text{CHClCH}_2\text{Cl}$ , wherein at least one of X is F, a chloropropene represented by Formula (5) :

$\text{CClY}_2\text{CCl}=\text{CH}_2$ , wherein at least one of Y is F, and a chloropropene represented by Formula (6) :  
 $\text{CZ}_2=\text{CClCH}_2\text{Cl}$ , wherein at least one of Z is F, the chlorine-containing compound being contained in the reaction product obtained in the first reaction step.

- V. According to the Appellant, the patent in suit did not provide sufficient information to the skilled person to reproduce all the embodiments covered by claim 1 as granted. Moreover, the patent in suit did not sufficiently describe how to measure the temperature. It was not indicated which zone or component was to be taken into account to implement the requirement "while heating". It was not specified in the patent whether it was, for example, the catalyst bed that had to be heated, the reactor or one of the starting compounds. The requirements of Article 83 were therefore not met for claim 1 of the patent as granted.

The embodiment disclosed on page 8 and 9 of document A1 was novelty destroying for claim 1 of the patent as granted and auxiliary request 1. All the features of claim 1 were disclosed in combination. If novelty were acknowledged, the subject-matter of claim 1 of the main and auxiliary request 1 would lack an inventive step. The problem to be solved could only be seen in the provision of an alternative process, since the selectivity was not improved. Starting from the embodiment using a pre-reactor, it was obvious for the skilled person to carry out the pre-reaction at the preferred temperatures indicated in document A1 and to carry out the fluorination process in the reactor with a catalyst, as preferred in document A1.

Document A2 was the closest prior art for the subject-matter of claim 1 of auxiliary request 2. This document disclosed a process for producing HFO-1234yf, comprising the steps of fluorinating HCO-1230xa in a liquid phase without catalyst to form HCFO-1233xf, which is thereafter fluorinated in a gas phase, in the presence of a catalyst to form HFO-1234yf. The process of claim 1 of auxiliary request 2 differed from the process of this document in that the first fluorination was carried out in the gas phase and that the intermediates were the compounds of formula (4), (5) or (6). The Respondent did not show any improvement of selectivity. Thus, the technical problem could only be seen in the provision of an alternative process to prepare HFO-1234yf. The proposed solution was obvious in the light of document A3 or A4.

Document A3 disclosed that partially chlorinated aliphatic hydrocarbons of 1-4 carbon atoms could be converted to chlorofluoroaliphatic hydrocarbons in the vapor phase in the absence of a fluorination catalyst. It was obvious to operate the first fluorination of HCO-1230xa in the gas phase without catalyst forming intermediates of formula (4), (5) and (6), thus arriving at the claimed subject-matter.

Document A4 described the preparation of HCFO-1233xf from tetra-chloropropene and HF. The reaction was carried out in the presence of a chromium oxide catalyst. Document A4 mentioned that when the catalyst lost its activity HCFO-1232xf was observed. This implied that in the absence of a catalyst, HCFO-1232xf was formed. Paragraph [0012] of document A4 taught that the reaction could also be performed in the absence of a catalyst. It was obvious to the skilled person that HCFO-1232xf was formed in addition to HCFO-1233xf in a

fluorination reaction of HCO-1230xa in the absence of a catalyst. The person skilled in the art would inevitably obtain HCFO-1232xf during the first stage of the process, which would necessarily be present in the starting products for the second stage. The subject matter of claim 1 of auxiliary request 2 lacked therefore an inventive step in view of document A2 in combination with document A4.

The subject-matter of claim 1 of auxiliary request 2 therefore lacked an inventive step in the light of document A2 in combination with document A3 or A4.

VI. According to the Respondent, claims 1 and 2 of document A1 disclosed a one-step process for producing HFO-1234yf by reacting at least one starting material of formula  $CX_3CHClCH_2X$ ,  $CClX_2CCl=CH_2$  and  $CX_2=CClCH_2X$  with HF in a reaction zone, optionally in the presence of a fluorination catalyst. However, this document did not disclose a two-step process for producing HFO-1234yf and, in particular, not a first step of reacting HF with at least one chlorine-containing compound of formula (1), (2) and (3) as specified in granted claim 1.

The use of a pre-reactor had to be selected amongst several possibilities disclosed in this document. Additionally the temperature employed in the pre-reactor had to be selected to be greater than about 100°C in order to allow the starting materials to react with HF and to be converted to compounds having a higher degree of fluorination.

Accordingly, even assuming that the process of claim 2 could be combined with the embodiment on page 8, lines 10 to 15 of document A1, which would require a first

selection, at least one further selection would be required with respect to the reaction temperature of the pre-reactor. At least a two-fold selection was required to arrive at the process of claim 1 of the patent as granted. Therefore document A1 did not directly and unambiguously disclose the process of claim 1.

Starting from this document as the closest prior to the invention, the technical problem to be solved was the provision of a more economical process for preparing HFO-1234yf with improved selectivity. The solution was the process of claim 1 characterized by the first step in the gas phase without catalyst, the second step a gas phase in the presence of a catalyst, the starting compounds and HFO-1234yf as the desired product.

The claimed process slowed the degradation of the catalyst since the catalyst was only present during the second step of the process. Furthermore, the selectivity toward HFO-1234yf was improved, as shown by comparing examples 1 and 2 of the contested patent with the example of document A1.

The skilled person had no incentive to choose the non-preferred embodiment of a pre-reactor, to specifically choose temperatures above 100°C and to carry out the second step of the process in the presence of a catalyst in the vapor phase when carrying out the fluorination process disclosed in claim 2 of document A1.

The subject-matter of claim 1 of the main request and auxiliary request 1 therefore involved an inventive step in the light of document A1.

For claim 1 of auxiliary request 2, document A2 represented the closest prior art to the invention. Claim 1 of auxiliary request 2 differed from the process described in document A2 in that the first reaction step was conducted in the gas phase; and the starting material obtained in the first reaction step and used in the second reaction step contained at least one chlorine-containing compound of formula (4), formula (5) and/or formula (6).

The technical problem to be solved was to provide a more economical process for preparing HFO-1234yf with improved selectivity.

The examples in the contested patent and the experimental report submitted on 21 November 2016 showed that the claimed process produced the desired HFO-1234yf with improved selectivity by conducting the first reaction step in the gas phase and using a starting material containing at least one chlorine-containing compound of Formula (4), Formula (5) and/or Formula (6).

The proposed solution was to use a gas phase reaction and a starting material containing at least one chlorine-containing compound of formula (4), formula (5) and/or formula (6) in the second reaction step.

Document A3 disclosed a process for preparing chlorofluoroaliphatic hydrocarbons by reacting aliphatic hydrocarbons or partially chlorinated aliphatic hydrocarbons with HF in the absence of a catalyst in the gas phase. As opposed to the claimed process, the process of document A3 required elemental chlorine. Document A3 disclosed neither HFO-1234yf as the target compound nor did it deal with mixtures of

fluorinated compounds including the intermediate HFCF-1233xf which was used as starting compounds for the second reaction step of document A2. There was also no indication that the specific reaction conditions disclosed therein could be suitable for preparing the compounds of formula (4), (5) or (6). By contrast, the teaching of document A3 rather aimed at achieving a very high degree of halogenation. This was confirmed by the examples wherein all products showed a very high degree of halogenation, the main products being always fully halogenated. This was incompatible with the manufacture of HFO-1234yf having two hydrogen atoms on C-1 of the propene.

Document A4 disclosed a process for producing HFO-1234yf comprising at least three reaction steps. In example 1 of document A4, the fluorination reaction of 1,1,2,3-tetrachloropropene (HCO-1230xa) in the presence of a catalyst produced HCFO-1233xf. Document (4) indicated that HCFO-1232xf appeared upon deactivation of the catalyst, there was no teaching that HCFO-1233xf would be formed without catalyst and/or that the reaction product containing HCFO-1232xf could be used in a two-step process for producing HFO-1234yf. Document A4 explicitly taught that the first reaction step should be conducted in the presence of a catalyst and also described technical measures to avoid catalyst deactivation and formation of HCFO-1232xf. Document A4 taught the skilled person away from the present invention.

The subject-matter of claim 1 of auxiliary request 2 involved therefore an inventive step.

VII. The Appellant (Opponent) requested that the decision under appeal be set aside and the patent be revoked.

VIII. The Respondent (Patent Proprietor) requested that the appeal be dismissed and the patent thus be maintained as granted (main request) or, auxiliary, maintained in amended form according to one of auxiliary requests 1-4, filed with a letter dated 15 October 2018.

IX. At the end of the oral proceedings held on 22 June 2021, the decision of the Board was announced.

### **Reasons for the Decision**

1. The appeal is admissible.

#### *Main request*

#### *Sufficiency of disclosure*

2. The Appellant submitted that the invention was insufficiently disclosed since the patent in suit did not provide sufficient information to the skilled person to carry out all the embodiments covered by claim 1 as granted and to measure the temperature.

In the communication dated 13 February 2020 the Board indicated that the objection of insufficiency of disclosure was prima facie not substantiated in the statement of grounds of appeal. During the oral proceedings before the Board the Appellant did not wish to add any further arguments.

In these circumstances, the Board has no reason to depart from its preliminary view and hence shares the reasoning and conclusion of the opposition division

that the invention is sufficiently disclosed in the patent in suit to be carried out by the skilled person.

*Main request (patent as granted)*

*Document A1 -novelty/inventive step*

3. Claim 1 of document A1 discloses a process for preparing a product mixture comprising *inter alia*  $\text{CF}_3\text{CF}=\text{CH}_2$  (HFO-1234yf). Claim 2 further requires that HFO-1234yf is recovered from this mixture. This process comprises reacting at least one compound selected from the group of
- (1) halopropanes of the formula  $\text{CX}_3\text{CHClCH}_2\text{X}$ ,
  - (2) halopropenes of the formula  $\text{CClX}_2\text{CCl}=\text{CH}_2$  and
  - (3) halopropenes of the formula  $\text{CX}_2=\text{CClCH}_2\text{X}$ , wherein each X is independently selected from the group consisting of F and Cl,
- with HF in a reaction zone, optionally in the presence of a fluorination catalyst for making  $\text{CF}_3\text{CF}=\text{CH}_2$  (HFO-1234yf) (see claims 1 and 2).

Suitable starting compounds comprise  $\text{CCl}_3\text{CHClCH}_2\text{Cl}$  (HCC-240db) which is a compound of formula (1) according to the patent in suit, and  $\text{CCl}_2=\text{CClCH}_2\text{Cl}$  which is a compound of formula (3) according to the patent in suit (see page 6, lines 26 to 35).

According to the embodiment disclosed on page 8, line 10 to 15 of document A1, the starting material may be contacted with HF in a pre-reactor prior reaction in a vapor-phase reactor. Preferably the pre-reactor and the reactor are heated (see page 8, lines 16 and 17; page 9, lines 3 and 4) and the reactor comprises a catalyst (see page 9, line 22 and 23).

3.1 According to the Appellant, document A1 discloses all the features of the process of claim 1 of the patent as granted in combination.

According to the Respondent, to arrive at the process of claim 1 of the patent as granted from the disclosure of document A1 multiple selections are required, i.e. selection of the HFO-1234yf as the desired product, selection of the starting products, the process being operated in gas phase, the use of a pre-reactor, the selection of suitable temperature in the pre-reactor, the presence of a catalyst in the reactor.

*Selection of HFO-1234yf as the recovered compound*

3.2 However, the claimed process produces a reaction mixture comprising HFO-1234yf, HFC-245cb and HCFO-1233xf (see table 3 of the patent in suit). The process of claim 1 of the main request does not require to recover HFO-1234yf from this mixture.

Therefore, there is no need to select in document A1 HFO-1234yf as final product to arrive at the presently claimed process.

*Selection of the starting product*

3.3 The starting materials of claim 1 of the patent as granted, compared to the starting materials of document A1, merely exclude  $CX_3CHClCH_2F$  and  $CF_3CHClCH_2Cl$  (formula 1) and  $CX_2=CClCH_2F$  (formula 3).

Accordingly, no selection of particular compounds from the starting materials disclosed in document A1 is required to arrive at the process of claim 1 of the main request.

*Selection of the gas phase versus the liquid phase*

- 3.4 According to document A1, the reaction is preferably carried out in the vapor phase (see page 8, line 4 and 5). It is preferred that the starting materials and HF are vaporized and fed to a pre-reactor or to a vapor phase reactor (page 9, lines 1 and 2).

Starting from the embodiment disclosed on page 8, line 10 to 37 of document A1 where the starting materials are contacted with HF in a pre-reactor prior to reaction in the vapor phase reactor, there is no need to select the gas phase required by the claimed process.

*Selection of the temperature in the pre-reactor*

- 3.5 Document A1 discloses that suitable temperatures for the pre-reactor are from about 80°C to about 250°C, preferably from about 100°C to about 200°C, and that temperatures above about 100°C result in some conversion of the starting materials to compounds having a higher degree of fluorination. Thus, according to the Respondent, when carrying out the process of document A1 using a pre-reactor, a temperature above 100°C must be selected for a reaction to occur.

*Choice to perform the fluorination reaction in the reactor with a catalyst*

- 3.6 Claim 1 of document A1 mentions that the reaction can optionally be carried out in the presence of a fluorination catalyst. Page 9, lines 22 and 23, discloses that a catalyst is preferably used. To carry

out the reaction with a catalyst as required by present claim 1 is therefore already disclosed in document A1.

4. According to the Respondent, the subject-matter of claim 1 of the main request is novel over document A1, since a temperature at which a reaction occurs, i.e. above 100°C, must first be selected from the disclosure of document A1 and then the second step must be carried out in the presence of a catalyst, constituting a second selection over the disclosure of document A1.

Since the Board comes to the conclusion that the process of claim 1 is not inventive even if the position of the Respondent with respect to novelty is followed, it is assumed in his favour that document A1 does not disclose the preferred reaction temperature in the pre-reactor (100°C - 200°C) in combination with the use of a catalyst in the reactor.

5. Starting from document A1 as the closest prior art, the Respondent defined the problem to be solved as the provision of a more economic process for preparing HFO-1234yf with improved selectivity.

The solution is the process of claim 1 characterized by carrying out the first step in the pre-reactor at a temperature at which a reaction occurs, i.e. above 100°C, and to use a catalyst in the second reactor.

6. The Respondent indicated that there was an economic improvement, as the catalyst was only present in the second reactor and so would not exhaust as quickly.

However, as the process disclosed in document A1 also involves a pre-reactor without catalyst, there cannot be an improvement in catalyst degradation with respect

to the process of document A1. An economic improvement is therefore not shown with respect to the process of document A1.

To show an improvement of the selectivity of HFO-1234yf over HFC-245cb, the respondent compared a reaction product obtained by the process disclosed in document A1 with that obtained by the process of example 1 of the patent in suit (pages 8 and 9, table 3) and example 2 of the experimental report filed with the letter date 21 November 2016.

However, the temperature used in the pre-reactor of the processes reflecting the invention was 400°C, i.e. well above the upper temperature of 200°C disclosed in document A1.

Therefore, the proposed comparison cannot show that the selectivity of HFO-1234yf over HFC-245cb is due to the combination of a temperature between 100°C and 200°C in the pre-reactor with a reaction operated with a catalyst in the reactor, since the effect on selectivity may be caused by using a much higher temperature in the pre-reactor.

Therefore, an improvement in selectivity is not demonstrated with respect to the process of the closest prior art document A1.

7. The technical problem defined by the Respondent therefore needs to be reformulated in a less ambitious way, namely in the provision of an alternative process for preparing HFO-1234yf.
8. Document A1 discloses that suitable temperatures for the pre-reactor are preferably from 100 to 200°C, which

result in some conversion of the starting materials to compounds having a higher degree of fluorination (see page 8, lines 16 to 20). Document A1 furthermore teaches that preferably a catalyst is used in the reaction zone for the vapor phase reactor (see page 9, line 22 and 23).

Therefore, the skilled person faced with the problem of providing an alternative process for the preparation of HFO-1234yf would as an obvious option combine the preferred pre-reactor temperature disclosed in document A1 with the preferred presence of a catalyst in the reactor and thus would arrive at the subject matter of claim 1 without the exercise of inventive skill.

The subject-matter of claim 1 of the main request lacks therefore an inventive step in view of document A1 alone.

#### First auxiliary request

9. Claim 1 of the first auxiliary request differs from claim 1 of the main request in that the product obtained in the first reaction step is optionally supplied in the second reaction step after removing hydrogen chloride contained therein.

As the additional feature with respect to claim 1 of the main request is optional, the subject-matter of claim 1 of auxiliary request 1 comprises the whole subject-matter of claim 1 of the main request, which lacks an inventive step.

Accordingly, the subject-matter of claim 1 of auxiliary request lacks an inventive step for the same reason as claim 1 of the main request

*Auxiliary request 2 -inventive step*

*Closest prior art*

10. The Appellant and the Respondent exclusively addressed document A2 as the closest prior art to the invention for the subject-matter of auxiliary request 2. Hence the Board limits itself to consider obviousness starting from this document.

Document A2 discloses a process for producing a hydro fluoroolefin of the formula  $C_3H_{(a+x-1)}F_{7-(a+x)}$  where  $a = 0, 1, 2, 3$  or  $4$  and  $x = 0, 1, 2$  or  $3$  and  $a+x$  is greater than or equal to  $1$ , comprising the steps of:

a) fluorinating a hydrochloroolefin in a liquid phase, without catalyst, to form a hydrochloro fluoroolefin of the formula  $C_3F_3H_{(a+x-1)}Cl_{4-(a+(a+x))}$  and HCL and first co-products; and thereafter

b) fluorinating the hydrochlorofluoroolefin in a gas phase, in the presence of a suitable catalyst to form a hydrofluoroolefin of the formula  $C_3H_{(a+x-1)}F_{7-(a+x)}$  and second co-products.

In particular document A2 discloses the preparation of HFO-1234yf starting from 1,1,2,3 tetrachloropropene (HCO-1230xa) with 2-chloro-3,3,3-trifluoropropene (HCFO-1233xf) as intermediate (see claim 22).

In particular 97.2% of HCFO-1233xf is obtained after the uncatalyzed liquid phase fluorination of HCO-1230xa with co-products HFO-1234yf (0.25%) and HFC-245cb (0.16%) (example 1, table 1).

*Technical problem underlying the invention*

11. According to the Respondent, the technical problem to be solved is the provision of a more economical process for preparing the HFO-1234yf with improved selectivity.

*Solution*

12. The proposed solution is the process of claim 1 characterized in that

(i) the first reaction step is conducted in the gas phase; and

(ii) the material obtained in the first reaction step and used in the second reaction step contains at least one chlorine-containing compound of Formula (4), Formula (5) and/or Formula (6).

*Obviousness*

13. The technical problem underlying the patent in suit is at least to provide a further process for the preparation of HFO-1234yf. Only in case the solution to this problem were found to be obvious in the light of the prior art, the issue whether or not an improved technical effect was achieved over that prior art would be of relevance for the decision.

According to the Appellant the proposed solution is obvious in the light of documents A3 and A4.

- 13.1 Document A3 discloses the conversion of aliphatic hydrocarbons of 1-4 carbon atoms and partially chlorinated aliphatic hydrocarbons of 1-4 carbon atoms

to chlorofluoroaliphatic hydrocarbons with at least one mole of hydrogen fluoride and at least one mole of chlorine per mole of aliphatic starting material in the vapor phase at a temperature of about 300-500° C in the absence of fluorination catalyst (see section crossing column 1 and 2; claim 1). The starting products exemplified in this document are methane, methyl chloride, ethylene, propylene, isobutylene and butadiene.

Thus, this document identifies neither the starting products of formula (1), (2) or (3), nor the intermediates of formula (4), (5) or (6), nor HFO-1234yf.

Therefore, the person skilled in the art would not turn to document A3 to find an alternative process to that disclosed in A2, and even if he did turn to this document, he would not arrive at the claimed solution.

13.2 Document A4 discloses a method for preparing HFO-1234yf comprising (a) fluorinating a compound of formula  $CX_2=CCl-CH_2X$ ,  $CX_3-CCl=CH_2$  or  $CX_3-CHCl-CH_2X$ , wherein X is independently selected from F, Cl, Br, and I, provided that at least one X is not fluorine, to produce HCFO-1233xf and chlorine-containing by-products; fluorinating HCFO-1233xf to produce 2-chloro-1,1,1,2 tetrafluoropropane (HCFC-244bb) and dehydrochlorinating HCFC-244bb to produce a HFO-1234yf (see claim 1).

The Appellant particularly relies on paragraph [0012] which discloses that in the first step of the method, a starting composition, preferably comprising 1,1,2,3-tetrachloropropane and/or 1,1,1,2,3-pentachloropropane (HCC-240db), reacts with anhydrous HF in a first vapor

phase reactor to produce HCFO-1233xf and HCl. Preferably the reaction occurs in the presence of a catalyst. The reaction conducted in a vapor phase reactor optionally comprises additional components, such as un-reacted HF, heavy intermediates, and HFC-245cb. This section thus reveals that HCFO-1233xf can be obtained in the vapor phase, possibly without catalyst.

However, this section does not teach how the compounds of formula (4), (5) and (6) can be prepared, let alone that these compounds can be subsequently converted into HFO-1234yf.

The Appellant also referred to example 1 of document A4, describing the continuous fluorination of 1,1,2,3-tetrachloropropene in vapor phase in the presence of a catalyst. The reaction product comprises 97.2% of HCFO-1233xt, 1.6% HCFC-244bb, 0.6% HFO-1234yf/HFC-245cb, 0.1% HCFO-1223xd, and 0.08% HCFO-1231. After 500 hours an underfluorinated intermediate, 2,3-dichloro-3,3-difluoropropene (HCFO-1232xf) appears, the selectivity to HCFO-1233xf is reduced as the catalyst activity decreases. After 650 hours, the selectivity to HCFO-1233xf is reduced to about 83% and the selectivity to HCFO-1232xf, according to formula (5) of the patent in suit, increases to about 15%. The reaction is then stopped due to loss of catalyst activity.

According to the Appellant, the skilled person concludes from this teaching that HCFO-1232xf will be formed when the reaction is carried out in the vapor phase without any catalyst. The skilled person will therefore contemplate the alternative to replace the fluorination of HCO-1230xa in the liquid phase by a fluorination in the gas phase without catalyst

producing HCFO-1232xf as an intermediate of synthesis for the production of HFO-1234yf and hence will arrive at the claimed process.

However this reasoning is based on an *ex post facto* reasoning. First, the fact that a given product is obtained with a deactivated catalyst does not mean that this product is also obtained when the reaction is performed without any catalyst at all. Second, without the knowledge of the invention, the skilled person does not know that HCFO-1232xf is a suitable intermediate of synthesis for the preparation of HFO-1234yf.

- 13.3 The Board therefore concludes that the subject-matter of claim 1 of auxiliary request 2 is not rendered obvious by the disclosure of document A2 in combination with document A3 or A4, even in order to provide an alternative process for the preparation of HFO-1234yf.
14. Hence, the subject-matter of claim 1 of the auxiliary request 2, and by the same token that of dependent claims 2 to 8 involves an inventive step.

*Other issues*

15. The Respondent also requested that some of the appellant's submissions on auxiliary request 2 not be admitted in the appeal proceedings.

In view of the positive conclusion in respect of patentability of claim 1 of auxiliary request 2 as set out above, a decision of the Board on this issue is unnecessary.

**Order**

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

1. The decision under appeal is set aside.
  
2. The case is remitted to the Opposition Division with the order to maintain the patent in amended form on the basis of claims 1-8 of auxiliary request 2, filed with a letter dated 15 October 2018 and a description yet to be adapted.

The Registrar:

The Chairman:



C. Rodríguez Rodríguez

P. Gryczka

Decision electronically authenticated