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**Datasheet for the decision
of 10 May 2021**

Case Number: T 0405/17 - 3.3.02

Application Number: 10770891.9

Publication Number: 2486027

IPC: C07D307/40, C07D307/44,
C07D307/46

Language of the proceedings: EN

Title of invention:

METHOD FOR THE PREPARATION OF 2,5-FURANDICARBOXYLIC ACID AND
ESTERS THEREOF

Patent Proprietor:

Furanix Technologies B.V.

Opponent:

Archer-Daniels-Midland Company

Headword:

Relevant legal provisions:

EPC Art. 54(3), 56, 123(2)
RPBA Art. 12(4)

Keyword:

Amendments - added subject-matter (no)

Novelty - (yes)

Inventive step - (yes)

Decisions cited:

T 0727/00, T 1807/15

Catchword:



Beschwerdekammern

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Case Number: T 0405/17 - 3.3.02

D E C I S I O N
of Technical Board of Appeal 3.3.02
of 10 May 2021

Appellant: Archer-Daniels-Midland Company
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
20 December 2016 concerning maintenance of the
European Patent No. 2486027 in amended form.**

Composition of the Board:

Chairman M. O. Müller
Members: P. O'Sullivan
W. Sekretaruk

Summary of Facts and Submissions

- I. The appeal of the opponent (hereinafter appellant) lies from the decision of the opposition division according to which European patent 2 486 027 in amended form was found to meet the requirements of the EPC.
- II. A notice of opposition was filed against the patent, invoking Article 100(a) (lack of novelty), and (b) EPC. Lack of inventive step as a further ground for opposition under Article 100(a) EPC was introduced during opposition proceedings with the agreement of the patent proprietor (hereinafter respondent).
- III. The following documents *inter alia* were cited during opposition proceedings and invoked by the parties in appeal proceedings:
- D1: WO 2010/132740 A2
 - D6: WO 2009/030507 A2
 - D7: Partenheimer et al., Adv. Synth. Catal., 2001, 343, 102-111
 - D14: Tashiro et al., Adv. Synth. Catal., 2001, 343, 220-225
 - D17: Wang et al., ChemCatChem, 2014, 6, 728-732
 - D18: Experimental Report filed 10 October 2016
- IV. With the statement setting out the grounds of appeal the appellant filed "Experimental report 2", hereinafter denoted D19.

The appellant submitted that the set of claims found allowable by the opposition division, the main request in the present proceedings, comprised added subject-

matter in contravention of Article 123(2) EPC, and lacked novelty and inventive step.

- V. With the reply to the statement of grounds of appeal the patent proprietor (respondent) filed *inter alia* the following document:

D21: Experimental report

- VI. With the communication pursuant to Article 15(1) RPBA the board set out its preliminary opinion, in particular that D19 was to be admitted into the proceedings, and that the subject-matter of claim 1 of the main request met the requirements of Article 123(2) EPC. Novelty and inventive step were also addressed.

- VII. With the letter of 10 March 2021 the respondent referred to first, second and third auxiliary requests. According to said letter, the first auxiliary request was based on claims 1-10 of the main request, the second auxiliary request was based on the claims of auxiliary request 6 filed with the letter dated 26 September 2016 and the third auxiliary request was based on claims 1-10 of said second auxiliary request. The respondent further stated that it did not approve of the holding of oral proceedings by videoconference.

- VIII. With the communication dated 16 March 2021 the board noted that the respondent's disapproval of the oral proceedings by videoconference was unsubstantiated and that there were no material reasons on file in support of not holding oral proceedings by videoconference. Accordingly, the board stated that oral proceedings by videoconference were maintained (note: said communication was issued prior to the issuance online

of decision T 1807/15 referring a question to the Enlarged Board of Appeal on 17 March 2021).

IX. Oral proceedings by videoconference were held on 10 May 2021. During those proceedings, the respondent did not reiterate its request not to hold the oral proceedings by videoconference, in particular when asked to confirm its requests. Furthermore, the respondent withdrew its request, filed in writing, not to admit D19 into the proceedings.

X. Requests

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

It further requests that neither document D21, nor auxiliary requests 1-3 of 10 March 2021 be admitted into proceedings.

The respondent requests that the appeal be dismissed or that the patent be maintained on the basis of the first, second or third auxiliary requests, referred to in the letter of 10 March 2021.

XI. The independent claims of the main request read as follows:

"1. Method for the preparation of 2,5-furandicarboxylic acid and an alkyl ester of 2,5-furandicarboxylic acid comprising the step of contacting a feed comprising a starting material selected from 5-alkoxymethylfurfural, 2,5-di(alkoxymethyl)furan and a mixture thereof wherein the alkyl of the alkoxy group of the starting material 5-(alkoxymethyl)furfural, or 2,5-bis-(alkoxylmethyl)furan is methyl, ethyl, propyl,

isopropyl, 2-butyl, tert butyl, pentyl, 2-pentyl, neopentyl or 3-pentyl, with an oxidant in the presence of an oxidation catalyst, wherein the oxidation catalyst contains both Co and Mn and comprises a source of bromine.

2. Method for the preparation of 2,5-furandicarboxylic acid and an alkyl ester of 2,5-furandicarboxylic acid comprising the step of contacting a feed comprising a starting material selected from 5-alkoxymethylfufural, 2,5-di(alkoxymethyl)furan and a mixture thereof with an oxidant in the presence of an oxidation catalyst, wherein the feed comprises 5-hydroxymethylfurfural as a further starting material.

11. Method for the preparation of alkyl esters of 2,5-furandicarboxylic acid or a mixture of 2,5-furandicarboxylic acid and alkyl esters thereof wherein a carbohydrate source is converted into products comprising 5-alkoxymethyl furfural and optionally 5-hydroxymethyl furfural, from which is isolated a feed comprising 5-alkoxymethyl furfural and optionally 5-hydroxymethyl furfural, which method comprises the subsequent step of contacting the feed with an oxidant in the presence of an oxidation catalyst, containing cobalt and manganese and bromide at appropriate reaction conditions."

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

Main request

Amendments, Article 123(2) EPC

The subject-matter of claim 1 failed to meet the requirements of Article 123(2) EPC. Claim 1 comprised four separate limitations compared to the application as filed, two of which involved an unallowable selection from two lists, which were consequently not disclosed in the application as filed.

Novelty, Article 54 EPC

The subject-matter of independent claims 1, 2 and 11 lacked novelty over the disclosure in D1. Experimental report D18 provided evidence that the method disclosed in D1 led to the obtention of both 2,5-furandicarboxylic acid and an alkyl ester thereof in the product.

Inventive step, Article 56 EPC

D21 submitted by the respondent with the reply to the statement of grounds of appeal in the context of inventive step, was not to be admitted into the proceedings.

The subject-matter of independent claims 1, 2 and 11 lacked an inventive step starting from D6 as closest prior art.

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

Main request

Amendments, Article 123(2) EPC

The subject-matter of claim 1 did not comprise a selection from two separate lists in the application as filed. The application as filed comprised clear pointers to the combination of the specific limitations in claim 1, which consequently met the requirements of Article 123(2) EPC.

Novelty, Article 54 EPC

The subject-matter of independent claims 1, 2 and 11 was novel over the disclosure in D1.

Inventive step, Article 56 EPC

The subject-matter of independent claims 1, 2 and 11 involved an inventive step starting from D6 as closest prior art.

Reasons for the Decision

1. The following abbreviations are employed below, where appropriate:

FDCA:	2,5-furandicarboxylic acid
FDCA ester:	alkyl ester of FDCA
HMF:	5-hydroxymethylfurfural
AMF:	5-alkoxymethylfurfural
MMF:	5-methoxymethylfurfural
EMF:	5-ethoxymethylfurfural
BMF:	5-butoxymethylfurfural
NHPI:	N-hydroxyphthalimide

Main request

2. Amendments - Article 123(2) EPC

The appellant submitted that claim 1 of the main request failed to meet the requirements of Article 123(2) EPC.

- 2.1 Claim 1 of the main request reads as follows:

"1. Method for the preparation of 2,5-furandicarboxylic acid and/or an alkyl ester of 2,5-furandicarboxylic acid comprising the step of contacting a feed comprising a starting material selected from 5-alkoxymethylfurfural, 2,5-di(alkoxymethyl)furan and a mixture thereof wherein the alkyl of the alkoxy group of the starting material 5-(alkoxymethyl)furfural, or 2,5-bis-(alkoxylmethyl)furan is methyl, ethyl, propyl, isopropyl, 2-butyl, tert butyl, pentyl, 2-pentyl, neopentyl or 3-pentyl, with an oxidant in the presence of an oxidation catalyst, wherein the oxidation

catalyst contains both Co and Mn and comprises a source of bromine." (strike through and underlined text denoting text deleted and added, respectively, compared to claim 1 of the application as filed)

2.2 According to the appellant, the four separate limitations in contested claim 1 compared to claim 1 of the application as filed led to a combination of features which added subject-matter. Those features were:

- (i) the deletion of "or" from "and/or" in the first line;
- (ii) the inclusion of a definition for the alkyl group of the alkoxy group present in the starting material, taken from the list recited on page 3, lines 1 to 3 of the description of the application as filed, with the omission of "butyl";
- (iii) the requirement that the oxidation catalyst contains both Mn and Co; and
- (iv) the requirement that the oxidation catalyst "comprises a source of bromine".

2.3 With respect to limitation (i), as noted by the appellant, a selection was made of one from three possibilities recited in claim 1 of the application as filed, specifically the choice that both compounds are present to the exclusion of the presence of only one compound or the other. This alternative, i.e. a method for the preparation of 2,5-furandicarboxylic acid **and** an alkyl ester is however specifically singled out in

the description as filed. Specifically, it is stated that

"... it was found that when using a bromide-containing cobalt and manganese-based catalyst, under specific reaction conditions, not only FDCA was obtained but that also significant amounts of ester could be obtained from direct oxidation of the ether function of HMF ethers" (page 2, lines 8-11 of the application as filed); and

*"In conclusion, the present inventors have now found that HMF alkyl ethers or 2,5-bis(alkoxymethyl)furan can be oxidized to FDCA **and** alkyl esters thereof"* (page 2, lines 15-16 of the application as filed; emphasis added).

- 2.4 Furthermore, the examples of the application as filed all demonstrate the co-production of both FDCA and esters thereof. Consequently, limitation (i) in contested claim 1 is to be regarded as a preferred embodiment of the application as filed.
- 2.5 Regarding limitation (ii), claim 11 of the application as filed recites that the alkyl group of the alkoxy of the 5-alkoxymethylfufural or 2,5-bis(alkoxymethyl)furan starting material is a C₁-C₅ alkyl group. The insertion into claim 1 of a list of specific alkyl groups falling within this definition, disclosed in the application as filed (page 3, lines 1-3), therefore represents a valid basis for the individual alkyl groups recited in claim 1, already pointed at by the broader definition in claim 11 of the application as filed. The deletion in claim 1 of a single member from this list, namely "butyl", does not amount to a selection either, since the remaining subject-matter is retained as a generic

group of alkyl moieties which differs from the original group only by its smaller size. Such a shrinking of a generic group does not lead to added subject-matter, since it does not result in the singling out in claim 1 of a specific combination not disclosed in the application as filed. As noted by the respondent, it is established jurisprudence that such a shrinking of a list, which maintains the remaining subject-matter as a generic list of alternative definitions differing from the original list only by its smaller size, does not add subject-matter (Case Law of the Boards of Appeal, 9th edition, II.E.1.6.3).

- 2.6 Furthermore, this conclusion is not contradicted by decision T 727/00, cited by the appellant to support its arguments. Specifically, in that decision it was found that a combination in the claim in question of one member from each of two different lists of features, without any support provided therefor in the application as filed, led to an infringement of Article 123(2) EPC (reasons 1.1.4). That situation is not comparable to the present one which involves a mere shrinking of a single list by deletion of a single member thereof.
- 2.7 In view of the above conclusions, it is also apparent that the combination in claim 1 of the preferred embodiment in limitation (i) with the allowable shrinking of a list in limitation (ii) does not infringe Article 123(2) EPC.
- 2.8 The appellant furthermore submitted that limitations (iii) and (iv) further focused the claims on specific limited subject-matter not clearly identified in the application as originally filed. However, as noted by the respondent, said limitations originate from

dependent claims 4 and 5 of the application as filed. Claim 5 recites that the oxidation catalyst comprises both Co and Mn, and is dependent on claim 4 which stipulates that the oxidation catalyst comprises a source of bromine. Since claim 4 in turn is dependent on claim 1, basis for limitations (iii) and (iv) is explicitly provided at least by a combination of claims 1, 4 and 5 of the application as filed.

It follows from the foregoing that the subject-matter of claim 1 complies with the requirements of Article 123(2) EPC.

3. Novelty - Article 54(3) EPC

3.1 The appellant submitted that the subject-matter of independent claims 1, 2 and 11 lacked novelty over patent document D1, which was to be regarded as belonging to the state of the art pursuant to Article 54(3) EPC.

3.2 The respondent submitted *inter alia* that the subject-matter of said claims was novel over D1.

3.3 The validity of the claim to priority in the contested patent (7 October 2009) was not contested by the appellant. D1 is a published Euro-PCT application (pursuant to Article 153(4) EPC) filed on 14 May 2010 and claiming priority from US 61/178,301 filed on 14 May 2009). Thus, assuming that the claim to priority in D1 is valid, D1 indeed represents state of the art pursuant to Article 54(3) EPC for the subject-matter of the contested patent.

methyl, ethyl, propyl, isopropyl, 2-butyl, tert butyl, pentyl, 2-pentyl, neopentyl or 3-pentyl, with an oxidant in the presence of an oxidation catalyst which contains Co and Mn and a source of bromine.

- 3.6.1 It was a matter of dispute between the parties whether D1 directly and unambiguously disclosed
- a method for the preparation of FDCA and FDCA ester as required by claim 1,
 - employing an alkyl group falling within the list of alkyl groups recited in contested claim 1.
- 3.6.2 Regarding the first feature, it was undisputed by the appellant that D1 failed to explicitly disclose that the product of the method included FDCA together with the FDCA ester. Rather, the co-production thereof, according to the appellant, was an inevitable consequence of carrying out the process of D1.
- 3.6.3 It is established jurisprudence of the Boards of Appeal that for concluding a lack of novelty, there must be a direct and unambiguous disclosure, either explicit or implicit, in the state of the art, which would inevitably lead the skilled person to subject-matter falling within the scope of what is claimed.
- 3.6.4 Thus in the present case it must be established not whether the production of FDCA together with FDCA ester, is possible or probable, but whether it is the inevitable consequence of performing the process disclosed in D1.
- 3.6.5 The appellant submitted experimental report D18 to demonstrate the co-production of FDCA in the method of example 13 of D1 (supra). D18 concerns an alleged

reworking of the method of said example in order to demonstrate the inevitable co-presence of FDCA in the product. According to D18, 82% butoxymethylfurfural in acetic acid was oxidised with 1000 psi oxygen in the presence of a catalyst comprising cobalt acetate, manganese acetate and sodium bromide. A GC/MS chromatogram (EtOH/water; non-polar GC column, 25 - 350°C) depicts the results of an analysis of the products of the reaction and reveals two peaks denoted 2 and 3, corresponding to the butyl ester of FDCA and FDCA, respectively. According to the authors of D18, the GC analysis confirmed that the reaction conditions in example 13 of D1 inevitably led to the production of both FDCA and the butyl ester thereof.

- 3.6.6 The board's view is as follows. Firstly, the only examples of D1 disclosing the oxidation of an alkoxyethylfurfural to an ester acid derivative (examples 13 and 14) employ **butoxymethylfurfural**. The isomer of the butyl moiety (i.e. whether it is an *n*-, 2- or *tert*-butyl group) is not specified. The board agrees with the respondent that in the absence of any specific qualification, the assumption - to the skilled person - must be that *n*-**butoxymethylfurfural** is employed. This interpretation is also indirectly confirmed by the terminology employed in the application as filed, wherein "butyl", and not "n-butyl" is listed alongside "2-butyl" and "tert-butyl" (page 3, lines 2) in the list of possible alkyl groups. Thus the disclosure of "**butoxymethylfurfural**" does not amount to disclosure of either a 2-butyl or *tert*-butyl group as required by claim 1. Thus, the examples of D1 do not disclose a preparation method falling within the scope of contested claim 1. Hence, it is irrelevant whether D18 shows that a mixture of FDCA and FDCA ester is obtained since the method

thereof is not according to claim 1: the starting material (butoxymethylfurfural) does not contain an alkyl group chosen from the list recited in claim 1.

3.6.7 Secondly, and more importantly in the board's view, D18 does not even show that the method disclosed in the examples of D1 results in a mixture of FDCA and FDCA ester as claimed. More specifically, the GC/MS chromatogram depicting the distribution of products obtained from the reaction disclosed in D18 (page 1) shows a peak (2) allegedly corresponding to the butyl ester (i.e. the product of scheme III of D1 where R = n-butyl), and a peak (3) allegedly corresponding to the acid, FDCA. Since the area under a GC peak is generally considered to be proportional to the amount of the product present, the chromatogram would appear to indicate a very large excess of the acid, and the presence of relatively a very small amount of the desired ester, which contradicts the statement in D1 according to which the "major resulting product is surprisingly found to be [the ester]" (paragraph [0019], second line). Hence, D18 is not a faithful reproduction of example 13 of D1. Lastly, in the view of the board, the fact that the GC column in D18 is operated at a temperature of up to 350°C, and in the presence of water, must cast doubt on whether the product distribution allegedly shown by the chromatogram reliably reflects the composition of the products of the reaction, or whether the relatively low FDCA ester yield depicted in the GC chromatogram resulted from hydrolysis of FDCA ester to provide FDCA in the GC column. As a consequence, the detected FDCA may result from operation of the GC column at such a high temperature rather than being the inevitable outcome of the process disclosed in example 13 of D1. Hence, even if D18 were a faithful reproduction of

example 13 of D1, it would still fail to conclusively demonstrate that a mixture of both FDCA and FDCA ester results from the process disclosed in this example. For these reasons, the board does not consider D18 sufficient to demonstrate the inevitable presence of FDCA in the product of example 13 of D1.

- 3.6.8 The appellant furthermore referred to paragraph [0020] of D1 to argue that FDCA is co-produced together with FDCA ester in D1. The relevant passage in this paragraph, refers to the production of the ester derivative according to paragraph [0019] (supra) and reads:

"The ester derivatives, however, can readily be hydrolyzed in the presence of acid or base catalysts, or further oxidized to provide FDCA when FDCA is ultimately the desired product. Because [sic] the differential solubility and ease of handling, formation of the ester acid derivative can improve upstream purification processes and yields when it is desired to ultimately obtain FDCA".

This passage however does not indicate that FDCA is co-produced in the reaction of scheme III of D1 depicted above, but rather that the ester derivatives (i.e. "AcMFA" in Scheme (III)) may be subsequently converted to FDCA, if desired. Thus if any information were to be drawn from this passage, it would be an indication that FDCA is not co-produced in the method according to Scheme (III), paragraph [0019] of D1.

- 3.6.9 Finally, the appellant argued that in the reaction underlying contested claim 1, water was produced. The presence of water would lead to the inevitable partial hydrolysis of FDCA ester under the reaction conditions.

Evidence was provided by D7, a journal article concerned with the catalytic oxidation of HMF. D7 disclosed the overoxidation of the products of the reaction (in D7, *inter alia* FDCA) to produce CO_x (D7, page 108, right hand column, last two paragraphs), which demonstrated that overoxidation of FDCA esters would occur in the reaction according to claim 1, and inevitably lead to the co-production of FDCA together with FDCA ester.

The board is of the following view. Even if it were to be accepted that some water was produced in the reaction as argued by the appellant, there is no evidence that this would inevitably lead to the co-production of FDCA under the reaction conditions. Furthermore, the board agrees with the respondent that evidence of potential overoxidation to CO_x in the oxidation of HMF to FDCA in D7 does not serve as evidence that FDCA will be inevitably co-produced in the process of D1. Indeed, it is not correct to equate ester hydrolysis (i.e. the hydrolysis of FDCA ester to FDCA), a process involving the splitting of a bond and the addition of the hydrogen cation, with overoxidation, a process in which the atoms of an element lose electrons leading to a change in oxidation state.

Thus, D1 fails to disclose a method for the preparation of FDCA and FDCA ester as required by claim 1.

- 3.6.10 In view of the foregoing, D1 does not directly and unambiguously disclose the subject-matter of contested claim 1, which is consequently novel.

3.6.11 Since novelty is established in claim 1 by the first feature addressed above, there is no need for the board to address the second feature, specifically whether D1 disclosed a process using starting materials comprising an alkyl group chosen from the list of alkyl groups recited in contested claim 1.

The subject-matter of claim 1 is consequently novel over D1.

3.7 Claim 2

3.7.1 Independent claim 2 (supra), similarly to claim 1, is directed to a method for the preparation of FDCA and FDCA ester. In the same way as for claim 1, above, it is therefore distinguished from D1 at least in this feature.

3.7.2 Furthermore, claim 2 differs from claim 1 *inter alia* in that the "alkyl" moiety of the 5-alkoxymethylfurfural and 2,5-di(alkoxymethyl)furan starting materials is not defined, and in that the starting material further comprises 5-hydroxymethylfurfural (HMF) in addition to AMF or 2,5-di(alkoxymethyl)furan. Furthermore, the oxidation catalyst is not defined in claim 2.

3.7.3 It was a matter of dispute between the parties whether D1 disclosed *inter alia* the presence of HMF in the starting material, as required by claim 2.

3.7.4 The appellant submitted that in the conversion of fructose to AMF by dehydration with sulphuric acid according to D1 (scheme (III)), HMF would inevitably be co-produced and subsequently oxidised together with AMF to form FDCA and FDCA ester. D17 was submitted as evidence that the dehydration of fructose according to

the first step of scheme (III) in paragraph [0019] of D1 inevitably led to the co-production of HMF.

3.7.5 The board is of the following view. It is undisputed that D1 does not explicitly disclose the presence of HMF in the starting material of the process disclosed therein. Furthermore, as noted by the respondent, the catalyst employed in D17 is graphene oxide, which is completely different from the acid catalysts recited in the first step of scheme (III) of D1. Thus D17 cannot serve as conclusive evidence that HMF is co-produced in the dehydration step of D1, scheme (III), and that it would thus inevitably be present as starting material in the subsequent step. As a consequence, D1 does not directly and unambiguously disclose the inevitable presence of HMF in the product of the dehydration reaction in scheme (III), let alone in the feed for the second step of scheme (III), as required by contested claim 1. For at least this reason, the subject-matter of claim 2 is novel over the disclosure in D1.

3.8 Claim 11

3.8.1 Independent claim 11 (supra) concerns a method for the preparation of FDCA esters or a mixture thereof with FDCA and *inter alia* includes a step wherein a carbohydrate source is converted into products comprising *inter alia* 5-alkoxymethylfurfural, "*from which is **isolated** a feed*" comprising the latter.

3.8.2 It was a matter of dispute between the parties whether D1 disclosed *inter alia* the isolation of a feed comprising 5-alkoxymethylfurfural, as required by claim 11.

3.8.3 The appellant submitted that although an isolation step was not explicitly disclosed in reaction scheme (III) on page 6 of D1, it was clearly implicit that the AMF product of the dehydration (scheme (III), first step) was isolated. This was all the more so since the patent lacked a definition for the term "isolated", which was thus to be interpreted broadly to include, for instance, the separation, removal or relocation of any amount of a feed comprising AMF. Substantially different conditions and reagents were employed in the first and second steps of D1, scheme (III), and the second step required a pressurised container; a change in equipment from the first step to the second was therefore required. These significant changes could not be carried out without "isolation", in the broader sense, of a feed comprising AMF. Thus isolation of a feed comprising AMF as required by contested claim 11 was inevitable, and therefore implicitly disclosed in D1.

3.8.4 Although the board agrees with the appellant that the term "isolated" has a significantly broad meaning, the term nevertheless necessarily requires some kind of manipulation of the products obtained in the conversion of a carbohydrate source to products comprising *inter alia* 5-alkoxymethylfurfural. There is however no indication in D1 that any kind of manipulation of said products is inevitably carried out. Although the board agrees with the appellant that a pressurised reactor would be required for the second step, there is no indication in D1 that the first step is not carried out in the same reactor. Therefore, D1 lacks a direct and unambiguous disclosure of the isolation of a feed comprising AMF as required by contested claim 11.

Consequently, at least for this reason, the subject-matter of claim 11 is novel over the disclosure in D1.

3.8.5 In conclusion, the subject-matter of independent claims 1, 2 and 11 is novel over D1 pursuant to Article 54 EPC.

3.9 Since novelty was established over D1 for all independent claims, there was no need for the board to address the respondent's further arguments concerning the validity of the priority of D1, or whether the subject-matter in D1 invoked in arguing a lack of novelty was also directly and unambiguously derivable from the priority document D1a.

4. Inventive step - Article 56 EPC

4.1 Admittance - D21, relevant to inventive step

4.1.1 D21 is an experimental report filed by the respondent with the reply to the statement of grounds of appeal in the context of inventive step to demonstrate an improved selectivity to the desired products (infra) when employing a catalyst according to the patent (comprising a source of bromine) compared to a catalyst according to D6 (NHPI/Co(OAc)₂/Mn(OAc)₂; D6, page 7, lines 30-32).

4.1.2 At oral proceedings before the board, the appellant requested that D21 not be admitted into the proceedings pursuant to Article 12(4) RPBA 2007. Claim requests comprising independent claims reciting the Co/Mn/Br catalyst in question had been on file in first instance proceedings, and the filing of D21 only in appeal proceedings was therefore late. It resulted in shifting the focus of proceedings to the presence of bromine in

the catalyst, an issue which had never been advanced in opposition proceedings, and therefore represented an amendment of the respondent's case.

- 4.1.3 Under Article 12(4) RPBA 2007, which applies to the admittance of D21 in view of Article 25(2) RPBA 2020, the board has the discretion not to admit into the proceedings *inter alia* evidence which could have been presented before the opposition division.
- 4.1.4 It was acknowledged by the appellant that inventive step under Article 100(a) EPC was not among the grounds for opposition invoked with the notice of opposition, but was raised by the appellant for the first time with the letter dated 31 August 2016, approximately six weeks before oral proceedings took place before the opposition division on 10 October 2016. Admittance of this new ground for opposition was consented to by the respondent at those oral proceedings, and admitted into the proceedings by the opposition division on the basis of its *prima facie* relevance (minutes of oral proceedings, page 3, fourth last point; page 4, first point).
- 4.1.5 The short period of time of only six weeks between the filing of the new ground for opposition and the oral proceedings before the opposition division, in the view of the board, cannot be considered sufficient to reasonably expect a party to react to new grounds with experimental evidence. It follows that the reply to the statement of grounds of appeal was the first procedural stage at which the respondent could reasonably have been expected to submit experimental evidence refuting the allegations of the appellant regarding inventive step filed at such a late stage in opposition proceedings.

- 4.1.6 In the view of the board therefore, D21 could not have been filed by the respondent in opposition proceedings, and the filing thereof with the reply to the grounds of appeal is considered timely.

Consequently, the board decided not to exclude D21 from the appeal proceedings pursuant to Article 12(4) RPBA 2007.

4.2 Closest prior art

D6 was identified as the closest prior art by both parties for all independent claims, and the board sees no reason to deviate from this choice.

- 4.2.1 D6 is a patent document which is concerned with a method for the manufacture of *inter alia* an ether of 5-hydroxymethylfurfural (D6, page 1, lines 2-4), i.e. a compound similar to the AMF starting material of claim 1, by reacting a hexose-containing starting material with a higher alcohol (D6, claim 1). The hexose-containing starting material can be fructose (D6, example 1), and the "higher alcohols" disclosed include 1-octanol and longer chain alcohols (D6, claim 2; examples). In describing the uses of the HMF ethers prepared according to the invention of D6, the possibility of oxidation thereof under appropriate conditions *inter alia* such as those described for p-xylene using an NHPI/Co(OAc)₂/Mn(OAc)₂ catalyst in D14 to prepare FDCA is addressed (D6, page 7, final paragraph).

- 4.2.2 It was accepted by both parties that the disclosure in D6 included specific information disclosed in D14, cited and referred to in D6 (page 7, lines 30-35),

namely the general procedure for the oxidation of p-xylene (D14, page 224, right hand column, "General Procedure for Oxidation of 1 or 2 under Pressure of Air (30 atm)").

4.3 Claim 1

4.3.1 Distinguishing features

As noted above, claim 1 is directed to a method for the preparation of FDCA and FDCA ester, which includes as a feature thereof the presence of an oxidation catalyst containing both cobalt and manganese and comprising a source of bromine.

It was common ground between the parties that D6 failed to disclose the use of a source of bromine in the catalyst system. Indeed D6 references the oxidation of HMF as described in D14 for p-xylene using an NHPI/Co(OAc)₂/Mn(OAc)₂ catalyst to result in the formation of FDCA (D6, page 7, final paragraph). The subject-matter of claim 1 is therefore distinguished from D6 at least in this feature.

4.3.2 Technical problem

According to the respondent, the technical effect of the distinguishing feature was an improved combined yield of FDCA and FDCA esters. Experimental report D21 was submitted by the respondent as evidence supporting this effect. The objective technical problem was thus the provision of an improved method for the preparation of FDCA and FDCA esters in improved combined yield.

The technical effect, and the technical problem as formulated by the respondent were accepted by the appellant. In view of the evidence presented in D21, the board sees no reason to differ.

4.3.3 Obviousness

The appellant submitted that the solution to the problem as set out in claim 1 was obvious to the skilled person starting from D6 in view of D14, D7 or D9, all of which provided evidence that the Co/Mn/Br catalyst recited in claim 1 would have been routine and conventional for the skilled person. Accordingly, the above-mentioned effect underlying claim 1 was to be considered as a mere bonus effect. The subject-matter of claim 1 consequently did not involve an inventive step.

The board does not share the appellant's view.

According to D6, the oxidation of HMF ethers can be performed using a specific catalyst, NHPI/Co(OAc)₂/Mn(OAc)₂, described in D14 for the oxidation of p-xylene (D6, page 7, lines 27-35). The publication D14 is concerned with the preparation of terephthalic acid (TPA) by aerobic oxidation of p-xylene (D14, title), and does not address the oxidation of HMF ethers at all. While D14 does disclose that the catalytic oxidation of p-xylene is commonly catalysed by cobalt and manganese salts in the presence of *inter alia* NaBr (page 220, left hand column, second paragraph), this disclosure, unlike the corresponding reaction using NHPI, is not referred to in D6 as being suitable for the oxidation reaction disclosed therein (page 7, final paragraph). That D6 refers to a specific method in D14 as being suitable for a specific

transformation (that of claim 1), does not mean that other methods disclosed in D14 for the oxidation of p-xylene will be equally suitable to the method specified in D6. D6 therefore lacks any teaching to use specifically a catalyst containing cobalt and manganese salts in the presence of *inter alia* NaBr in the oxidation of HMF ethers, let alone to use said catalyst to solve the above-mentioned technical problem.

The appellant also referred to journal article D7. This document discloses the synthesis of 2,5-diformylfuran (DFF) and FDCA by catalytic oxidation of HMF using a metal/bromide catalysts, the most common being a mixture of Co/Mn/Br, and reports that HMF can be oxidised to DFF or FDCA with unexpectedly high selectivity (D7, paragraph bridging pages 102 and 103). However, this reaction involves both a different starting material (HMF versus *inter alia* AMF) and different products (DFF and FDCA versus FDCA and FDCA esters). There is therefore no indication nor motivation in D7 that the Co/Mn/Br catalyst employed therein would provide a solution to the above-mentioned problem, specifically, to provide an improved combined yield of FDCA and FDCA esters in the method according to D6.

Patent document D9, also referred to by the appellant, is similar to D7 in that it concerns a method for the conversion of HMF to DFF and FDCA, DFF being the main target of the method (D9, page 1, lines 6-9; page 2, lines 33-38; page 3, lines 2-5). Similarly to D7, D9 discloses the use of a catalyst comprising cobalt, manganese and bromide ("Co/Mn/Zr/Br", page 15, Examples 16-40). However, also similarly to D7, D9 concerns different starting materials and different product to those underlying claim 1. There is therefore no

indication nor motivation in D9 that the catalyst employed therein would provide a solution to the above-mentioned problem.

Finally, the appellant's argument that the effect of an improved combined yield of FDCA and FDCA esters underlying claim 1 was to be considered as a mere bonus effect is not convincing. A "bonus effect" can arise in a situation where the state of the art obliges the skilled person to adopt a certain solution, the lack of alternatives leading to a so-called "one-way-street" situation. In such a situation an additional effect, such as, in the present situation, an improved combined yield of FDCA and FDCA esters, does not automatically contribute to inventive step. However, such a scenario does not arise in the present case: there is no indication in the prior art that in searching for a mere alternative to the method of D6, the skilled person would have been obliged specifically to choose only an oxidation catalyst containing both cobalt and manganese and a source of bromine as required by claim 1. Thus, the aforementioned effect underlying claim 1 and extending over the mere provision of an alternative, cannot be considered as a mere bonus effect.

It follows from the foregoing that the subject-matter of contested claim 1 involves an inventive step pursuant to Article 56 EPC.

4.4 Claim 11

Claim 11 is directed to a method for the preparation of FDCA and FDCA ester, starting from *inter alia* AMF, and similarly to claim 1, includes as a feature thereof the

presence of an oxidation catalyst containing both cobalt and manganese and bromide.

In the same way as for contested claim 1 (supra), the subject-matter of claim 11 is distinguished from D6 at least by the presence of bromine. It follows that the technical effect of said feature, and the resultant objective technical problem are also the same as for contested claim 1. Consequently, the solution proposed in contested claim 11, for the same reason as set out above for contested claim 1, involves an inventive step pursuant to Article 56 EPC.

4.5 Claim 2

In contrast to independent claims 1 and 11, independent claim 2 does not require a specific oxidation catalyst.

4.5.1 Distinguishing features

In its statement of grounds of appeal the appellant firstly acknowledged that the subject-matter of claim 2 was distinguished from the disclosure in D6 at least by the inclusion of HMF as a further starting material (section 6.29), but subsequently stated in contradiction with the earlier statement that "the inclusion of HMF as an additional starting material is unlikely even to constitute a distinguishing feature over D6" on the basis that the oxidation reactions described in D6 would inevitably lead to the formation of HMF (section 6.33). At oral proceeding the appellant conceded that the relevant section of D6 lacked any explicit reference to the presence of HMF in the feed, and did not present further arguments in this regard.

While D6 discloses the preparation of an ether of HMF from a hexose-containing starting material (e.g. page 3, lines 1-5), and HMF is produced in this reaction according to example 1 (see table 1), there is no indication in D6 that the "HMF ethers of the invention" employed as starting material in D6 in the context of further conversion to FDCA (page 6, lines 27-35), comprise also HMF. In the view of the board, the argument that HMF is inevitably, and therefore implicitly disclosed in D6 (page 7, final paragraph) as a further starting material in combination with HMF ethers disclosed in D6, without any evidence to support it, is merely an unsupported allegation, and therefore cannot be accepted.

Consequently, contested claim 2 is distinguished from the disclosure in D6 at least by the inclusion of HMF as a further starting material.

4.5.2 Problem solved

As submitted by the respondent, a technical effect linked to this distinguishing feature can be derived from the patent (example 1 and table 1, page 8). Thus, experiments using a feed comprising a mixture of AMF with HMF provided a higher combined yield of FDCA and FDCA ester than similar experiments employing the same AMF in the absence of HMF. Specifically, experiment 1c (EMF/HMF) provided a higher combined yield of FDCA and FDCA ester compared to experiment 1a (EMF alone; 60.69% versus 57.76% respectively; table 1, final column, "s Furandicarboxylics [%]"). Similarly, experiment 1d (MMF/HMF) provided a higher combined yield compared to experiment 1b (MMF alone; 66.52% versus 60.89%); experiment 1g (EMF/HMF) provided a higher combined yield compared to experiment 1e (EMF alone; 69.63%

versus 67.57%); experiment 1k (EMF/HMF) provided a higher combined yield compared to experiment 1i (EMF alone; 71.70% versus 69.21%). Minor improvements were also observed in further experiments (compare experiments 1h and 1f, and experiments 1l and 1j).

The appellant submitted that a technical effect was not derivable from table 1 of the patent due to differing feed concentrations in the comparative examples. For example, the feed concentration for experiment 1c was 3.6 wt%, while for experiment 1a with which it was compared the corresponding concentration was 4 wt%. Thus the comparative examples did not differ solely in the distinguishing feature, which therefore could not be reliably linked with the alleged technical effect of an improved combined yield.

However, as noted by the respondent, the results in the table indicate that the increase in combined yield cannot be attributed merely to the decrease in the feed concentration in the experiments done with a mixture, compared to those carried out only using MMF or EMF. Specifically, the increase in the combined yield of FDCA and FDCA esters for experiment 1c compared to experiment 1a (approximately 3%) is accompanied by a decrease in the feed concentration of 0.4% (4 wt % for experiment 1a and 3.6 wt% for experiment 1c). This increase in combined yield is however less than that obtained comparing experiments 1d with 1a (approximately 6%), despite a less significant decrease in the feed concentration for the latter of 0.2% (3.7 wt% for experiment 1b and 3.5 wt% for experiment 1d). Thus, it can be accepted that the technical effect of an increase in combined yield of FDCA and FDCA ester originates in the distinguishing feature outlined above.

In view of the foregoing, the objective technical problem underlying claim 2 is the provision of a method to provide FDCA and FDCA ester in improved combined yields.

4.5.3 Obviousness

The appellant submitted that the solution to the above-mentioned problem set out in contested claim 2 would be obvious in view of the teaching in paragraph [0033] of the patent as well as in view of D7.

Paragraph [033] of the patent reads as follows:

"It is surprising that the oxidations of EMF and MMF [both ethers] are also complete after 1 hour, and provide almost the same yield on furandicarboxylics as HMF [an alcohol]. This is contrary to the teachings of the prior art that indicates that a significantly lower amount of products may be expected in the oxidation of an ether. In US3173933 the oxidation of alcohols and ethers over a cobalt and bromine-containing catalyst has been described. It appeared that the yield of oxidation products such as a carboxylic acid and the corresponding ester is significantly higher when an alcohol is oxidised compared o the oxidation of an ether" (insertions in squared brackets by the board).

This paragraph however does not refer to the oxidation of a mixture of AMF and HMF as recited in claim 2. It is stated that the oxidations of EMF and MMF (individually) provide almost the same yield of furandicarboxylics as HMF. It is furthermore not known to the board, nor has it been argued by the appellant, whether the cited US patent concerns the same catalysts

as defined in claim 2: this document itself was not cited in the present appeal proceedings and its precise content was therefore not part of the appellant's arguments. Furthermore, it is stated in paragraph [0007] of the patent that the "oxidation of HMF ethers has not been reported". Hence, it is doubtful whether the cited US patent discloses the oxidation of compounds similar to those underlying the patent. Lastly, the skilled person at the priority date of the contested patent is aware only of the state of the art pursuant to Article 54(2) EPC, which does not include information provided in the patent itself. For all these reasons, the claimed solution cannot be considered obvious in view of paragraph [0033] of the patent.

Furthermore, D7, also cited by the appellant as set out above, discloses that the oxidation of HMF provides FDCA in 60% yield (D7, abstract). The specific yield of FDCA obtained from HMF in individual experiments in D7 ranges from 42 to 65% (table 1, row entitled "Select.,%"). However, there is no comparison in D7 between the oxidation of HMF and the oxidation of HMF ethers. Therefore there is no teaching nor indication in D7 that a mixture of AMF and HMF would solve the objective technical problem as set out above, namely the provision of a method to provide FDCA and an FDCA ester in improved combined yields.

Accordingly, and in view of the foregoing, starting at the disclosure of D6, there is no incentive in D7 which would motivate the skilled person to add HMF to the feed in the oxidation reaction disclosed in D6 in order to arrive at the solution provided by contested claim 2.

For these reasons, the subject-matter of claim 2 involves an inventive step pursuant to Article 56 EPC.

5. The main request is consequently allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



N. Maslin

M. O. Müller

Decision electronically authenticated