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**Datasheet for the decision  
of 27 July 2010**

**Case Number:** T 0175/08 - 3.3.01

**Application Number:** 00203602.8

**Publication Number:** 1118614

**IPC:** C07D 307/88

**Language of the proceedings:** EN

**Title of invention:**

Process for the preparation of 5-carboxyphthalide

**Patentee:**

INFOSINT SA

**Opponent:**

H. Lundbeck A/S

**Headword:**

Preparation of 5-carboxyphthalide/INFOSINT

**Relevant legal provisions:**

EPC Art. 54, 56

**Keyword:**

"Main and first auxiliary requests: novelty (yes), novel combination of process features"

"Main request: inventive step (no), obvious alternative process"

"First auxiliary request: inventive step (yes), fair comparative tests"

**Decisions cited:**

T 0279/89

**Catchword:**

-



Case Number: T 0175/08 - 3.3.01

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.01  
of 27 July 2010

**Appellant:**  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 13 December 2007  
rejecting the opposition filed against European  
patent No. 1118614 pursuant to Article 102(2)  
EPC 1973.

**Composition of the Board:**

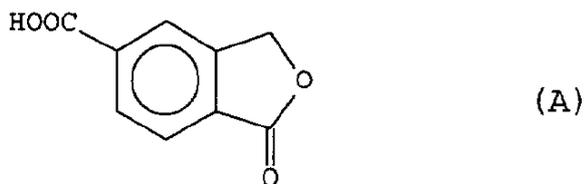
**Chairman:** P. Ranguis  
**Members:** L. Seymour  
D. S. Rogers

## Summary of Facts and Submissions

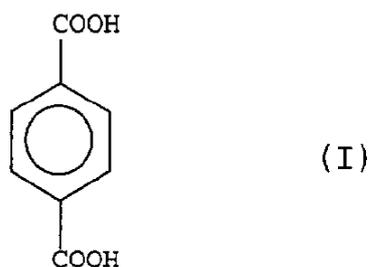
- I. European patent No. 1 118 614, which was filed as application number 00 203 602.8, was granted on the basis of twenty-two claims.

Independent claims 1 and 22 as granted (main request) read as follows:

"1. A process for the preparation of 5-carboxyphthalide of formula A in an open and however not pressurized reactor



which comprises adding formaldehyde and terephthalic acid of formula I



to fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>, heating the mixture at 120÷145°C and isolating the 5-carboxyphthalide thus obtained.

...

22. A process for the synthesis of citalopram, in which a process for the synthesis of 5-carboxyphthalide according to claim 1 is contained."

II. An opposition was filed and revocation of the patent in its entirety requested pursuant to Article 100(a) EPC, for lack of novelty and inventive step.

III. The following documents were cited *inter alia* during the opposition/appeal proceedings:

- (1) WO 01/32642
- (2) L S Forney et al., J. Org. Chem., 1971, Vol. 36, 689-693
- (3) US 3 607 884
- (4) L S Forney, J. Org. Chem., 1970, Vol. 35, 1695-1696
- (5) Danish Patent Application PA 1999 01569 (priority application of document (1))
- (8) US 3 976 751
- (9) Product specification of "Sulfan B" (General Chemical Division, Allied Chemical & Dye Corporation, 1949)
- (10) "Stabilised Liquid Sulphur Trioxide" (Imperial Chemical Industries Ltd., 1950)
- (11) CRC Handbook of Chemistry and Physics, 50th edition, 1969-1970, page F-8
- (12) C V Herrmann, Ind. Eng. Chem., 1941, 898-899
- (14) WO 00/23431
- (15) The Merck Index, 12th Edition (1996), pages 1535-1536
- (16) Experimental report originally submitted by respondent during examination proceedings with letter of 24 October 2001
- (17) Experimental report originally submitted by respondent during examination proceedings with letter of 21 November 2001

(18) Experimental report originally submitted by respondent during examination proceedings with letter of 11 December 2001

IV. The appeal lies from the decision of the opposition division rejecting the opposition.

The opposition division considered that the subject-matter of the claims as granted met the requirements of novelty.

In particular, the opposition division found that the part of document (1) enjoying the claimed priority did not disclose that the fuming sulfuric acid ( $H_2SO_4$ ) had to contain at least 20% by weight of sulfur trioxide ( $SO_3$ ).

Moreover, the opposition division was of the opinion that there was a chemical difference between the reaction medium "fuming sulfuric acid", as used in the process according to the patent in suit, and "sulfur trioxide", as used in the processes specifically disclosed in documents (3) and (4).

With respect to the issue of inventive step, the opposition division considered that, regardless of whether document (2) or (3) was considered to represent the closest prior art, the process of the patent in suit could not be derived in an obvious manner by combination with the remaining cited prior art.

V. The appellant (opponent) lodged an appeal against this decision and filed grounds of appeal.

VI. With letter of 25 May 2010, the respondent (patentee) filed five auxiliary requests, and resubmitted three experimental reports, which had originally been filed during examination proceedings (documents (16), (17) and (18)).

The first auxiliary request differed from the claim set as granted in that the feature "at least 20%" in claim 1 had been replaced by "20÷33%".

VII. Oral proceedings were held before the board on 27 July 2010.

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

Concerning the main request, the appellant argued that the subject-matter of claim 1 lacked novelty with respect to documents (1), (3) and (4). Document (1) constituted prior art under Article 54(3) EPC insofar as its content corresponded to that of its priority document (5).

In all these documents the synthesis of 5-carboxyphthalide was conducted in an open, non-pressurised reactor. Although this was not explicitly stated in documents (1), (4) and (5), the skilled person would understand that, in the absence of any further explanation, no specific measures had been taken in this regard. In this context, the appellant pointed to the fact that documents (2) and (4) specifically identified the use of sealed conditions, as a deviation from common procedure.

In addition, the appellant argued that the reaction medium as defined in claim 1 of the patent in suit could not be relied on as a novelty rendering feature.

Thus, in document (5), the reaction medium employed was oleum. Since, by definition, oleum was sulfuric acid containing varying amounts of  $\text{SO}_3$ , this amounted to a disclosure of a range of 0 to 100% by weight of  $\text{SO}_3$  in sulfuric acid. When compared to this range, it was clear that the sub-range inherently disclosed in claim 1 of the patent in suit, namely, 20 to 100% by weight, did not fulfil the criteria for selection inventions as set out in decision T 279/89.

With respect to document (3), the appellant submitted that the solvent defined in claim 1, namely, "liquid  $\text{SO}_3$ ", corresponded to the top end of the range in the open-ended definition "fuming sulfuric acid containing at least 20% by weight of  $\text{SO}_3$ " specified in the patent in suit. This was confirmed by documents (11) and (12) (Tables V and VI) wherein "fuming sulfuric acid" or "oleum" was identified as being a mixture of sulfuric acid and sulfur trioxide having from 0 to 100% free  $\text{SO}_3$ .

In addition, the appellant argued that the commercially available liquid  $\text{SO}_3$ , also known under the trade name "Sulfan", which was exemplified in document (3) (see example 1 and column 1, lines 60, 61), necessarily contained a certain amount of sulfuric acid. As support for this contention, the appellant cited documents (8), (9) and (10). Thus, document (8) disclosed stabilised liquid sulfur trioxide containing up to 1.0% of sulfuric acid (see column 2, lines 53 to 57). Similarly, document (9) specified strengths of at least 99%  $\text{SO}_3$  for

the stabilised liquid form "Sulfan B". Finally, document (10) referred to fully stabilised 100% liquid sulfur trioxide containing at least 99.5% sulfur trioxide, with the balance being sulfuric acid (page 4, lines 1, 2). The appellant therefore maintained that, since the commercially available  $\text{SO}_3$  according to document (3) was in fact a mixture containing a certain amount of sulfuric acid, it was also encompassed by the definition "fuming sulfuric acid containing at least 20% by weight of  $\text{SO}_3$ ".

Turning to document (4), the appellant developed a similar line of argument as for document (3), submitting that this document also exemplified a reaction in a commercially available sulfur trioxide medium, namely, "Sulfan B". In addition, the appellant argued that the reference in document (4) to the formation of by-products in reaction media containing less than 20%  $\text{SO}_3$  conversely amounted to a disclosure of reactions free of by-products in sulfur trioxide media containing more than 20%  $\text{SO}_3$  (page 1696, first complete paragraph).

Finally, the appellant generally submitted that it made no technical sense to distinguish between sulfur trioxide and fuming sulfuric acid within the context of the present reaction, since, at the same rate as 5-carboxyphthalide was formed,  $\text{SO}_3$  was consumed and sulfuric acid generated. The resulting mixture of  $\text{SO}_3$  and sulfuric acid was by definition fuming sulfuric acid within the meaning of claim 1 of the patent in suit.

In its assessment of inventive step of the main request, the appellant pointed out that documents (2) to (4) were all publications by the same author. The appellant was of the opinion that document (3) constituted the closest prior art. In so far as the process according to document (3) was not considered to be novelty destroying, any distinguishing feature could only be seen in the minimal differences in the reaction medium used. Document (4) was somewhat more remote, since it did not focus on the objective of avoiding pressure equipment. Document (2) was an even less promising starting point for the evaluation of inventive step since it related to a study into mechanistic aspects and did not aim at an improvement to a reaction to be carried out on an industrial scale. Moreover, the reaction conditions used differed in several aspects from those defined in the patent in suit.

In the appellant's view, none of the advantages advanced by the respondent, such as yield, purity, reproducibility, ease of handling on an industrial scale and avoidance of gas generation, had been substantiated for the full scope claimed.

Thus, the yields obtained according to the examples of the patent in suit were between 60 and 90%; that obtained in example 2 of document (3) was 93%.

Concerning the experimental data provided in documents (16), (17) and (18), the appellant argued that the results of the HPLC analyses on the product mixtures, at best, gave an indication of the conversion ratio of starting material to product. Since some purification of the reaction mixture must have been

carried out in order to perform HPLC analysis, the results reflected the conditions employed in the purification step, rather than those used in the reaction itself.

On the issue of reproducibility, the appellant argued that this objective was not derivable from the patent in suit or the application as originally filed. Moreover, document (17) did not allow any conclusions to be reached in this respect, since four runs had been performed for the process according to document (2) (see first experiment of document (17)), but no comparable data was available for the process according to the patent in suit.

With reference to document (15), the appellant argued that there was no substantiation for the contention that liquid SO<sub>3</sub> would be any more or less difficult to handle than fuming sulfuric acid.

Finally, the avoidance of gas generation was an artificial problem that would only be encountered after opening of a sealed tube. This was not an effect that was associated with the reaction as such.

The problem to be solved could therefore only be viewed as lying in the provision of a further process for the synthesis of 5-carboxyphthalide.

The appellant submitted that the solution proposed, namely the choice of "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>" instead of "liquid SO<sub>3</sub>" as the reaction medium, was rendered obvious by the teaching of document (2), and optionally document (4).

In particular, the appellant pointed to the passage of document (2) emphasising that "SO<sub>3</sub> is a critical factor for the condensation" (page 690, right-hand column, first sentence). Furthermore, in Table II the solvents "30% SO<sub>3</sub>-H<sub>2</sub>SO<sub>4</sub>" and "100% SO<sub>3</sub>" were directly compared and found to provide excellent conversions. The skilled person would therefore immediately recognise that fuming sulfuric acid of a strength falling within that according to claim 1 of the patent in suit would be a suitable alternative for use in the claimed reaction.

The appellant submitted in this context that a fixed temperature of 150°C and sealed conditions had been employed in the reactions of document (2) in order to allow sensible conclusions to be drawn with regard to the effect of other parameters of interest, such as acid strength and content of SO<sub>3</sub>. No indication or suggestion could be found in document (2) that the temperature or sealed conditions were to be regarded as critical factors for the reaction as such.

Finally, the appellant submitted that the use of oleum was also rendered obvious by document (4), which taught that the reaction in sulfur trioxide media was generally free of by-product formation over a fairly wide range of reaction conditions.

The appellant did not raise any objections with respect to the first auxiliary request under Articles 123(2) and 123(3) EPC.

Concerning the issue of novelty of the subject-matter of the first auxiliary request, the appellant

maintained its objection and referred to its previous submissions with respect to the main request.

In its analysis of inventive step of the first auxiliary request, the appellant relied substantially on the arguments already brought forward with regard to the main request, and submitted that document (3) should again be regarded as constituting the closest prior art and the problem to be solved as lying in the provision of a further process for the synthesis of 5-carboxyphthalide.

In addition, the appellant argued that a specific incentive to work with "fuming sulfuric acid containing 20÷33% by weight of SO<sub>3</sub>" could be derived from document (2), which disclosed that an excellent conversion to 5-carboxyphthalide could be obtained in "30% SO<sub>3</sub>-H<sub>2</sub>SO<sub>4</sub>" (Table II, Run 1). Moreover, document (2) explicitly taught that the highest rate of conversion of terephthalic acid was achieved at 60 mole % SO<sub>3</sub> in sulfuric acid (corresponding to about 55% by weight) (cf. Figure 1; and page 690, right-hand column, end of second paragraph). Finally, document (4) taught that reaction media containing <20% SO<sub>3</sub> should be avoided owing to by-product formation.

As regards independent claim 22, the appellant argued that use of 5-carboxyphthalide for the manufacture of citalopram was known at the filing date of the patent in suit from document (14), as confirmed in paragraph [0002] of the patent in suit. In this context, the appellant submitted that the patent in suit was not entitled to the claimed priority and that its effective

date was the filing date. An inventive step could therefore also not be acknowledged for claim 22.

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

The respondent disputed that document (10) was within the state of the art, since it was an internal document with a limited circulation list (see page 2).

On the question of novelty, the respondent submitted that this should not be assessed on a balance of probabilities. It was not clearly and unambiguously derivable from the priority document (5) whether the oleum used therein had an SO<sub>3</sub> content lower, equal or higher than 20%. Consequently, the subject-matter claimed in the patent in suit and the first auxiliary request was not anticipated by document (5).

Furthermore, the respondent contested that the feature "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>" encompassed "sulfur trioxide". The skilled person would rule out such an interpretation as not making chemical sense, since fuming sulfuric acid was by definition a mixture of two components. In addition, there was no indication in document (9) that "Sulfan B" contained even small amounts of sulfuric acid. It was immaterial whether sulfuric acid was generated in the course of the reaction, since claim 1 of the patent in suit defined the strength of the fuming sulfuric acid at the beginning of the process. The subject-matter claimed was therefore also novel over documents (3) and (4).

Turning to the issue of inventive step of the main request, the respondent argued that document (2) represented the closest prior art, since the reaction medium disclosed therein was oleum having a defined content of SO<sub>3</sub>. In contrast, the solvent employed in document (3) was liquid SO<sub>3</sub>, which was a completely different medium than oleum. This was confirmed by document (3) itself from which it could be derived that liquid SO<sub>3</sub> was a very thick medium (column 1, lines 60 to 68). Further confirmation was provided by entry 9152 in document (15) on "sulfur trioxide", in which it was stated that "on exposure to air, it absorbs moisture rapidly, emitting dense white fumes" and that "it combines with water with explosive violence ... forming sulfuric acid".

The respondent defined the problem to be solved as lying in the provision of a process that allows the synthesis of 5-carboxyphthalide with higher yield and purity, without significant gas generation, and which was easily controllable and reproducible on an industrial scale.

The respondent identified the solution to the above-mentioned problem as lying in the fact that the claimed process was carried out at a lower temperature and in an open, non-pressurised reactor.

In order to demonstrate that the problem had been solved, the respondent relied on the results presented in documents (17) and (18), in which an exact comparison had been provided with the reaction according to document (2). The respondent emphasised

that the HPLC analyses on the product mixtures had been performed without substantive purification, using the same procedure in each case. Therefore, the results obtained were indeed directly associated with the reaction conditions employed. The respondent submitted that, although data had only provided for 30% oleum, this could be considered to be representative for the full scope claimed. No evidence to the contrary had been provided by the appellant.

Moreover, the respondent argued that there was no teaching in the prior art that would have led the skilled person to the claimed subject-matter as a solution to the problem posed. In particular, documents (3) and (4) disclosed processes carried out in liquid SO<sub>3</sub> and not in oleum. Moreover, there was no indication in the prior art that temperature was a critical factor in the present reaction.

The respondent further considered that, even were document (3) to be taken as the closest prior art, the claimed invention would involve an inventive step. The only document specifically disclosing reaction in oleum was document (2). This document, which was a later publication than document (3), only disclosed a reactions carried out at 150°C and in a sealed test tube. The skilled person would therefore assume that these were the preferred reaction conditions when employing oleum, and would not consider modifying these according to the present claims.

The respondent was therefore of the opinion that the claimed process according to the main request was based on an inventive step.

Finally, the respondent submitted that this conclusion applied all the more to the subject-matter claimed in the first auxiliary request since there could be no doubt that the range of "20÷33% by weight of SO<sub>3</sub>" was supported by the comparative tests according to documents (17) and (18).

- X. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 1118614 be revoked.

The respondent (patentee) requested that:

1. The appeal be dismissed; or alternatively
2. that the patent be maintained on the basis of one of the auxiliary requests 1 to 5 filed with the letter dated 25 May 2010.

- XI. At the end of the oral proceedings, the decision of the board was announced.

### **Reasons for the Decision**

1. The appeal is admissible.
2. *Main request – Novelty*
  - 2.1 Document (1) was filed as an international application under the PCT on 19 October 2000, that is, two days after the filing date of the patent in suit. However, the document from which it claims priority, i.e.

document (5), was filed 1 November 1999, which is earlier than the priority date claimed for the patent in suit. Document (1) has been published in an official language of the EPO, and the national fees have been paid for all the contracting states designated in the present application (Article 158(2) EPC 1973).

Insofar as its content corresponds to that of its priority document (5), document (1) therefore constitutes prior art under Article 54(3) EPC and Article 54(4) EPC 1973, which are the articles applicable in accordance with the transitional provisions of the EPC 2000 (see OJ EPO 2007, special edition no. 1, 197, Article 1, paragraph 1).

Document (5) discloses a method for the preparation of 5-carboxyphthalide comprising reaction of terephthalic acid with paraformaldehyde in oleum.

It is a general principle consistently applied by the boards of appeal that, for concluding lack of novelty, there must be a direct and unambiguous disclosure in the state of the art which would inevitably lead to subject-matter falling within the scope of what is claimed.

In the present case, the generic term "oleum" is not limited with regard to the concentration of  $\text{SO}_3$ . It follows that the feature "fuming sulfuric acid containing at least 20% by weight of  $\text{SO}_3$ " according to claim 1 of the patent in suit cannot be unambiguously derived from the content of document (5). At least for this reason, the subject-matter of claim 1 of the patent in suit is already novel over document (5).

The board cannot accept the appellant's approach based on decision T 279/89. The criteria for selection inventions indicated therein relate to the selection of a sub-range of numerical values from a known broader range. In the present case, document (5) discloses the generic term "oleum". The intended strength thereof is simply not specified. This cannot be equated with an implicit disclosure of a full range of SO<sub>3</sub> content in sulfuric acid of 0 to 100%. The case law referred to by the appellant is therefore not applicable to the present situation.

2.2 In the course of the discussions on novelty with respect to documents (3) and (4), it was a matter of dispute between the parties how the feature "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>" according to claim 1 of the patent in suit was to be construed.

Fuming sulfuric acid, also known as oleum, is generally defined as being a mixture of sulfuric acid and sulfur trioxide (see e.g. document (15), entry 9147: "Sulfuric acid, fuming. H<sub>2</sub>SO<sub>4</sub> with free SO<sub>3</sub>, designated in commerce as oleum"). Therefore, although the expression "at least 20% by weight" is open-ended, when used in conjunction with "fuming sulfuric acid", the skilled person would understand the contested feature to exclude the upper limit of 100% by weight, that is, pure SO<sub>3</sub>.

This construction is confirmed by the fact that "fuming sulfuric acid" and "sulfur trioxide" are listed as

separate entries in standard chemical handbooks, such as document (15) (entries 9147 and 9152).

The arguments of the appellant based on documents (11) and (12) are not considered to be persuasive. These documents are concerned with properties of oleums at various concentrations of  $\text{SO}_3$  and not with providing definitions of what is to be understood by the term "oleum". In this context, the skilled person would understand the inclusion of the end points of the range of 0 and 100% in a table as providing useful reference points for comparison. Document (12) itself makes a distinction between "liquid oleum" and "liquid sulfur trioxide" (see page 898, left-hand column, bottom). These documents would therefore not lead the skilled person to deviate from the generally accepted meaning of oleum outlined above.

The board is also not convinced by the appellant's argument based on documents (8) to (10) as supporting the contention that commercially available  $\text{SO}_3$  necessarily contains a certain amount of sulfuric acid and is therefore a form of fuming sulfuric acid. In this connection, it is noted that the board does not consider it to be necessary to ascertain whether document (10) was available to the public before the priority date of the patent in suit, since the passage thereof referred to by the appellant merely summarises the content of a patent document published in 1949 (see document (10), reference [7]).

Thus, in document (8) it is disclosed that liquid sulfur trioxide produced in a particular manner "**generally** contains about 0.01% to 0.1%  $\text{H}_2\text{SO}_4$  but **may**

contain as much as 0.2% H<sub>2</sub>SO<sub>4</sub>" (column 2, lines 50 to 52; emphasis added). Furthermore the method of document (8) "may be applied to stabilization of **completely anhydrous liquid sulfur trioxide** or liquid sulfur trioxide containing up to about 1.0% H<sub>2</sub>SO<sub>4</sub>" (column 2, lines 53 to 57; emphasis added).

Similarly, document (9) discloses "Sulfan B" with **minimum** grades or strengths of 99% SO<sub>3</sub>. The constitution of any remaining components is not specified, but it must be assumed that, since this is a stabilised liquid form, at least some stabiliser must be present.

Finally, document (10) states that "in producing fully stabilised 100% liquid sulphur trioxide (**at least** 99.5% sulphur trioxide, balance sulphuric acid) no free water of constitution must be in the stabiliser" (page 4, lines 1, 2).

As becomes evident from the passages cited above, said documents cannot support the contention that the liquid forms of SO<sub>3</sub> necessarily contain a certain amount of sulfuric acid, since, in each case, a minimum purity is specified. This does not exclude the possibility of obtaining completely anhydrous liquid SO<sub>3</sub>, as confirmed by document (8). Further confirmation can be found in entry 9152 of document (15), which refers to "absolutely dry SO<sub>3</sub>".

As an additional point it should be noted that, in document (8), "liquid sulfur trioxide containing up to about 1.0% H<sub>2</sub>SO<sub>4</sub>" is nevertheless considered to be "liquid sulfur trioxide" rather than "oleum".

In view of the above, the board concludes the skilled reader would not construe the feature "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>" to encompass "sulfur trioxide" or stabilised liquid forms thereof such as "Sulfan B".

- 2.3 Document (3) relates to a process for the production of 5-carboxyphthalide that comprises reacting, at atmospheric pressure, terephthalic acid dissolved in liquid SO<sub>3</sub> with formaldehyde (see claim 1). It is further disclosed in document (3) that "the solvent used in the process of this invention is liquid (100 percent) SO<sub>3</sub>, a commercially available commodity" (see column 1, lines 60, 61). This is confirmed in examples 1 and 3, which refer to the use of "sulfur trioxide (... "Sulfan")" and "100 percent SO<sub>3</sub>", respectively.

In view of the analysis under point 2.2, the subject-matter of claim 1 according to the patent in suit differs from the process according to document (3) in the definition of the reaction medium used.

- 2.4 Document (4) states the following in the first complete paragraph on page 1696:

"We wish to report the condensation of terephthalic acid with formaldehyde in sulfur trioxide media, a process which produces 5-carboxyphthalide (**1**) cleanly and in excellent yield. The reaction is generally free of by-product formation over a fairly wide range of reaction conditions, although terephthaloyloxyacetic acid (**2**) has been identified (as its dimethyl ester)

from reaction in the presence of excess formaldehyde and from reaction media containing <20% SO<sub>3</sub>".

In this general statement, no specific reaction conditions are disclosed, such as reaction temperature or pressure. It is also not specified that the remaining component making up the "reaction media containing <20% SO<sub>3</sub>" is in fact sulfuric acid. It is noted that sulfuric acid is not the only medium that can be envisaged in this context, as is confirmed by document (2) (cf. Table II).

It is further noted that the only specific confirmation for the statement "terephthaloyloxyacetic acid (2) has been identified (as its dimethyl ester) ... from reaction media containing <20% SO<sub>3</sub>" is provided in the last passage of the experimental section of document (4), wherein the reaction is performed in 98% sulfuric acid, in a sealed glass tube and at a temperature of 150°C (page 1696, right-hand column). These reaction conditions clearly differ from those specified in claim 1 of the patent in suit.

Contrary to the appellant's opinion, it cannot therefore be accepted that the passage cited above provides a clear and unambiguous disclosure of all the features of claim 1 according to the patent in suit.

In the only specific example in document (4) for the synthesis of 5-carboxyphthalide, the reaction medium is "sulfur trioxide (... "Sulfan B")". As outlined above under point 2.2, this is not considered to fall within the scope of the reaction medium as defined in claim 1 of the patent in suit.

2.5 Finally, the argument of the appellant according to which it made no technical sense to distinguish between sulfur trioxide and fuming sulfuric acid in the context of the present reaction is not considered to be relevant to assessment of novelty with respect to documents (3) and (4), since claim 1 according to the patent in suit defines the composition of the reaction medium to which formaldehyde and terephthalic acid are added, that is, prior to commencement of the reaction process.

In this context it is additionally noted that there is no reference in documents (3) and (4) to the presence of even trace amounts of water or sulfuric acid in the sulfur trioxide used as medium, nor can the presence thereof be seen as inevitable (see point 2.2).

2.6 In view of the above, the subject-matter of claim 1, and that of dependent claims 2 to 21, are regarded as being novel over documents (1), (3) and (4). The same is true of claim 22, which comprises all the features of claim 1.

None of the remaining cited prior art documents disclose a process according to present claim 1.

Accordingly, the subject-matter of the respondent's main request meets the requirements of novelty (Articles 52(1) and 54 EPC).

3. *Main request – Inventive step*

3.1 The subject-matter of claim 1 relates to a process for the preparation of 5-carboxyphthalide by reaction of formaldehyde and terephthalic acid.

In accordance with the problem-solution approach consistently applied by the boards of appeal, it is necessary, as a first step, to establish the closest prior art. This is normally a prior art document disclosing subject-matter aiming at the same objective as the claimed invention and having the most relevant technical features in common.

The appellant considered document (3) to represent the closest prior art, whereas the respondent was of the opinion that document (2) was closer.

Both documents may be said to aim at the same objective in that they both relate to the production of 5-carboxyphthalide by reaction of terephthalic acid with formaldehyde (see document (2), introductory section and "Results"; document (3), claim 1).

As defined in the patent in suit, the reaction medium is "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>". According to the analysis outlined above under point 2.2, this feature is to be construed as encompassing mixtures of H<sub>2</sub>SO<sub>4</sub> and SO<sub>3</sub> with an SO<sub>3</sub> content of at least 20% by weight, up to but not including values where the H<sub>2</sub>SO<sub>4</sub> present would be regarded by the skilled person as representing a trace amount in the sulfur trioxide medium (cf. document (8), column 2, lines 50 to 57).

In document (2) the experiments are *inter alia* conducted in H<sub>2</sub>SO<sub>4</sub> with a wide range of SO<sub>3</sub> concentrations, and in 100% SO<sub>3</sub> (page 690, Figure 1, Table II). In document (3), the solvent employed is liquid SO<sub>3</sub>.

As defined in the patent in suit, the reaction is conducted in an open, non-pressurised reactor at a temperature of 120 to 145°C.

In document (2) the reaction conditions used are 150 ± 0.2°C in sealed glass tubes (page 693, "Methods"). In document (3), the reaction is performed at atmospheric pressure and at a temperature of between 120 and 180°C (claim 1); the temperature exemplified in Examples 1 to 3 is 130°C.

Thus, identical conditions of temperature and pressure are employed in document (3) and in the patent in suit. Moreover, any differences in the composition of the reaction medium must be seen as being of an incremental nature. Having regard to the open-ended range defined for the SO<sub>3</sub> content in the patent in suit, the respondent's argument that "liquid SO<sub>3</sub> is a completely different medium than oleum" is not considered to be convincing.

Consequently, in view of its greater similarity with the claimed subject-matter, document (3) is considered to represent a more appropriate starting point for the assessment of inventive step than document (2).

3.2 As the next step according to the problem-solution approach, it is necessary to determine the problem which the claimed invention addresses and successfully solves, in the light of the closest prior art.

In the comparative examples provided by the respondent in documents (17) and (18), reactions according to the patent in suit are compared with reactions according to document (2) rather than document (3). These results cannot therefore provide adequate support that any of the improvements alleged by the respondent, such as higher yield and purity, are attributable to the distinguishing feature of the invention with respect to the closest state of the art, namely, the incremental differences in the reaction medium as outlined above under point 3.1. Accordingly, documents (17) and (18) cannot be taken into consideration with respect to the determination of the problem to be solved.

Hence, in the light of the closest prior art, the problem to be solved is to be seen as lying in the provision of an alternative process for the synthesis of 5-carboxyphthalide.

The solution as defined in claim 1 relates to a process characterised by the fact that the reaction medium is "fuming sulfuric acid containing at least 20% by weight of SO<sub>3</sub>".

Having regard to the experimental results reported in the patent in suit (see examples 1 to 6) as well as in documents (16) to (18), the board is satisfied that the problem has been plausibly solved.

3.3 It remains to be investigated whether the proposed solution would have been obvious to the skilled person in the light of the prior art.

As outlined above, document (3) itself relates to a process for the production of 5-carboxyphthalide by reaction of terephthalic acid with formaldehyde in a non-pressurised reactor. The reaction is performed in liquid  $\text{SO}_3$ .

From stoichiometric considerations, the skilled person would be aware of the fact that, for every mole of 5-carboxyphthalide formed, one mole of water is generated. This is confirmed by the reaction scheme depicted on page 1696 of document (4). It is also within the common general knowledge of the skilled person that sulfur trioxide combines with water to form sulfuric acid (see e.g. document (12), and document (15), entry 9152). The resulting mixture of  $\text{SO}_3$  and sulfuric acid is, by definition, fuming sulfuric acid.

The appellant has calculated that, by the end of the reaction according to Example 1 of document (3), the fuming sulfuric acid generated has an  $\text{SO}_3$  content of 67.8% by weight (see letter of 25 June 2010, point 2.3). This was not disputed by the respondent.

Hence, in view of the above considerations, the skilled person would have been aware of the fact that, for the greatest part of the reaction according to document (3), the reaction medium would in fact be fuming sulfuric acid with an  $\text{SO}_3$  content falling within that defined in claim 1 according to the patent in suit.

It would therefore have been an obvious measure for the skilled person, faced with the above-mentioned problem, to replace the sulfur trioxide medium used in document (3) with an oleum having a high SO<sub>3</sub> content. In doing so, he would thus arrive at the claimed subject-matter without the exercise of inventive skill.

- 3.4 The board is not convinced by the submissions of the respondent according to which the skilled person would have been dissuaded by the disclosure of document (2) from employing non-pressurised conditions in connection with oleum.

Document (2) concerns a mechanistic study into the reaction of terephthalic acid and formaldehyde (see page 689, right-hand column). The results section focuses on the effect of three variables on this reaction, namely, acid strength, nature of the solvent and SO<sub>3</sub> content. In all the experiments, the reactions concerned are performed at a specific temperature of 150°C and in a sealed glass tube (page 693, "Methods"). However, the significance of temperature and pressure is not otherwise discussed in document (2). The skilled person would therefore have no reason to regard these as being mandatory reaction conditions for obtaining 5-carboxyphthalide in oleum.

- 3.5 Consequently, the respondent's main request is rejected for lack of inventive step of claim 1 (Articles 52(1) and 56 EPC).

4. *First Auxiliary request - Amendments*

In claim 1 of the first auxiliary request, an upper limit of 33% by weight has been introduced for the content of SO<sub>3</sub>. This amendment find its basis in claim 6 of the application as originally filed.

This claim has been restricted with respect to claim 1 of the granted version.

The amended request therefore meets the requirements of Article 123(2) and (3) EPC.

5. *First Auxiliary request - Novelty*

Since the first auxiliary request only differs from the main request in a limitation in the SO<sub>3</sub> content of the fuming sulfuric acid, the conclusions under point 2 apply equally to this request.

Therefore, the subject-matter of the first auxiliary request meets the requirements of novelty (Articles 52(1) and 54 EPC).

6. *First Auxiliary request - Inventive step*

6.1 Claim 1 has now been limited such that the reaction medium is a dilute oleum with a narrow range for the SO<sub>3</sub> content of 20 to 33% by weight.

As for the main request, the appellant maintained that document (3) represented the closest prior art, and the respondent document (2).

Document (2) discloses an example in which the solvent is "30% SO<sub>3</sub>-H<sub>2</sub>SO<sub>4</sub>" (Table II, Run 1). It is noted that, in document (2), the SO<sub>3</sub> content is given in mole % (see e.g. Figure 1). The value of 30% corresponds to about 26% by weight, which is within the claimed range.

In contrast, the value of 100% SO<sub>3</sub> employed in document (3) (cf. column 1, lines 60, 61) is far removed from the claimed range.

Thus, in view of the significant differences between the media according to document (3) and the present claim, the board considers that document (2) now represents a more realistic starting point for the assessment of inventive step.

The appellant argued that document (3) should nevertheless be regarded to be the closest prior art since it aimed at the same objective as the claimed invention, namely, an improvement on an industrial scale. However, the board notes that, in the patent in suit, it is explained why neither document (2) nor (3) disclose a process suitable for implementation on an industrial scale (see paragraphs [0004], [0007], [0008]). Moreover, this is not an objective that can be derived from document (3) itself.

- 6.2 As outlined above under point 3.4, document (2) relates to a mechanistic study into the reaction of terephthalic acid and formaldehyde. The effect of the solvent and SO<sub>3</sub> content are amongst the variables investigated (see Figure 1 and Table II). In all the experiments disclosed, the reactions are performed at a temperature of 150°C and in a sealed glass tube, that

is, under pressurised conditions (cf. page 693, "Methods"). In Run 1 of Table II, "30% SO<sub>3</sub>-H<sub>2</sub>SO<sub>4</sub>" is used as solvent, which is a concentration falling within the range now claimed, as explained above under point 6.1. A conversion to 5-carboxyphthalide of 95% is obtained under these conditions after two hours.

- 6.3 The respondent defined the problem to be solved, in the light of document (2), as lying in the provision of a process that allows the synthesis of 5-carboxyphthalide with higher yield and purity, without significant gas generation, and which was easily controllable and reproducible on an industrial scale. As support that this problem had been solved, the respondent relied on the results presented in documents (17) and (18).

It is noted that the comparative experiments in these documents are not performed on an industrial scale. Furthermore, it is noted that the advantages listed in the above definition of the problem were contested by the appellant. For example, it was criticised that no conclusion on reproducibility could be reached based on documents (17) and (18), since repeated runs under identical conditions had only been performed for the process according to document (2) but not for that according to the present invention.

Under these circumstances, the problem to be solved may be defined in a somewhat less ambitious manner as lying in the provision of a simplified process for the synthesis of 5-carboxyphthalide without sacrificing product yields.

The solution as defined in claim 1 relates to a process characterised in that it is performed at a lower temperature and in an open, non-pressurised reactor.

- 6.4 As a next step, it has to be decided whether it has been rendered plausible that the problem defined under point 6.3 has been successfully solved with respect to the closest prior art.

In the first experiment of document (17), the reaction between terephthalic acid and trioxane was performed in 30% oleum, in accordance with reaction conditions used in document (2), namely, in a sealed test-tube at about 150°C for two hours. It is stated that "the HPLC analysis of the product mixture detects a 5-carboxyphthalide content of 95%". Three further runs performed under the same conditions gave conversion results of 78.3, 81.3 and 82.9%.

In the fourth experiment of document (17), the reaction was repeated, on an identical scale, in an open flask and at a temperature of 132°C, that is, under conditions in accordance with present claim 1. After two and four hours, a content of 5-carboxyphthalide was obtained of 94.6 and 99.2%, respectively. In the last experiment listed in document (17), the experiment was repeated with similar results using slightly different amounts and proportions of reagents. In the experiment of document (18), the temperature used was 140°C; after two hours a content of 5-carboxyphthalide of 92.3% was obtained.

According to the second and third experiments listed in document (17), worse conversion values of 73.5 and

80.6% were obtained when lowering the pressure and temperature separately, namely, in an open flask at 150°C and in a sealed glass tube at 132°C, respectively.

The appellant questioned these results, arguing that the HPLC analyses on the product mixtures, at best, provided conversion results, which merely reflected the conditions used in the purification step performed prior to HPLC analysis, rather than being attributable to the reaction itself. However, no evidence in support of this allegation was provided by the appellant. In the absence of any evidence to the contrary, the board sees no reason to doubt the respondent's submission according to which, as long as the same procedure was performed prior to HPLC analysis in each case, a higher conversion would indeed reflect an increase in yield of the desired product, that is, 5-carboxyphthalide.

Therefore, the board considers that the comparative tests reported in documents (17) and (18) represent a fair basis for the assessment of inventive step. Having regard to the results summarised above, the board is satisfied that the problem has been plausibly solved over the whole breadth of claim 1, that is, that at least comparable yields are obtained for the reaction conditions defined in claim 1.

- 6.5 It remains to be investigated whether the proposed solution would have been obvious to the skilled person in the light of the prior art.

As already indicated above, document (2) discloses that excellent conversions to 5-carboxyphthalide may be obtained in "30% SO<sub>3</sub>-H<sub>2</sub>SO<sub>4</sub>". However, since all

reactions are performed in a sealed glass tube at 150°C, no pointer can be derived from document (2) that comparable conversions could be obtained under the milder conditions claimed.

Document (3) discloses processes performed at atmospheric pressure and at a temperature of 130°C (Example 1 to 3). However, the solvent used is liquid SO<sub>3</sub> (cf. claim 1). Document (3) contains no information regarding reactions in dilute oleums of the type now claimed.

Document (4) is directed to a brief study of the reaction of terephthalic acid with formaldehyde in sulfur trioxide media. The passage reproduced in the second paragraph of point 2.4 above suggests that the authors of this paper examined the effect of variations in certain reaction conditions on the yield of 5-carboxyphthalide. However, this passage is extremely vague. It is not specified what reaction conditions were investigated, apart from the content of formaldehyde and SO<sub>3</sub> (see in particular reference to "reaction media containing <20% SO<sub>3</sub>"). Moreover, no details are given regarding the nature of the media used. In the specific teaching in document (4) regarding the synthesis of 5-carboxyphthalide, the reaction medium employed is, as in document (3), sulfur trioxide. In a second experiment, the reaction between terephthalic acid and formaldehyde is performed in 98% sulfuric acid in a sealed glass tube at 150°C, whereby only a small amount of the 5-carboxyphthalide product is obtained (see "Experimental Section").

Therefore, there is no hint in documents (3) or (4) leading the skilled person to modify the closest prior art reaction according to document (2) by lowering the temperature and pressure as a solution to the problem posed.

The further prior art documents available in the present case do not come closer to the claimed subject-matter than those addressed above. Hence, the subject-matter of claim 1 of the first auxiliary request involves an inventive step.

In view of the fact that claims 2 to 21 are dependent on claim 1 and that claim 22 is directed to a process comprising the features of claim 1, it is concluded that the subject-matter of the claim set according to the first auxiliary request meets the requirements of Articles 52(1) and 56 EPC.

Since the first auxiliary request is considered to be allowable, the board need not decide on the lower ranking requests.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent as amended in the following version:
  - claims 1-22 of the 1st auxiliary request filed with a letter dated 25 May 2010; and
  - amended pages 2 to 5 of the patent specification received during the oral proceedings of 27 July 2010.

The Registrar:

The Chairman:

B. Atienza Vivancos

P. Ranguis