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Datasheet for the decision of 14 April 2011

Case Number: T 0756/08 - 3.3.01

Application Number: 02740416.9

Publication Number: 1373236

IPC: C07D 301/12

Language of the proceedings: EN

Title of invention:
Process for the epoxidation of olefins

Patentee:
Evonik Degussa GmbH, et al

Opponents:
THE DOW CHEMICAL COMPANY
BASF SE

Headword:
Olefin epoxidation/EVONIK

Relevant legal provisions:
EPC Art. 83, 54, 56
RPBA Art. 13(1)

Keyword:
"Auxiliary request, filed at oral proceedings: admissible (yes)"
"Sufficiency of disclosure (yes)"
"Novelty (yes), temperature profile not inevitable result of prior art process"
"Inventive step (no), obvious alternative, routine activity"

Decisions cited:
G 0001/03

Catchword:
-

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Case Number: T 0756/08 **-** 3.3.01

D E C I S I O N
of the Technical Board of Appeal 3.3.01
of 14 April 2011

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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 13 February 2008 rejecting the oppositions filed against European patent No. 1373236 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman: P. Ranguis
Members: L. Seymour
C.-P. Brandt

Summary of Facts and Submissions

I. European patent No. 1 373 236 was granted on the basis of one independent claim and eleven dependent claims. Claim 1 as granted reads as follows:

"1. A process for the catalytic epoxidation of olefins with hydrogen peroxide in a continuous flow reaction system, wherein the reaction mixture is passed through a fixed catalyst bed within a reactor equipped with cooling means while maintaining a temperature profile within the reactor such that the cooling medium temperature of the cooling means is at least 40°C and the maximum temperature within the catalyst bed is 60°C at the most."

II. Oppositions were filed against the granted patent by opponents I and II. The patent was opposed under Article 100(b) EPC for insufficiency of disclosure, and under Article 100(a) EPC for lack of novelty and inventive step.

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

(1) WO 97/47614
(2) EP-A-0 659 473
(3) US-A-5,466,835
(4) WO 99/01445
(5) US-A-5,599,955
(6) EP-A-930 308
(8) WO 01/10855
(19) Affidavit of Dr. Teles dated 13 March 2006, including experimental data, submitted with notice of opposition by opponent II.

IV. The appeals lie from the decision of the opposition division rejecting the oppositions under Article 101(2) EPC.

The opposition division considered the requirement of sufficiency of disclosure to be fulfilled, and was further of the opinion that the subject-matter claimed met the requirements of novelty, since the test results submitted by opponent II in document (19) could not prove beyond reasonable doubt that comparative example 1 according to document (8) inevitably produced a temperature profile as claimed in the patent in suit.

With respect to the issue of inventive step, the opposition division considered document (2) to represent the closest prior art and defined the problem to be solved as lying in the provision of an alternative epoxidation process providing high product selectivity and H_2O_2 conversion.

The opposition division did not accept that the characterising feature as defined in claim 1, namely, the cooling medium temperature of at least 40°C, represented an arbitrarily selected value. This allegation had not been substantiated since the experimental data provided by opponent II with letter of 16 November 2007 had only been carried out under conditions falling outside those claimed. In contrast, the data submitted by the patentee with letter of 31 October 2007 demonstrated that the claimed cooling temperature contributed to the solution of the problem posed. Since the cited prior art did not prompt the skilled person to modify the process according to

document (2) such as to arrive at the subject-matter of the contested claims, an inventive step could be acknowledged.

V. Appellants I and II (opponents I and II) both lodged appeals against this decision and filed additional experimental data with the grounds of appeal.

VI. With its reply, the respondent (patentee) filed counterarguments.

VII. Oral proceedings were held before the board on 14 April 2011.

VIII. During the course of oral proceedings, the respondent filed an auxiliary request. Claim 1 of this request differed from claim 1 according to the main request (cf. point I above) in that it included the following features inserted at the end of the claim: "wherein the reactor is a tubular reactor and the cooling means is a cooling jacket and a titanium-containing zeolite is used as catalyst".

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

The main request (i.e. claims as granted) was objected to under Article 100(b) EPC with the argument that, in order to carry out the invention over the whole scope claimed, the skilled person would have to perform a research programme so as to determine combinations amongst the host of variable parameters that were suitable for achieving an optimised balance between conversion and selectivity. No guidance was given in

the patent in suit beyond the examples, which employed a very specific reactor configuration together with very specific reaction conditions.

The novelty of the subject-matter of claim 1 of the patent in suit was disputed in view of the comparative example 1 of document (8). Although the maximum temperature within the catalyst bed (T_{max}) had not been specified in document (8), repetition of said comparative example using conventional methods for the measurement of T_{max}, as outlined in document (19), demonstrated that a temperature profile as claimed in the patent in suit had been maintained for approximately 50 hours, namely between the measurement points of 535 and 585 hours. In this context, the appellants emphasised that the wording of claim 1 of the patent could not be seen as excluding a temperature rise during the course of reaction, as long as the temperature profile remained within that claimed.

In their assessment of inventive step of the main request, the appellants started by analysing the features of claim 1 as granted. The temperature profile in this claim had been defined in an unusual manner, in terms of a minimum cooling medium temperature (T_{cool}) of 40°C and a maximum temperature within the catalyst bed (T_{max}) of 60°C. However, what was effectively being claimed was no more than a continuous catalytic epoxidation performed within a temperature range of 40 to 60°C. A number of the cited documents suggested working within this range, namely, documents (3) (Example 2), (4) (page 6, lines 7 to 9; page 11, line 28 to page 12, line 3), (5) (Example I) and (6) (Example 9). Any of these documents could be viewed as

constituting the closest prior art. The overall picture conveyed by the state of the art was that epoxidations of the type claimed should be performed within said temperature range.

The only feature that was not explicitly mentioned in the prior art was the T_{cool} value of at least 40°C. The data provided in the patent in suit did not provide evidence of an unexpected effect exclusively linked to this distinguishing feature. This was confirmed by the test reports filed with the statements of grounds of appeal. The claimed temperature profile therefore merely constituted an arbitrary selection of a range within that suggested by the prior art, which could not be seen as an inventive solution to the problem of providing a further process for the epoxidation of olefins.

Moreover, the feature "a reactor equipped with cooling means", specified in claim 1 of the patent in suit, could not render the claimed process inventive. This feature was very general and did not exclude apparatuses using external cooling, such as that disclosed in document (2). In addition, the thermostatting of reactors by means of a cooling medium was well known in the prior art, for example, from document (8), which disclosed the use of a tubular reactor equipped with a cooling jacket.

With respect to the auxiliary request, the appellants raised an objection of admissibility, in view of the fact that it had been filed at a very advanced stage of the proceedings. All the relevant arguments of the appellants had been included in the statements of

grounds of appeal. Therefore, the respondent should also have presented its complete case at the outset of the appeal proceedings, as required by the Rules of Procedure of the Boards of Appeal (RPBA).

The appellants did not raise any formal objections with respect to the auxiliary request. Concerning the issues of sufficiency and novelty, the appellants maintained their objections and referred to their previous submissions with respect to the main request. In their analysis of inventive step, the appellants also relied substantially on the arguments already brought forward with regard to the main request.

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

With respect to the main request, the respondent submitted that the allegations of lack of sufficiency of disclosure had not been substantiated by means of any verifiable facts. On the contrary, the test results provided by the appellants with their statements of grounds of appeal demonstrated that the skilled person would not have any difficulty in reproducing the claimed process within the specified temperature profile.

The respondent also refuted the novelty objection by arguing that the claimed temperature profile could not be seen as being the direct and inevitable result of the comparative example of document (8). No instructions were given in document (8) with regard to the method of measurement of T_{max}. In the method

according to document (19), the temperature-sensing devices had been inserted into a protective tube which took up a considerable proportion of the reactor volume. This would be expected to shift T_{max} towards lower values. Other methods of measurement could be envisaged that had less impact on the results obtained. In this context, the respondent referred to the experiments submitted by appellant II under the heading "Neue Versuche (II)" with its statement of grounds of appeal, in which a protective tube had been dispensed with (see page 23, second paragraph of point (ii)).

As second difference between the claimed process and that of document (8) was to be seen in the feature "maintaining a temperature profile within the reactor". This was to be understood as referring to the maintenance of a constant temperature profile over the complete duration of the epoxidation reaction. In contrast, in the process of document (8), the temperature had been increased with running time.

Turning to the issue of inventive step of the main request, the respondent argued that document (2) represented the closest prior art, since it disclosed a continuous process for the epoxidation of propene with hydrogen peroxide employing a fixed catalyst bed, and aimed at improving selectivity and yields by controlling the reaction temperature. The reactor employed in document (2) involved a complex set-up comprising a series of reaction zones, whereby the reaction liquid stream from each zone was removed and separately cooled.

The problem to be solved in view of document (2) was to be defined as lying in the provision of a process for the epoxidation of olefins that allowed high product selectivity and conversion to be obtained using a simpler reactor system.

This problem had been solved by using "a reactor equipped with cooling means" in combination with the claimed temperature profile characterised by specific values of T_{cool} and T_{max}, as demonstrated by the results presented in Table 1 of the patent in suit. The respondent emphasised that the values of T_{cool} and T_{max} were clearly inextricably linked; the critical parameter was thus not T_{cool} alone, but T_{cool} in combination with T_{max}. The opposition division had been wrong to regard these as being independent variables. In the appeal proceedings, the respondent no longer relied on its data submitted during the opposition proceedings with letter of 31 October 2007.

Document (2) itself could not render the claimed subject-matter obvious, since it related to a reactor with external cooling rather than "a reactor equipped with cooling means", and highlighted the disadvantages of tubular reactors with respect to heat removal when carrying out highly exothermic reactions.

Documents (1) and (8) disclosed tubular reactors equipped with a cooling jacket. However, a T_{cool} of 0 to 5°C was taught in example 8 of document (1). Moreover, document (8) addressed a different problem to that of the patent in suit, namely, that of gradual catalyst deactivation. The solution offered was the simultaneous adjustment of temperature and pH. In

Figure 2, the required value of T_{cool} was maintained below 40°C. It was only in the comparative example without pH adjustment, as depicted in Figure 1, that greater values of T_{cool} had been employed. Thus, documents (1) and (8) suggested T_{cool} values below 40°C, and therefore taught away from the claimed subject-matter as a solution to the problem posed.

Document (4) also did not suggest the claimed solution. Like document (8), it had a different objective than the patent in suit, namely, counteracting catalyst deactivation. The solution proposed involved increasing temperature and pressure over time, rather than maintaining a specific temperature profile, as required by claim 1 of the patent in suit. Moreover, higher reaction temperatures than those claimed were employed in the examples of document (4), and lower selectivities were obtained than in the examples according to the patent in suit. In addition, the reactors disclosed in document (4) employed vaporisation and indirect heat exchange to control temperature, rather than "a reactor equipped with cooling means".

Finally, the respondent disputed the pertinence of the various test reports submitted by the appellants with their respective statements of grounds of appeal.

With respect to the question of admissibility of the auxiliary request, the respondent argued that it had been filed in response to arguments raised at oral proceedings with respect to claim breadth and construction. Moreover, the restricted subject-matter was purely based on preferred features that were to be

found in the claims as granted, and corresponded to the system used in the examples of the patent in suit and by the appellants in their comparative tests. The amendments did not therefore raise any fresh or surprising issues.

The respondent did not advance any additional arguments with respect to the restrictions undertaken in the auxiliary request, except to indicate that the previous submissions on inventive step applied all the more to the subject-matter claimed in the auxiliary request, since there could be no doubt that the reactor configuration was less complex than that disclosed in document (2).

XI. The appellants (opponents I and II) requested that the decision under appeal be set aside and that the European patent No. 1373236 be revoked.

The appellants further requested that the auxiliary request, filed at the oral proceedings, not be admitted into the proceedings.

The respondent (patentee) requested that the appeals be dismissed or, in the alternative, the patent be maintained on the basis of the claims 1-10 according to the auxiliary request dated 14 April 2011, filed at the oral proceedings.

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

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the auxiliary request*

The auxiliary request was filed during the oral proceedings before the board as a direct response to the previous discussion on inventive step. The amendments resulted in a clear restriction to a preferred embodiment by incorporation of features of dependent claims of the main request into claim 1. This limitation was easy to handle and did not require a fresh discussion. The board therefore decided to exercise its discretion to admit the auxiliary request into the proceedings (Article 13(1) RPBA).

3. *Amendments, auxiliary request (Articles 123(2),(3) EPC)*

In the auxiliary request, granted claims 3 and 9 have been deleted, and the features thereof incorporated into claim 1. The board is satisfied that the amended claims comply with the requirements of Articles 123(2) and (3) EPC. Since this was not contested by the appellants, a detailed reasoning is not required.

4. *Sufficiency of disclosure (Articles 100(b), 83 EPC)*

The appellants argued that insufficient information was provided in the patent in suit to allow the skilled person to achieve "an optimised balance between conversion and selectivity" within the whole scope claimed.

However, it is noted that said effect is not included as a feature characterising the subject-matter claimed, but is rather mentioned in connection with the definition of the problem underlying the patent in suit (see paragraph [0013]). Under these circumstances, the question as to whether or not an alleged effect has been plausibly demonstrated over the whole range claimed arises under Article 56 and not Article 83 EPC (cf. Enlarged Board of Appeal decision G 1/03, OJ 2004, 413, point 2.5.2).

No convincing evidence or arguments have been brought forward by the appellants demonstrating that the skilled person would not be in a position to reproduce the claimed process within the claimed temperature profile, based on the information provided in the patent in suit, in the light of the common general knowledge in the art.

Consequently, the board has come to the conclusion that the ground of opposition under Article 100(b) EPC does not prejudice the maintenance of the main or auxiliary requests.

5. *Novelty (Articles 52(1), 54 EPC)*

The appellants contested the novelty of the subject-matter of claim 1 of the main and auxiliary requests over the process disclosed in comparative example 1 of document (8).

This example discloses a continuous epoxidation of propene in a tubular reactor equipped with a cooling jacket and charged with a TS-1 catalyst, which is a

titanium-containing zeolite catalyst (cf. page 8, lines 11, 12). According to Figure 1, the cooling medium temperature (T_{cool}) is initially set at –5°C and is increased to a value of over 50°C, over a period of 950 hours. With respect to the maximum temperature within the catalyst bed (T_{max}), no methods of measurement or corresponding values are specified in this example.

5.1 The board cannot agree with the respondent's contention that this process of document (8) already differs from that claimed owing to the fact that T_{cool} had not been held at a constant value within the prescribed range of "at least 40°C" for the whole of the reaction period.

The corresponding feature in claim 1 of the main and auxiliary request requires "maintaining a temperature profile within the reactor".

The board firstly notes that this feature does not specify that a constant temperature profile need be maintained. Therefore, the board concludes that the process will fall within the terms of the claim as long as it is performed within the prescribed limits of T_{cool} and T_{max}, even if the values themselves increase over time, as is the case in comparative example 1 of document (8).

Secondly, it is noted that the claims do not specify any period of time for which the reaction must be performed. There is therefore no reason why a reaction run for some time within the specified temperature profile should not be regarded as falling within the

claimed scope, even if this was not maintained for the whole period of the reaction.

Thus, the skilled person would construe the feature "maintaining a temperature profile within the reactor such that the cooling medium temperature of the cooling means is at least 40°C" to encompass the situation depicted in Figure 1 of document (8) wherein T_{cool} is "at least 40°C" in the period between 535 and 950 hours. Consequently, the board concludes that this feature does not in itself distinguish the claimed processes from that disclosed in comparative example 1 of document (8).

5.2 The question must therefore be answered whether, as alleged by the appellants, the claimed temperature profile is implicitly disclosed in document (8) as the direct and inevitable result of the process described in comparative example 1. As evidence in support thereof, the appellants relied upon the experimental data submitted by appellant II as document (19).

However, the respondent has convincingly argued that several methods could be envisaged for the measurement of T_{max}, and that that chosen by appellant II, namely, involving a protective tube which took up a considerable proportion of the reactor volume, would be expected to significantly influence the results obtained.

It follows that the experimental data provided by appellant II are not sufficient to prove beyond any reasonable doubt that the process described in comparative example 1 of document (8) directly and

inevitably leads to a temperature profile according to claim 1 of the main and auxiliary requests.

5.3 Accordingly, the board concludes that the subject-matter of claim 1 of the main and auxiliary requests, and that of their remaining dependent claims, are novel over document (8).

6. *Inventive step, main request (Articles 52(1), 56 EPC)*

6.1 The subject-matter of claim 1 relates to a continuous process for the epoxidation of olefins with hydrogen peroxide over a fixed catalyst bed. The reactor used is "equipped with cooling means", and a defined temperature profile is maintained. According to paragraph [0013], the patent in suit aims to achieve an optimised balance between conversion and selectivity.

With respect to the feature "a reactor equipped with cooling means", there was disagreement between the parties as to how this should be construed. In view of the outcome of the appeal, the board is prepared to start from the premise, as argued by the respondent and the opposition division, that this feature is to be understood as relating to a reactor with integrated cooling means, such as a tubular reactor equipped with a cooling jacket (cf. claim 3 of the patent in suit), as opposed to a reactor using external cooling.

6.2 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 appellants considered ***inter alia*** document (4) to represent the closest prior art, whereas the respondent was of the opinion that document (2) was closer.

Both documents disclose continuous processes, and share the objective with the patent in suit of seeking to maximise yields of propene oxide by optimising conversion and selectivity, and address the issue of temperature control (cf. document (2), page 2, lines 17 to 19 and lines 45 to 47; page 3, lines 42 to 44; document (4), page 4, line 20 to page 5, line 12; page 6, lines 5 to 23).

In document (2), indirect heat exchange is used to control temperature, and this is contrasted with the use of conventional tubular reactors equipped with a heat exchanger (see page 2, lines 13 to 19, 30 to 32; and examples). In document (4), the reactors specifically disclosed employ vaporisation or indirect heat exchange (see page 11, lines 1 to 9).

Consequently, in view of the fact that document (2) is the only one of these two documents that specifically discloses "a reactor equipped with cooling means" in the sense outlined above under point 6.1, the board considers, in agreement with the respondent and the opposition division, that this document represents the closest prior art.

6.3 As outlined in the previous section, document (2) discloses "a continuous process for the exothermic

reaction of propylene and hydrogen peroxide in the liquid phase to produce propylene oxide in a series of separate reaction zones each containing a packed bed of solid catalyst" wherein "the reaction liquid stream from each zone is removed and separately cooled" (see claim 1). Solid titanium silicalite is employed as catalyst (see page 4, line 10). The procedure used ensures that only a modest temperature rise takes place in any one reaction zone, preferably 5 to 15°C, and that optimum results are thus obtained (see page 2, lines 34, 35, 45 to 47; page 3, lines 39 to 41).

In the introductory section of document (2), this reaction employing external cooling is contrasted with reaction in a tubular reactor equipped with a heat exchanger (page 2, lines 13); the following is stated in the paragraph on page 2, lines 17 to 19:

"The tubular reactor cost becomes prohibitive when high heats of reaction have to be removed through heat exchanger surfaces operating with a low heat transfer coefficient. There is also a temperature gradient from the center of the tube which is often detrimental to a process which requires nearly isothermal conditions."

Examples 1 to 3 of document (2) disclose, with reference to Figures 1 to 3, respectively, epoxidation reactions performed in a multi-zone reactor. In Example 1, the liquid stream entering each reaction zone is at 50°C, and the temperature increases to 58°C as a result of the reaction exotherm. Each zone is connected to an external heat exchanger to cool the reaction medium. The temperature of the cooling medium is not specified. Analogous processes are repeated in

Examples 2 and 3, with temperature rises from 54.4 to 60°C. The propene oxide yields obtained are 90, 90.8 and 92%, respectively. This is contrasted in each case with the results obtained for tubular reactors, as follows:

"This compares with a yield of about 80% which is achieved using conventional tubular reactors wherein the temperature rise in the catalyst exceeds 15°C."

6.4 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 paragraph [0014] of the patent in suit, the following is stated with reference to document (2) (emphasis added):

"... as will be shown in more detail below in the examples **better overall yields** based on hydrogen peroxide **comparable** to the most preferred embodiments in EP-A-659 473 are obtainable although a conventional reactor system without intermediate external cooling is used according to the present invention."

Thus, this passage asserts that yields are achieved for the present process that are better than those hitherto obtainable with conventional reactor systems, and comparable to those achieved in the most preferred embodiments of document (2), employing a reactor system with external cooling. This is also the assumption that underlies the respondent's definition of the problem to be solved, "as lying in the provision of a process for

the epoxidation of olefins that allowed high product selectivity and conversion to be obtained using a simpler reactor system" (see point X above). As outlined above under point 6.3, the propene oxide yields obtained in the examples of document (2) are at least 90%, and this is therefore the standard to be used in assessing "high product selectivity and conversion" in this context.

The results from the examples of the patent in suit are summarised in Table 1, which is reproduced below. An additional column has been added listing the corresponding yields of propene oxide (PO), which are calculated by multiplying conversion and selectivity (cf. document (4), page 4, line 30 to page 5, line 2). Entries E1 and E2 relating to Examples 1 and 2 according to the patent in suit are highlighted in bold. Entries CE1 to CE5 relate to comparative examples.

Table 1:

No.	T_{cool} [°C]	T_{max} [°C]	Flow Rate kg/h	H_2O_2 Conversion [%]	PO Selectivity [%]	PO Yield [%]
CE1	30	40	0.35	71	98	70
CE2	30	35	0.7	45	99	45
E1	**41**	**59**	**0.35**	**96**	**96**	**92**
E2	**41**	**51**	**0.7**	**79**	**98**	**77**
CE3	49	78	0.7	90	91	82
CE4	49	67	1.4	80	93	74
CE5	61	81	2.8	74	91	67

In entry E1, the yield obtained is 92%. This result is indeed comparable to the best result of 92% obtained in document (2).

However, in entry E2, a propene oxide yield of 77% is obtained. This result is only comparable to the yields of 80%, which, according to document (2), are achievable using conventional tubular reactors. This is confirmed by entry CE3 in the above table, in which a yield of 82% is obtained, for the same flow rate as in E2, but employing higher values of T_{cool} and T_{max}, falling outside the claimed temperature profile, but within the range of 40 to 80°C generally disclosed in document (4) as being suitable for use with a titanium silicalite catalyst and hydrogen peroxide (cf. point 6.6.3 below).

Thus, in view of the results provided in Table 1 of the patent in suit, it cannot be said to have been rendered credible that the problem as defined by the respondent has been successfully solved within the whole scope of claim 1.

Consequently, the problem to be solved must be reformulated in a less ambitious manner, starting from the process performed in the conventional tubular reactor as disclosed in document (2), as lying in the provision of an alternative continuous process for the epoxidation of olefins.

6.5 The solution as defined in claim 1 relates to a process characterised by the fact that "the cooling medium temperature ... is at least 40°C and the maximum temperature within the catalyst bed is 60°C at the most".

Having regard to the experimental results reported in the patent in suit (see Table 1), the board is satisfied that this problem has been solved.

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

6.6.1 As outlined above under point 6.3, document (2) itself does not contain any general disclosure of suitable temperatures in which to operate. In examples 1 to 3, temperatures of 50 to 58, 54.4 to 60, and 54.4 to 60°C, respectively, are achieved with indirect heat exchange, that is, a maximum temperature of 60°C and a maximum temperature rise of 8°C. The temperature of the cooling medium is not specified. In contrast, for the reactions performed in the conventional tubular reactors, the temperature rise in the catalyst exceeds 15°C. However, absolute temperature values are not specified.

6.6.2 The skilled person, seeking additional information on suitable reaction temperatures in which to operate, would have looked to further documents relating to continuous epoxidation reactions, such as document (4).

Contrary to the respondent's view, it cannot be accepted that document (4) would be disregarded as relating to a different objective than the patent in suit, and to a different solution. Indeed, like the patent in suit, document (4) aims to maximise yields of propene oxide (see page 4, line 20 to page 5, line 12). This achieved by counteracting catalyst deactivation by increasing temperature and pressure over time (page 5,

line 13 to page 6, line 4). As explained above under point 5.1, the present feature of "maintaining a temperature profile within the reactor" does not exclude an increase in temperature over time. Moreover, a continuous process such as that presently claimed is by its very nature designed to be performed over extended periods of time. Therefore, changes in catalyst activity are also not excluded in the present process (cf. paragraph [0018] of patent in suit).

It is further noted that the teaching of document (4) is not limited to reactors employing vaporisation or indirect heat exchange, since heat removal by other means is also envisaged (see page 11, lines 6, 7 and 15 to 17). The use of a double-walled reactor, such as that described in document (8) (cf. paragraph bridging pages 20 and 21), is therefore not excluded.

6.6.3 Document (4) discloses the desirable temperature range for use with a titanium silicalite catalyst and hydrogen peroxide to be 40 to 80°C (see page 6, lines 7 to 9).

As outlined above under point 6.6.2, temperature is increased over time in the process according to document (4). The choice of initial and final temperatures is dictated by the objective of maintaining acceptable yields, whereby increasing competition occurs from non-selective decomposition of the active oxygen species and sequential reactions of the desired epoxide product with increasing temperature (page 6, lines 11 to 18). Typically, the difference between initial and final temperatures is at least 5°C, but no greater than 25°C when using hydrogen peroxide

and a titanium-containing zeolite catalyst (page 6, lines 19 to 25).

Over the length of the reaction zone, the temperature may be kept substantially constant or may be permitted to increase to a moderate degree, depending on whether all, only a portion or none of the heat of reaction is removed. The maximum temperature rise across an individual catalyst bed is 40°C (page 11, lines 15 to 25).

As an example, document (4) discloses an initial reaction temperature, upon start-up of epoxidation, of 50°C, with a temperature rise along the length of the catalyst bed to 60°C, and an incremental rise in these values to corresponding final temperatures of 55 and 65°C (see page 11, line 28 to page 12, line 10). In examples 1 and 2 (pages 14 and 15), the reactor temperature is increased from 65.6 to 71.1°C over 85 hours.

6.6.4 Thus, applying the teaching of Document (4) to the reactions performed in a conventional tubular reactor, as disclosed in document (2), the skilled person would seek to work within the temperature range of 40 to 80°C.

It can be derived from document (2) that the minimum temperature rise in the catalyst bed achievable with a conventional tubular reactor is around 15°C. Thus, when starting a reaction at the lower end of the temperature range suggested in document (4), that is, at 40°C, the skilled person would inevitably arrive at corresponding values of T_{max} within the reactor of less than 60°C, that is, falling within that specified in claim 1.

Thus, the present T_{max} value of 60°C corresponds to that exemplified in document (2), and falls within that envisaged by the general disclosure of document (4). Moreover, in view of the teaching of document (4) regarding the influence of temperature on yields and selectivity (cf. point 6.6.3 above), the choice of most appropriate maximum temperature for a specific reaction system must be seen as a matter of routine optimisation within the range suggested.

6.6.5 It is true, as pointed out by the respondent, that higher reaction temperatures than those claimed were employed in the examples of document (4).

However, the content of document (4) is not limited to its examples. As explained under point 6.6.3 above, lower temperatures, within the claimed ranges, are generally taught in the description of document (4) (see page 6, lines 7 to 9 and also page 11, line 28 to page 12, line 3).

Moreover, the skilled person would understand the lower selectivities obtained in said examples, compared to those obtained in the examples of the patent in suit, to be a direct result of the higher temperatures used (cf. document (4), page 6, lines 14 to 18). It is noted that comparable yields are nevertheless achieved, owing to the higher conversion value of 98.5% (document (4), page 14, lines 21 to 23; cf. entry E2 in Table 1 reproduced under point 6.4 above).

6.6.6 Concerning the claimed cooling medium temperature T_{cool}, it is noted that documents (2) and (4) disclose the

necessity of cooling these highly exothermic epoxidation reactions (see document (2), page 2, lines 6 to 19; document (4), page 10, line 22 to page 12, line 10). Given that the presently claimed values of T_{max} are already taught in the prior art, establishing the corresponding suitable values of T_{cool} for a given system can also only be seen as lying within the routine activity of the skilled person. This is also consistent with the conclusion on sufficiency of disclosure (see point 4 above).

6.6.7 The respondent's arguments with respect to documents (1) and (8) cannot alter this finding:

The only mention of the cooling medium temperature in document (1) is the value of 0 to 5°C disclosed in example 8. No further indication of the significance of this value is provided. Therefore, the skilled person would have no reason to derive the general teaching from this disclosure that other temperatures were not to be contemplated.

In Figure 1 of document (8), T_{cool} was increased from −5 to 55°C over period of 950 hours, such that the hydrogen peroxide conversion at the outlet from the reactor remained constant at 85±3%. The propene oxide selectivities observed were in the range from 92 to 95% (see "Beispiel 1: Vergleichsbeispiel" and Figure 1). Thus, this example confirms that acceptable results may be obtained over wide range of T_{cool} values. The respondent did no provide any justification for its assertion that a skilled person would disregard these results simply because they appear in a comparative example in document (8).

6.6.8 In view of the above analysis, the choice of temperature profile proposed in claim 1 of the main request is considered to be an obvious modification in view of the contents of documents (2) and (4).

Consequently, the respondent's main request is rejected for lack of inventive step of claim 1.

7. *Inventive step, auxiliary request (Articles 52(1), 56 EPC)*

In claim 1 of the auxiliary request, the definition of the "reactor equipped with cooling means" has been specified to be a tubular reactor equipped with a cooling jacket, and the catalyst has been limited to a titanium-containing zeolite.

The respondent did not submit any additional arguments in favour of inventive step for this request.

In view of the fact that said limitations were already taken into account in the analysis under point 6 (cf. in particular, point 6.1), the reasoning and conclusions detailed therein also apply ***mutatis mutandis*** to claim 1 of the auxiliary request.

Hence, the auxiliary request is also rejected for lack of inventive step of claim 1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The European patent No. 1373236 is revoked.

The Registrar: The Chairman:

M. Schalow P. Ranguis