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**Datasheet for the decision
of 4 September 2007**

Case Number: T 1307/05 - 3.2.04

Application Number: 97927716.7

Publication Number: 0898645

IPC: F02C 3/30

Language of the proceedings: EN

Title of invention:

Process and apparatus for achieving power augmentation in gas turbines via wet compression

Patentee:

THE DOW CHEMICAL COMPANY

Opponent:

ALSTOM (Switzerland) Ltd

Headword:

-

Relevant legal provisions:

EPC Art. 123(2)

Keyword:

"Amendments - added subject-matter (all requests) (yes)"

Decisions cited:

T 0284/94, T 1067/97

Catchword:

-



Case Number: T 1307/05 - 3.2.04

D E C I S I O N
of the Technical Board of Appeal 3.2.04
of 4 September 2007

Appellant:
(Opponent)

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Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office posted
8 August 2005 concerning maintenance of
European patent No. 0898645 in amended form.

Composition of the Board:

Chairman: M. Ceyte
Members: A. de Vries
T. Bokor

Summary of Facts and Submissions

- I. The Appellant (Opponent) lodged an appeal, received 12 October 2005, against the interlocutory decision of the Opposition Division posted 8 August 2005 to maintain the European patent 0 898 645 in amended form, and simultaneously paid the appeal fee. The statement setting out the grounds was received 19 December 2005.
- II. Opposition was filed against the patent as a whole and based on Article 100(c) EPC as its subject-matter extended beyond the content of the application as filed, and on Article 100(a) together with Articles 52(1), 54 and 56 EPC, for lack of novelty and inventive step.

In response to the grounds the Respondent (Proprietor) introduced into the claims of the main and auxiliary requests further distinguishing features.

The Opposition Division held that the grounds for opposition mentioned in Article 100 EPC did not prejudice the maintenance of the patent as amended in accordance with the main request having regard to the documents cited by the parties.

- III. Oral proceedings were duly held before this Board on 4 September 2007.
- IV. The Appellant (Opponent) requested that the decision under appeal be set aside and the patent be revoked in its entirety.

The Respondent (Proprietor) requested that the appeal be dismissed and that the patent be maintained on the

basis of independent claims 1, 14 and 16 in accordance with a main request filed with letter of 26 July 2007, or, alternatively, on the basis of independent claims 1, 14 and 16 in accordance with first, second and third requests also filed with letter of 26 July 2007, or in accordance with a fourth request filed at the oral proceedings.

- V. The wording of the independent claims of the requests is as follows :

Main Request

1."A process for augmenting the net output of an industrial gas turbine (101), the gas turbine (101) including an axial-flow multistage compressor (103) having an inlet (102) for acquiring a working fluid comprising air, the process comprising the step of: providing (201) to the working fluid acquired by the axial-flow compressor (103), in a ramped, incremental or otherwise controllably augmented manner of addition, droplets of a liquid which possess a high latent heat of vaporisation, to reduce the temperature increase of the working fluid caused by compression (103) and to thereby achieve an increase in the net output of the gas turbine (101) as measured against the net output of the gas turbine (101) under comparable conditions but without said liquid being provided, wherein the liquid droplets are water and the amount of said droplets is sufficient to provide a working fluid to the compressor inlet (102) which comprises at least three-quarters of one weight percent of liquid water in admixture with fully humidified air and wherein the

liquid droplets are added for a continuous period of at least 90 minutes."

14."A power production apparatus comprising an industrial gas turbine (101) including an axial-flow multistage compressor (103) having an inlet (102) for acquiring a working fluid comprising air, and droplet-addition means (201) for incrementally augmenting by a process of Claim 1 the net output of said turbine (101) by providing the liquid droplets to the working fluid acquired by the axial flow compressor (103) over a period of operation, in the form of a plurality of nebulized liquid mass flow increments, said droplet-addition means (201) comprising a first means positioned substantially adjacent the compressor inlet for providing liquid droplets thereof to the working fluid acquired by the axial flow compressor and supplemental means for providing liquid droplets to the working fluid, which supplemental means is positioned a greater distance away from the compressor inlet than the first means, wherein the first and supplemental means collectively are sized to provide a working fluid to the compressor inlet (102) which comprises at least three-quarters of one weight percent of liquid water in admixture with fully humidified air and wherein the first and supplemental means are controllable to provide said working fluid including the liquid water for a continuous period of at least 90 minutes."

16."A power production apparatus comprising an industrial gas turbine (101) including an axial-flow multistage compressor (103) having an inlet (102) for acquiring a working fluid comprising air; evaporative

inlet air cooling means for cooling ambient air feed to the compressor inlet (102) and, separate from the evaporative inlet air cooling means, droplet-addition means (201) for incrementally augmenting by a process of Claim 1 the net output of said turbine (101) by providing liquid water droplets to the working fluid acquired by the axial flow compressor (103) over a period of operation, in the form of a plurality of nebulized liquid water mass flow increments in an amount to achieve full humidification of the working fluid and a measure of interstage evaporative cooling in one or more stages of the compressor, wherein the droplet addition-means are sized to provide a working fluid to the compressor inlet (102) which comprises at least three-quarters of one weight percent of liquid water in admixture with fully humidified air and wherein the droplet-addition means are controllable to provide said working fluid including the liquid water for a continuous period of at least 90 minutes."

First Auxiliary Request

Claims 1, 14 and 16 are as in the main request but for the replacement of "at least 90 minutes" by "more than 90 minutes" in the final line of these claims.

Second Auxiliary Request

Claim 1 is as in the first auxiliary request but for the step of providing being "by the use of first and supplemental water addition means" (inserted after "compressor (103)" in line 7 of the claim).

Claims 14 and 16 are as in the first auxiliary request.

Third Auxiliary Request

Claim 1 is as in the second auxiliary request but for the following amendments:

- in the providing step, "droplets of liquid which possess a high latent heat of vaporisation" is replaced by "droplets of water in the form of a plurality of nebulised water mass flow increments" and "compression (103)" now reads "compressions"

- the final feature - "wherein ..." - is amended to read: "causing the working fluid to be fully humidified the water to the working fluid the first and supplemental means being sized to provide essentially at least three-quarters of one weight percent of liquid water in admixture with fully humidified air, the supplemental means being provided at a position a greater distance from the compressor inlet than the first means and wherein the liquid droplets are added for a continuous period of more than 90 minutes."

- reference signs have been removed.

Claims 14 and 16 are as in the first auxiliary request

Fourth Auxiliary Request

Claims 1, 14 and 16 are as in the main request but for the replacement of "at least 90 minutes" by "greater than 90 minutes wherein said process is used for at least six hours within a given twenty four hour period".

VI. The Appellant argued as follows :

The claimed duration lower limit of 90 minutes is not clearly and unambiguously derivable from the first paragraph of page 10. That passage mentions 90 minutes in relation to the prior art. As is clear from its opening lines, this passage should moreover be read together with the preceding paragraph on page 9 corresponding to independent claim 26 as filed which gives a value of six hours in a 24 hour period.

The various passages in the application as filed mentioning 3/4 weight percent do so in a specific context, the features of which are absent from the independent claims.

As for the combination of the specific amount and duration ranges claimed these derive from different respective ones of the various strings of development identifiable in the filed description and numerous claims. Nowhere is an explicit connection made between the specific ranges. In each case individual features have been singled out from different combinations of features.

These arguments apply to all the requests.

VII. The Respondent argued as follows :

Page 6, lines 30 to 32 brings together the basic concepts of extended duration and high levels of water.

The first of these aspects is considered in the first paragraph of page 10. This passage provides a yardstick for duration which is not bound to a particular context. The second aspect is identified in the following lines 24 to 27 on page 10 as "controllably augmenting or modifying the amount of liquid water", details of which the skilled person finds in the description of the embodiment of figure 3 on pages 18 to 19. This is a preferred embodiment in which the skilled person recognizes, in the light of the general statement on page 6, that the amount is essential, but not e.g. the spray rack.

Both amount and duration may be allowably isolated from their respective contexts following T 284/94 as they undoubtedly belong to the complete solution set out on page 6, lines 30 to 32 of the invention's technical problem.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.
2. *Background*

The invention relates to long term power augmentation in industrial gas turbines with a multi-stage axial flow compressor by injecting into its intake liquid water in an amount over and above what is necessary for full humidification of the working fluid and for an extended period of time. The double effects of evaporative cooling and added mass flow of such

continuous, high level water injection (also termed "wet compression" or "overspray"), result in an increase of power output beyond that of conventional evaporative cooling, where no liquid water enters the compressor.

Wet compression per se is a known measure for boosting power output in gas turbines as is clear from the prior art cited in opposition. This is also acknowledged by the Appellant. The claimed invention therefore now focuses on the specific amounts and duration of this wet compression.

3. *Allowability of the Amendments under Article 123(2) EPC*

3.1 In deciding the question of allowability of amendments under Article 123(2) EPC the Board, following well-established practice (see e.g. the Case Law of the Boards of Appeal, fifth edition, December 2006 - hereinafter the CLBA - section III.A.2), must consider whether the amendments in question are *directly and unambiguously* derivable from the application as filed, taking into account matter which is implicit to a person skilled in the art.

3.2 The independent claims 1, 14 and 16 of each of the requests have their origin in as filed claims 1 with 3, claim 33 with 35, and claim 77 respectively. To these claims have been added in combination further features which in particular define - expressed in different terms in the requests - lower limits of the amount and duration of wet compression.

As regards **duration**, the step of adding water droplets is required to be *"for a continuous period of"*, in the main request, *"at least 90 minutes"*, or, as in the first to third auxiliary requests, *"more than 90 minutes"*, or, as in the fourth auxiliary request, *"greater than 90 minutes"*. In the fourth auxiliary request the claims additionally require that the *"process is used for at least six hours within a given twenty four hour period"*.

In accordance with each of the requests the **amount** of water added must be sufficient to provide a working fluid to the compressor inlet which comprises *"at least three-quarters of one weight percent (3/4 wt %) of liquid water in admixture with fully humidified air"*.

- 3.3 Minimum duration and amount are disclosed separately in different passages in the originally filed application documents. The parties are in agreement that the only passage in the originally filed application which mentions 90 minutes in the context of **duration** is found on description page 10, lines 1 to 13.

As for the required **amount** of water of at least 3/4 wt % of liquid water in admixture with fully humidified air it is common ground that the relevant passages in the originally filed application are:

- claim 49
- claim 67
- page 19, lines 4 to 11

- 3.4 The Board firstly notes that in each of the above passages the values appear in a specific context.

3.4.1 The first paragraph of page 10 discusses the duration in the specific context of a *conventional compressor water washing system*. This follows from the paragraph itself (lines 2 to 4) ("augmentation is *simply* accomplished by continuously providing at least a conventional compressor water wash amount of liquid water" (italics added)) and its explicit mention in the following paragraph, lines 14 to 16 providing further detail of "this particular aspect". Finally, this passage indicates that an "at least conventional compressor water wash amount of liquid water" is involved, which on page 21, lines 5 to 7, is given as "typically between 0.1 to 0.5 per cent by weight of the working fluid"

Claim 49 as dependent on claim 33 includes *first and supplemental means* for providing liquid droplets positioned adjacent, respectively further away from the compressor inlet and which are appropriately sized to provide the 3/4 wt % of water. Claim 67 is dependent on claims 53 and 52 which include features of a *spray rack group with spray rack pipe and a sufficient number of spray rack nozzles* as means for providing the 3/4 wt % water. Finally, the passage on page 19 undoubtedly relates to the embodiment of figure 3, as follows from the reference to the immediately preceding paragraph on pages 18 and 19 in its opening lines ("the invention in this regard"). This embodiment is detailed in the final two paragraphs of page 19 continued onto page 20 as including a *spray rack group assembly 201 with spray rack water nozzles 305* at one of the compressor inlets. None of these passages provides any specific values for the duration of the extended wet compression.

3.4.2 Not all of the above features in italics are included in claims 1, 14 and 16 according to any of the requests, so that the features of minimum duration, respectively minimum amount, have been extracted in isolation from their original context. Following established jurisprudence, see in particular T 1067/97 cited in CLBA, section III.A.1.1, page 240, third paragraph, this is only justified in the absence of any clearly recognizable functional or structural relationship among the features.

3.4.3 The Board is not convinced that this is so in the case at hand. The discussion on page 21, line 3 onwards, is significant in this regard. It distinguishes between extended wet compression using only conventional compressor water washing, which produces lower levels of power augmentation (up to 10%), and - see final paragraph of page 21 - arrangements with plural water spray means, one of which is in the form of a spray rack group assembly as in figure 3 and specifically linked to the 3/4 wt % figure, which results in higher levels of augmentation, above 10%. It stands to reason that these different levels depend on differences in design and operating conditions such as in particular amount and duration. In the Board's view these are thus inextricably linked with the particular designs. Their abstraction from that particular context thus represents an unallowable generalization of the extracted features in question to apply to a wider range of arrangements than that defined by the specific context.

3.5 For the same reasons, the *combination* of the above features in *claims 1, 14 and 16 of each the requests*,

in the Board's view extends beyond the content of the application as filed. As is evident from the above, these features consistently appear separately from each other in different, distinct embodiments. Their combination, in the Board's opinion, presents the skilled person with a new set of conditions for wet compression which are not derivable from the original application.

- 3.5.1 Neither the passage on page 6, lines 30 to 32, nor that on page 10, third complete paragraph, in the Board's view serve to establish an incontrovertible, necessary and exclusive link between the two features. Lines 30 to 32 of page 6 may combine extended periods and high levels in a single context, but it does so only in the most general terms (which may also be read as stressing the fact that the invention provides a way in which wet compression is "pragmatically implemented" to allow extended periods and high levels). Likewise the third paragraph of page 10, relating to a "second aspect of the invention", when read in context is open to different readings, for example focusing on the concept of controllable augmentation or modification as one further separate idea out of many presented in the following paragraphs on pages 10 and 11 describing further aspects of the invention. In any case neither passage can detract from the fact that the features in question are presented in separate, distinct contexts. In as far as these passages might reflect on the motivation of the skilled person to consider these features in combination and abstracted from their respective contexts, this bears upon the question of obviousness, rather than on the issue of what is

unequivocally and clearly disclosed to the skilled person in the as filed application.

3.5.2 Nor is it "clear beyond any doubt" that the introduction in combination of the minimum duration and amount after isolation from their respective contexts results in subject-matter that "provides a complete solution to a technical problem unambiguously recognizable from the application" as stipulated in T 284/94 (OJ EPO 1999, 464), see head-note I. The Board notes that the 38 filed description pages and 81 filed claims including 12 independent claims offer a multiplicity of different ideas and definitions of the invention, each addressing different problems or part problems. Of these the passage on page 6 - the sole to mention extended duration and high levels in combination - is only one. The skilled person is hard put to identify among these many different threads of development a clear teaching that the claimed specific minimum duration and amount in combination and of themselves represent a complete solution to any particular problem in wet compression.

3.6 Finally, the Board is also not convinced that the specific minimum duration of 90 minutes as appearing in *claims 1, 14 and 16 of each of the requests* has a clear and incontestable basis in the first paragraph of page 10 cited by the Respondent. This paragraph states parenthetically that augmentation by wet compression is over a period of time "extended beyond what would be dictated by on-line wash considerations". Further on conventional compressor water washing is stated to be "typically limited in duration to from about thirty to perhaps about ninety minutes".

- 3.6.1 The Board firstly notes that the upper duration limit for conventional washing is expressed in rather uncertain terms, lying somewhere "from about thirty to *perhaps about* ninety minutes" (italics added), followed by a qualification regarding practical and economical considerations in determining the correct value ("as determined by what is practically recoverable in performance terms from continued washing versus costs ..."). This passage thus teaches the 90 minutes for conventional compressor washing as an approximate ("about"), tentative ("perhaps") value about which maximum duration may vary depending on cost and practical considerations, rather than as a distinct demarcation. Given such terms and the practical proviso the Board believes that this passage teaches the skilled person that if he is to avoid conventional compressor washing durations at all he will stay well clear of the tentative value of "perhaps about 90 minutes".
- 3.6.2 In its first line the above passage on page 10 refers to "this first aspect" which is detailed in the immediately preceding paragraph at the bottom of page 9. That paragraph (first two lines) speaks of "a process used for six hours or more within a given 24 hour period". Though this paragraph could refer to a *total* duration of intermittent periods of operation (it does not mention *continuous* wet compression), it may also be read as a lower bound on the duration of continuous wet compression, which is entirely consistent with the passage on page 10 of extending beyond conventional durations. The Board notes that this minimum six hour process time itself appears in original independent

claims 22 and 26, whereas the value of 90 minutes does not feature in any of the as filed claims.

3.6.3 From the above the Board concludes that an exact value of 90 minutes as the lower bound for the duration of power output augmenting wet compression is not directly and unambiguously derivable from the first paragraph of page 10 read on its own or contextually, together with the preceding paragraph on page 9. This conclusion applies irrespective of whether the value of the lower bound is included, as in the formulation "at least 90 minutes", or not, as in the formulation "more than" or "greater than 90 minutes", or, whether, as in the fourth auxiliary request, it appears additionally together with the indication that the process is used at least six hours in a 24 hour period.

3.7 In summary the Board holds that there is no clear and unambiguous basis in the original application for introducing *in combination* into claims 1, 14 and 16 of all requests the features of the lower bounds on duration and amount which are moreover *extracted in isolation* from respective, different contexts. It also holds that such a clear and unambiguous basis is absent for the specific value of 90 minutes as lower bound on the duration. In conclusion therefore the Board finds that the subject-matter of claims 1, 14 and 16 according to each of the main and first to fourth requests extends beyond the content of the application as filed. The ground mentioned under Article 100(c) EPC therefore prejudices the maintenance of the patent as amended according to any of these requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar

The Chairman

G. Magouliotis

M. Ceyte