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D E C I S I O N
of 31 May 2006

Case Number: T 0882/04 - 3.4.02

Application Number: 02075114.5

Publication Number: 1241723

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Language of the proceedings: EN

Title of invention:
Water recovery for a fuel cell system

Applicant:
Delphi Technologies, Inc., et al

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"
"Problem and solution approach"

Decisions cited:
-

Catchword:
-

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Case Number: T 0882/04 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 31 May 2006

Appellants: Delphi Technologies, Inc.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 19 March 2004 refusing European application No. 02075114.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. Klein
Members: A. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellants lodged an appeal, received on 17 April 2004, against the decision of the examining division, dispatched on 19 March 2004, refusing the European patent application 02075114.5. The fee for the appeal was paid on 19 April 2004 and the statement setting out the grounds of appeal was received on 28 June 2004.

The examining division objected that the set of claims then on file was not allowable because the subject-matter of claims 1 to 19 did not involve an inventive step (Articles 52(1) and 56 EPC) having regard to the disclosures in the following documents:

D1: WO-A-99 54 667

D3: Patent Abstracts of Japan vol. 1999, no. 2, 26 February 1999 and JP-A-10 311 564.

II. With the statement containing the grounds of appeal the appellants filed an amended set of claims to be considered by the board and filed an auxiliary request for oral proceedings. With a further letter dated and received 15 May 2006 the appellants filed a new set of claims with clarified wordings of claims 6 and 10 and a revised page 2a.

III. The documents comprising the request include:

Claims:	1 to 18, as received with the letter of 15 May 2006;
Description:	pages 1, 3 to 7 as originally filed; pages 2 and 8 as received with the letter of 26 August 2003;

page 2a as received with the letter of 15 May 2006;

Drawings: sheet 1/1 as originally filed.

IV. The wording of independent claim 1 reads as follows:

"A fuel cell system (10), comprising:

a solid oxide fuel cell stack (24);

a steam reformer (22) in thermal communication and fluid communication with said fuel cell stack (24); and

an air conditioning system (50) in fluid communication with said reformer (22) such that condensate from the air conditioning system (50) can be directed to the reformer (22), wherein said condensate is condensed water vapor from air".

The wording of independent claim 6 reads as follows:

"A method of making a fuel cell system (10), comprising:

disposing a steam reformer (22) in thermal communication and fluid communication with a solid oxide fuel cell stack (24) such that reformate produced in said reformer (22) can be directed to said fuel cell stack (24) and

thermal energy produced in said fuel cell stack (24) can be directed to said reformer (22); and

disposing an air conditioning system (50) in fluid communication with said reformer (22) such that condensate from the air conditioning system (50) can be directed to said reformer (22), wherein said condensate is condensed water vapor from air".

The wording of independent claim 10 reads as follows:

"A method of using a fuel cell system (10), comprising:

producing a condensate (52) by condensing water vapor from air using an air conditioning system (50);

directing said condensate (52) from said air conditioning system (50) to a steam reformer (22);

producing a reformate (34) in said reformer (22);

utilizing said reformate (34) in a solid oxide fuel cell stack (24) to produce electricity and thermal energy; and

utilizing said thermal energy in said reformer (22)".

The wording of independent claim 17 reads as follows:

"A method of using a fuel cell system (10), comprising:

producing a condensate (52) in an air conditioning system (50); and hydrating a proton exchange membrane fuel cell (24) with at least a portion of said condensate (52)".

Claims 2 to 5, 7 to 9, 11 to 16 and 18 are dependent claims.

V. The appellants' arguments may be summarised as follows:

Support for the amendments to independent claims 1, 6 (originally claim 7) and 10 (originally claim 13) can be found in original claims 2 and 4 and in the specification at page 4, lines 3 to 13; page 6, lines 13 to 18; and page 7, lines 3 to 6, similarly for the dependent claims. In accordance with the

requirements of Rule 27(1)(b) EPC the specification has been amended to include a description of document D1.

With regard to independent claims 1, 6, and 10, the examining division found that these claims lack an inventive step over Dl but the appellants disagree. Dl is directed to a method of improving the efficiency of a heating boiler, an air conditioning plant, and a central heating system (page 1, lines 7 to 9). Dl teaches that high-efficiency central heating boilers "are based on a heat exchanger arranged in the egressive stream of combustion gases (flue gases) of the heating boiler, the incoming cooled water being preheated by heat exchange with the egressive stream of combustion gases" (page 1, lines 18 to 24). Dl further discloses that the energy gain (e.g. heat transfer) "remains limited to the temperature difference between the egressive gas stream and the incoming water" (page 1, lines 26 to 28) and teaches an improved efficiency over high-efficiency central heating boilers by utilizing the heat present in the moist gas stream. More particularly, Dl teaches that a higher efficiency can be obtained by a method that "extracts water from waste gases by means of a sorbent" (page 2, lines 1 to 3). In other words, Dl is directed to solving the problem of efficiency of a heating boiler, an air conditioning plant, and a central heating system by employing a sorbent material to extract water from a waste gas.

The application, however, solves the problem of storage of water for supply to a fuel cell system, a problem that is not addressed by Dl. For example, independent claim 1 defines, "an air conditioning system (50) in

fluid communication with said reformer (22) such that condensate from the air conditioning system (50) can be directed to the reformer (22), wherein said condensate is condensed water vapor from air". Absent in D1 is any teaching or suggestion of directing condensed water vapour from an air conditioning system to a reformer. Rather, D1 teaches removing thermal energy from, e.g., a moist exhaust gas of a fuel cell using a sorbent material (see page 8, lines 5 to 6). For example, the sorbent can be "a solid desiccant, such as calcium hydride, magnesium perchlorate, aluminium oxide, silica, zeolites, molecular sieves or a synthetic drying agent such as polymer and the like" (page 8, lines 19 to 24). Additionally, it is noted that D1 teaches a method and system wherein water is first removed from a moist gas stream using a sorbent (adsorption plant), and then the sorbent is regenerated by heating the sorbent to form steam (regeneration plant). While it is true the method of D1 produces water as a product that may be used in a fuel reforming processes in a fuel cell (see its Abstract), water is not being produced as condensate from air or directed from an air conditioner to a reformer. In D1 the source of the water is from a moist exhaust gas of a fuel cell compared to water vapour in air being condensed to produce a condensate as defined in the present claims.

Put another way, D1 would not solve the problem outlined in the present patent application. The application teaches a problem of storage of water for supply to a fuel cell system. For example the description discloses "to avoid the requirements of space and maintenance, a possible source of water than can be harnessed for use by the reformer is from the

air conditioning system" (page 7, lines 1 to 3). Dl teaches the use of a sorbent that needs to be regenerated. In other words, since Dl teaches the use of additional equipment to regenerate the sorbent, the system of Dl would only increase the problem solved by the present invention, because the system of Dl would require a greater amount of both space and maintenance compared to a water storage system outlined in the description as the problem in the background section (page 2, lines 14 to 18).

In summary, document D1 does not teach or suggest that condensate (i.e. condensed water vapor from air) from an air conditioning system is directed to a reformer. This is also not disclosed or suggested in document D3, because D3 discloses a means simultaneously to use the heat and moisture of exhaust gas from a cathode of a fuel cell, paying attention to the point that the exhaust gas contains steam which almost contains no impurities (paragraph [0007]). The document further discloses that condenser 132 condenses the generated steam to moisture in tank 124, while the gas may be discharged outside (paragraph [0035]). D3 does not teach or suggest fluidly connecting the air conditioning system with the reformer such that condensate produced in the air conditioning system can be directed to the reformer as defined in the present patent application.

For these reasons it is submitted that independent claims 1, 6 and 10 have an inventive step over document D1 and are therefore allowable. As dependent claims from allowable independent claim claims 2 to 5, 7 to 10 and 11 to 16 are, by definition, also allowable.

Claim 17 had been found novel over the prior art by the examining division, and no objections as to inventive step had been raised. Therefore this claim and appended claim 18 should equally be allowable.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

According to the decision under appeal, all amendments of the then valid claims and description meet the requirements of Article 123(2) EPC. The only further amendment in the present claims with respect to the former claims is the additional feature in claim 1 specifying that the condensate "...is condensed vapor from air" and similar wordings in claims 6 and 10. The passage on page 7, first paragraph, provides a fair basis for this feature. Also the acknowledgement of the prior art is found to be admissible under Article 123(2) EPC.

3. *Patentability*

3.1 *Novelty - Claim 1*

3.1.1 *Document D1*

In its decision the examining division had based its analysis of patentability on the embodiment defined in independent claim 6 of document D1 (hereafter: "embodiment I"). This embodiment I relates to a method of improving the efficiency of an air conditioning

plant. On page 5, lines 12 to 15, D1 discloses that the inlet of an absorption plant (shown in Figure 1 with reference sign "2") can be connected with the outlet of a preceding combustion plant (reference sign "1" in Figure 1) or, in the present embodiment, with the outlet of an air conditioning plant (which therefore replaces the symbolically outlined "boiler" in Figure 1). According to claim 6, in the absorber plant 2, a recirculating sorbent is loaded with moisture from the egressive gas stream of the air conditioning plant. In a first heat exchanger 3, connected in a cycle with the absorption plant 2, heat is absorbed from the recirculating sorbent. A part of the moisture-loaded sorbent is supplied to a regeneration plant 5, in which, using heat, the sorbent is regenerated, thereby forming steam. The regenerated sorbent is then recycled to the absorption plan 2. The steam obtained in the regeneration plant 5 may be utilized in a fuel reforming process, see claim 17, which is appended to claim 6.

3.1.2 Therefore the following features in claim 1 are known from embodiment I:

- a steam reformer; and
- an air conditioning system.

Although the hydrogen gas generated in the steam reformer may be used in a fuel cell system, a fuel cell (in particular, a solid oxide fuel cell stack) is not comprised in this embodiment. Nor is in embodiment I the air conditioning system in fluid communication with the reformer; furthermore, the moisture from the egressive gas stream of the air conditioning system is

absorbed by the sorbent and not condensed as defined in claim 1.

3.1.3 On page 7, line 33 to page 8, line 11, a further embodiment (hereafter: "embodiment II") is disclosed wherein the moist exhaust gases of a fuel cell is used "in accordance with the invention" (page 8, line 7) for recovering water. In this embodiment II, the moist gas stream coming from a fuel cell is passed into the absorber plant 2 via inlet 1 (Figure 1) and a recirculating sorbent is loaded with this moisture. In a heating step in regenerator 5 the water-loaded sorbent is regenerated under release of steam (page 9, lines 32 and 33). According to page 8, lines 1 to 3, this steam can be used as input to the reforming process in order to generate fuel for a fuel cell.

3.1.4 The following features from claim 1 are known from embodiment II:
- a fuel cell system comprising a fuel cell stack;
- a steam reformer.

From embodiment II it is not known that the fuel cell stack is a solid oxide fuel cell stack. Since according to this embodiment the output of the fuel cell is connected to the absorber plant which in its turn is connected to the regenerator which outputs steam entering the reformer there is neither "thermal communication" nor "fluid communication" between the fuel cell and the steam reformer. The only direct communication disclosed in D1 is the fuel (hydrogen) communication generated in the reformer and redirected to the fuel cell (see page 8, lines 1 to 14).

Furthermore, an air conditioning system as defined in claim 1 is not comprised in this embodiment.

3.1.5 *Document D3*

This document discloses a fuel cell system 100 comprising a steam reformer 126. The moisture and heat of the waste gas generated at the cathode 102 of the fuel cell 101 are used in an air conditioning system 402. The steam reformer 126 is in thermal communication with the fuel cell stack 101 (via units 127 and 128). Via condensers 131 and 132 it is also in fluid communication with the fuel cell stack.

Document D3 does not disclose that the fuel cell is of the solid oxide type. Nor is there any fluid communication between the air conditioning system and the reformer.

3.1.6 The other documents from the European Search Report disclose more remote prior art. Therefore the subject-matter of claim 1 is novel.

3.2 *Inventive step - claim 1*

3.2.1 *Closest prior art*

The closest prior art document for assessing inventive step should disclose subject-matter conceived for the same purpose or aiming at the same objective as the claimed invention and having the most relevant technical features in common, i.e. requiring the minimum of structural modifications. In its decision the examining division had reasoned that the patent application was concerned with water and heat management in a combined fuel cell / air conditioning

system and that the technical object consisted in optimising the utilization of water. According to the division, the proposed solution consisted in the idea of using the condensate from an air conditioning system in the reformer of a fuel cell (claims 1, 6, and 10), respectively in the humidification of a polymeric proton exchange membrane (claim 17). In the opinion of the examining division document D1 represented the closest prior art.

3.2.2 The appellants have argued that whereas the object of the patent application is solving the problem of storage of water to a fuel cell system, Dl is directed to the different problem of improving the efficiency of, *inter alia*, an air conditioning plant.

3.2.3 The board agrees with the examining division that the patent application is concerned with water and heat management in a combined fuel cell / air conditioning system and that the technical object consists in optimising the utilization of water. However, although document D1 relates to methods of improving the efficiency of an air conditioning plant and to an apparatus for recovering water from the exhaust gases of a fuel cell (see page 1, lines 5 to 14), this document does not disclose combined fuel cell / air conditioning systems.

3.2.4 Rather, in embodiment I (see points 3.1.1 and 3.1.2) the output moisture of an air conditioning plant is absorbed by a recirculating sorbent and the steam generated at regeneration of the sorbent can be used in a steam reformer for converting natural gas into

hydrogen. In this process a fuel cell is not involved at all.

3.2.5 In embodiment II the moisture output of a fuel cell is absorbed by a sorbent material and the steam generated at regeneration of the sorbent can be used in a steam reformer (see points 3.1.3 and 3.1.4). In this embodiment no air conditioning system is involved.

3.2.6 Furthermore, the object addressed in document D1 is not "optimizing the utilization of water", but rather: "improving the (energetic) efficiency of combustion plants and air conditioning plants". Actually, as shown in Figure 1 with reference number 8 and disclosed on page 9, lines 33 to 35, at the end of the process (after passing through a second heat exchanger 7) the condensed water is discharged. Therefore the problem addressed in the patent application is not considered in document D1. In consequence, this document does not provide a proper starting point for the discussion of inventive step following the problem and solution approach. In fact, apart from the fact D1 teaches that the condensed water is simply disposed of, the gist of the teaching in document D1 is to absorb the moisture by a sorbent which is recirculated through heat exchangers in order to improve the system efficiency: this feature is defined in all independent claims 1 and 5 to 8 and it follows immediately by inspection of Figure 1. Therefore, even if starting from the embodiment I in D1, comprising an air conditioning system and a steam reformer, there would be no motive whatsoever for the skilled person to modify the processing system in Figure 1 by providing a fluid communication between the air conditioning system and

the (not shown) steam reformer since this would imply rejecting the core of the teaching of this document.

3.2.7 If document D3 is considered as the closest prior art, the subject-matter of claim 1 differs from the fuel cell system disclosed in that document in that the fuel cell comprises a solid oxide fuel cell stack and by the feature that the air conditioning system is in fluid communication with the steam reformer such that condensed water vapor from the air conditioning system can be directed to the reformer.

3.2.8 Whereas solid oxide fluid cells are well known and the selection of this type of cell does not appear to involve a particular contribution towards inventive step, the problem of reducing the amount of (external) water input to a fuel cell system is not known from document D3. Furthermore, this document does not provide any hint towards the solution defined in claim 1. Indeed, the only recirculation of water disclosed in D1 is the collection in condensers 131 and 132 of the moisture in the exhaust gas produced at the cathode, whereupon the condensate may flow to the reformer 126.

3.2.9 Therefore, in the opinion of the board, neither the teaching of document D1, nor the disclosure in D3, taken alone or in combination, would lead to the subject-matter of claim 1 in an obvious way. The other citations of the European Search Report are still less relevant. Therefore the subject-matter of this claim involves an inventive step (Article 52(1) and 56 EPC).

3.3 *The further claims*

3.3.1 Independent claims 6 and 10 are directed respectively to methods of making and of using a fuel cell system. Both claims comprise the feature that condensate from an air conditioning system is directed to a steam reformer. By means of this step, the water produced in the air conditioning system can be efficiently used in the steam reforming process. Therefore these claims define subject-matter which is novel and non-obvious for the same reasons as given for claim 1.

3.3.2 Independent claim 17 defines a method of using a fuel cell system, wherein condensate produced in an air conditioning system may be used for hydrating a proton exchange membrane fuel cell. This claim shares the same inventive concept as the other independent claims, of efficiently using the water produced in the air conditioning system of a combined fuel cell / air conditioning system. It is added that the examining division had not raised any objections against this claim (claim 29 as originally filed).

3.3.3 The further claims 2 to 5, 7 to 9, 11 to 16 and claim 18 are dependent claims and are therefore equally allowable.

4. For the above reasons, the board finds that the appellants' request meets the requirements of the EPC and that a patent can be granted on the basis thereof.

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 grant a patent on the basis of the following documents:

Claims:	1 to 18, as received with the letter of 15 May 2006;
Description:	pages 1, 3 to 7 as originally filed; pages 2 and 8 as received with the letter of 26 August 2003; page 2a as received with the letter of 15 May 2006;
Drawings:	sheet 1/1 as originally filed.

The Registrar: The Chairman:

M. Kiehl A. Klein