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**Datasheet for the decision  
of 5 March 2010**

**Case Number:** T 1305/07 - 3.2.03  
**Application Number:** 99912230.2  
**Publication Number:** 1171834  
**IPC:** G06F 17/00, F23N 5/00,  
F22B 35/18  
**Language of the proceedings:** EN

**Title of invention:**

Input/loss method for determining fuel flow, chemistry,  
heating value and performance of a fossil-fired system

**Patentee:**

Exergetic Systems, Ltd.

**Opponent:**

ABB Patent GmbH  
EVONIK Energy Services GmbH

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 84, 123(2)(3), 56

**Relevant legal provisions (EPC 1973):**

-

**Keyword:**

"Clarity - main request (no)"  
"Extended subject-matter (no)"  
"Inventive step (no)"  
"Late filed request - not admitted"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 1305/07 - 3.2.03

**D E C I S I O N**  
**of the Technical Board of Appeal 3.2.03**  
**of 5 March 2010**

**Appellant:** EVONIK Energy Services GmbH  
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**Decision under appeal:** Interlocutory decision of the Opposition  
Division of the European Patent Office posted  
8 June 2007 concerning maintenance of the  
European patent No. 1171834 in amended form.

**Composition of the Board:**

**Chairman:** U. Krause  
**Members:** C. Donnelly  
K. Garnett

## Summary of Facts and Submissions

I. The appeal lies from the interlocutory decision of the opposition division posted on 8 June 2007, to maintain European patent No. 1171 834 in amended form.

II. Opponent II (hereinafter the "appellant") filed a notice of appeal against this decision by letter of 25 July 2007 received on 31 July 2007 and paid the appeal fee the same day. The grounds were filed on 17 October 2007 by letter of 16 October 2007.

III. In support of its case under Article 100(a) EPC concerning novelty and inventive step the appellant referred to the following documents:

E1: US-A-5 367 470;

E3: US-A-5 790 420;

D4: "Abnahmeversuche an Dampferzeugern", Deutsches Institut für Normung e.V., (DIN 1942), 02/1994.

IV. The patent proprietor (hereinafter the "respondent") reacted to the arguments raised in the grounds by letter of 29 February 2008 and requested that the appeal be dismissed.

V. In a further letter of 29 January 2009 the appellant referred to a further document:

A1: "Anwendung der Ausgleichsrechnung bei wärmetechnischen Versuchen", Wien, 1. Juli 1975, Dissertation by Siegfried Streit.

VI. In a communication dated 11 December 2009, pursuant to Article 15(1) RPBA annexed to the summons to oral proceedings, the Board informed the parties of its provisional opinion. In particular, the Board mentioned that an expression introduced into claim 1 as maintained by the opposition division appeared to be vague and raised doubts as to which features of the claim were effective to delimit the claim.

VII. In letter of 10 December 2009, the respondent requested that A1 not be admitted into the proceedings. By letter of 1 February 2010, the respondent filed auxiliary requests 1 to 6.

VIII. Oral proceedings before the Board were held on 5 March 2010. During these proceedings, after the Board had announced its conclusions concerning clarity, the respondent filed auxiliary requests 1 to 4 to replace auxiliary requests 1 to 6 of 1 February 2010. After the announcement of the conclusion concerning inventive step the respondent filed auxiliary request 5.

IX. The final requests of the parties were as follows:

The appellant requested that the decision under appeal be set aside and that European Patent No. 1171834 be revoked.

The respondent requested that the appeal be dismissed, alternatively that the patent be maintained on the basis of auxiliary requests 1 to 5 filed during the oral proceedings.

X. **Claim 1** as maintained by the opposition division reads (feature reference numbers added corresponding to "Anlage 1" of appeal grounds 16 October 2007 for convenience):

"1.1 A method for quantifying the operation of a fossil-fueled thermal system having a heat exchanger/combustion region producing combustion products, the method comprising the steps of :  
1.2 before on-line operation, obtaining reference fuel characteristics; and thereafter

1.3 operating on-line and using a mathematical description of the thermal system comprising explicit solutions of fuel chemistry, the criterion for their use being decided by the reliability and availability of effluent data and its relative impact on fuel terms, the step of operating on-line including the steps of

1.4 measuring a set of measurable operating parameters, including at least effluent concentrations of O<sub>2</sub>, CO<sub>2</sub>, and SO<sub>2</sub>, these measurements being made at a location downstream of the heat exchangers/combustion region of the thermal system,

1.4a obtaining the concentrations of pollutants CO and NO<sub>x</sub>,

1.5 obtaining an effluent concentration of H<sub>2</sub>O, if reference fuel characteristics indicate fuel water is not predictable, as an obtained effluent H<sub>2</sub>O,

1.6 obtaining a fuel ash concentration using a method selected from the group comprising a constant value of

fuel ash, a predicatable value of fuel ash determined from reference fuel characteristics, a measured value of fuel ash determined from a fuel ash instrument and a value of fuel ash determined from an explicit solution requiring the measurement of the system's wet combustion Air/fuel mass ratio, as an obtained fuel ash concentration,

1.7 obtaining a concentration of O<sub>2</sub> in the combustion air local to the system,

1.8 obtaining the air pre-heater leakage factor, and

1.9 calculating a complete As-Fired fuel chemistry, including fuel water and fuel ash, as a function of reference fuel characteristics, said explicit solutions, the set of measurable operating parameters, the concentrations of pollutants CO and NO<sub>x</sub>, the obtained effluent H<sub>2</sub>O, the obtained fuel ash concentration, the concentration of O<sub>2</sub> in the combustion air local to the sytem and the air pre-heater leakage factor."

XI. Claim 1 according to auxiliary request 1 filed during the oral proceedings of 5 March 2010 is identical to the main request, except for feature 1.3 which reads (amendments underlined):

"1.3 operating on-line and using a mathematical description of the thermal system comprising explicit solutions of fuel chemistry, the step of operating on-line including the steps of"

and feature 1.9, which reads:

"1.9 calculating a complete As-Fired fuel chemistry, including fuel water and fuel ash, as a function of reference fuel characteristics, resolving said explicit solutions, the set of measurable operating parameters, the concentrations of pollutants CO and NO<sub>x</sub>, the obtained effluent H<sub>2</sub>O, the obtained fuel ash concentration, the concentration of O<sub>2</sub> in the combustion air local to the sytem and the air pre-heater leakage factor."

XII. Claim 1 according to auxiliary request 2 filed during the oral proceedings of 5 March 2010 is identical to the main request, except for feature 1.3 which reads:

"1.3 operating on-line and using a mathematical description of the thermal system comprising a set of explicit solutions to a complete As fired fuel chemistry, including at least an explicit solution for fuel carbon, the step of operating on-line including the steps of"

and feature 1.9, which reads

"1.9 calculating the complete As-Fired fuel chemistry, including fuel water and fuel ash, as a function of reference fuel characteristics, resolving the set of explicit solutions, the set of measurable operating parameters, the concentrations of pollutants CO and NO<sub>x</sub>, the obtained effluent H<sub>2</sub>O, the obtained fuel ash concentration, the concentration of O<sub>2</sub> in the combustion air local to the sytem and the air pre-heater leakage factor."

XIII. Claim 1 according to auxiliary request 3 filed during the oral proceedings of 5 March 2010 is identical to auxiliary request 2, except for feature 1.3 which reads:

"1.3 operating on-line and using a mathematical description of the thermal system comprising a set of explicit solutions to a complete as fired fuel chemistry, but including at least an explicit solution for fuel carbon and fuel water, the step of operating on-line including the steps of"

XIV. Claim 1 according to auxiliary request 4 filed during the oral proceedings of 5 March 2010 is identical to auxiliary request 2, except for feature 1.3 which reads:

"1.3 operating on-line and using a mathematical description of the thermal system comprising a set of explicit solutions to a complete as fired fuel chemistry, but including at least an explicit solution for fuel carbon, fuel nitrogen, fuel oxygen, fuel sulfur and fuel water, the step of operating on-line including the steps of"

XV. Claim 1 according to auxiliary request 5 filed during the oral proceedings of 5 March 2010 is identical to auxiliary request 2, except for feature 1.2 which reads:

"1.2 before on-line operation, obtaining reference fuel characteristics including relationships between an independently determined MAF molar carbon fraction  $\alpha$  MAF<sub>4</sub> and dependent hydrogen, nitrogen, oxygen and sulfur fractions, and thereafter".



XVI. The arguments of the parties relevant to the decision can be summarised as follows:

(a) Main request, Claim 1 as maintained by the opposition division.

Extended subject-matter (Article 123(2) EPC) and clarity (Article 84 EPC)

Appellant

The feature:

"the criteria for their use being decided by the reliability and availability of effluent data and its relative impact on fuel terms"

does not exclude the use of any type of general explicit solution, which can either be deemed an extension in breach of Article 123(2) EPC or, since this feature was added during the opposition proceedings, a lack of clarity under Article 84 EPC.

Respondent

The objection under Article 84 EPC was brought up for the first time in the oral proceedings. However, the basis for the amendment maybe found in the passage at page 42, lines 22 to 23 of the published application, which deals with deciding which explicit solutions of fuel chemistry are to be used. This phrase is also clear since it specifies that, under certain circumstances, it may not be desirable or possible to

use the explicit equations and that it is possible to fix concentrations of certain components as constants.

(b) Auxiliary requests

Extended subject-matter, Article 123(2)

Appellant

Feature 1.3

Feature 1.3 of all requests comprises the expression:

"and using a mathematical description of the thermal system comprising explicit solutions of fuel chemistry"

since this expression does not have the same meaning as the originally disclosed terms "a modelling analysis" and certainly not the originally disclosed term "a modelling analysis to quantify the As-Fired fuel chemistry of the fuel feed", Article 123(2) is contravened.

In the above expression "As-Fired fuel chemistry" has been generalised to "fuel chemistry". Further, in the original documents this analysis did not concern chemistry in general but only the chemistry of the "fuel feed".

Feature 1.4

According to claim 1 as maintained not only are O<sub>2</sub> and CO<sub>2</sub> measured as originally disclosed, but also SO<sub>2</sub>, which was not.

Feature 1.4a

The measurement of the SO<sub>2</sub> concentration is an extension since in the original claim 1 SO<sub>2</sub> was included in the list of pollutants and "measurement" does not mean the same thing as "obtaining", otherwise there would be no point in splitting features 1.4 and 1.4a.

Feature 1.6

Feature 1.6 was extended during the examination procedure upon the respondent's own admission by inclusion of the wording "obtaining a fuel ash concentration using a method selected from....." since previously it was "unduly limited". It may be that the measurement of air-fuel ratio is merely alternative to the determination of the fuel-ash concentration; however, an exchange of alternatives to determine a value is, in the present case, an unallowable extension.

Also there is no indication of any support for introducing in relation to "a value of fuel ash determined from an explicit solution" the additional wording "requiring the measurement of the systems wet combustion air/fuel mass ratio".

Respondent

Feature 1.3

The expression:

"using a mathematical description of the thermal system comprising explicit solutions of fuel chemistry",

is mentioned in the description page 22, lines 25 to 29 which reads:

"The present invention provides an input/loss method which allows for a complete understanding of fossil fueled combustion systems such as power plants, through application of non-direct but explicit determination of fuel and effluent flows, fuel chemistry, fuel heating value and thermal efficiency, resulting in improved thermal efficiency."

Thus, in view of equation 29 it cannot be doubted that the patent uses a mathematical description of the thermal system. A literal disclosure is given at page 33, lines 17 to 19. Other instances are directly given in equations 42 to 47 on pages 41 to 42. A line-by-line presentation of the mathematical description is given in Fig A - appendix 2, which is based on page 41, lines 23 to 45 of the application as filed.

The passage at page 42, lines 22 to 23 makes it clear which explicit solutions of fuel chemistry are to be used and hence that the phrase "the criterion for their use.....etc..." is related to the mathematical description of the thermal system.

Features 1.4 and 1.4a:

The measurement of the effluent SO<sub>2</sub> is disclosed at page 17, lines 14 to 15.

Feature 1.6:

Examples of the alternative ways of obtaining fuel ash concentration are given on page 16, lines 23 to 29, in particular "by explicit solution requiring the measurement of the systems wet combustion Air/Fuel mass ratio". See also equation 54 on page 44.

(c) Inventive step, Article 56 EPC

Auxiliary request 1

Appellant

The most relevant prior art is described in E1. This document discloses all the features of claim 1 only stopping short of providing actual explicit solutions.

However, the use of explicit solutions derived from stoichiometric considerations to back-calculate as-fired fuel chemistry is suggested by E1. Such explicit solutions are well known in the art and detailed for example in D4.

Respondent

1. Fuel ash is not mentioned in E1; the determination of a complete fuel chemistry was thus never part of E1's scope;
2. E1 contains no teachings as to how fuel carbon is to be computed explicitly or implicitly, nor any other fuel constituent, except fuel water;

3. E1 only invokes an iterative solution for fuel water on the basis of high accuracy effluent measurements since there is no mention of explicit solutions;
4. E1 requires the input of the dry fuel chemistry.

Furthermore,  $O_2$  is typically measured at the exit of the heat exchanger region ("Boiler  $O_2$ ") not at the stack where  $CO_2$  and  $H_2O$  measurements are made. Hence, the issue of air leakage, through the air pre-heater (located between the boiler measurement point and the stack) arises. E1 computes a fuel chemistry, but a chemistry whose dry constituents are held constant, since dry chemistry is the input, air leakage as affecting the computation of a fuel chemistry is not relevant.

Thus, the invention of the contested patent does not require the input of the fuel's chemical composition on a dry basis, yet it enables the determination of fuel's composition by explicit solutions.

In conclusion, E1 does not disclose the calculation of a complete as-fired fuel chemistry by explicit solutions. In particular, it does not teach a person skilled in the art how to calculate fuel water and fuel ash. Equation 29 is "a generic combustion equation" and when using it in an attempt to obtain explicit solutions the number of variables will always be greater than the number of equations, such that they cannot be resolved.

(d) Auxiliary requests 2 to 5

Appellant

The amendments introduced in auxiliary requests 2 to 4 do not appear to add anything to the subject-matter of the claim since auxiliary request 1 already calls for "a complete as-fired fuel chemistry" to be calculated. Thus, it would normally be assumed that the explicit solutions of claim 1 according to auxiliary request 1 implicitly included those for the major fuel components which have now been explicitly included in these auxiliary requests. The arguments against the recognition of an inventive step therefore remain the same.

Auxiliary request 5

This request was made at the last possible moment and relies on subject-matter taken from the description. Thus, it is not reasonable to expect the appellant to deal with it on the spur of the moment and the request should not be admitted into the proceedings.

Respondent

Auxiliary requests 2 to 4 make clear which components of the as-fired fuel chemistry are calculated from the explicit solutions. E1 does not specify any explicit solutions at all let alone go into any detail about individual fuel components.

Auxiliary request 5 may have been filed late, but the respondent had been left with little choice.

## **Reasons for the decision**

1. The appeal is admissible.
2. Main request - claim 1 as maintained by the opposition division.
  - 2.1 Clarity, Article 84 EPC
    - 2.1.1 The qualification reading "the criterion for the use of the explicit solutions of fuel chemistry is decided by the reliability and availability of effluent data and its relative impact on fuel terms" was introduced into feature 1.3 of claim 1 during the opposition proceedings and finds support in the description at page 42, lines 22 to 23 of the published application, which deals with deciding which explicit solutions of fuel chemistry are to be used. Since the amendment is based on the description rather than a granted claim it must be examined whether the requirements for clarity under Article 84 EPC are met. The fact that this expression appeared to raise doubts as to which features of the claim actually applied, was mentioned by the Board in its communication of 11 December 2009 when presenting its provisional opinion on inventive step. Thus, discussion of this matter during the oral proceedings could not have come as a complete surprise to the respondent.
    - 2.1.2 In the Board's view the amendment is vague in that no criteria are actually defined and the implication is given that the explicit solutions need not necessarily



be applied if the effluent data is either unavailable or not reliable. This effectively means that, under certain undefined and subjective conditions, it is not necessary to use the explicit solutions at all. The amendment therefore does not meet the requirements of Article 84 EPC since it adds to, rather than clears up, the ambiguity of the claim.

3. Auxiliary request 1

3.1 Articles 123(2), (3) EPC

3.1.1 Feature 1.3

The expression:

"using a mathematical description of the thermal system comprising explicit solutions of fuel chemistry",

finds a basis in the description page 22, lines 25 to 29 of the published application, which refers to "explicit determination of fuel and effluent flows, fuel chemistry..." together with a literal disclosure given at page 33, lines 17 to 19.

3.1.2 Feature 1.4

The justification for changing the categorisation of SO<sub>2</sub> from an obtained pollutant to a measured effluent can be found at page 17, lines 14-15 of the published application. Since "measuring" has a narrower meaning than the generic term "obtaining", Article 123(3) EPC is not infringed.

3.1.3 Feature 1.6

The alternative ways of obtaining fuel ash concentration are given on page 16, lines 23 to 29 of the published application, in particular "by explicit solution requiring the measurement of the systems wet combustion Air/Fuel mass ratio". See also equation 54 on page 44.

Thus, claim 1 according to auxiliary request 1 meets the requirements of Articles 123(2) and (3) EPC.

3.2 Inventive step, Article 56 EPC

3.2.1 Interpretation of claim 1.

3.2.2 Claim 1 according to auxiliary request 1, apart from the addition of feature 1.4a, essentially corresponds to claim 1 as granted, so that clarity is not a formal issue. However, certain characteristics of the claim require an explanation as to their interpretation.

3.2.3 The claim is directed at a method for quantifying the operation of a fossil-fueled thermal system i.e. it is not restricted to coal-fired systems, but also covers gas and oil-fired plant (see figure 4B of the patent in suit). However, it is debatable whether bio-mass may be considered a fossil fuel.

3.2.4 The reference fuel characteristics of feature 1.2 are not specified in any detail. Thus, the fuel's dry chemical analysis falls within this definition (reference fuel chemistry in terms of an ultimate analysis is indeed suggested as an input at page 29,

- line 12 and page 26, line 53 of the contested patent), but also something as basic as the nominal composition of a gas fuel, such as natural gas or even simply the type of fuel, would suffice.
- 3.2.5 There is no particular definition of the form that the "explicit solutions" mentioned in featured 1. 3 should take. The contested patent confirms this in paragraph [0080] of the description.
- 3.2.6 Given the respondent's definition of "obtaining" at page 59, lines 22-25 of the application as published to mean "measuring, calculating, assuming a non-zero value, assuming a zero value, estimating, gathering from a published reference work, gathering from a database, or any other operational approach" feature 1.5 is not concise since predicting effluent fuel water falls under the term "obtained". However, this feature makes it clear that the method is intended to cover fuels which have a predictable fuel water value on the basis of the reference characteristics, e.g. with oil and gas little or no water is present (see E1, column 13, lines 32 to 33).
- 3.2.7 Feature 1.6 states that fuel ash need not be determined by resolution of an explicit solution, but can be set to a constant and/or predicatable value. This value may be zero (see contested patent page 19, line 24) and would cover the case of fuels which produce negligible amounts of ash such as oil and gas, which fuels fall within the scope of the claim (also see figure 4B).

- 3.2.8 The respondent's own definition of "obtaining" includes database references and the expression "local to the system" places no particular constraints on exactly where the concentration is to be obtained. Thus, in feature 1.7 the concentration could be taken to be the nominal percentage of oxygen in the atmosphere.
- 3.2.9 Feature 1.9 must be read in conjunction with the previous features of the claim. The feature requires "calculating a complete As-Fired fuel chemistry, including fuel water and fuel ash". However, fuel water and fuel ash have already been taken care of in features 1.5 and 1.6. Feature 1.5 states that fuel water may be predicted (e.g. it could be zero). Similarly fuel ash can be a constant value, e.g. zero for some fuels. The feature therefore comes down to calculating the rest of the fuel chemistry from the effluent measurements by resolving the explicit solutions, whatever form they may take.
- 3.2.10 The description of the contested patent provides a large reservoir of detailed information concerning performance monitoring of fossil-fuel fired plant. However, the scope of protection is determined by the features of claim 1 which are couched in general terms. Further, despite its length and detail, the contested patent relies principally on algebraic generalisations and does not contain a single explicit numerical example of how the calculation of an as-fired fuel chemistry according to claim 1 would be made. The examples given by the respondent in letter of 1 February 2010 refer to general procedural guidelines.

3.2.11 The most relevant prior art is described in E1. Bearing in mind the above comments, this document discloses:

1.1 a method for quantifying the operation of a fossil-fueled thermal system having a heat exchangers/combustion region producing combustion products, the method comprising the steps of:

1.2 before on-line operation, obtaining reference fuel characteristics (see column 13, line 18); and thereafter

1.3 operating on-line and using a mathematical description of the thermal system (see equation 29, column 10), the step of operating on-line including the steps of:

1.4 measuring a set of measurable operating parameters, including at least effluent concentrations of  $O_2$ ,  $CO_2$  and  $SO_2$ , these measurements being made at a location downstream of the heat exchangers/combustion region of the thermal system (see column 13, lines 15 to 20, column 15, lines 1 to 5 and column 16, line 8),

1.4a obtaining the concentrations of pollutants CO and  $NO_x$  (see column 15, lines 3 to 5),

1.5 obtaining an effluent concentration of  $H_2O$ , if reference fuel characteristics indicate fuel water is not predictable, as an obtained effluent  $H_2O$  (see column 15, lines 15 to 20),

1.6 obtaining a fuel ash concentration using a constant value of fuel ash (see equation 29 and also the contested patent, page 5, line 48)

1.7 obtaining a concentration of  $O_2$  in the combustion air local to the system (ref. equation 29; see column 10, line 65). Since it is only necessary to "obtain" a value, the standard atmospheric value of 21% fulfils this requirement.

1.8 obtaining the air pre-heater leakage factor (ref equation 29, column 10, line 64).

The subject-matter of claim according to auxiliary request 1 differs therefrom in that:

the mathematical description of the thermal system comprises explicit solutions of fuel chemistry; and that it comprises the step of:

1.9 calculating a complete as-fired fuel chemistry, including fuel water and fuel ash, as a function of reference fuel characteristics, resolving said explicit solutions, the set of measurable operating parameters, the concentrations of pollutants CO and  $NO_x$ , the obtained effluent  $H_2O$ , the obtained fuel ash concentration, the concentration of  $O_2$  in the combustion air local to the system and the air pre-heater leakage factor.

3.2.12 By calculating the complete as-fired fuel chemistry it is possible to compute the actual efficiency of the thermal system as opposed to the theoretical efficiency based on nominal fuel chemistry. By so doing it is

possible to improve the thermal performance-monitoring of fossil fuel fired generating plant. Thus, improvement of thermal performance-monitoring must be seen as the objective technical problem to be solved and which is in itself known from E1 (see column 1, lines 36 to 46).

3.2.13 Although the method described in E1 may have been developed with a particular application to certain types of coal fuel in mind, this document makes several explicit suggestions to the effect that it is possible to use the gaseous effluent measurements to determine as-fired fuel chemical composition in general. At column 3, lines 54 to 56 a statement is made to the effect that "any hydrocarbon fuel will produce unique relative concentrations of effluent. At column 11, lines 13 to 16 it is stated that "The next stage of the process involves the recognition that a given fuel has an unique chemical composition, thus when burned will yield unique stoichiometrics in its gaseous effluent." Further, at column 11, lines 42 to 47 it is indicated that "Thus for any fossil-fired plant, if accurate measurements are made of CO<sub>2</sub>, H<sub>2</sub>O and O<sub>2</sub> effluent, then not only can the  $\mu_c$  term be calculated accurately, but inherent consistency checks are afforded through stoichiometric considerations involving carbon, hydrogen and oxygen balances".

3.2.14 In particular, the Board is of the view that the expression "stoichiometric considerations" is a direct hint towards using explicit solutions to perform the "inherent consistency checks" which themselves suggest a calculation of as-fired fuel chemistry. Indeed when discussing the particular case of coal in E1 at

column 11, lines 52 to 55 the term "back-calculate" is explicitly used and the phrase bridging columns 11 and 12 expressly refers to the calculation of certain fuel chemistry on the basis of such stoichiometric relationships and effluent measurements.

- 3.2.15 Thus, E1 gives the skilled person a general teaching that a back-calculation of as-fired fuel chemistry using basic stoichiometric considerations is possible. Although it stops short of detailing the explicit solutions to be applied, an indication is given that for gas or oil fuel "chemical analysis of fuel is usually highly accurate (sic) obtained on a routine basis" (see column 13, lines 36 to 38).
- 3.2.16 As explained above, claim 1 neither specifies the nature of the explicit solutions to be used nor excludes the making of assumptions for certain values, in particular those of fuel ash and fuel water (see contested patent figures 4A and 4B), but also fuel nitrogen and oxygen concentrations, "which are small and typically maybe fixed as constants" (see contested patent, page 20, lines 30 to 31). Under these conditions, the skilled person would not require any inventive skill to come up with basic stoichiometric equations allowing a calculation of a complete as-fired fuel chemical analysis. Such equations are also given for example in D4.

The respondent has argued that any single product of combustion which is made up of three or more reacting constituents yields an insufficient system of equations to allow resolution, such that no equation for example of fuel carbon is possible using the teachings of E1,



and refers in particular to pages 36 to 46 of the application as published. In the Board's view, pages 40 to 43 of the application in particular describe various algebraic manipulations and assumptions, such as setting various parameters to constants or changing bases to eliminate the influence of fuel water and ash, which are used to enable the set of equations to be solved. These procedures, none of which appear in the claims, are standard chemical and mathematical manipulations used when faced with the task of resolving such a set of equations. The Board cannot see any inventive step in resolving a set of equations which are themselves derived in an obvious manner using basic mathematical and chemical knowledge.

3.2.17 Thus, the subject-matter of claim 1 according to the auxiliary request 1 does not involve an inventive step.

4. Auxiliary requests 2 to 4

4.1 Inventive step

4.1.1 Feature 1.3 of auxiliary request 2 has been amended to clarify that a set of explicit solutions, including at least an explicit solution for fuel carbon, is under consideration. Either this amendment does not add any subject-matter not already implicitly present in auxiliary request 1 or the subject-matter of auxiliary request 1 does not even require calculation of carbon by an explicit solution, since an as-fired chemistry of a fossil fuel without a carbon figure would not normally be deemed complete. However, as stated in the contested patent at page 20, lines 49 to 52, CO<sub>2</sub> does not exist in the combustion air to any appreciable

concentration, it does not leak into the system, and it is generated only from combustion. Since these facts are known, the skilled person would not need to exercise any inventive activity to come up with an explicit solution for fuel carbon based on a knowledge of basic combustion theory.

4.1.2 The amendment to claim 1 of auxiliary request 3 adds the feature that there is also an explicit solution for fuel water which according to feature 1.9 requires resolving. Feature 1.5 remains unamended and states that fuel water may still be predicted. Thus, it can only be assumed that the predicted value is incorporated into an explicit solution, which, seeing as the claim covers gas and oil, must allow for zero values.

4.1.3 Claim 1 of auxiliary request 4 specifies that the set of explicit solutions includes solutions for fuel nitrogen, fuel oxygen, and fuel sulphur. The contested patent deals with how these constituents may be calculated at page 20, lines 30 to 35. The Board cannot see any inventive activity in applying these measures, which relate to standard stoichiometrical considerations, particularly when applied to oil and gas.

5. Auxiliary request 5

5.1 This request was filed at the last possible moment during the oral proceedings of 5 March 2010. The amendment made related to the nature of the reference fuel characteristics and was based solely on the description. Furthermore, during the appeal proceedings the reference fuel characteristics had not been

regarded as a relevant distinguishing feature. As such, neither the Board nor the appellant could be expected to deal with this request. Thus, the request cannot be admitted into the proceedings.

## **Order**

### **For these reasons it is decided that:**

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

Registrar:

Chairman:

C. Eickhoff

U. Krause