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Datasheet for the decision of 6 September 2007

Case Number: T 1427/04 - 3.2.04

Application Number: 95117896.1

Publication Number: 0717178

IPC: F01N 3/20

Language of the proceedings: EN

Title of invention:
Operation of catalytic converters

Patentee:
NGK INSULATORS LTD.

Opponent:
Emitec Gesellschaft für Emissionstechnologie mbH

Headword:
-

Relevant legal provisions:
EPC Art. 100(a), 100(b), 54, 56

Keyword:
"Inventive step - main, auxiliary requests 2 and 3 (no) - surprising effects"
"Sufficiency of disclosure - auxiliary request 1 (no) - unusual parameters"

Decisions cited:
-

Catchword:
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Case Number: T 1427/04 **-** 3.2.04

D E C I S I O N
of the Technical Board of Appeal 3.2.04
of 6 September 2007

Appellant: (Opponent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 7 October 2004 rejecting the opposition filed against European patent No. 0717178 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: M. Ceyte
Members: M. Poock
T. Bokor

Summary of Facts and Submissions

I. This appeal lies from the decision of the Opposition Division, posted 7 October 2004, rejecting the opposition against European patent 0 717 178.

II. Opposition was filed against the patent as a whole and based on Article 100(a) and (b) EPC.

The Opposition Division held that the invention was disclosed in a manner sufficiently clear and complete for it to be carried out by the skilled person. The subject-matter of claim 1 was found to be novel. Moreover it was found to involve an inventive step for a surprising synergistic effect which emerged from the comparison of the tests described in the examples of the patent specification and in particular from tests 6 and 7 of table 4. Above a certain threshold level of the power supplied per unit flow of exhaust gas, the conversion of CO and HC was surprisingly high.

III. The Opponent lodged the notice of appeal on 3 December 2004 and paid the prescribed fee simultaneously. The statement of grounds of appeal was received on 4 February 2005.

IV. Of the documents mentioned in the opposition or appeal, the following are cited in this decision:

D1: WO-A-8 910 471;

D10: W. A. Whittenberger, J.E. Kubsh, "Recent Developments in Electrically Heated Metal Monoliths", SAE Technical Paper Series, no. 900503, 1990, pages 61 to 70;

D13: US-A-3 440 817;

D14: Kathleen C. Taylor, "Automobile Catalytic Converters", Springer Verlag, 1984, pages 8, 9;

CT_{flow}: description of a comparative engine test by the Respondent, mentioned in the Respondent's letter of 3 February 2005 on pages 4 to 7.

V. Oral proceedings took place on 6 September 2007.

The Appellant (Opponent) requested that the decision under appeal is set aside and that the European patent be revoked.

The Respondent (Patent Proprietor) requested that the appeal be dismissed (main request), or that the decision under appeal be set aside and the patent be maintained on the basis of claims 1 to 5 filed as first auxiliary request, or claims 1 to 5 filed as second auxiliary request, both filed during oral proceedings before the opposition division, or on the basis of claims 1 to 5 filed as third auxiliary request with letter of 31 July 2007. Further, a request for correction of Table 4 of the description was submitted.

VI. Claim 1 of the main request reads:

"A method of operating a catalytic converter which incorporates a heater and at least one of a main catalyst and a light-off catalyst carried on the heater, to treat exhaust gas from an engine, comprising without energising the heater before start of the engine and concurrently with the introduction of exhaust gas to the heater, starting energising the heater at an average power level of at least 1.5kW per

unit m^3/min flow of exhaust gas, while supplying oxidising gas to the catalytic converter, and after the temperature of the heater has exceeded a value at which the main catalyst of the catalytic converter, or the light-off catalyst carried on the heater, functions, reducing the power level of the heater and stopping supply of the oxidising gas".

In claim 1 of the auxiliary request 1 the following feature was added: "wherein the amount of oxidising gas supplied is controlled such the oxidation-reduction index given by

$$\frac{(O_2 + \frac{1}{2}NO)}{(\frac{1}{3}CO + \frac{1}{2}HC)}$$

is in the range 0.7-1.1, where 0_2, NO, CO and HC are concentrations of the respective gases".

In claim 1 of the auxiliary request 2 the following feature was added to the features of claim 1 of the main request: "wherein the exhaust gas flows through a heated body of the heater and the heater is energised to said average power level by a current density of at least 5 A/mm^2".

The added feature in claim 1 of auxiliary request 2 is further specified in auxiliary request 3 by: "to heat the heater to a temperature of 300°C or above within 10 seconds".

VII. The Appellant's submissions may be summarised as follows:

(a) The method of claim 1 is not new because it is known from document D10 but at least not inventive in combination with D1.

(i) From the statement on page 66, right-hand column of document D10 "Current flow to EHC was then switched off while the vehicle was started" it follows that immediately before the start of the engine no energy was supplied to the heater. The feature in claim 1 "without energizing the heater before start of the engine" has to be interpreted in view of the patent specification, page 3, lines 11 to 15 to mean that electrical energy is not supplied immediately before start of the engine. Thus, this feature is known from document D10.

(ii) It was accepted that the feature to energise the heater at an average power level of at least 1.5kW per unit m^3/min flow of exhaust gas is not explicitly mentioned in document D10. However, it is implicitly disclosed therein. The skilled person knows that conventional engines provide an exhaust gas flow of 1 to 2 m^3/min as can be seen from documents D13, D14 and CT_{flow}. On page 67, right-hand column, second paragraph an electrical power available at the heater of 4,9 kW is disclosed. The skilled person immediately recognizes that when 4,9kW

electrical power is applied on this exhaust gas flow, the heater is energised as claimed.

(iii) It was contested that from the tests described in the patent specification, it results that the claimed method has a surprisingly high conversion rate at cold start of the engine. They would only demonstrate that increasing the electrical power results in a higher current density and a shortened time for heating the converter to its operative temperature at engine start. The trend in this field is to energise the heater of the converter with the maximum electrical power available in the vehicle for a high conversion rate when the engine is started.

(b) The patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art because the oxidation-reduction index is not a usual parameter in this field and is not sufficiently defined in the patent. Neither the unit of the gas concentrations to be used with the index is specified in the patent nor how the amount of supplied oxidising gas is controlled to meet the index, in particular how the respective concentrations in the fraction

$$\frac{(O_2 + \frac{1}{2}NO)}{(\frac{2}{3}CO + \frac{3}{2}HC)}$$

are determined.

VIII. The Respondent's submissions regarding claim 1 may be summarised as follows:

(a) The method of claim 1 is new and involves an inventive step.

(i) Document D10 does not disclose the features that the heater is not energised before start of the engine and that the heater is energised at an average power level of at least 1.5kW per unit m^3/min flow of exhaust gas.

(ii) There is no incentive for the skilled person to apply the teaching of document D1 to the method known from document D10, because he could not expect satisfactory results when the heater is not pre-heated and because it does not disclose the supply of oxidising gas to the converter. Even if the teaching of document D1 were applied to the method known from document D10, it would not result in a method as claimed.

(iii) In contrast, the claimed method of operating a catalytic converter provides a surprisingly high conversion rate at cold start of the engine which emerged from the tests described in the patent specification and in particular from the tests 6 and 7 of example 4 shown in the corrected table 4. These tests reflect realistic conditions with an exhaust gas flow rate of 0,7 or 1,0 m^3/min.

(iv) A current density of at least 5A/mm^2 or a current density of at least 5A/mm^2 to heat the heater to a temperature of 300°C or above within 10 seconds is not known from documents D1 or D10.

(b) The person skilled in the art immediately recognises that the oxidation-reduction index is to ensure stoichiometric conditions, that only Mol-% are meant and how the supplied oxidising gas is controlled to meet the index.

Reasons for the Decision

1. The appeal complies with the requirements of Article 106 to 108 and Rules 1(1) and 64 EPC. It is therefore admissible.

Main request - claim 1- Article 100(a) EPC

2. Novelty

2.1 Document D10 relates to electrically heated catalytic converters (EHC) for reducing the cold start emissions of light duty vehicles.

2.1.1 Such converters and associated power controllers were tested on a 1987 VW Golf vehicle equipped with a 1.8 litre engine (see page 64, left-hand column, last paragraph and page 70, left-hand column, "CONCLUSIONS"). The results showed that combining air injection with resistance heating results in substantial reduction in

cold start emissions (see page 65, right-hand column, first paragraph).

2.1.2 In these tests, the converter was either not heated at all or prior to engine start (see table 4 on page 64). It is noted that on page 66, right-hand column, second paragraph it is stated that the pre-heating of the converter is switched off while the vehicle is started. However, this relates to early designs of power controllers and not to the controllers used in the test engine. Therefore, it cannot be concluded that the test engine known from document D10 discloses the feature of claim 1 not to energise the heater before start of the engine.

2.1.3 The exhaust gas flow rate of the test engine is not explicitly disclosed in document D10 and the Appellant referred to documents D13, D14 and CT_{flow} to demonstrate that conventional engines provide an exhaust gas flow rate of 1 to 2 m^3/min. However, since these documents do not relate to the 1987 VW Golf engine tested in document D10, in fact they relate to different engines, e.g. CT_{flow} to a 1994 VW Passat engine, they cannot demonstrate that the D10 test engine had such exhaust gas flow rate.

In the absence of any evidence as regards the exhaust gas flow rate of the 1987 VW Golf 1.8 litre test engine, it cannot be concluded that the heater of document D10 is energised at an average power level of at least 1.5kW per unit m^3/min flow of exhaust gas, as required by claim 1.

2.1.4 Thus, in connection with the test engine, document D10 does not disclose all features of claim 1.

2.2 Since no further facts were cited in this respect, it is concluded that the subject-matter of claim 1 is new.

3. Inventive step

3.1 Closest prior art

The parties agree that the closest prior art for the claimed method is known from document D10. More particularly, it is known from the tests of the converters and associated power controllers on the 1987 VW Golf 1.8 litre engine (see above 2.1.1).

3.2 Derivation of the technical problem

3.2.1 Distinguishing features

The subject-matter of claim 1 is distinguished from the closest prior art by the features that

- the heater is not energised before start of the engine (see above 2.1.2), and
- the heater is energised at an average power level of at least 1.5kW per unit m^3/min flow of exhaust gas (see above 2.1.3).

Moreover, the claimed method is not restricted to be applied only with the tested 1987 VW Golf 1.8 litre engine.

3.2.2 Effects of the distinguishing features

(a) Although the Respondent claimed a surprisingly high conversion rate at cold start of the engine, the following is to be observed.

– Claim 1 also covers embodiments in which the current density is below 5 A/mm^2 and requires that the heater is not pre-heated before engine start.

– In contrast, it is stated in the patent (see paragraph 16) that, if the current density is below 5 A/mm^2, the heater must be pre-heated before the engine is started to obtain the desired exhaust gas conversion characteristics, i.e. a high conversion rate at cold start.

– In this respect, the claim thus contradicts the description. In the absence of any evidence that the claimed method provides a surprisingly high conversion rate at cold start of the engine even at a current density below 5 A/mm^2, this effect cannot be taken into consideration.

(b) In contrast, what is clearly achieved by these distinguishing features is that the claimed method is applicable to treat the exhaust gas of other engines and the method does not require a "waiting time" before the engine is started so that a higher battery potential is available when the engine is started.

3.2.3 Formulation of the technical problem

Therefore, the technical problem can be formulated as to adapt the method of operating a catalytic converter known from document D10 to treat the exhaust gas from other combustion engines, which method does not require a "waiting time" before the engine can be started.

3.2.4 Person skilled in the art

In view of the foregoing, the skilled person faced with this technical problem is considered as a graduated engineer with experience in the field of exhaust purification of combustion engines.

3.3 Obviousness

3.3.1 The teaching of document D10 is not restricted to the tested engine, i.e. a method to treat the exhaust gas from the test engine. In fact, it relates to catalytic converters for light duty vehicles, of which the tested 1987 VW Golf 1.8 litre engine is only an example.

(a) Thus, it is obvious for the skilled person to apply its teaching to any kind of combustion engine and in particular to the engines of the most common middle class cars.

(b) In such vehicles, the electrical power available at the heater is typically 4,9kW (see page 67, right-hand column, second paragraph and figure 4).

Taking into account the Respondent's argument that the tests described in the patent reflect realistic conditions with an exhaust gas flow rate of 0,7 or 1,0 m^3/min, the Board therefore concludes that the engines of D10 provide in operation the same exhaust gas flow.

This inevitably results in the heater being energised at a power level of at least 4,9kW per m^3/min exhaust gas flow.

3.3.2 Document D1 relates in general to three-way catalytic converters for the treatment of the exhaust gas of combustion engines. More particularly, it aims at shortening the time span required for the catalyst to reach its operative temperature after an engine cold start (see page 1, paragraph 4) with the power sources usually available in conventional vehicles (see page 3, second paragraph 2).

Different heating strategies for catalysts are presented in figure 4 and described on pages 10, line 34 to page 12, line 28. The catalyst is heated either before the engine is started or only after the engine was started. In the first case, the power consumption should be arranged such that the "waiting time" and the battery load are acceptable (see page 12, paragraph 3). In the second case, higher battery potential is available at the catalyst but the load on the generator and cabling is higher (see page 12, paragraph 4).

Thus, for the avoidance of a "waiting time" before the engine is started, the skilled person is taught not to pre-heat the catalyst before engine start and, if necessary, to adapt the generator and the cabling correspondingly. As a result a higher battery potential is available at the catalyst when the engine is started.

3.3.3 Since document D1 thus relates to the same technical field and addresses in essence the same technical problem and in fact it addresses an important part of the problem, it is obvious to apply this specific teaching to the method known from document D10. Thus, the skilled person would arrive at a method as covered by claim 1 without exercise of inventive ingenuity.

For these reasons it is not of importance whether the method of document D1 proposes to supply oxidising gas to the converter or not.

3.4 In view of the foregoing, the Board concluded that the subject-matter of claim 1 does not involve an inventive step as required by Articles 52(1) and 56 EPC. Consequently, the main request was not allowable.

Auxiliary request 1 - claim 1 - Article 100(b) EPC

4. Article 100(b) EPC stipulates that the European patent must disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art.

4.1 This requirement must be assessed on the basis of the application as a whole - including the description and claims .

4.1.1 The oxidation-reduction index is defined in the description (paragraph 24) as follows:

$$\text{Oxidation-reduction index} = \frac{\text{Oxidizing gas}}{\text{Reducing gas}} = \frac{(O_2+1/2NO)}{(2/3CO+3/2HC)}$$

.

According to claim 1, it is given by

$$\frac{(O_2 + \frac{1}{2}NO)}{(\frac{2}{3}CO + \frac{3}{2}HC)}$$

where O_2, NO, CO and HC are concentrations of the respective gases. The latter is not mentioned in the application as filed.

However, neither the unit of these concentrations is specified in the patent nor how the amount of supplied oxidising gas is controlled to meet the index, in particular how the respective concentrations in this fraction are determined.

4.1.2 The Board acknowledges that a usual parameter having a well recognised meaning does not have to be specifically defined in a patent because it is comprised by the skilled person's general technical knowledge. However, this does not necessarily apply to unusual parameters. In the latter case, it has to be demonstrated that such parameter has a distinct meaning in this field and gives a distinct teaching to the skilled person.

(a) The Respondent argued that the person skilled in the art knows that the oxidation-reduction index is to ensure stoichiometric conditions, that only Mol-% could be meant and how the supplied oxidising gas is controlled to meet the index. However, these arguments were contested and were not supported by evidence. Therefore, they could not be taken into account.

(b) The Board had thus to conclude that the claimed oxidation-reduction index is neither a well known parameter nor has a distinct meaning for the skilled person.

4.2 Thus, the European patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a skilled person.

Auxiliary request 2 -claim 1 - Article 100(a) EPC

5. Inventive step

5.1 The following feature was added to claim 1 of the main request: "wherein the exhaust gas flows through a heated body of the heater and the heater is energised to said average power level by a current density of at least $5A/mm^2$".

5.2 With this limitation the heater must not be pre-heated to achieve the desired exhaust gas conversion characteristics (see patent, paragraph 16). The Respondent claimed a surprisingly high conversion rate.

5.2.1 In general, if comparative tests have been chosen to demonstrate an inventive step on the basis of an improved effect, according to the case law (see i.a. the decisions cited in "Case Law of the Boards of Appeal of the European Patent Office", 5th English edition 2006, I.D.9.8, page 167), the nature of the comparison with the closest state of the art must be such that the said effect is convincingly shown to have its origin in the distinguishing feature of the invention.

(a) In tests 6 and 7, none of the heaters was energised before engine start. Thus, they cannot demonstrate that the claimed surprisingly high conversion rate has its origin in the feature to not energise the heater before engine start.

(b) Moreover, in the corrected version of table 4 it can be seen that not only the power level was varied but also different heaters having different geometry were used, as results from table 3.

Thus, it is unclear whether the claimed surprisingly high conversion rate has its origin in the power level or the geometry of the heaters. It could well have its origin only in the geometry.

(c) Therefore, the requirements mentioned above are not met in this case.

5.2.2 Accordingly, in accordance with the case law (see the decisions cited in "Case Law of the Boards of Appeal of the European Patent Office", 5th English edition 2006, I.D.4.2), it cannot be taken into consideration for the determination of the technical problem that the high conversion rate at cold start of the engine was surprising.

5.3 The technical problem can thus be formulated as to adapt the method of operating a catalytic converter known from document D10 to treat the exhaust gas from other combustion engines with a high conversion rate at engine cold start and not requiring a "waiting time" before the engine can be started.

5.4 For a high conversion rate at engine start, the trend in this field is to energise the heater of the converter with the maximum electrical power available in the vehicle. However, as stated in the patent in paragraph 16, the available electrical power might not be sufficient to achieve the desired conversion rate without pre-heating.

5.4.1 In such a case, D1 teaches to energise only a smaller portion of the heater for shortening the heat-up time of the catalyst (see page 11, lines 22 to 28).

5.4.2 The current density is given by the fraction I/A, wherein I is the electrical current and A is the cross-section of the conductor (see, for example, paragraph 0015 of the patent specification).

When the same amount of electrical power is supplied to a smaller portion of the heater, i.e. the cross-section

of the catalyst to which the power is supplied is reduced, it means that the current density is increased.

5.4.3 Thus, in addition to what was stated in 3.3.1, document D1 also teaches to increase the current density when the available power is not sufficient for an acceptable conversion rate at engine cold start.

5.5 Following the argumentation regarding claim 1 of the main request, it is also obvious for the skilled person to apply this additional teaching of document D1 to the method known from document D10.

5.5.1 The skilled person will adjust the current density so that the method provides a high conversion rate at cold start without the need for pre-heating as required by claim 1.

This does not require the exercise of inventive ingenuity but remains in the framework of routine optimisation considerations. This is confirmed by the patent specification. From paragraph 16 it is concluded that acceptable conversion rates can only be achieved without pre-heating when the heater is energised by a current density of at least 5 A/mm^2. Thus, the skilled person will energise the heater at this current density or above.

5.6 Therefore, the Board concluded that the subject-matter of claim 1 does not involve an inventive step as required by Articles 52(1) and 56 EPC

Auxiliary request 3 - claim 1 - Article 100(a) EPC

6. Inventive step

6.1 The following indication of an effect was added to claim 1 of auxiliary request 2: "to heat the heater to a temperature of 300°C or above within 10 seconds".

6.2 All other features of the methods mentioned in claim 1 of the auxiliary requests 2 and 3 are identical. Thus, these methods necessarily provide the same effects. It is only in claim 1 of auxiliary request 2 that this effect is not recited. Therefore, no additional effects are achieved with the method of claim 1 of auxiliary request 3 in comparison with auxiliary request 2.

6.3 Consequently, the subject-matter of claim 1 does not involve an inventive step for the same reasons as set out above for auxiliary request 2.

7. In view of the foregoing, also the auxiliary requests were not allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The European patent is revoked.

The Registrar: The Chairman:

G. Magouliotis M. Ceyte