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D E C I S I O N
of 8 April 2005

Case Number: T 0653/03 - 3.2.4

Application Number: 96112309.8

Publication Number: 0758713

IPC: F01N 3/02

Language of the proceedings: EN

Title of invention:

A method for purifying exhaust gas of a diesel engine

Patentee:

Toyota Jidosha Kabushiki Kaisha

Opponent:

Johnson Matthey PLC

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 111(1), 123(2)

Keyword:

"Amendments - generalisation (main request: not allowed)"

"Novelty - inevitable outcome (auxiliary requests 1 and 2: not allowed)"

"Inventive step - aggregation (auxiliary requests 3 and 4: not allowed)"

"Inventive step (auxiliary request 5: allowed)"

Decisions cited:

T 0793/93, T 0309/00

Catchword:

-



Case Number: T 0653/03 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 8 April 2005

Appellant 1:
(Proprietor of the patent)

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Decision under appeal:

**Interlocutory decision of the Opposition
Division of the European Patent Office posted
15 April 2003 concerning maintenance of
European patent No. 0758713 in amended form.**

Composition of the Board:

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

Summary of Facts and Submissions

- I. Appellant 1 (proprietor of the patent) lodged an appeal against the interlocutory decision of the opposition division on the amended form in which European patent No. 0 758 713 could be maintained.

The impugned decision was dispatched on 15 April 2003. The appeal and the appeal fee were received at the European Patent Office on 10 June 2003, the statement of grounds of appeal on 8 August 2003.

Appellant 2 (opponent) likewise lodged an appeal against this decision. The appeal and the appeal fee were received at the European Patent Office on 12 June 2003, the statement of grounds of appeal was received on 15 August 2003.

- II. The opposition was based *inter alia* on the ground of Article 100(a) in conjunction with Articles 52(1), 54(1) and 56 EPC and on the ground of Article 100(c) EPC.

The documents cited in the opposition proceedings included:

- D1: EP-A-341 832;
- D2: EP-A-580 389;
- D3: US-A-5 041 270;
- D4: "Diesel Emission Control Technology", P.N. Hawker, Platinum Metals Review, January 1995, pages 1-8;
- D5: SAE-Paper 890 404;
- D6: "Dépollution des gaz d'échappement des moteur diesel au moyen de pots catalytiques",

Goldberg et al, Revue de l'institut français
du pétrole, Vol. 38, No. 6, 1983, pages 793-
805 and

D7: SAE-Paper 830 087;

The impugned decision states that the subject-matter of claims 1 and 7 according to the main request extends beyond the content of the application as filed, that the subject-matter of claim 1 according to the first auxiliary request lacks novelty in view of document D1 and that the subject-matter of claims 1 and 7 according to the second auxiliary request is novel and involves an inventive step so that the cited grounds of opposition do not prejudice the maintenance of the patent in this form.

III. The following documents were filed during the appeal proceedings:

D17: JP-A-6 159 037;

D17': translation of JP-B-2 722 987 (family member of D17);

D18: "Catalytic Air Pollution Control - Commercial Technology", Ronald M. Heck et al, John Wiley & Sons Inc., 1995;

D19: SAE-950 809.

IV. Oral proceedings took place on 8 April 2005.

Appellant 1 (proprietor of the patent) requested that the decision under appeal be set aside and that the patent be maintained on the basis of the main or the auxiliary request 1, filed with letter of 8 August 2003, or one of the auxiliary requests 2-8, filed with letter

of 8 March 2005. Further, he requested that the late filed documents D17-D19 be disregarded.

Appellant 2 (opponent) requested that the patent be revoked in its entirety and that the late filed documents D17-D19 be admitted into the proceedings.

- V. The relevant claims or features of the respective requests read (emphasis added by the board to indicate amendments with respect to the foregoing request):

Main request (claim 1 as granted)

"1. A method for purifying the exhaust gas of a combustion engine (1) comprising:
a step of oxidizing nitrogen monoxide in the exhaust gas of said combustion engine (1) into nitrogen dioxide, thereby forming nitrogen dioxide in the exhaust gas; ..."

First auxiliary request

"1. A method for purifying the exhaust gas of a diesel engine (1) comprising: a step of oxidizing nitrogen monoxide in the exhaust gas of said diesel engine (1) into nitrogen dioxide, thereby forming nitrogen dioxide in the exhaust gas;
a step of collecting carbon particles contained in the exhaust gas;
a step for reacting nitrogen dioxide in the exhaust gas formed by said oxidation of nitrogen monoxide with the collected carbon particles, thereby oxidizing the collected carbon particles by nitrogen dioxide in the exhaust gas and, at the same time, reducing nitrogen dioxide in exhaust gas to nitrogen monoxide;

a step for removing, via either an absorbent (9) or a reducing catalyst (10), nitrogen monoxide formed by the reaction between nitrogen dioxide and the collected carbon particles from the exhaust gas; and a step of reacting nitrogen dioxide with the collected carbon by intermittently raising the exhaust gas temperature".

Second auxiliary request

"1. ... a step of collecting carbon particles contained in the exhaust gas in a filter; a step of reacting nitrogen dioxide in the exhaust gas formed by said oxidation of nitrogen monoxide with the collected carbon particles by flowing the exhaust gas containing said nitrogen dioxide into the filter, thereby oxidizing the collected carbon particles by nitrogen dioxide in the exhaust gas and, at the same time, reducing nitrogen dioxide in exhaust gas to nitrogen monoxide; ..."

Third auxiliary request

"1. ... a step of reacting nitrogen dioxide with the collected carbon by intermittently raising the exhaust gas temperature when it is determined that a regeneration operation of the filter should be conducted."

Fourth auxiliary request

"1. ... a step of removing, via either an absorbent (9) or a reducing catalyst (10) downstream of the filter, nitrogen monoxide formed in the filter by the reaction

between nitrogen dioxide and the collected carbon particles from the exhaust gas which has passed the filter; ..."

Fifth auxiliary request

"1. A method for purifying the exhaust gas of a diesel engine (1) comprising:
a step of oxidizing nitrogen monoxide in the exhaust gas of said diesel engine (1) into nitrogen dioxide, thereby forming nitrogen dioxide in the exhaust gas;
a step of collecting carbon particles contained in the exhaust gas in a filter;
a step of reacting nitrogen dioxide in the exhaust gas formed by said oxidation of nitrogen monoxide with the collected carbon particles, by flowing the exhaust gas containing said nitrogen dioxide into the filter thereby oxidizing the collected carbon particles by nitrogen dioxide in the exhaust gas and, at the same time, reducing nitrogen dioxide in [deleted: the] exhaust gas to nitrogen monoxide;
a step of removing, via either an absorbent (9) or a reducing catalyst (10) [deleted: downstream of the filter], nitrogen monoxide formed [deleted: in the filter] by the reaction between nitrogen dioxide and the collected carbon particles from the exhaust gas [deleted: which has passed the filter]; and
a step of reacting nitrogen dioxide with the collected carbon by intermittently raising the exhaust gas temperature when it is determined that a regeneration operation of the filter should be conducted, wherein the air-fuel ratio of the exhaust gas is maintained at a lean air-fuel ratio when the exhaust gas temperature is raised, and the air-fuel ratio of the exhaust gas is

periodically made rich even during the regeneration operation of the filter."

"5. An exhaust gas purification device that purifies the exhaust gas of a diesel engine (1), said device comprising:
an oxidizing catalyst (5) that oxidizes nitrogen monoxide in the exhaust gas of said diesel engine (1) into nitrogen dioxide, thereby forming nitrogen dioxide in the exhaust gas; and
filter means (7) that collect carbon particles contained in the exhaust gas;
said device effecting a reaction of nitrogen dioxide in the exhaust gas formed by said oxidation of nitrogen monoxide with the collected carbon particles by flowing the exhaust gas containing said nitrogen dioxide into said filter means, thereby oxidizing the collected carbon particles by nitrogen dioxide in the exhaust gas and, at the same time, reducing nitrogen dioxide in exhaust gas to nitrogen monoxide;
and further comprising
an absorbent (9) or reducing catalyst (10) that removes nitrogen monoxide formed by the reaction between nitrogen dioxide and the collected carbon particles from the exhaust gas; and
a heater (1) for intermittently raising the exhaust gas temperature to react nitrogen dioxide with the collected carbon when it is determined that a regeneration operation of the filter means should be conducted;
said filter means (7) being disposed downstream from said oxidizing catalyst (5) and said absorbent (9) or reducing catalyst (10) being disposed downstream from said filter means (7), wherein the air-fuel ratio of

the exhaust gas is maintained at a lean air-fuel ratio when the exhaust gas temperature is raised, and the air-fuel ratio of the exhaust gas is periodically made rich even during the regeneration operation of the filter means.

VI. The essential arguments of appellant 1 (proprietor of the patent) may be summarized as follows:

- (a) The replacement of the term "diesel engine" by the term "combustion engine" in the independent claims of the main request only brings the core teaching of the invention into adequate language. The skilled reader would immediately realize that the treatment of exhaust gas is the essential matter and not the type of the engine. Moreover, the intended purpose does not provide a technical contribution to the invention and no real modifications of the method steps are necessary to adapt the method of claim 1 to different types of combustion engines.
- (b) D1 does not disclose all features of the independent claims according to the auxiliary requests.

Although the particulate filter of D1 may, to a very low extent, have some NO_x removing capacity, it cannot be regarded as a reducing catalyst even if it contained a precious metal, because no such function is disclosed therein. In this respect he refers to items 6.1.3 and 6.1.4 of decision T 309/00. Moreover, the wording of claim 1 requires that the NO_x is removed separately of the

particulate filter and oxidising catalyst, this however not being disclosed in D1. Also, it would not make sense that the particulate filter on which the particulate is oxidised by NO₂ also works as a reducing catalyst for NO₂.

When the system of D1 is used in a hilly landscape, the increase of the exhaust gas temperature happens by chance. This accidental increase could not be compared with the intentional and controlled step of intermittently raising the temperature as required by claim 1.

- (c) The subject-matter of the independent claims according to the auxiliary requests also involves an inventive step.

The person skilled in the art would not combine the method of D1 with an active filter regeneration technique.

The claimed invention is inventive because no document gives any indication that in the method of D1 the reaction (b) $\text{NO}_2 + \text{C} \rightarrow \text{NO} + \text{CO}$ is dominant over the reaction (c) $\text{NO}_2 + \text{C} \rightarrow \text{N}_2 + \text{CO}_2$ during normal operational conditions of the diesel engine and, at low temperatures, the amount of NO emitted from the combustion engine is too small to form sufficient NO₂ for burning all of the carbon particles in the filter. As a result carbon particles are accumulated in the filter.

The partial technical problems formulated by appellant 2 (opponent) regarding claim 1 of the fourth auxiliary request are not correct. The problem to be solved should be based on the fact that the D1 method does not work at low temperatures because there is not sufficient nitrogen monoxide which could be oxidised for the reaction with the collected carbon.

The person skilled in the art would not combine the teachings of D1 and D2 or D3. Should he nevertheless combine their teachings, he would be prompted to install the NO_x absorbent or reducing catalyst between the engine and the oxidising catalyst.

VII. The essential arguments of appellant 2 (opponent) may be summarized as follows:

- (a) The subject-matter of claim 1 of the first and second auxiliary request lacks novelty in view of D1 or D17 and D17'.

The particulate filter of D1 acts as a lean NO_x catalyst, ie as a reducing catalyst because it is coated with alumina and platinum. The diesel engine of D1 is subjected during normal use to high load operating conditions, eg when driving in a hilly landscape. Thus, the exhaust gas temperature is intermittently raised and the NO₂ reacts with the collected carbon.

- (b) The subject-matter of claim 1 of the third auxiliary request does not involve an inventive

step in view of the combination of the teachings of D4 with D7 or D17 and D17'. D4 represents the closest state of the art because it contains a reference to D1 and its incorporation renders D4 more relevant than D1.

- (c) The subject-matter of claim 1 of the fourth auxiliary request does not involve an inventive step in view of the combination of the teaching of D4 with the teachings of D2, D3 and D7 or D17 and D17' respectively.

Two partial technical problems can be established which are:

- (i) to treat NO resulting from combustion of soot in NO₂
 - (ii) to improve combustion of soot in NO₂ under normal operating conditions to a level exceeding accumulation.
- (d) With respect to the independent claims of the fifth auxiliary request, he referred essentially to his submissions regarding the foregoing requests.

Regarding the teaching of D17 and D17', he stated in the oral proceedings that: "To combine the DPF regeneration (lean) with NO_x absorbent regeneration (rich), the skilled engineer would use the general teaching of D17 to reprogram the engine control unit" of D1.

Reasons for the Decision

1. The appeals comply with the requirements of Article 106 to 108 and Rule 64 EPC and are therefore admissible.

2. *Late filed documents*

The documents D17-D19 were filed after the expiry of the opposition period. Since they are *prima facie* relevant to the decision to be taken, they were allowed to be introduced into the proceedings.

Main request

3. *Amendments*

3.1 In claim 1, the original term "diesel engine" was replaced by the term "combustion engine". Thus, the suitability of the claimed method has been generalised to any type of combustion engine.

3.2 According to the wording of Article 123(2) EPC a European patent application may not be amended in such a way that it contains subject-matter which extends beyond the content of the application as filed.

This is to protect the legitimate interest of the public not to be confronted with subject-matter in the granted patent which could not have been foreseen by a person skilled in the art having studied the whole disclosure of the application as filed.

3.3 It therefore has to be examined whether the person skilled in the art can derive directly and unambiguously

- from the original application as a whole that the claimed method is suitable for any type of combustion engine.
- 3.3.1 The original application consistently refers to the exhaust gas purification of a diesel engine. For instance in the presentation of the background of the invention only a diesel engine is mentioned (see page 1, line 5 - page 3, line 4). The problem of the invention and its solution are related to a diesel engine (see page 3, lines 5-27). This is also true of the preferred embodiments (see page 5, line 2ff). Thus, the original application discloses explicitly only a purifying method suitable for a diesel engine.
- 3.3.2 Moreover, the original application refers to the problems of exhaust gases having a high content of carbon particles (see eg page 3, lines 13-27). The argument of the opposition division that at the priority date no lean burn engines were known to produce considerable amount of carbon particles has not been contested. Therefore, the person skilled in the art could not even implicitly derive from the original application that the method is suitable for engine types other than diesel.
- 3.3.3 Thus, the treatment of exhaust gas in the original application is always related to a diesel engine and it could not be derived by the person skilled in the art that the subject-matter of the granted patent extends to a method which is suitable for any type of combustion engine.

- 3.3.4 For these reasons, the board does not share the view of appellant 1 that the replacement in claim 1 would only bring the core teaching of the invention into adequate language.

Moreover, the board does not share appellant 1's view that the intended purpose of the method does not provide a technical contribution to the invention and that no real modification of the method steps are necessary to adapt the method of claim 1 to different types of combustion engines. The technical contribution is that the amended method has to be suitable for any type of combustion engine whereas in the original form it is suitable only for a diesel engine. If the method steps need real modification or not is irrelevant when the amendment of the claim is not supported by the original application.

- 3.4 Therefore, the board concludes that the generalisation to a method which is suitable for any type of combustion engine is not directly and unambiguously derivable from the original application so that the application contains subject-matter which extends beyond the content of the application as filed contrary to the requirements of Article 123(2) EPC. Consequently, the main request is not allowable.

Auxiliary requests 1 and 2

4. *Novelty*

4.1 General considerations

In the case where a prior art document fails explicitly to disclose something falling within a claim, availability in the sense of Article 54 may still be established if the inevitable outcome of what is literally or explicitly disclosed falls within the ambit of that claim (see T 793/93, 2.1, mentioned in Case Law of the Boards of Appeal of the European Patent Office, 4th edition, I.C.2.3, 3rd paragraph).

4.2 D1

4.2.1 This document relates to a method for purifying the exhaust gas of a diesel engine (see eg page 2, lines 2, 3) and discloses:

A step of oxidizing nitrogen monoxide (NO) in the exhaust gas of the diesel engine into nitrogen dioxide (NO₂), thereby forming NO₂ in the exhaust gas (see eg page 1, lines 32-36 and page 3, reaction a) and a step of collecting carbon particles contained in the exhaust gas in a filter 3 (see eg fig. 1 and page 1, lines 32-36).

A step of reacting NO₂ in the exhaust gas formed by said oxidation of NO with the collected carbon particles by flowing the exhaust gas containing said NO₂ into the filter 3, thereby oxidizing the carbon particles by NO₂ in the exhaust gas and, at the same

time, reducing NO₂ in the exhaust gas to NO (follows from page 3, reaction b and page 4, lines 6-8).

4.2.2 The filter works as a reducing catalyst for nitrogen oxides (NO_x).

It is part of the common general knowledge of the person skilled in the art that catalysts for reducing NO_x in internal combustion engines comprise a metal such as platinum loaded on a support formed from a porous material such as alumina or zeolite (see eg D3: col. 1, lines 23-53 or paragraph 0071 of the contested patent) and require a reducing atmosphere for reducing NO_x. This means that the exhaust gas must have a rich or stoichiometric air-fuel ratio, ie it contains almost no oxygen. Such catalysts then reduce NO using unburned hydrocarbons (HC) and carbon monoxides (CO) trapped in the porous material (see eg paragraph 0071 of the contested patent).

The particulate filter 3 of D1 comprises platinum loaded on an alumina support (see page 8, example 4a and lines 22-24) and is used in internal combustion engines, ie in a similar temperature range. From fig. 4 it can be seen that the method does not remove all of the HC and CO so that the exhaust gas still provides a reducing atmosphere.

Thus, the board has no doubts that the particulate filter 3 of D1 inevitably works (to some extent) as a reducing catalyst either by reducing the NO directly with the HC and CO available in the exhaust gas when the air-fuel ratio is rich or stoichiometric or with

the HC and CO trapped in the alumina support when the air-fuel ratio is lean.

For these reasons, the board does not share the view of appellant 1 that the particulate filter 3 of D1 could not be regarded as a reducing catalyst. The cited decision T 309/00 (not published in OJ EPO) is not relevant in this context, because it relates to a NO_x absorbent (see sections 6.1.3 and 6.1.4.) contrary to the reducing catalyst discussed above. Moreover, the board does not agree that the wording of claim 1 requires that NO_x is removed separately of the particulate filter 3 and oxidising catalyst 1, ie in separate units. This wording requires only that the NO which is formed by the reaction between NO₂ and the collected carbon particles is removed from the exhaust gas via an absorbent or a reducing catalyst. This can be achieved in the particulate filter itself as set out above. Finally, the board does not agree with the argument that it would not make sense that the particulate filter on which the particulate is oxidised by NO₂ also works as a reducing catalyst for NO₂ because systems are known in which both functions are combined (eg D17: figs. 1, 2).

Taking into account the considerations set out above in section 4.1, the board therefore concludes that D1 does in fact disclose a step of removing, via a reducing catalyst, NO formed by the reaction between NO₂ and the collected carbon particles from the exhaust gas.

4.2.3 D1 also discloses a step of reacting NO₂ with the collected carbon by intermittently raising the exhaust gas temperature.

D1 discloses a method for the removal of carbon particles from the exhaust gas of a diesel engine (see eg the title and claim 1) and a diesel engine in which this method is applied (see eg page 8, lines 35, 36 in conjunction with lines 14-17). It also discloses to the person skilled in the art, at least implicitly, the use of this method with a diesel vehicle because he would take into account common general knowledge and would not adhere only to the literal or explicit disclosure of this document.

When driving diesel vehicles, the exhaust gas temperature varies but does normally not exceed 300°C (D1: page 1, line 17). However, high load periods occur in which the exhaust gas temperature is increased to higher temperatures, such as 500°C (D1: page 1, line 16) when the vehicle is driven under dynamic conditions with strong accelerations or in a hilly landscape. Thus, the exhaust gas temperature is raised at intervals, ie intermittently.

The board has no doubts that this intermittent raise of the exhaust gas temperature has the inevitable effect that NO₂ is reacted with the collected carbon because NO₂ already reacts with the collected carbon at temperatures of 250-400°C (see D1, page 4, lines 6-8).

Appellant 1 argues that such accidental increase of the exhaust gas temperature cannot be compared with the intentional and controlled step of intermittently

raising the temperature of claim 1. Moreover, D1 does not disclose the usefulness or necessity to periodically cause such high load operating conditions.

The board does not share these views. Firstly, the last feature does not specify that the step of intermittently raising the exhaust gas temperature has to be taken intentionally or in a controlled manner. It includes no restrictions as to how the temperature is raised. Secondly, taking into account the considerations set out above in section 4.1, it is concluded that D1 discloses the last feature of claim 1 because it is the inevitable outcome of the use of the method in a diesel vehicle known from D1 which falls within the ambit of claim 1.

4.2.4 Therefore, D1 discloses all features of claim 1.

4.3 The board comes to the conclusion that the subject-matter of claim 1 is not new (Article 54(1), (2) EPC). Consequently, auxiliary requests 1 and 2 are not allowable.

Auxiliary request 3

5. *Inventive step*

5.1 Closest state of the art

5.1.1 According to the case law of the Boards of Appeal, the closest state of the art is normally a prior art disclosure conceived for the same purpose or having the same objective as the claimed invention and having the most relevant technical features in common (see Case

Law of the Boards of Appeal of the European Patent Office, 4th edition in English, 2001, I.D.3.1, page 102).

In the present case, the closest state of the art is known from D1 which concerns not only the removal of particulate as D4 but also the removal of NO (see section 4.2.3 above).

According to the appellant 2, the closest state of the art is disclosed in D4 because it contains a reference to the mechanism for the catalytic regeneration of traps of D1 (on page 3, right column, last paragraph) and its incorporation renders D4 more relevant than D1.

The board does not share this view. D4 describes a system with an oxidising catalyst and a filter unit to remove particulate from diesel exhaust. However, D4 is silent about the removal of NO_x. D1 was cited exclusively with regard to the mechanism for the removal of particulate and not for other details of this system. The particulate filter of D4 consists only of ceramic (see page 4, right column, last paragraph). Thus and in contrast to some examples presented in D1 (eg example 4a), NO formed by the reaction between NO₂ and the collected carbon particles from the exhaust gas cannot be reduced by this filter. Therefore, the state of the art of D1 is more closely related to the subject-matter of claim 1 than the one of D4.

- 5.1.2 The diesel vehicle according to D1 cannot continuously purify the exhaust gas when it is driven at low loads or when its engine runs idle for a certain time because the exhaust gas temperature will be too low for burning

the carbon particles in the filter. The increasing backpressure across the filter reduces the engine output and the carbon particles are released to the atmosphere when the filter storage capacity is reached and exceeded.

5.2 Formulation of the technical problem

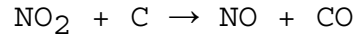
5.2.1 The subject-matter of claim 1 is distinguished from the method disclosed in D1 in that the exhaust gas temperature is intermittently raised when it is determined that a regeneration operation of the filter should be conducted. This ensures that the regeneration of the filter is always initiated when necessary, independent of the operating conditions of the diesel engine.

5.2.2 Based on this objective analysis of the effects achieved with the claimed subject-matter over the method of D1, the technical problem to be solved by the distinguishing feature of claim 1 is to provide a method for purifying the exhaust gas of a diesel engine which is capable of easily and continuously removing the carbon particles collected by the particulate filter.

5.2.3 This problem is different to the problem mentioned in paragraph 0009 of the opposed patent which specifies "without increasing the amounts of nitrogen oxide and sulfate released to the atmosphere".

This problem is not necessarily solved by the method of claim 1 because its current wording does not exclude

the temperature being raised only to a relatively low temperature but high enough that the reaction



takes place. Thus, the method of claim 1 does not exclude the amount of nitrogen oxide released to the atmosphere being increased during the regeneration of the particulate filter.

Moreover, although it is appreciated that sulphate can be removed from the exhaust gas by the NO_x absorbent, there is no information in D1 that it is removed also by the reducing catalyst.

Consequently, the wording "without increasing the amounts of nitrogen oxide and sulfate released to the atmosphere" of the problem specified in the opposed patent, cannot be part of the problem derived objectively above.

5.3 Obviousness of the solution

- 5.3.1 D7 relates to particulate control systems for diesel engines and in particular to regeneration techniques in which the particulate accumulated in the filter is burnt to ensure a continuous removing activity of the filter (see for instance page 97, right column; fig. 1; page 100, left column, line 31-35 and pages 106-107). Thus, it relates to the same technical field and addresses in essence the same technical problem as the claimed invention.

Of these regeneration techniques, throttling, the application of external energy prior to the combustion chamber, or fuel injection in front of the particulate filter are presented for raising the exhaust gas temperature (see pages 106-107). The regeneration is initiated in dependency on the critical exhaust back pressure, ie after the end of the balance stage to ensure that the system works properly under dynamic conditions (see fig. 5 and the corresponding description on pages 99 and 100 and page 109, right column, item 5 from the top). Thus, D7 discloses the distinguishing feature of claim 1 with the same advantages as in the patent in suit.

Therefore, it is obvious to the person skilled in the art to apply the step of raising the exhaust gas temperature known from D7 to the method known from D1 with the effect that NO_2 is reacted with the collected carbon, thereby arriving at the solution claimed in claim 1.

- 5.3.2 The opposition division argued that the person skilled in the art could have chosen the claimed filter regeneration technique of increasing the exhaust gas temperature from the variety of particulate filter regeneration techniques disclosed in D7. However, since the opponent had not presented a conclusive argument why the skilled person would have chosen especially this filter regeneration technique, the claimed solution was not obvious.

The board does not share this view and is convinced that the person skilled in the art would have selected from the regeneration techniques presented on

pages 106-107 of D7 those regeneration techniques which provide a solution to the (objective) technical problem facing him, ie the techniques for raising the exhaust gas temperature. This view is also supported by the fact that the D7 regenerating techniques for raising the exhaust gas temperature work in the same way and provide the same advantages as the claimed regeneration technique.

Appellant 1 argued that the person skilled in the art would not combine the method of D1 with an active filter regeneration technique because page 2, lines 18-20 of D1 state that "Means may be provided to increase the temperature of the exhaust gas to above 300°C to facilitate combustion of the collected particulate but this creates other difficulties" and, according to the disclosure of D1, all of the carbon particles were burnt during normal operation of the diesel engine.

The board does not share these views. The sentence on page 2, lines 18-20 of D1 relates to a known solution for the problem of facilitating the combustion of the collected particulate and not to the system in which NO₂ gas functions to combust soot particulate on the filter at relatively low temperatures (see page 9, lines 22-25; page 3, lines 7, 8 and 24-27). Moreover, there is a need for regeneration of the particulate filter, because it is clearly stated on page 3, lines 45, 46 that carbon particles are accumulated on the filter, ie not all of them were burnt during normal operation of the diesel engine.

Appellant 1 also argued that none of the cited documents gives any indication why carbon particles are

accumulated in the filter. Only the inventors of the patent in suit have found that in the method of D1 the reaction (b) $\text{NO}_2 + \text{C} \rightarrow \text{NO} + \text{CO}$ is dominant over the reaction (c) $\text{NO}_2 + \text{C} \rightarrow \text{N}_2 + \text{CO}_2$ during normal operational conditions of the diesel engine and the amount of NO emitted from the combustion engine is too small at low temperatures to form sufficient NO_2 for burning all of the carbon particles in the filter.

However, this argument is not supported by the current wording of claim 1. Therefore, the board had no reason to deviate from its previous findings.

- 5.3.3 Therefore, the board comes to the conclusion that the subject-matter of claim 1 does not involve an inventive step (Article 56 EPC). Consequently, auxiliary request 3 is not allowable.

Auxiliary request 4

6. *Inventive step*

- 6.1.1 From the closest state of the art disclosed in D1, the subject-matter of claim 1 is distinguished in that

- (a) a step of removing, via either an absorbent or a reducing catalyst downstream of the filter, NO formed in the filter by the reaction between NO_2 and the collected carbon particles from the exhaust gas which has passed the filter, and

- (b) the exhaust gas temperature is intermittently raised when it is determined that a regeneration operation of the filter should be conducted.

These two distinguishing features actually provide two different technical effects so that two partial technical problems are established.

- 6.1.2 The partial technical problem derived from the first distinguishing feature is to provide a method for purifying the exhaust gas of a diesel engine with improved removal of NO formed in the filter by the reaction between NO₂ and the collected carbon particles from the exhaust gas.

The partial technical problem derived from the second distinguishing feature is to provide a method for purifying the exhaust gas of a diesel engine which is capable of easily and continuously removing the carbon particles collected by the particulate filter (see section 5.2.2).

Therefore, the person skilled in the art has to solve two technically independent partial problems separately starting from D1.

- 6.1.3 D2 discloses NO_x absorbents, D3 NO_x catalysts which are installed in the exhaust conduit of an internal combustion engine and work in a lean, ie oxidising atmosphere.

The standards for exhaust gas purification are ever more demanding, see eg D4 table 1 on page 3, and the D1 exhaust purification is unable to completely remove NO_x

from the exhaust gas, as can be seen from fig. 4. Thus, there is a strong incentive for the person skilled in the art to improve the exhaust gas purification and in particular its NO_x removal so that he would consult the documents D2 and D3 which refer to more specialized catalysts for NO_x removal.

In applying the teaching of these documents in the method of D1, it would be self-evident for him to position the catalysts in the exhaust conduit where they can remove the NO formed in the filter, ie downstream of the filter.

Therefore, it would be obvious to the person skilled in the art to use the catalysts known from D2 or D3 in the method known from D1, thereby arriving at the solution of claim 1 of the first partial technical problem.

Appellant 1 argued that from D2 or D3 the person skilled in the art would not know where to install the NO_x absorbent or reducing catalyst in the exhaust conduit. Even if he were to consider D2 or D3 for solving the problem underlying the patent in suit, he would arrive at a different solution because he would be prompted to install the NO_x absorbent or reducing catalyst between the engine and the oxidising catalyst.

The board does not share this view. It is evident that the person skilled in the art would install the NO_x absorbent or catalyst where it can work, ie where NO_x is present in a lean atmosphere, and where it does not exclude other functionalities of the exhaust gas purification. If the absorbent were installed between

the engine and the oxidising catalyst it would remove NO which is essential after having been oxidised to NO₂ for the reaction with the carbon particles. Thus, the removal of the carbon particles from the filter would be poorer. The person skilled in the art would therefore exclude this location of the NO_x absorbent or catalyst.

- 6.1.4 The distinguishing feature (b) relating to the removal of the accumulated carbon particulate is known from D7.

Therefore and for the same reasons as those set out above in section 5.3, it would be obvious to the person skilled in the art to apply this known feature to the method known from D1 and thereby to arrive at the solution of claim 1 for the second partial technical problem.

- 6.1.5 Accordingly, the subject-matter of claim 1 does not involve an inventive step. Consequently, also auxiliary request 4 is not allowable.

Auxiliary request 5

7. *Amendments*

- 7.1 Claims 1 and 5 are amended to specify that the exhaust gas is of a diesel engine and by the wording "by flowing the exhaust gas containing said NO₂ into the filter" in the features relating to the reaction of NO₂ in the exhaust gas with carbon particles. These amendments are supported in the application as filed by claim 1 and page 10, lines 4 and 5.

Further, the wordings "when it is determined that a regeneration operation of the filter should be conducted" and "wherein the air-fuel ratio of the exhaust gas is maintained at a lean air-fuel ratio when the exhaust gas temperature is raised, and the air-fuel ratio of the exhaust gas is periodically made rich even during the regeneration operation of the filter" are included, which are supported by page 21, line 10 - page 22, line 1 in connection with fig. 3; page 13, lines 21-23 and 29-32; and page 14, lines 32-36.

The amendments in claims 2 and 6 are supported by fig. 1 in conjunction with page 8, line 6ff, those in claims 3 and 7 by fig. 6 in conjunction with page 25, line 17ff and those of claims 4 and 8 by page 15, line 34 to page 16, line 21.

These amendments reduce the scope of protection.

7.2 Therefore, Articles 123(2) and (3) EPC are not contravened.

8. *Novelty*

No objection as to lack of novelty of the subject-matter of the claims of this auxiliary request was raised by appellant 2 and the board does not see any objection.

9. *Inventive step*

9.1 Closest state of the art and derivation of the technical problem

9.1.1 From the closest state of the art disclosed in D1, the subject-matter of claim 1 is distinguished in that the exhaust gas temperature is intermittently raised when it is determined that a regeneration operation of the filter should be conducted, wherein the air-fuel ratio of the exhaust gas is maintained at a lean air-fuel ratio when the exhaust gas temperature is raised, and the air-fuel ratio of the exhaust gas is periodically made rich even during the regeneration operation of the filter.

9.1.2 When the air-fuel ratio of the exhaust gas is maintained lean during the regeneration of the filter, any NO in the exhaust gas can be removed by the absorbent or the reducing catalyst as long as their storage capacity is not reached and exceeded.

In order to maintain their storage capacity, the absorbent and the reducing catalyst have to be regenerated more frequently than the particulate filter (see fig. 5 and paragraphs 0040 and 0073 of the patent in suit). Their periodical regeneration during the regeneration of the filter ensures that NO is continuously removed from the exhaust gas.

Based on this objective analysis of the effects achieved with the claimed subject-matter over the method of D1, the technical problem to be solved by the distinguishing feature of claim 1 is to provide a method for purifying the exhaust gas of a diesel engine which is capable of easily and continuously removing the carbon particles collected by the particulate filter without increasing the amounts of NO released to the atmosphere.

9.2 Non-obviousness of the solution

9.2.1 None of the cited documents discloses directly and unambiguously that the air-fuel ratio of the exhaust gas is maintained at a lean air-fuel ratio when the exhaust gas temperature is raised for the regeneration of the particulate filter.

Paragraph 0021 of D17' describes the regeneration of the particulate filter in which a high quantity of air flows into the filter. However this lean air-fuel ratio is then made rich by supplying fuel so that the particulate is ignited and the particulate filter is regenerated.

Moreover, it is known, eg from D7 and D17', to initiate the regeneration of the particulate filter by fuel supply. However, it is not known from these documents that the air-fuel ratio of the exhaust gas is periodically, ie occurring at regular intervals, made rich even during the regeneration operation of the filter.

The person skilled in the art thus had no incentive to combine the teaching of any of these documents with the method known from D1. Nevertheless, even if he had combined them, he would not have arrived at the solution described in claims 1 and 5 without inventive activity.

In this respect, appellant 2 referred particularly to D2, D3 and D17' and argued: "To combine the DPF regeneration (lean) with NO_x absorbent regeneration

(rich), the skilled engineer would use the general teaching of D17 to reprogram the engine control unit" of D1.

The board does not share this view. D2 and D3 relate to NO_x- but not to particulate removal and the stated general teaching cannot be derived from D17'. Therefore there is no information to reprogram the engine control unit so that the air-fuel ratio of the exhaust gas is periodically made rich even during the regeneration operation of the filter.

9.2.2 These considerations also apply to the subject-matter of claim 5.

10. Therefore the board comes to the conclusion that the subject-matter of claims 1 and 5 is new and involves an inventive step. Consequently, auxiliary request 5 is allowable.

11. *Remittal*

It should be noted that the board considered the one-part form of claims 1 and 5 as acceptable having regard to Rule 29(1) EPC. Nevertheless, the description has to be adapted to meet the requirements of Rule 27 EPC and should set out which features of these claims are part of the state of the art (see also Guidelines for Examination in the European Patent Office, 2003, C-III, 2.3b, sentences 2 and 3).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside

2. The case is remitted to the first instance with the order to maintain the patent with claims 1-8 according to the fifth auxiliary request as filed with letter of 8 March 2005, the drawings as granted and the description to be adapted.

The Registrar:

The Chairman:

G. Magouliotis

M. Ceyte