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D E C I S I O N
of 21 February 1995

Case Number: T 0422/92 - 3.4.2
Application Number: 87306035.4
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Language of the proceedings: EN

Title of invention:

A process for removal of mercury vapor and/or vapor of noxious organic compounds and/or nitrogen oxides from flue gas from an incinerator plant

Patentee:

NIRO A/S

Opponent:

- (01) BABCOCK-BSH AG
(02) Von Roll AG

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

- "Novelty (main request - yes)"
"Inventive step (main request - yes)"

Decisions cited:

T 0153/85

Catchword:



Case Number: T 0422/92 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 21 February 1995

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Decision under appeal: Decision of the Opposition Division of the
European Patent Office dated 27 February 1992,
posted on 11 March 1992, revoking European patent
No. 0 253 563 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: R. Zottmann
M. Lewenton

Summary of Facts and Submissions

I. The Appellant (Proprietor of the patent) lodged an appeal against the decision of the Opposition Division revoking the patent No. 0 253 563 (application No. 87 306 035.4).

A first opposition was filed against the patent as a whole and based on Article 100(a) EPC in conjunction with Articles 52(1), 54 and 56 EPC. A second opposition was also filed against the patent as a whole and based on Article 100(a) EPC in conjunction with Articles 52(1) and 56 EPC.

The Opposition Division held that the grounds for opposition mentioned in Article 100(a) EPC prejudiced the maintenance of the patent, having regard inter alia to following documents:

- D1: 76th Annual Meeting of the Air Pollution Control Association, Atlanta, Georgia, 19-24 June, 1983, A.J. Teller et al.: "Control of Dioxin Emissions from Incineration", pages 1 to 16,
- D2: US-A-4 319 890,
- D3: US-A-4 293 524,
- D4: US-A-4 061 476,
- D5: WO-A-85/03455,
- D6: DE-A-2 907 177,
- D7: Müll und Abfall, 2/1986, H. Braun et al.: "Zur Problematik der Quecksilber-Abscheidung aus Rauchgasen von Müllverbrennungsanlagen", 1. Teil, pages 62 to 71,
- D8: DE-A-3 235 020,
- D9: K.J. Thomé-Kozmiensky (Hrsg.): "Müllverbrennung und Umwelt", EF-Verlag für Energie- und Umwelttechnik GmbH, 1985, pages 181 to 199,

- D10: Meyers Lexikon der Technik und der exakten Naturwissenschaften, Bibliographisches Institut, Mannheim, 1969, Erster Band A-E, page 85,
- D11: Ullmans Encyklopädie der technischen Chemie, 4. Auflage, Verlag Chemie, Weinheim/Bergstr., 1972, Band 2, Verfahrenstechnik I (Grundoperationen), page 603,
- D12: EP-A-0 001 456,
- D13: G.T. Austin, Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill Book Company, 1984, pages 136 and 137,
- D14: US-A-4 273 747.

II. The Appellant requested that the decision under appeal be set aside and the patent be maintained with the documents according to a main request or, alternatively, four auxiliary requests (see the letter of 18 January 1995, pages 8 and 9).

The documents according to the **main request** are as follows:

- **claims:**
Nos.: 1 to 9 received with letter of 29 June 1992,
- **description:**
pages: 2 to 10 of the patent specification,
- **drawings:**
figures: 1 and 2 of the patent specification.

III. Both the Respondent I (Opponent I) and the Respondent II (Opponent II) requested that the appeal be dismissed.

IV. The wording of Claim 1 according to the Appellant's main request reads as follows:

"A process for removal of mercury vapor and/or vapor of noxious organic compounds and/or nitrogen oxides from a stream of hot flue gas exhausted from an incinerator plant and possibly containing fly ash, combined with a simultaneous removal of acidic components of the flue gas, by passing said stream at a temperature of 135-400°C into a spray absorption chamber wherein an aqueous liquid containing a basic absorbent is atomized to cool the flue gas at a temperature between 180°C and 90°C and to absorb acidic components from the flue gas, and simultaneously to evaporate the water in said aqueous liquid, thereby forming a particulate material containing reaction products of the basic absorbent with acidic components of the flue gas, and non-reacted absorbent, which particulate material together with the fly ash, if any, is separated from the flue gas in a particle separator selected from an electrostatic precipitator and a bag filter downstream of the spray absorption chamber, comprising injecting powdery activated carbon having a particle size permitting passage of at least 40% by weight thereof through a sieve having 44 µm apertures by wet sieving and which by microscopic examination is at average a few µm or less, in an amount of 1-800 mg per Nm³ flue gas into the stream of flue gas at at least one location selected from locations upstream of the spray absorption chamber, locations within the spray absorption chamber and locations downstream the spray absorption chamber but upstream of the particle separator, and separating said powdery carbon in the particle separator together with said particulate material."

Claims 2 to 9 according to the Appellant's main request depend on Claim 1.

V. The Appellant essentially argued as follows:

The invention is based on the recognition that by combining a spray absorption process with the injection of a given quantity of powdery activated carbon a very efficient cleaning of incinerator flue gases may be obtained and, simultaneously, the difficulties of recovering the powdery carbon from the cleaned flue gases are avoided. The process according to Claim 1 thus comprises the injection of powdery carbon into the flue gases, which is then recovered together with the reaction products from the spray absorption step. This process is new and is not rendered obvious by any of the cited prior art documents, either taken alone or in combination.

In particular, D1 and D2 disclose a process in which the essential feature is the capture of small pollutants particles by bigger target particles introduced into the flue gas. By inelastic impact capture the target particles grow. On the contrary, the carbon particles injected according to the present invention do not act as targets and do not grow at all.

D4 discloses a process for removing noxious substances, in particular NO_x , from exhaust gases by injecting a pulverulent sorption agent into the gases. Although powdery carbon is mentioned as possible absorbent, there is no teaching that the carbon is suitable for removal of NO_x .

D5 refers to a process for removing pollutants like NO_x and heavy metals from flue gases, based on the injection of fly ashes alone or mixed with additives. Activated carbon is used in a fixed bed through which the gases pass after a large portion of the noxious substances has been removed.

D6 discloses a process for removal of sulphur oxides and fly ashes from waste gases which pass through a quench reactor and a particle separator. Although this document mentions the possibility of recovering fly ash and reaction products by means of the separator, there is no indication that the presence of reaction products should facilitate the removal of fly ash.

D7 concerns the removal of mercury from exhaust gases. The relevant teaching is that for an industrial removal of mercury it is essential that the gases are cooled below 150°C and fly ash is present. Activated carbon is also mentioned. However, the possibility of using it apparently does not come into consideration in an industrial process.

VI. The Respondent I's argumentation with respect to Claim 1 of the main request is summarized as follows:

D6, considered as the closest prior art, refers to a process for removal of sulphur oxides and fly ashes from waste gases, according to which the gases interact in a quench reactor with a basic solution and are cooled down, a particulate sulphite and sulphate reaction material being thereby formed, which is removed in a particle separator, in particular a baghouse or an electrostatic precipitator, downstream of the quench reactor.

Starting from this known process, the problem to be solved consists in removing mercury, noxious organic compounds and nitrogen oxides. From D7 it is known that fly ash together with a temperature reduction or, even better, activated carbon at any temperature are useful in removing mercury. Furthermore, D5 teaches to add fly ash alone or mixed with additives to remove NO_x and heavy metals. It is thus obvious for the skilled person starting from the process of D6 to inject activated carbon into the gas upstream of the particle separator in order to remove pollutants like mercury, noxious organic compounds and nitrogen oxides. As to the size of the carbon particles to be injected, it is known that the degree of removal of pollutants increases with decreasing size of the particles. Anyhow, a hint at sizes of a few μm is given by D6. With regard to the injected amount, it can easily be determined with experiments or inferred from D6.

Therefore, the process according to Claim 1 of the main request lacks inventive step with regard to D6 combined with D7 and D5.

VII. The Respondent II's argumentation concerning Claim 1 of the main request is summarized as follows:

D1, considered with D2 and D3 incorporated by reference in D1, discloses a process comprising all the features of the process according to Claim 1 of the main request except that activated carbon in an amount of 1 to 800 mg per Nm^3 is injected into the flue gas, possibly at a location upstream of the spray absorption chamber. Considering that the target particles according to D2 have a roughened surface and in view of the fact that gaseous substances must be adsorbed and fine particles bound to bigger target

particles, it is obvious to use activated carbon. Concerning the size of the carbon particles, a hint at the claimed values is given by D2. As to the amount to be injected, it can easily be determined experimentally. Therefore, the process according to Claim 1 of the main request lacks inventive step with regard to D1 incorporating D2 and D3.

The same conclusion can be drawn with regard to the combination of D1 (incorporating D2 and D3) with D4. Indeed, D4 discloses that powdery carbon is suitable both for adsorbing gaseous substances and for absorbing solid pollutants in a gas stream.

The removal of mercury according to the claimed process is, moreover, rendered obvious by the combination of D1 (incorporating D2 and D3) with D7. In fact, according to D7, a complete removal of mercury can be achieved at any temperature by the use of activated carbon.

Reasons for the Decision

- 1. The appeal is admissible.

- 2. *Main request*
 - 2.1 Amendments
 - 2.1.1 The features which, according to the present Claim 1, have been introduced into the original Claim 1, are disclosed in the application as filed; in particular:

- the feature that the particle separator is selected from an electrostatic precipitator and a bag filter, is disclosed in the original Claims 3 and 5,
- the feature that the powdery activated carbon has a particle size permitting passage of at least 40% by weight thereof through a sieve having 44 μm apertures by wet sieving and which by microscopic examination is at average a few μm or less, is disclosed in the original Claim 7.

2.1.2 Dependent Claims 2 to 9 correspond to the original Claims 2 to 6 and 8 to 10.

2.1.3 As compared with Claim 1 as granted, in the present Claim 1 the particle separator has been defined as well as the particle size of the powdery activated carbon. Thus, the amendments did not result in an extension of the scope of protection.

2.1.4 Therefore, the amended version of the claims according to the Appellant's main request, on the basis of which the Appellant requests that the patent be maintained, does not contravene the requirements of Article 123(2) and (3) EPC.

2.2 Clarity

The claims are clear and supported by the description (Article 84 EPC).

2.3 Novelty

2.3.1 D1 discloses a process for removal of vapour of noxious organic compounds, in particular PCDD and PCDF (see page 2), from an incinerator flue gas, based on (see page 8 and Figure 3)

- a quench reactor having the upflow design according to D3, in which reactor the flue gas at 230°C interacts with a basic solution and is cooled down to a temperature of 125°C, a particulate material being thereby formed,
- an injection apparatus, i.e. the dry venturi according to D2, downstream of the quench reactor, in which apparatus target particles injected into the flue gas stream capture the fine contaminating particulate material formed in the quench reactor, and
- a particle separator, in particular a baghouse, downstream of the injection apparatus.

The problem of the incorporation by reference of the disclosures of D2 and D3 in D1 should be seen in the light of the decision T 0153/85 (OJ EPO 1988, 1 - see point 4.2 of the Reasons). According to it, "... , where there is a specific reference in one prior document (the "primary document") to a second prior document, when construing the primary document (i.e. determining its meaning to the skilled man) the presence of such specific reference may necessitate that part or all of the disclosure of the second document be considered as part of the disclosure of the primary document." In that case, it was specified in a primary document that copolymers having given repeat units may be conveniently prepared by using the

method of preparing certain polymers described in a second document. On the basis of this referral it was concluded that the method of preparation described in the second document - nothing else - had been incorporated by reference into the disclosure of the primary document.

In the present case, it is specified in D1 (see page 8) that "... the incinerator flue gas at 230°C enters the quench reactor where neutralization by slurry or solution occurs simultaneous with reduction in temperature to 125°C. As a result of the upflow design (18), a dry product is formed. The gas then proceeds to the dry venturi (16) where the fine particles are captured by imposed targets continuously fed to the system where the temperature is reduced to 100-110°C." It thus appears that **only** following parts of the disclosures of D2 (see reference (16) in D1) and D3 (see reference (18) in D1) should be considered as part of the disclosure of D1:

- the design of the injection apparatus according to the various embodiments represented in Figures 2 to 9 (see also Figure 1) of D2 and
- the upflow design of the quench reactor of D3 as described in column 6, line 53 to column 7, line 28 and represented in Figures 1 to 3.

Other features of D2, for example the cyclone separator mentioned in column 4, line 4, and D3, for example the basic substances mentioned in column 5, lines 21 to 27, should not be regarded as incorporated into D1.

In view of the foregoing, D1 does not disclose the injection of powdery activated carbon having the particle size and in the amount according to the present Claim 1. Neither are these features disclosed in the parts of the disclosures of D2 and D3 incorporated by reference into D1 (see above).

- 2.3.2 D2 (see column 3, line 65, to column 4, line 43, Claim 1, Figure 1) discloses a method similar to that known from D1 and is, in particular, concerned with the conditions for providing that the contaminating particles impact with and are captured on the injected target particles.

According to column 4, lines 38 to 42, the injected target particles "can comprise any suitable solid and should have an average particle size of at least about 3 microns, ...". Particulate nepheline syenite or phonolite is preferred (see column 4, lines 42 and 43).

Accordingly, D2 does not disclose or give any hint to the use of powdery carbon in the amount mentioned in the present Claim 1.

- 2.3.3 D3 (see Figure 3) refers to a method similar to that disclosed in D2 or D1. It is, in particular, concerned with the upflow design of the quench reactor (see Figure 1).

The injection of particulate nepheline syenite or phonolite is envisaged (see column 7, lines 50 and 51) so that also D3 does not disclose the use of powdery carbon in the amount mentioned in the present Claim 1.

2.3.4 D4 discloses a method for removing noxious substances, in particular nitrogen oxides NO_x , from flue gases, thereby achieving a very high degree of purification (see column 2, lines 7 to 11, column 3, line 43 to column 4, line 40). A pulverulent sorption agent, which reacts with or adsorbs one or more of the noxious components, is injected into and brought into intimate contact with the flue gas subjected to intense turbulence (see column 2, lines 28 to 39). Thereafter, the sorption agent is separated from the gas by means of, for example, a tissue filter (see column 6, lines 19 to 25, column 7, lines 20 and 21). As sorption agents are envisaged, among other materials, powdery filtering charcoal or powdery carbon (see column 4, lines 58 to 62, and Claim 6). The grain size of the absorbents is of less than $100 \mu\text{m}$, preferably less than $50 \mu\text{m}$ (see column 4, lines 65 and 66).

According to column 10, lines 52 to 60, contaminated gas compositions as well as the particular pulverulent sorption agents to be used for the specific contaminants and noxious components are known. However, in D4 it is not stated explicitly, for which pollutants charcoal or carbon could come into consideration.

Accordingly, D4 (see Claim 1) does not teach any spray absorption step, in which the flue gas containing the noxious substances interacts with a basic solution with formation of a particulate material. Moreover, it does not disclose the injected amount of carbon, i.e. 1 to 800 mg per Nm^3 flue gas, mentioned in the present Claim 1.

2.3.5 D5 (see page 1, lines 1 to 6, Claim 1, Figures) discloses a process for removing pollutants like SO₂, NO_x, fluorine and chlorine compounds, and heavy metals from flue gases. According to a first step (see page 3, lines 2 to 11), fly ash either alone or mixed with additives like lime, magnesium oxide and/or limestone is added to the flue gases at given temperature conditions. In a second step (see page 4, lines 10 to 24), the fly ash and the additives, if present, are removed by means of a conventional filter. A third step (see page 5, lines 3 to 15) consists in that the flue gas after addition of a reducing gas like ammonia goes through a bed of activated carbon.

Accordingly, D5 does not disclose the injection of powdered carbon having the particle size and in the amount according to the present Claim 1.

2.3.6 D6 discloses a process for removal of sulphur oxides and solid particles, in particular fly ash, from waste gases, based on (see Figure with the corresponding part of the description on pages 25 to 27, Claims 1, 6, page 24, lines 1 to 3)

- a quench reactor, in which the flue gas at at least 100°C, in particular 100 to 230°C, interacts with a basic solution and is cooled down to a temperature of 65 to 135°C, a particulate sulphite and sulphate reaction material being thereby formed, and
- a particle separator, in particular a baghouse or an electrostatic precipitator, downstream of the injection apparatus.

D6 does not refer to pollutants like mercury vapour, vapour of noxious organic compounds and nitrogen oxides. Neither does it disclose the step of injecting powdery activated carbon having the particle size and in the amount according to the present Claim 1.

- 2.3.7 D7 is concerned with the removal of mercury from flue gases exhausted from an incinerator plant. According to it (see pages 70 and 71, "Zusammenfassung der wichtigsten Ergebnisse"), mercury is present in the flue gases as HgCl_2 . Fly ash present in the flue gas acts as agent adsorbing the chloride, provided the temperature is lower than a given value. In particular, for an efficient removal of mercury by a dry sorption method it is essential that the gas temperature is reduced to a value lower than 150°C and fly ash is present, which acts as reaction partner. The separation of the mercury adsorbing fly ash is achieved by a bag filter.

A complete adsorption of mercury, on the contrary, can be achieved at any temperature with activated carbon (see page 69).

Accordingly, D7 does not disclose a process according to the present Claim 1 comprising, in particular, the injection of powdery activated carbon having the mentioned particle size and in the mentioned amount.

- 2.3.8 The other documents cited do not come closer to the claimed subject-matter.
- 2.3.9 Therefore, in view of the foregoing, the subject-matter of Claim 1 submitted as the Appellant's main request is novel within the meaning of Article 54 EPC.

2.4 Inventive step

2.4.1 Claim 1 according to the main request refers to a process for removal of mercury vapour **and/or** vapour of noxious organic compounds **and/or** nitrogen oxides from a stream of hot flue gas exhausted from an incinerator plant. The presence of the conjunctions "and/or" means that the process is not necessarily intended for removal of all three kinds of pollutants at the same time (but which is suitable for such a removal).

Furthermore, the flue gas **possibly** contains fly ash. It follows that fly ash must not necessarily be present.

Moreover, in the claimed process a particle separator is used, which is **selected from** an electrostatic precipitator and a bag filter. This means that an electrostatic precipitator or, alternatively, a bag filter could be used.

2.4.2 The process according to Claim 1 is regarded by the Respondents I and II as lacking inventive step having regard to following prior art documents:

- (i) as to the removal of vapour of noxious organic compounds, **D1** incorporating the disclosures of **D2** and **D3** owing to the citations on page 8 of the references (16) and (18) corresponding to said documents D2 and D3, respectively (see Respondent II's letter of 16 November 1992, page 7, third paragraph, in connection with page 6, third paragraph, and page 10, last paragraph),

- (ii) alternatively to case (i), the combination of **D1**, incorporating the disclosures of **D2** and **D3**, and **D4** (see Respondent II's letter of 16 November 1992, page 7, third paragraph, in connection with page 6, fourth paragraph, and page 10, last paragraph),
- (iii) as to the removal of mercury vapour, the combination of **D1**, incorporating the disclosures of **D2** and **D3**, and **D7** (see Respondent II's letter of 16 November 1992, page 10, last paragraph),
- (iv) the combination of **D6**, considered as the closest prior art, with **D7** and **D5** (see Respondent I's letter of 25 January 1993, paragraph II).

2.4.2.1 Case (i)

D1 refers to a process for removal of vapour of noxious organic compounds from an incinerator flue gas, comprising passing the flue gas through a quench reactor in which it interacts with a basic solution and is cooled down, a particulate material being thereby formed, injecting target particles into the flue gas downstream of the quench reactor, and separating the particles in a separator, in particular a baghouse, downstream of the injection apparatus.

The essential feature of this process consists in the fact that the fine particles formed by the spray absorption in the quench reactor with the upflow design disclosed in D3 (incorporated by reference in D1 - see section 2.3.1 above) are captured by target particles continuously fed to the system. The injection apparatus (dry venturi) according to D2

(also incorporated by reference in D1 - see the said section 2.3.1) is such that an inelastic impact capture takes place (see D2, column 4, lines 44 to 56). The grown particles obtained are then collected in a baghouse.

According to D2 (see column 4, lines 38 to 43), target particulates can comprise any suitable solid and should have an average particle size of at least about 3 μm , preferably 3 to 50 μm , more preferably 3 to 20 μm and most preferably 10 to 20 μm . Particulate nepheline syenite or phonolite is preferred.

The cleaning mechanism underlying the process of Claim 1 is quite different. In the spray absorption chamber an aqueous liquid containing a basic absorbent is atomized to cool the flue gas, to absorb acidic components from the flue gas and simultaneously to evaporate the water in the said aqueous liquid, a particulate material being thereby formed, which contains reaction products of the basic absorbent with the acidic components of the flue gas and non-reacted absorbent. Powdery activated carbon, is, moreover, injected into the flue gas at a given location, in a given amount. The size of the carbon is at average a few μm or less; in particular, according to Example 1, microscopic examination indicates that most particles have a diameter of 1 μm or less. Said powdery carbon, onto which mercury and/or noxious organic compounds have been adsorbed (see the original application, page 7, lines 6 and 7), is then separated in the particle separator together with the said particulate material.

The present invention teaches (see the original application, page 7, line 9, to page 9, line 19) that the use of pulverized activated carbon, although

involving advantages over the use of coarse carbon due to the higher adsorption capacity and the lower price, was not regarded in the prior art as suitable because of the difficulties deriving from the separation of the fine carbon particles in mechanical or electrostatic separators. However, the presence of the particulate material formed by the spray absorption facilitates the recovery of the powdery activated carbon from the gas stream both by using a mechanical filter and an electrostatic precipitator. This fact is confirmed by Mr W.A. Brown III in point 6 of his declaration of 11 April 1989, filed with Appellant's letter of 22 May 1991, stating that "... the fine particles of activated carbon may be recovered efficiently from a gas stream in one single step using either an electrostatic precipitator or a baghouse filter, **provided that** (underline added) said gas stream also comprises the entrained powdery reaction product from a spray drying absorption flue gas cleaning process."

It thus appears that, according to the claimed process, the powdery activated carbon is not used as target particulate with the aim of capturing the fine particles formed by the spray absorption in the quench reactor. The purification effect of the carbon consists in the adsorption of mercury and/or noxious organic compounds, as mentioned above, rather than in the capture of pollutants in the form of fine particles. The size of the carbon particles is thus smaller than that of the target particles known from D2.

D1, therefore, considered as comprising the relevant parts of the disclosures of D2 and D3 incorporated by reference in D1 (see section 2.3.1 above), does not give any hint at the solution of injecting powdery

activated carbon into the flue gas, whereby, on the one hand, the said carbon increases the efficiency with which pollutants are removed and, on the other hand, the presence of the particulate material formed by the spray absorption facilitates the recovery of the carbon in spite of its powdery form. Indeed, D1 teaches the quite different solution of injecting target particles for capturing the pollutant particles formed in the spray absorption step.

D1, moreover, does not mention carbon as possible material for the said target particles. In this respect, a known property of activated carbon (within the meaning given to this expression in the patent in suit - see page 4, lines 47 to 55) is its ability of cleaning contaminated gases and liquids by adsorbing pollutants like noxious organic substances, in particular PAH, PCB, PCDF and PCDD (see D9, paragraphs 2.1 and 2.2; D10, page 85, "Aktivkohle"; D11, page 603, "Oberflächeneigenschaften"), mercury vapour (see D7, page 69, last paragraph of left column; D12, Claim 1) and nitrogen oxides NO_x (see D4, column 2, lines 7 to 11, column 3, line 43 to column 4, line 40, column 4, lines 58 to 62). Another known property of activated carbon consists in that its grain size distribution affects the filtration properties, in particular the pressure drop through a bed (usually a granular form is used for purification of gases and vapours, whereas powdered material is preferred in case of liquids - see D13, page 136, end of first paragraph). However, assuming that activated carbon is used as material for the target particles and keeping in mind that the essential function of such hypothetical carbon particles to be injected in the flue gas according to the process of D1 would be to act as targets for the pollutant particles formed in the quench reactor, the properties mentioned above,

although advantageous, do not appear to be so relevant as, for instance, the size of the particles. Therefore, it appears that the skilled person does not have any reason to consider activated carbon as a material more suitable or advantageous than those indicated in D2 with regard to the application for target particles.

2.4.2.2 Case (ii)

The combination of D4 and D1 (incorporating D2 and D3 by reference) in the sense that powdery carbon, which is injected in the flue gas as sorption agent according to a step of the process known from D4, should be used as the target particulate foreseen in D1, is not justified because the processes according to D4 and D1 are of a quite different kind. Indeed, as mentioned in section 2.3.4 above, D4, contrary to D1, does not teach any spray absorption step, in which the flue gas containing the noxious substances interacts with a basic solution with formation of a particulate material. The carbon particles in D4 have the function of adsorbing pollutants present in the flue gas (as in the patent in suit with regard to mercury and/or noxious organic compounds), not of capturing by inelastic impact fine particles, which deriving from the spray absorption step cannot be present due to the absence of a quench reactor. Thus, the replacement of the particulate nepheline syenite or phonolite, envisaged in D2 as materials suitable for the target particles, with the powdery carbon mentioned in D4, does not appear to lead to the claimed process for the same reasons mentioned in section 2.4.2.1 above.

2.4.2.3 Case (iii)

D7 deals with the removal of mercury from flue gases exhausted from an incinerator plant. According to this document (see page 66, section 3, first three paragraphs), pollutants are removed from flue gases by bringing the gases into contact with lime either in a dry reactor or in a spray absorption reactor in connection with an electrostatic precipitator or a bag filter. As far as mercury is concerned, it appears that the temperature plays a role. The presence of fly ash, which interacts with mercury, combined with a reduction of the temperature of the flue gas leads to better results both in dry systems and in spray absorption systems. In particular, the gas temperature should be reduced to a value lower than 150°C, preferably lower than 120°C (see paragraph bridging pages 68 and 69 in conjunction with point 3 of section 4 on pages 70 and 71). On the contrary, a one-hundred-percent adsorption of mercury is achieved by using activated carbon at any temperature. Lime or calcium chloride are useful, if at all, at temperatures below 100°C (see paragraph bridging pages 69 and 70).

It thus appears that D7 teaches that the combination of two features, i.e. the presence of fly ash and the temperature reduction, is essential for an efficient removal of mercury. The use of activated carbon is only mentioned as an alternative which, however, is not discussed in detail.

In view of the foregoing, the combination of D1 (incorporating D2 and D3 by reference) and D7 could not lead to the process of the present Claim 1. Indeed, the process according to D1, even though carbon would be used as material for the target

particles, would basically differ from the claimed one for the reasons mentioned in section 2.4.2.1 above.

2.4.2.4 Case (iv)

D6 discloses a process for removal of sulphur oxides and fly ash from waste gases, comprising a first step of passing the gases into a quench reactor, in which the flue gas interacts with a basic solution and is cooled down to a temperature of 65 to 135 °C, a particulate sulphite and sulphate reaction material being thereby formed, and a second step of removing the particulate in a particle separator, in particular a baghouse or an electrostatic precipitator, downstream of the injection apparatus.

D6 does not refer to pollutants like mercury vapour, vapour of noxious organic compounds or nitrogen oxides. Starting from this known process, the skilled man will try to improve it so as to remove also mercury, noxious organic compounds and/or nitrogen oxides.

According to D7, the reduction of the gas temperature to a value lower than 150°C and the presence of fly ash are essential conditions for the removal of mercury. The process of D6, by which these conditions are met, should thus be suitable for removing mercury. Although D7 also mentions the fact that carbon can be used for the purpose of mercury removal at any temperature, the skilled man does not have any reason to apply this alternative solution to the process of D6 because, as already stated, the known process already meets the requirements presented in D7 as essential for mercury removal. Moreover, D7 does not give any detail concerning the said alternative solution, in particular how the carbon should be used.

Therefore, the combination of D6 with D7 does not lead to the process according to the present Claim 1 in the sense that either it leads to the conclusion that the steps of the process according to D6 already remove mercury, or simply suggests to make use of carbon in the process known from D6, the details concerning how the carbon should be used remaining, however, undefined.

The further combination of D6 and D7 with D5 cannot lead to the claimed process a fortiori. Should carbon be used in the process of D6, D5 does not appear to suggest the further features which would be necessary for arriving at the process of Claim 1 starting from the combination of D6 and D7. D5 discloses a process for removing pollutants like SO₂, NO_x, fluorine and chlorine compounds, and heavy metals from flue gases. According to a step of this process, after removal of fly ash and additives added to the gas and addition of a reducing gas like ammonia the flue gas goes through a bed of activated carbon. Therefore, concerning the use of carbon, D5 teaches a solution which is substantially different from that of injecting powdery activated carbon according to Claim 1 having the claimed particle size, in the claimed amount.

2.4.2.5 Therefore, having regard to the foregoing, the subject-matter of Claim 1 according to the main request involves an inventive step in the sense of Article 56 EPC.

Claim 1 and also the dependent Claims 2 to 9, which refer to particular embodiments of the invention as defined in Claim 1, are thus allowable.

2.5 Since the patent and the invention to which it relates meet the requirement of the Convention, the patent can be maintained as amended on the basis of the Claims 1 to 9 according to the main request (Article 102(3) EPC). The description and drawings need to be correspondingly adapted. For this reason, the Board remits the case to the department of the first instance responsible for the decision appealed (Article 111(1) EPC, second sentence, second case).

3. *Auxiliary requests*

Considering that the main request is allowable, the subsidiary requests need not be discussed.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of the first instance with the order to maintain the patent with the Claims 1 to 9, received with letter of 29 June 1992, according to the main request and a description and drawings to be adapted.

The Registrar:

The Chairman:

P. Martorana

E. Turrini