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(54) FILTER FOR CIGARETTE AND CIGARETTE HAVING SAME

(57) A cigarette filter includes a cigarette filter material to which 2-phenyl-4,4,5,5-tetramethylimidazoline-3-oxide-1-oxyl is added.

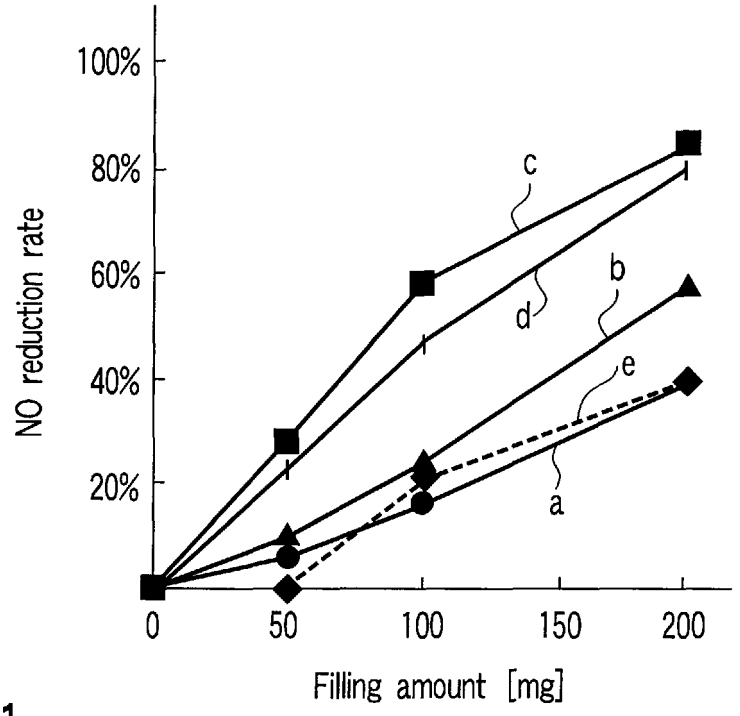

FIG. 1

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Description

Technical Field

[0001] The present invention relates to a cigarette filter and a cigarette provided with the same, and more specifically, to a cigarette filter excellent in efficiency of removing nitrogen oxides (NOx) in the mainstream smoke and a cigarette provided with the same.

Background Art

[0002] Nowadays, various requirements are imposed on cigarettes, one of which is to decrease the amount of NOx in the mainstream smoke of cigarettes (Jpn. Pat. Appln. KOKAI Publication No. 2002-119270). Jpn. Pat. Appln. KOKAI Publication No. 2002-119270 discloses a tobacco filter in which a procyanidin is incorporated in filaments that form the filter.

[0003] However, it has been found that the conventional tobacco filters are not capable of removing NOx from the mainstream smoke to a satisfactory degree.

Disclosure of Invention

[0004] Thus, it is an object of the present invention to provide a cigarette filter that can efficiently remove nitrogen oxides from the tobacco mainstream smoke, and a cigarette provided with such filter.

[0005] According to the present invention, there is provided a cigarette filter comprising a cigarette filter material to which 2-phenyl-4,4,5,5-tetramethylimidazoline-3-oxide-1-oxyl is added.

[0006] Further, according to the present invention, there is provided a cigarette provided with a cigarette filter according to the present invention.

Brief Description of Drawings

[0007]

FIG. 1 is a graph showing the reduction rate of NO in the mainstream smoke of cigarettes manufactured in Example 1, which will be described later in detail, together with that of a comparative example;

FIG. 2 is a graph showing the reduction rate of NO in the mainstream smoke of cigarettes manufactured in Example 2, which will be described later in detail, together with that of a comparative example;

FIG. 3 is a graph showing the reduction rate of NO in the mainstream smoke of cigarettes manufactured in Example 3, which will be described later in detail, together with that of a comparative example; and

FIG. 4 is a graph showing the reduction rate of NO in the mainstream smoke of cigarettes manufactured in Example 4, which will be described later in detail, together with that of a comparative example.

Best Mode for Carrying Out the Invention

[0008] The present invention will be described in more detail below.

[0009] A cigarette filter according to the present invention comprises a cigarette filter material to which 2-phenyl- 4,4,5,5- tetramethylimidazoline- 3- oxide- 1- oxyl (PTIO) is added.

[0010] In the cigarette filter of the present invention, PTIO, an effective ingredient for removing nitrogen oxides, is a compound known per se (see, for example, Jpn. Pat. Appln. KOKAI Publication No. 9-43153).

[0011] In the cigarette filter of the present invention, use may be made, as the filter material, of cellulose acetate fiber tow, filter paper and porous particulate carrier such as activated carbon. In the case where cellulose acetate fiber tow is used as the filter material, PTIO can be added by spraying PTIO onto the fiber tow. When filter paper is used, PTIO can be impregnated into the filter paper. The filter material thus obtained can be wrapped with a wrapper by an ordinary method, and connected to an end of a cigarette.

[0012] In the case where a porous particulate carrier such as activated carbon is used as the filter material, PTIO is impregnated in the porous particulate carrier, and then the thus obtained PTIO-carrying particles are filled in a cavity as is known in the art or added to a tow. More specifically as to the cavity filling, a plain filter is provided to either end of a filter wrapper paper pipe. The PTIO-carrying particles are filled in the cavity between these plain filters. On the other hand, the addition to the tow is carried out by a method similar to that used for charcoal filters of commercially available cigarettes, that is, the PTIO-carrying particles are dispersed between the fibers of the acetate filter.

[0013] PTIO is added preferably in an amount of 3 to 10 parts by weight, particularly preferably, 5 to 7 parts by weight based on 100 parts by weight of the filter material. PTIO significantly reduces the amount of NO and NOx contained in the cigarette mainstream smoke even under wet conditions, which are equivalent to the actual smoking conditions.

[0014] The present invention will be described by way of Examples, but the present invention should not be limited to the Examples.

Example 1

<Preparation of PTIO-impregnated activated carbon>

[0015] 10 mg, 30 mg, 50 mg and 100 mg of PTIO (available from Wako Pure Chemical Industries, Ltd.; CAS: 18390-00-6) were completely dissolved in 2490 mg, 2470 mg, 2450 mg and 2400 mg of ethanol, respectively, thus preparing PTIO ethanol solutions having a concentration of 0.4% by weight, 1.2% by weight, 2% by weight and 4% by weight, respectively. To each of the ethanol solutions, 1g of coconut shell activated carbon (available from

Japan Envirochemicals Ltd; a specific surface area: about 1200 m^2/g), which was dried in advance by heating at 200°C in vacuo, was added, and stirred for 60 minutes using a test tube mixer. Thereafter, the solvent ethanol was removed in a water bath of 50°C while blowing nitrogen gas into the solution, and then the resultant material was dried by heating at 120°C in vacuo. Thus, PTIO-impregnated activated carbon was obtained. It was measured that the PTIO-impregnated activated carbon obtained using the ethanol solution having a PTIO concentration of 0.4% by weight was impregnated with PTIO in an amount corresponding to 1% of the weight of activated carbon (PTIO-impregnated activated carbon I), the PTIO-impregnated activated carbon obtained using the ethanol solution having a PTIO concentration of 1.2% by weight was impregnated with PTIO in an amount corresponding to 3% of the weight of activated carbon (PTIO-impregnated activated carbon II), the PTIO-impregnated activated carbon obtained using the ethanol solution having a PTIO concentration of 2% by weight was impregnated with PTIO in an amount corresponding to 5% of the weight of activated carbon (PTIO-impregnated activated carbon III), and the PTIO-impregnated activated carbon obtained using the ethanol solution having a PTIO concentration of 4% by weight was impregnated with PTIO in an amount corresponding to 10% of the weight of activated carbon (PTIO-impregnated activated carbon IV) .

<Manufacture of Cigarette Samples>

[0016] Commercially available American blend tobacco rods were used as tobacco rods. Filter plugs in which PTIO-impregnated activated carbons obtained above were cavity-filled were attached to one-end sides of the tobacco rods respectively. The filter plugs had a plain filter (made of cellulose acetate fiber tow) having a length of 5 mm provided on both ends of each plug and 0 mg, 50 mg, 100 mg and 200 mg of PTIO-impregnated activated carbon particles were filled at closest packing. The plugs had no ventilation holes.

<Measurements of Amount of NO and NOx>

[0017] The cigarette samples obtained above were set on a smoking machine (RM 26 available from Borgwaldt GmbH), and were burnt under the following conditions.

Smoke suction volume: 17.5 mL/puff
Puffing time: 2 seconds/puff
Puff interval: 58 seconds
Number of times of puffing: 7 times

[0018] For each of 7 times of puffing (smoke suction) and an idle running puff (one time after completion of burning), smoke having passed though the Cambridge filter was diluted 20-fold (by collecting it with an aluminum bag in which 17.5 mL x 19 = 332.5 mL of nitrogen gas was injected in advance). Then, the concentrations of NO and NOx were measured by the chemiluminescent method. The weights of NO and NOx were calculated from the concentrations obtained above, and the calculated weight values of all the puffs and idle-running puff were summed up to obtain a delivery amount per cigarette. For comparison purpose, a similar cigarette sample was manufactured with activated carbon not impregnated with PTIO, and the delivery amount per cigarette was obtained in a similar manner. The NO and NOx reduction rates were calculated based on the NO and NOx delivery amounts per cigarette obtained similarly for a plain cigarette without the filter connected thereto. The NO reduction rate (%) of each sample was illustrated in FIG. 1. In FIG. 1, a line indicates the results obtained in the case where the PTIO-impregnated activated carbon I was used, a line b indicates the results obtained in the case where the PTIO-impregnated activated carbon II was used, a line c indicates the results obtained in the case where the PTIO-impregnated activated carbon III was used, a line d indicates the results obtained in the case where the PTIO-impregnated activated carbon IV was used, and a line e indicates the results obtained in the case where the activated carbon with no PTIO impregnated was used.

[0019] From the results shown in FIG. 1, it can be seen that the filters that contain PTIO-impregnated activated carbon particles significantly reduce the amount of NO as compared to the activated carbon particles that do not contain PTIO. In particular, the activated carbons carrying 3 to 10% by weight of PTIO have a remarkably high NO reduction effect. It should be noted that the NOx reduction rate exhibited a tendency similar to those of the above-described NO reduction rates.

Example 2

[0020] PTIO-impregnated activated carbon II prepared in Example 1 was subjected to moisture absorption until it reaches the equilibrium at a temperature of 22°C and a relative humidity of 60%, and thus moisture-absorbed PTIO-impregnated activated carbon III was obtained. Cigarettes were manufactured as in Example 1 except that the moisture-absorbed PTIO-impregnated activated carbon III was used, and the NO reduction rate in the mainstream smoke was obtained. The results were illustrated in FIG. 2. In FIG. 2, a line a indicates the results obtained in the case where the moisture-absorbed PTIO-impregnated activated carbon III was used, and a line b indicates the results obtained in the case where activated carbon obtained by similar moisture absorption except that PTIO was not impregnated. From the results shown in FIG. 2, it can be seen that when the moisture absorption is carried out, the NO reduction rate is slightly lowered as compared to the case of the dry PTIO-impregnated activated carbon III (Example 1); however the NO amount is significantly reduced as compared to the case where simple activated carbon is used, indicating that PTIO will

sufficiently have an effect of reducing the NO amount, even under actual smoking (corresponding to filter ventilation of 50%). It should be noted also here that the NOx reduction rate exhibited a tendency similar to that of the NO reduction rate described above.

Example 3

[0021] The cigarette samples manufactured in Example 1 were burnt under the same conditions as in Example 1 except that the smoke suction volume was changed to 35 mL/puff. Cigarette samples using activated carbon not impregnated with PTIO were burnt also at a smoke suction volume of 35 mL/puff. The NO reduction rate in the mainstream smoke was calculated. The results are illustrated in FIG. 3. In FIG. 3, a line a indicates the results obtained in the case where the PTIO-impregnated activated carbon III was used, and a line b indicates the results obtained in the case where the activated carbon without PTIO was used. From the results shown in FIG. 3, it can be seen that when the smoke suction volume is increased, the NO reduction rate is lowered as compared to the case of Example 1; however the samples using the PTIO-impregnated activated carbon III exhibits a significantly higher NO reduction rate than that of the cigarette samples using the activated carbon without PTIO. It should be noted also here that the NOx reduction rate exhibited a tendency similar to that of the NO reduction rate described above.

Example 4

[0022] Cigarette samples similar to those of Example 2 (which used moisture-absorbed PTIO) were burnt under the same conditions as those in Example 3, and the NO reduction rate in the mainstream smoke was calculated. With regard to cigarette samples using activated carbon not impregnated with PTIO, the NO reduction rate in the mainstream smoke was calculated. The results were illustrated in FIG. 4. In FIG. 4, a line a indicates the results obtained in the case where the PTIO-impregnated activated carbon was used, and a line b indicates the results obtained in the case where the activated carbon without PTIO was used. From the results shown in FIG. 4, it can be seen that when the smoke suction volume is increased, the NO reduction rate is lowered as compared to the case of Example 2; however the samples using the PTIO-impregnated activated carbon exhibits a significantly higher NO reduction rate than that of the cigarette samples using the activated carbon without PTIO. It should be noted also here that the NOx reduction rate exhibited a tendency similar to that of the NO reduction rate described above.

[0023] As described above, the cigarette filter of the present invention can efficiently remove nitrogen oxides from the tobacco mainstream smoke.

Claims

1. A cigarette filter comprising a cigarette filter material to which 2-phenyl-4,4,5,5-tetramethylimidazoline-3-oxide-1-oxyl is added.

2. The cigarette filter according to claim 1, **characterized in that** the filter material comprises activated carbon particles.

3. The cigarette filter according to claim 1, wherein 3 to 10 parts by weight of 2-phenyl-4,4,5,5-tetramethylimidazoline-3-oxide-1-oxyl is added based on 100 parts by weight of the filter material.

4. A cigarette provided with a cigarette filter according to claim 1.

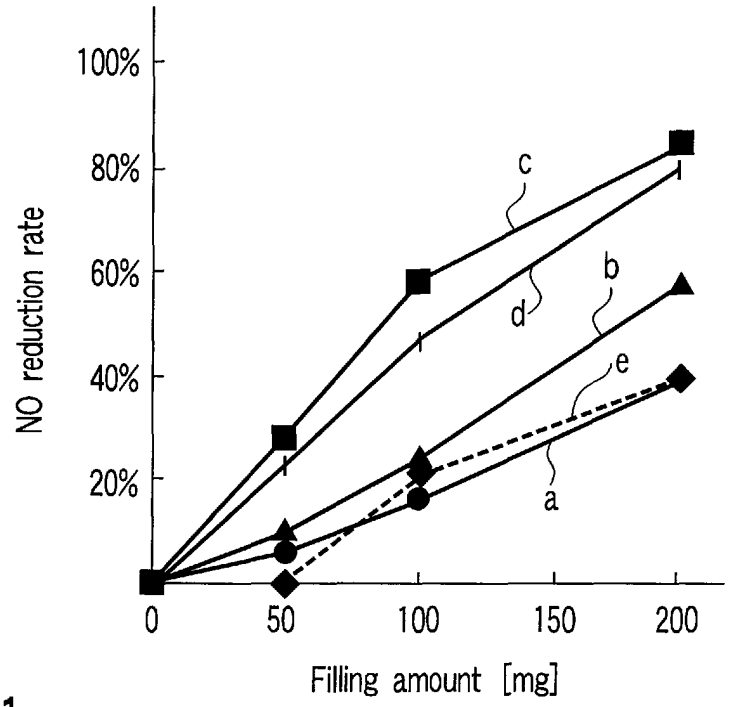
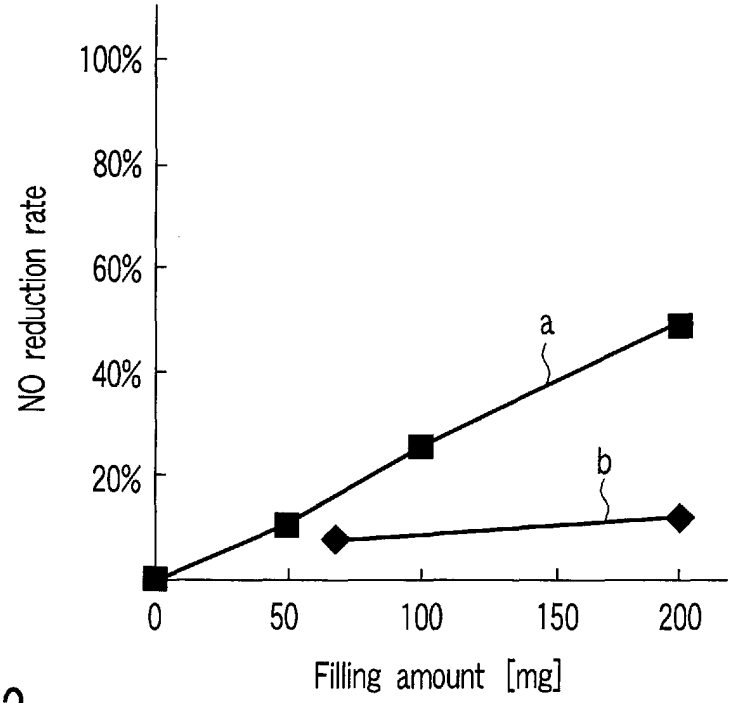

100%
80%
60%
40%
20%
NO reduction rate
0
50
100
150
200
Filling amount [mg]
a
b
c
d
e

FIG. 1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80%
60%
40%
20%
NO reduction rate
0
50
100
150
200
Filling amount [mg]
a
b

FIG. 2

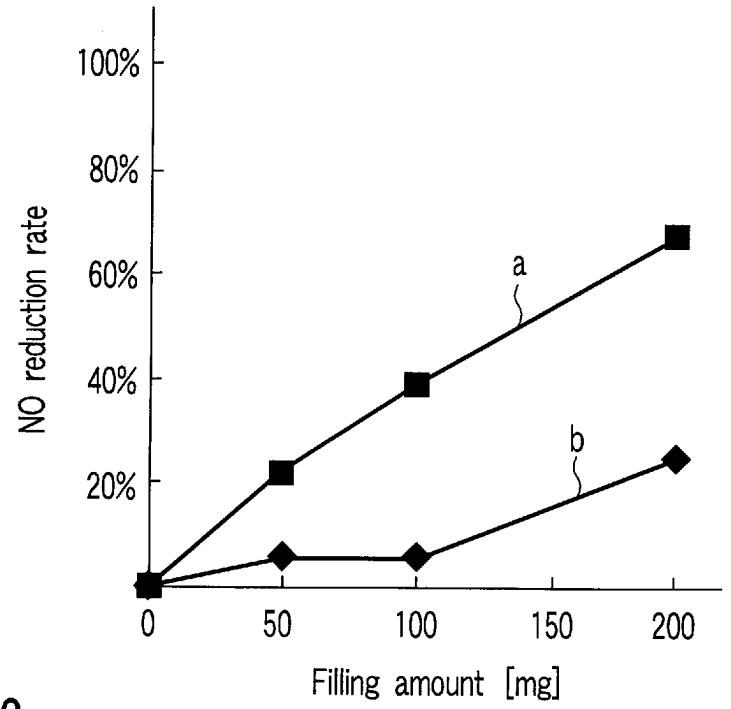
100%
80%
60%
40%
20%
NO reduction rate
a
b
0
50
100
150
200
Filling amount [mg]

FIG. 3

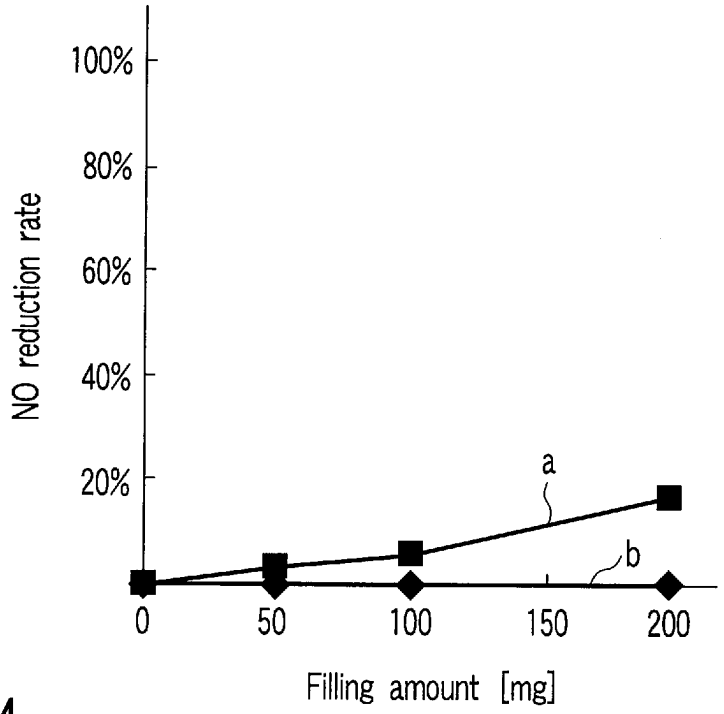
100%
80%
60%
40%
20%
NO reduction rate
a
b
0
50
100
150
200
Filling amount [mg]

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/013659

A. CLASSIFICATION OF SUBJECT MATTER
A24D3/14 (2006.01), ***A24D1/04*** (2006.01), ***A24D3/16*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24D3/14 (2006.01), ***A24D1/04*** (2006.01), ***A24D3/16*** (2006.01), ***B01D53/02*** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-137789 A (Yaizu Suisan Kagaku Kogyo Kabushiki Kaisha), 14 May, 2003 (14.05.03), Claims 1, 4 (Family: none)	1-4
A	JP 6-105675 A (Matsushita Electric Industrial Co., Ltd.), 19 April, 1994 (19.04.94), Column 2, line 41 to column 3, line 17; table 2; Figs. 1, 3, 4 (Family: none)	1-4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
19 October, 2005 (19.10.05)	01 November, 2005 (01.11.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/013659

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2-113878 A (MOSKOVSKAYA TABACHNAYA FABRIKA "YAVA"), 26 April, 1990 (26.04.90), Claims 1 to 14; table 1 & EP 351252 A & US 5083579 A	1-4
A	US 5671758 A (Paul Rongved), 30 September, 1997 (30.09.97), Column 2, lines 26 to 64; Fig. 1A (Family: none)	1-4
A	US 4637408 A (Philip Morris Inc.), 20 January, 1987 (20.01.87), (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002119270 A **[0002] [0002]**
- JP 9043153 A **[0010]**