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(71) Applicant(s)

Reemtsma Cigarettenfabriken GmbH

(72) Inventor(s)

Peters, Gunther; Seidel, Henning; Henning, Paul-Georg; Pienemann, Thomas

(74) Agent/Attorney

FB Rice, Level 23 44 Market Street, Sydney, NSW, 2000

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(74) Anwälte: BOTH, Georg usw.; Uexküll & Stolberg, Be-
selerstr. 4, 22607 Hamburg (DE).

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(71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von
US): REEMTSMA CIGARETTENFABRIKEN GMBH
[DE/DE]; Max-Born-Strasse 4, 22761 Hamburg (DE).

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(72) Erfinder; und

(75) Erfinder/Anmelder (nur für US): PETERS, Gunther
[DE/DE]; Königstrasse 5, 21244 Buchholz (DE). HEN-
NING, Paul-Georg [DE/DE]; Kampstrasse 61, 25451
Quickborn (DE). PIENEMANN, Thomas [DE/DE];
Bgm.-Gustav-Erhm-Strasse 9, 21224 Rosengarten (DE).
SEIDEL, Henning [DE/DE]; In der Marsch 16, 21358
Mechtersen (DE).

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(54) Title: FILTER CIGARETTE

(54) Bezeichnung: FILTERCIGARETTE

(57) Abstract: The invention relates to a filter cigarette comprising a length of tobacco, an enveloping and a filter. Said filter comprises at least one gas-phase active filter part, which contains the at least one gas-phase reducing substance. Said gas-phase reducing substances are embedded in a filter material matrix. Said substances are introduced in an amount of at least 75 mg per filter and at least 5 mg/mm of the length of the gas phase active filter part. Said filter cigarette comprises a filter ventilation of a maximum of 30 % (or from 30 % - 70%). The NFDPM-value lies in the region between 4 and 10 mg/cigarette (or in the region of 2 - 4 mg/cigarette), which is measured according to the ISO-smoking conditions. The gas phase quotient Q₁, which is defined as (µg benzol per cigarette) / (mg CO per cigarette), which is measured according to ISO-smoking conditions, is below 1.5, preferably below 1.

WO 2006/081931 A1

(57) Zusammenfassung: Bei einer Filtercigarette mit einem Tabakstrang, einer Umhüllung und einem Filter weist der Filter min-
destens ein gaspha- senaktives Filterteil auf, das mindestens eine gasphasenredu- zierende Substanz enthält. Die gasphasenredu-
zierenden Substanzen sind in eine Filtermaterial-Matrix eingebettet. Sie sind in einer Menge von mindestens 75 mg pro Filter und
mindestens 5 mg/mm Länge des gasphasenaktiven Filterteils eingebracht. Die Filtercigarette weist eine Filterventilation von höchst-
ens 30% auf (oder von 30% bis 70%). Der NFDPM-Wert liegt zwischen 4 und 10 mg/Cigarette (oder im Bereich von 2 bis 4 mg/Ci-
garette), gemessen nach ISO-Abrauchbedingungen. Der Gasphasen- Quotient Q₁, definiert als (µg Benzol pro Cigarette) / (mg CO
pro Cigarette), gemessen nach ISO-Abrauchbedingungen, liegt unter 1.5, vorzugsweise unter 1.

Filter cigarette

The invention relates to a filter cigarette.

- 5 The smoke of cigarettes is composed of a particle phase and a gas phase. In many filters which are employed conventionally, cellulose acetate is used for filtering the smoke. The gas phase is often not reduced to a satisfactory degree in this connection, for which
10 reason other constructional features are also frequently adjusted. For example, it is customary to provide cigarettes with relatively high ventilation, with this resulting in the gas phase additionally being diluted with air. Another possibility for additionally
15 reducing the gas phase is that of using gas phase-active, that is gas phase-reducing, substances in the filter. In order to determine the gas phase substances in cigarette smoke, cigarettes are usually smoked in accordance with the ISO Standard. If alternative
20 smoking conditions are chosen, for example if the cigarettes are smoked under intense smoking conditions (see definitions below) as is customary in Canada, the gas phase values are markedly higher.
- 25 The prior art discloses filter cigarettes which use gas phase-active substances to influence the tobacco smoke so as to reduce the quantity of gas phase in the mainstream smoke which is inhaled by the smoker.
- 30 For example, filter cigarettes whose gas phase values are reduced by adding gas phase-active substances such as active charcoal are on the market. Active charcoal filters, in which the active charcoal is introduced into a chamber, have been frequently employed for a
35 long time, in particular in Japan, and are disclosed in WO 02/37990 A2 or in other documents such as DE 42 056 58 A1 or WO 00/49901 A1.

In the case of the product "Advance", the filter consists of a filter segment containing active charcoal and a filter segment containing ion exchange resins as well as, optionally, a mouth-end filter segment
5 composed of cellulose acetate. Comparable cigarettes are described in WO 03/015544 A1 and WO 2004/103099 A2.

The gas phase reduction is furthermore influenced by the combination of the design parameters of a filter
10 cigarette, with these design parameters including not only the filter additives but also the constitution of the tobacco, of the wrapping material and of the filter components.

15 However, a feature possessed in common by all the abovementioned previous uses and previous descriptions is that the gas phase is not reduced to a satisfactory extent in the cigarettes which are described. In the case of cigarettes which are customary in the market,
20 the values for the total gas phase content G_{tot} (see below) are greater than 1200 µg/cigarette, as measured in accordance with ISO.

A high gas phase reduction is often only achieved using
25 very high ventilation, with this then resulting in the gas phase values being extremely elevated when they are determined under intense smoking conditions.

Another disadvantage is that, after a certain storage
30 time, conventional gas phase-active cigarette filters lose efficacy.

Other substances are frequently added either to the tobacco mixture or the filter in the case of cigarettes
35 of the prior art, with palladium, for example being added to the tobacco as in WO 02/37990 A1. The high costs and aggravated manufacturing conditions are disadvantageous in this connection.

Elaborate and expensive multifilter constructions, involving a large number of different adsorbents or expensive special materials, are also disadvantageous.

- 5 The object of the invention is to create a filter cigarette in which the gas phase in the tobacco smoke is significantly reduced. This gas phase reduction should also occur under what are termed intense smoking conditions (see below). The gas phase efficiency of the
- 10 filter should, if at all possible, be constant, or at least only change to a slight extent, over a relatively long period, for example the period during which the cigarettes are stored.
- 15 This object is achieved by means of a filter cigarette having the features of Claim 1 or of Claim 28. Advantageous embodiments of the invention ensue from the subclaims.
- 20 The filter cigarette according to the invention has a tobacco strand, a filter and a wrapping (preferably composed of cigarette paper, filter wrapping paper and filter joining paper). The filter contains a filter material matrix containing gas phase-reducing
- 25 substances.

The tobacco in the tobacco strand preferably consists of an American Blend mixture or a Virginia mixture. The tobaccos in the tobacco mixture are preferably provided

30 with an additive content of less than 1% of non-volatilizable constituents, based on the tobacco dry matter; in particular preference is given to using no additives. The tobaccos are preferably selected such that the TSNA (TSNA: tobacco-specific nitrosamines)

35 content of the total mixture is less than 2 µg/g of tobacco. It is even more advantageous if the content of TSNA in the tobacco is less than 1 µg/g of tobacco.

The tobacco can contain additives such as casing,

flavouring agents, humectants, sugar, cocoa, liquorice and menthol.

5 The cigarette paper which surrounds the tobacco strand is preferably porous and has a porosity of more than 40 CU (Coresta units) or more than 60 CU. In order to achieve particularly low NFDPM values (see below) in the range of 4-7 mg/cigarette, the porosity is preferably greater than 300 CU. For this, the cigarette
10 paper, which is naturally porous, can additionally be electroperforated, mechanically perforated or laser-perforated.

15 The cigarette paper preferably contains a relatively high content of glow salt for the purpose of reducing the CO content in the smoke. Customary glow salt quantities are at 0.7%. According to the invention, glow salt quantities of 1.3% or more, preferably 2% are used. Preference is given to using sodium/potassium
20 citrates.

In one embodiment, the grammage of the cigarette paper is preferably lower than in the case of comparable conventional cigarettes and is 22 g/cm².

25 The filter can consist, for example of one, two, three, four or five filter sections and preferably has two filter sections. If the filter has more than one filter section, a filter section which does not contain any
30 gas phase-reducing substances is preferably arranged at the mouth end. Different gas phase-reducing substances can be introduced in one filter part or in different filter parts. When several filter parts are present, they can be arranged longitudinally one after the other
35 or else arranged coaxially.

The filter material (the matrix and other material as well) contains, for example, cellulose, cellulose derivatives (preferably cellulose acetate), and polymers

such as polyolefins (polypropylene, polyethylene),
polyesters, or mixtures thereof.

5 The filter material consists, for example, of fibres,
tow, paper, textile web, non-woven material, fibrous
web, extrudate and/or foam.

10 Before being shaped into the filter form, the filter
material is preferably shrunk and treated and/or
provided with further filter additives such as
catalysts or taste-influencing additives, such as
flavours or sugars.

15 The gas phase-reducing substances are introduced into a
filter material matrix (e.g. interspersed or by means
of an airlaid process), specifically in a quantity of
at least 75 mg per filter and at least 5 mg/mm of the
length of the gas phase-active filter part.

20 Examples of gas phase-reducing substances which can be
used are active charcoal, aluminium oxide, aluminium
hydroxide, ion exchangers (preferably ion exchange
resins), molecular sieves, silica gel or natural or
synthetic materials such as magnesium silicate,
25 argillaceous earth, zeolites, bentonites, kieselguhr or
sepiolite. The gas phase-reducing substances which are
introduced into the filter preferably have a high
surface area in the region of more than 1000 m²/g,
preferably 1000-1200 m²/g, as measured by the BET
30 method, and/or an uptake of CCl₄ of 60%-70% based on the
proper weight of the gas phase-reducing substance.

The filter wrapping paper wraps the filter parts. It
can be porous or nonporous. The filter joining paper or
35 binding paper connects the filter to the tobacco
strand. It can be naturally porous, mechanically
perforated or electroporated or laser-perforated.

To produce the filter ventilation, the filter is

preferably laser-perforated online, that is during the production of the cigarette and after the filter has been attached to the tobacco strand. The filter ventilation is between 0% and 30% and is preferably
5 between 10% and 25%. In other embodiments, the filter ventilation is in the range of 30% to 70%, preferably in the range of 30% to 60%.

10 In the following, some terms are clarified or defined so as to enable the invention to be better understood.

The gas phase of the cigarette smoke is a complex substance mixture composed of permanent gases, such as N_2 and CO_2 , as well as a large number of readily volatile
15 and medium-volatile compounds. Some of these components have been associated with the effects of smoking on health. Thus, formaldehyde, prussic acid and benzene, for example, are mentioned in the cigarette pack warning notices which are stipulated in Germany.

20 The content of many readily volatile and medium-volatile compounds in the smoke can be reduced by using gas phase-reducing substances (in particular adsorbents) such as active charcoal. On the other hand,
25 the content of permanent gases such as CO remains largely unaltered. A measurable variable which describes the efficacy of these adsorbents in a manner which is as far as possible not subject to the influence of other construction features should be
30 found for characterizing this effect.

For this purpose, the influence of different parameters on the quantity and composition of the gas phase was investigated in the context of an internal study. In
35 this connection, it was found that a quotient of the benzene and CO contents in the smoke is best suited for describing the adsorption of gas phase components. In this quotient, the unit of the benzene content is given by definition in $\mu g/cigarette$ while the unit of the CO

content is given by definition in mg/cigarette. On the one hand, the influence of filter ventilation and strand ventilation is compensated by the standardization to the CO content. On the other hand, while the benzene content in the gas phase is to a large extent independent of the tobacco mixture, it can be lastingly influenced by adsorbents, whereas CO is practically unabsorbed. In that which follows, this quotient is designated Q1 for data which were determined under ISO smoking conditions. If the data were determined under intense smoking conditions, the quotient is designated Q2. A low value for Q1 or Q2 is consequently a measure of a high gas phase reduction.

Another advantage is to be seen in the fact that the determination of CO in cigarette smoke is described by international standards. As a constituent of what are termed the "Hoffman analytes" benzene is likewise frequently determined in the smoke. Other information in this regard can be found, for example in M.E. Counts et al. J. Regulatory Toxicology and Pharmacology 39 (2004), 111-134.

The same document also contains benzene and CO data for a selection of cigarette brands from different countries, a selection of which are listed in Table 1. Our own investigations were used to determine the filter type. It turns out that, at values of from 3.5 to 5.5, the quotient is relatively constant for a broad range of products having a conventional filter composed of cellulose acetate (CA). On the other hand, lower values of between 1.8 and 3.0 are found in the case of products containing an active charcoal (AC) filter.

Table 1

Brand	Filter	CO [mg/cig]	Benzene [µg/cig]	Q1 (benzene /CO)
Marlboro KS (US)	CA	12.9	45.2	3.5

Marlboro KS (EU)	CA	11.5	43.6	3.8
Marlboro 100 (EU)	CA	11.6	43.8	3.8
Marlboro KS Lights (EU)	CA	6.4	25.9	4.0
Philip Morris One (EU)	CA	2.0	11.0	5.5
Muratti Ambassador (EU)	AC	7.5	17.6	2.3
Marlboro KS (Japan)	AC	11.2	24.5	2.2
Parliament KS Lights (Japan)	AC	7.5	15.1	2.0
Marlboro KS Lights (Japan)	AC	6.8	12.8	1.9
Omni Lights (US)	AC	13.6	23.8	1.8
Advance Lights (US)	AC	9.0	27.4	3.0

According to the invention, the gas phase is specifically influenced such that the ratio Q1 is less than the values which are measured in the case of commercially available cigarettes, i.e. less than 1.5, as measured in accordance with ISO smoking conditions. Q2 is preferably less than 3 as measured in accordance with intense smoking conditions.

- 10 The intense smoking conditions (CINT: Canada Intense) correspond to the Health Canada Official Method T-115, "Determination of Tar, Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke", conditions as in section 14(6)(b) (modified conditions) of the Canadian Federal Tobacco Regulations.

In this method, the cigarette is smoked with an increased inhalation volume (55 ml/2 seconds) and a reduced inhalation pause (28 seconds) while the filter ventilation zone is at the same time completely covered, see <http://www.hc-sc.gc.ca/hecs-sesc/tobacco/pdf/T-115e4.pdf>.

When reference is made below to ISO smoking conditions, this then refers to the ISO Standard No. 4387. In this standard, the inhalation volume is 35 ml/2 seconds while the inhalation pause is 58 seconds; the filter ventilation zone is not covered.

In the case of the examples which are explained below the cytotoxicity was determined using the method presented at the New Orleans 2002 Coresta congress (Röper, W., Wieczorek, R.: In-vitro cytotoxicity of cigarette mainstream smoke. Evaluation of different cell exposure methods, including "native" smoke aerosol exposure). The tests were carried out using HEP-G2 (human hepatocellular carcinoma) cells. For the tests, serum-free medium was prepared with the gas phase from the cigarettes according to the invention. The cells were then incubated with this medium for 65 h. Proliferation tests were then carried out and EC50 values were determined. EC50 is the effective concentration of a substance or substance mixture which brings about a 50% inhibition of the growth of cells.

Proliferation tests: in the NRU test (neutral red uptake cytotoxicity assay), the proliferation is measured on the basis of the membrane activity of the living cells. NRU test protocols have been published in ECVAM, FRAME, CAAT, INVITOX and ICCVAM. The tests in the examples were carried out in accordance with the INVITOX protocol No. 64 (1992) "The neutral red cytotoxicity assay". In the MTS test (Owen's reagent, Promega kit, cell proliferation assay), the proliferation is measured on the basis of the metabolic activity of the living cells (CellTiter 96[®] Aqueous non-radioactive cell proliferation assay (MTS) supplied by Promega GmbH).

In the examples, the gas phase components in the mainstream smoke of the filter cigarettes were determined by means of GC-FID. For this, a 20-channel smoking machine supplied by Borgwaldt (RM 20/CS) was equipped with 20 cigarettes and with a 92 mm glass fibre filter for separating off the moist condensate. The test cigarettes had previously been conditioned in accordance with ISO 3402. 20 cigarettes were smoked in accordance with ISO 3308, the moist condensate was

separated off on the glass fibre filter and the gas phase was conducted to the pump of the smoking machine. Defined inhalations from different cigarettes were taken for the subsequent analysis using a sampling valve and collected in a glass sampling syringe. Immediately after smoking, 6 ml of the gas sample were transferred using a sample loop into the injector of a gas chromatograph (GC), fractionated and detected by means of FID. A test gas comprising methane in nitrogen was used as the internal standard. The GC-FID conditions were as follows: injector temperature, 110°C; split, 80 ml/min; carrier gas helium, 1.7 ml/min; column 0.5 µm DB Wax 60 m x 0.32 mm; temperature programme: 20°, 1°/min to 28°C; 2°C/min to 60°C; 20°/min to 110°C; FID temperature 200°C.

A quantification was carried out for the following gas phase components: isoprene, acetaldehyde, propionaldehyde, furan, i-butyraldehyde, acetone, acrolein, methylfuran, butanone, methanol, benzene, butenone, dimethylfuran, diacetyl, acetonitrile, hydrogen cyanide and toluene. The results are given in µg of the respective gas phase component per cigarette. The measurement was carried out as a duplicate determination.

The sum of the values of the above-listed gas phase components is termed the total gas phase G_{tot} .

NFDPM: Nicotine-free dry particulate matter; is customarily also termed "tar" or condensate value.

The ratio of CO to NFDPM is preferably less than 1.

The TSNA contents in the smoke are based on the NFDPM contents and are preferably less than 15 ng/mg of NFDPM, in particular less than 13 ng/mg of NFDPM. The NO content is preferably less than 50 µg per cigarette.

In the case of the cigarette according to the

invention, the quantity of the gas phase substances, preferably described as total gas phase G_{tot} , is significantly reduced.

- 5 The quotients Q_1 and Q_2 , which describe the ratio of benzene to CO, have declined below the limit values of 1.5 for Q_1 (measured in accordance with ISO) and, respectively, 3 for Q_2 (measured in accordance with the intense smoking method).

10

In this connection, the decline in gas phase constituents of the smoke and the quotients Q_1 and, respectively, Q_2 of the cigarette according to the invention are to a large extent independent of the storage time and of the smoking conditions as well.

15

It was demonstrated in biomarker studies that, in the case of the filter cigarettes according to the invention, the uptake of gas phase constituents is effectively reduced under everyday conditions as compared with conventional products.

20

In the case of the cigarette according to the invention, the cytotoxicity of the gas phase, as measured using the NRU and MTS standard tests, is significantly reduced as compared with conventional cigarettes both under ISO smoking conditions and under intense smoking conditions.

25

The TSNA values in the smoke of the cigarettes according to the invention are low as compared with conventional filter cigarettes, and with this applying both in the case of ISO smoking conditions and in the case of intense smoking conditions. They are preferably less than 50% of the values of the conventional filter cigarettes.

30
35

It was furthermore observed that the sensory acceptance of the cigarette according to the invention is at least

equivalent to that of a commercially available brand product.

The invention is described in more detail below with the aid of examples.

Example 1

A Virginia blend tobacco mixture without additives was prepared for the variant in Example 1. A commercially available cigarette brand containing Virginia blend mixture was examined for comparison.

The tobacco strand was wrapped with a cigarette paper which has a porosity of 50 CU, which was provided with a glow salt content of 1.3% sodium/potassium citrate and whose grammage was 22 mg/m².

The strand was attached to a filter consisting of two parts, with 75 mg of active charcoal having been introduced into its strand-end filter part of 15 mm in length. The mouth-end filter part was made of cellulose acetate.

The filter was surrounded by a filter wrapping paper. The tobacco strand was connected to the filter by a binding paper. A filter ventilation of 25% was established using an online laser device.

Table 2 shows the values which were determined both for cigarettes according to the invention and for the comparison cigarettes, with the cigarettes being smoked either in accordance with ISO conditions or in accordance with intense conditions (CINT) in which the ventilation zone was covered.

The total gas phase G_{tot} is clearly lower in the case of the cigarette according to the invention than in the case of the comparison cigarette. At 1.4, Q1 is below

the desired limit value of 1.5 and, at 2.5, Q2 is below the desired limit value of 3.

In addition, the product according to the invention was compared, in a field study, with a commercially available product having similar nicotine, condensate and CO values. In this study, 50 smokers first of all smoked the comparison product (commercially available cigarette containing a comparable tobacco mixture), then smoked the product according to the invention for six weeks and, in conclusion, smoked the comparison product once again for six weeks.

The test subjects lived under everyday conditions; there were no restrictions with regard to consumption and smoking behaviour. Every three weeks, the test subjects were examined for the contents of different biomarkers (metabolic products of smoke constituents) in body fluids.

It was found that the uptake of nicotine was at the same level for both the comparison product and the test product, that is no change in smoking behaviour had occurred. On the other hand, a marked reduction of biomarkers for gas phase constituents in the smoke was detected during the period in which the product according to the invention was smoked.

Table 2

Example 1		Cigarette according to the invention	Cigarette according to the invention	Comparison	Comparison
Smoking standard		ISO	CINT	ISO	CINT
Filter ventilation	%	25	0	25	0
Active charcoal quantity	mg	75	75	0	0

Cigarette paper grammage	g/m ²	22	22	25	25
Cigarette paper porosity	CU	50	50	54	54
Glow salt content in the cigarette paper	%	1.3	1.3	0.7	0.7
Nicotine in the smoke	mg/cig	0.87	2.07	0.85	2.05
NFDPM	mg/cig	9.3	25.4	10.6	28.6
CO	mg/cig	8.4	23.6	10.9	29.9
CO/NFDPM		0.90	0.93	1.03	1.05
Total gas phase	µg/cig	910	4219	1998	5512
Benzene	µg/cig	12	60	41	99
Q = benzene/CO		1.4	2.5	3.8	3.3

Example 2

- 5 An American blend tobacco mixture was also prepared entirely without additives for the version in Example 2. A commercially available cigarette brand containing American blend mixture was investigated for comparison.
- 10 The individual results for the two cigarettes are compiled in Table 3.

Table 3

15

Example 2		Cigarette according to the invention	Cigarette according to the invention	Comparison	Comparison
Smoking standard		ISO	CINT	ISO	CINT
Filter ventilation	%	18	0	46	0

Active charcoal quantity	mg	75	75	0	0
Cigarette paper grammage	g/m ²	35	35	25	25
Cigarette paper porosity	CU	320	320	33	33
Glow salt content in the cigarette paper	%	2.0	2.0	0.7	0.7
Nicotine in the smoke	mg/cig	0.62	1.68	0.54	1.58
NFDPM	mg/cig	6.3	19.3	6.2	21.7
CO	mg/cig	5.6	16.9	6.9	24.3
CO/NFDPM		0.89	0.88	1.11	1.12
Total gas phase	µg/cig	307	2312	1305	5438
Benzene	µg/cig	2.8	24.4	27.7	92.7
Q = benzene/CO		0.5	1.4	4.0	3.8

The filter consisted of a filter section composed of pure cellulose acetate and of a strand-end section of 15 mm in length which was composed of cellulose acetate into which 5 mg of active charcoal had been introduced per mm such that the filter contained a total of 75 mg of active charcoal.

The cigarette paper of the cigarette according to the invention had a porosity of 320 CU and a grammage of 35 g/m².

For this version, the glow salt content was 2.0% sodium/potassium citrate.

The filter was enclosed in a filter wrapping paper. The tobacco strand was connected to the filter by means of a binding paper.

A filter ventilation of 18% was established on an on-line laser device.

For both versions, this choice of the design parameters
5 resulted in the desired reduction in the gas phase
values both under ISO smoking conditions and under
intense smoking conditions (CINT).

These design parameters also made it possible to
10 markedly reduce the Q1 and Q2 quotients.

Example 3

Cigarettes according to Example 1 were stored for a
15 period of 12 months. After every 3 months, the gas
phase values were determined once again under ISO
smoking conditions. It was observed that the efficacy
of the cigarette filters in regard to the total gas
phase G_{tot} values remained to a very large extent
20 stable. After 3 months, the quantity of the total gas
phase was only 3.6% more than the quantity of the total
gas phase which was determined on freshly prepared
filter cigarettes. After 6 months, a further increase
of only 4.1% was determined. The decrease in efficacy
25 by less than 10% within 6 months is extremely
advantageous.

Table 4

Example 3		0	3 months	6 months
Total gas	µg/cig	910	943	982
phase				

30

Example 4

The cigarettes according to Example 4 correspond to the
cigarettes according to Example 1. The tobacco in the
35 tobacco strand was chosen such that the TSNA content was

less than 1 µg/g of tobacco, namely 0.4 µg/g of tobacco.

Table 5

Example 4		Cigarette according to the invention	Comparison
Smoking standard		ISO	ISO
Tobacco chloride	%	0.4	0.9
Tobacco nitrate	%	0.2	0.5
Tobacco TSNA	µg/g	0.4	1.1
Tobacco brand		Virginia	Virginia
Smoke NO	µl/cig	42.00	71.00
Smoke TSNA	ng/cig	65.0	142.0
Smoke TSNA	ng/mg of NFDPM	7.0	15.4

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The smoke of the cigarettes according to Example 1 was examined with regard to its TSNA values and NO values. In Table 5, these values are compared with those of a conventional cigarette. The TSNA content in the smoke is 54% lower than in the conventional cigarette.

10

Example 5

The experimental cigarettes according to Examples 1 and 2 were smoked both under ISO smoking conditions and under intense smoking conditions and the cytotoxicity of the gas phase in accordance with NRU and MTS tests was determined.

15

EC50 values of the gas phases were determined. The toxicity values are given in percentage decrease in the toxicity based on a commercially available comparison cigarette having comparable NFDPM values and containing comparable tobacco mixtures. It can be seen from the table that, in all the samples investigated, the cytotoxicity of the experimental cigarettes is markedly

25

lower than that of the appurtenant comparison cigarettes. The cigarettes were smoked in accordance with ISO conditions and the gas phase was analysed. In addition, the cigarettes were smoked in accordance with
5 intense conditions and the gas phase was analysed. Under both smoking conditions, the cytotoxicity was markedly lower in the case of the cigarettes according to the invention than in the case of the comparison.

10 Table 6

Toxicity	Example 1		Example 2	
	ISO	CINT	ISO	CINT
Decrease in membrane toxicity (NRU) in %	45.0	47.0	95.0	72.0
Decrease in metabolic toxicity (MTS) in %	76.8	52.2	85.0	77.0

Example 6

15 An American blend tobacco mixture was likewise prepared entirely without additives for the version in Example 6. A commercially available Ultra cigarette brand was examined as comparison.

20 The individual results for the two cigarettes are compiled in Table 7.

The filter consisted of a filter section composed of pure cellulose acetate and a strand-end section of
25 15 mm in length which was composed of cellulose acetate into which 5 mg of active charcoal had been introduced per mm such that the filter contained a total of 75 mg of active charcoal.

30 The cigarette paper in the cigarette according to the invention had a porosity of 50 CU and a grammage of

22 g/m².

The glow salt content for this version was 1.3% sodium/potassium citrate.

5

The filter was enclosed in a filter wrapping paper. The tobacco strand was connected to the filter by means of a binding paper.

10 A filter ventilation of 60% was established on an on-line laser device.

This choice of design parameters resulted in the desired reduction in the gas phase values both under

15 ISO smoking conditions and under intense smoking conditions (CINT).

These design parameters also made it possible to markedly reduce the Q1 and Q2 quotients.

20

Table 7

Example 6		Cigarette according to the invention	Cigarette according to the invention	Comparison	Comparison
Smoking standard		ISO	CINT	ISO	CINT
Filter ventilation	%	60	0	69	0
Active charcoal quantity	mg	75	75	0	0
Cigarette paper grammage	g/m ²	22	22	25	25
Cigarette paper porosity	CU	50	50	49	49
Glow salt content in the cigarette paper	%	1.3	1.3	1.0	1.0

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Nicotine in the smoke	mg/ cig	0.44	2.37	0.28	1.68
NFDPM	mg/ cig	3.6	24.0	2.6	21.2
CO	mg/ cig	2.3	20.0	2.8	23.9
CO/NFDPM		0.64	0.83	1.08	1.13
Total gas phase	µg/ cig	88	2873	680	5381
Benzene	µg/ cig	1.3	36.9	15.4	93.2
Q = benzene/ CO		0.56	1.8	5.5	3.9

Claims

1. Filter cigarette having a tobacco strand, a
wrapping and a filter, wherein
 - 5 a) the filter possesses at least one gas phase-
active filter part which contains at least one gas
phase-reducing substance,
 - b) the gas phase-reducing substances are embedded in
a filter material matrix,
 - 10 c) the gas phase-reducing substances are introduced
in a quantity of at least 75 mg per filter and at
least 5 mg/mm of the length of the gas phase-active
filter part,
 - d) the filter cigarette exhibits a filter
15 ventilation of at most 30%,
 - e) the NFDPM value is between 4 and 10 mg/cigarette,
as measured in accordance with ISO smoking
conditions,
 - f) the gas phase quotient Q1, defined as (μg of
20 benzene per cigarette)/(mg of CO per cigarette) and
measured in accordance with ISO smoking conditions,
is less than 1.5, preferably less than 1.
2. Filter cigarette according to Claim 1,
25 characterized in that the gas phase quotient Q2,
defined as (μg of benzene per cigarette)/(mg of CO
per cigarette) and measured in accordance with
intense smoking conditions, is less than 3,
preferably less than 2.5, particularly preferably
30 less than 2.
3. Filter cigarette according to Claim 1 or 2,
characterized in that the filter is equipped to
hold an increase in the quotients Q1 and/or Q2 to
35 less than 20%, preferably less than 10%, over a
cigarette storage period of 6 months.
4. Filter cigarette according to one of Claims 1 to
3, characterized in that the tobacco strand

tobacco contains an additive content of less than 1% w/w based on the tobacco dry matter.

5. Filter cigarette according to Claim 4, characterized in that the tobacco strand
5 tobacco does not contain any additives.

6. Filter cigarette according to one of Claims 1 to 5, characterized in that the
tobacco strand exhibits a tobacco mixture which contains Virginia tobacco and/or
Oriental tobacco.

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7. Filter cigarette according to one of Claims 1 to 6, characterized in that the
tobacco has a TSNA content of less than 2 $\mu\text{g/g}$ of tobacco, preferably less than 1 $\mu\text{g/g}$
of tobacco.

15 8. Filter cigarette according to one of Claims 1 to 7, characterized in that the nitrate
content of the tobacco is less than 0.4% based on the tobacco dry matter.

9. Filter cigarette according to one of Claims 1 to 8, characterized in that the NO
content in the smoke is less than 50 μg per cigarette, as measured in accordance with
20 ISO smoking conditions.

10. Filter cigarette according to one of Claims 1 to 9, characterized in that the
TSNA content in the smoke based on NFDPM is less than 15 ng/mg of NFDPM,
preferably less than 13 ng/mg of NFDPM, as measured in accordance with ISO
25 smoking conditions.

11. Filter cigarette according to one of Claims 1 to 10, characterized in that the gas
phase-reducing substances exhibit a surface area of more than 500 m^2/g , preferably
more than 1000 m^2/g ,

particularly preferably more than 1200 m²/g.

12. Filter cigarette according to one of Claims 1 to 11, characterized in that the gas phase-reducing substances comprise at least one of the substances contained in the following group: active charcoals, aluminium oxides, aluminium hydroxides, ion exchangers, ion exchange resins, molecular sieves, silica gels, natural minerals, synthetic minerals, magnesium silicates, argillaceous earths, zeolites, bentonites, kieselgur, sepiolite.
13. Filter cigarette according to one of Claims 1 to 12, characterized in that the gas phase-reducing substances are introduced in a quantity of at least 82.5 mg per filter and at least 5.5 mg/mm of the length of the gas phase-active filter part, preferably in a quantity of at least 100 mg per filter, particularly preferably in a quantity of at least 200 mg per filter.
14. Filter cigarette according to one of Claims 1 to 13, characterized in that the total gas phase G_{tot} is less than 1000 µg/cigarette as measured under ISO smoking conditions and/or less than 5000 µg/cigarette as measured under CINT smoking conditions.
15. Filter cigarette according to one of Claims 1 to 14, characterized in that the filter material matrix comprises at least one of the materials selected from the following group: cellulose, cellulose derivatives, cellulose acetate, polymers, polyolefins, polypropylene, polyethylene, polyesters.
16. Filter cigarette according to one of Claims 1 to 15, characterized in that the filter material

and/or the filter material matrix is present in at least one of the forms selected from the following group: fibres, tows, papers, textile webs, non-woven materials, fibrous webs, extrudates, foams.

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17. Filter cigarette according to one of Claims 1 to 16, characterized in that the filter material is provided with additives, preferably with taste-influencing additives and/or catalysts.

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18. Filter cigarette according to one of Claims 1 to 17, characterized in that the filter cigarette exhibits a filter ventilation of at most 25%, preferably of at most 15%, particularly preferably of at most 10%.

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19. Filter cigarette according to one of Claims 1 to 17, characterized in that the filter cigarette does not exhibit any filter ventilation.

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20. Filter cigarette according to one of Claims 1 to 19, characterized in that the filter consists of more than one part.

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21. Filter cigarette according to one of Claims 1 to 20, characterized in that the cigarette paper porosity is at least 40 CU, preferably at least 60 CU.

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22. Filter cigarette according to one of Claims 1 to 20, characterized in that the cigarette paper porosity is at least 300 CU.

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23. Filter cigarette according to one of Claims 1 to 22, characterized in that the glow salt content in the cigarette paper is at least 1%, preferably at least 2%, based on the weight of the cigarette paper.

24. Filter cigarette according to one of Claims 1 to 23, characterized in that the grammage of the cigarette paper is less than 25 g/m², preferably 22 g/m².
- 5
25. Filter cigarette according to one of Claims 1 to 24, characterized in that the NFDPM value is between 4 and 7 mg per cigarette as measured in accordance with ISO smoking conditions.
- 10
26. Filter cigarette according to one of Claims 1 to 24, characterized in that the NFDPM value is between 4 and 6 mg per cigarette as measured in accordance with ISO smoking conditions.
- 15
27. Filter cigarette according to one of Claims 1 to 26, characterized in that the NFDPM value is between 10 and 32 mg per cigarette, preferably between 10 and 25 mg per cigarette, as measured in accordance with CINT smoking conditions.
- 20
28. Filter cigarette having a tobacco strand, a wrapping and a filter, wherein
- 25
- a) the filter possesses at least one gas phase-active filter part which contains at least one gas phase-reducing substance,
- b) the gas phase-reducing substances are embedded in a filter material matrix,
- 30
- c) the gas phase-reducing substances are introduced in a quantity of at least 75 mg per filter and at least 5 mg/mm of the length of the gas phase-active filter part,
- d) the filter cigarette exhibits a filter ventilation of from 30% to 70%, preferably in the range of from 30% to 60%,
- 35
- e) the NFDPM value is in the range of from 2 to 4 mg/cigarette as measured in accordance with ISO smoking conditions,
- f) the gas phase quotient Q₁, defined as (µg of

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benzene per cigarette)/(mg of CO per cigarette)
and measured in accordance with ISO smoking
conditions, is less than 1.5, preferably less than
1.

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29. Filter cigarette according to Claim 28,
characterized by the features which are explicitly
cited in at least one of the Claims 2 to 17 and 20
to 24.