

Description

The present invention relates to a fuel element for a smoking article which produces an aerosol that resembles tobacco smoke, and which contains no more than a minimal amount of incomplete combustion or pyrolysis products.

Many fuel elements for smoking articles have been proposed through the years, especially over the last 20 to 30 years, but none of these products has ever realized any commercial success.

EP-A-0 117 355 (Hearn et al.), describes a proposed cigarette smoking article having a carbon heat source with an axial passageway and a separate flavor generator. The axial passageway is provided in order to prevent gaseous combustion products from flowing through the carbonaceous fuel material of the fuel element during puffs. The heat source (page 2, line 23 to page 7, line 14) is formed by pyrolyzing a preformed, tube-shaped ligno-cellulosic material of e.g. 90 mm or 65 mm length (see Comparative Example 1 and Example 4, respectively) under specified conditions, followed by at least one additional specified process step. The purported flavor generator (page 8, lines 8-27) comprises a substrate material, which may be tobacco, alumina, etc., adjacent the mouth end, which is impregnated with or inherently contains at least one thermally releasable flavorant. The flavor generator also may comprise a flavored, foamed core inside the heat source. A conventional filter may be placed after the flavor generator. The purported formation of an aerosol during use is described from page 8, line 28 to page 9, line 8.

Despite decades of interest and effort, there is still no fuel element comprising smoking article on the market which provides the benefits and advantages associated with conventional cigarette smoking, without delivering considerable quantities of incomplete combustion and pyrolysis products.

It is the object of the present invention to provide a carbonaceous fuel element for combining with a separate aerosol generator in order to form a smoking article which is more efficient during smoking.

According to the present invention this object is achieved by the features of claim 1.

A relatively short carbonaceous segment of a cigarette type smoking article is already known per se from EP-A-0 074 201. This document teaches to use a combustible carbonized rod as a segment of a cigarette type smoking article wherein this segment is either a filter with a length of from 10 mm to 40 mm, or the sole fuel element of a tobacco-free cigarette, said fuel element having a length of from 85 mm to 120 mm. In this known smoking article the carbonaceous filter may be intended to be consumed by smoking thereby releasing some

of the previously trapped TPM released by previously smoked tobacco disposed upstream of the filter in order to achieve that the last few puffs of the smoking article may be perceived by the user to be as mild as the initial puffs.

Preferably, the fuel element comprises at least 60 % to 80 % by weight carbon as such.

Moreover, fuel elements are preferred which have a diameter of from about 4 mm to 5 mm.

For easy lighting, it is proposed to provide the fuel element with a tapered end.

Further advantageous features are subject of the enclosed claims.

In all of the aforesaid smoking articles having a fuel element according to subject invention the heat generated by the fuel element during smoking is more efficiently used for producing an aerosol resembling the smoke of a conventional smoking article.

A smoking article with an inventive fuel element and a separate aerosol generator is capable of producing substantial quantities of aerosol, both initially and over the useful life of the product, without significant thermal degradation of the aerosol former and without the presence of substantial pyrolysis or incomplete combustion products, and preferably without substantial quantities of sidestream smoke. Upon lighting, the fuel element generates heat which is used to volatilize the aerosol forming substance or substances in the aerosol generating means. These volatile materials are then drawn toward the mouth end, especially during puffing, and into the user's mouth, akin to the smoke of a conventional cigarette.

Because the inventive fuel element is relatively short, the hot, burning fire cone is always close to the aerosol generating means, which maximizes heat transfer thereto and maximises the resultant production of aerosol, especially in embodiments which are provided with a member conducting heat from the fuel element to the aerosol generating means.

Because the aerosol forming substance is physically separate from the fuel element, it is exposed to substantially lower temperatures than are present in the burning fire cone, thereby minimizing the possibility of thermal degradation of the aerosol former. Moreover, the use of a carbonaceous fuel element which is substantially free of volatile organic material eliminates the presence of substantial pyrolysis or incomplete combustion products and eliminates the generation of substantial sidestream smoke.

As used herein, and only for the purposes of this invention "aerosol" is defined to include vapors, gases, particles, and the like, both visible and invisible, and especially those components perceived by the user to be "smoke-like," generated

by action of the heat from the burning fuel element upon substances contained within the aerosol generating means, or elsewhere in the article. As so defined, the term "aerosol" also includes volatile flavoring agents and/or pharmacologically or physiologically active agents, irrespective of whether they produce a visible aerosol.

The fuel element according to the present invention and its use in smoking articles is described in greater detail in the accompanying drawings and in the detailed description of the invention which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 through 9 are longitudinal views of various smoking articles using a fuel element according to the present invention;

Figure 1A is a sectional view of the embodiment of Figure 1, taken along lines 1A-1A in Figure 1;

Figure 2A is a longitudinal view of a modified, tapered fuel element of the embodiment of Figure 2;

Figure 3A is a sectional view of the embodiment of Figure 3, taken along lines 3A-3A in Figure 3; and

Figure 10 depicts the average peak temperature profile of the smoking article of Example 5 during use.

DETAILED DESCRIPTION OF THE INVENTION

The smoking article illustrated in Figure 1, which preferably has the diameter of a conventional cigarette, includes a short, combustible carbonaceous fuel element 10, an abutting aerosol generating means 12, and a foil lined paper tube 14, which forms the mouthend piece 15 of the article. In this embodiment, fuel element 10 is provided with five longitudinally extending holes 16. See Figure 1A. The fuel element 10, which is about 20 mm long, optionally may be wrapped with cigarette paper to improve lighting of the fuel. This paper may be treated with known burn additives.

Aerosol generating means 12 includes a plurality of glass beads 20 coated with an aerosol forming substance or substances, such as glycerin. The glass beads are held in place by a porous disc 22, which may be made of cellulose acetate. This disc may be provided with a series of peripheral grooves 24 which provide passages between the disc and the foil lined tube 14.

The foil lined paper tube 14, which forms the mouthend piece of the article, surrounds aerosol generating means 12 and the rear, non-lighting end of fuel element 10. The tube also forms an aerosol delivery passage 26 between the aerosol generating means 12 and mouth end 15 of the article.

The article illustrated in Figure 1 also includes an optional mass or plug of tobacco 28 to contribute flavor to the aerosol. This tobacco charge 28 may be placed at the mouth end of disc 22, as shown in Figure 1, or it may be placed between glass beads 20 and disc 22. It also may be placed in passage 26 at a location spaced from aerosol generator 12.

In the embodiment shown in Figure 2, the short fuel element 10 is a carbon rod or plug, about 20 mm long, which is provided with an axial hole 16 and may be formed from carbonized fibers and preferably also with an axial passageway corresponding to hole 16. In this embodiment, aerosol generating means 12 includes a thermally stable conductive carbonaceous substrate 30, such as a plug of porous carbon, which is impregnated with an aerosol forming substance or substances. This substrate may be provided with an optional axial passageway 32, as is shown in Figure 2. This embodiment also includes a mass of tobacco 28 which is preferably placed at the mouth end of substrate 30. For appearance sake, this article also includes an optional high porosity cellulose acetate filter 34, which may be provided with peripheral grooves 36 to provide passages for the aerosol forming substance between filter 34 and foil tube 14. Optionally, as shown in Figure 2A, the lighting end 11 of the fuel element may be tapered to improve lightability.

The embodiment of the invention illustrated in Figure 3, includes a short combustible carbonaceous fuel element 10, connected to aerosol generating means 12 by a heat conductive rod 99 and by a foil lined paper tube 14, which also leads to the mouth end 15 of the article. In this embodiment, fuel element 10 may be an extruded carbon rod or plug.

Aerosol generating means 12 includes a thermally stable carbonaceous substrate 30, such as a plug of porous carbon, which is impregnated with an aerosol forming substance or substances. This embodiment includes a void space 97 between the fuel element 10 and the substrate 30. The portion of the foil lined tube 14 surrounding this void space includes a plurality of peripheral holes 100 which permit sufficient air to enter the void space to provide appropriate pressure drop.

As shown in Figures 3 and 3A, the heat conducting means includes a conductive rod 99 and the foil lined tube 14. The rod 99, preferably formed of aluminum, has at least one, preferably from 2 to 5, peripheral grooves 96 therein, to allow air passage through the substrate. The article of Figure 3 has the advantage that the air introduced into the void space 97 contains less carbon oxidation products because it is not drawn through the burning fuel.

The embodiment illustrated in Figure 4 includes a fibrous carbon fuel element 10, such as carbonized cotton or rayon. The fuel element includes a single axial hole 16. The substrate 38 of the aerosol generator is a granular, thermally stable carbon. A mass of tobacco 28 is located immediately behind the substrate. This article is provided with a cellulose acetate tube 40, in place of the foil lined tube of previous embodiments. This tube 40 includes an annular section 42 of cellulose acetate tow surrounding an optional plastic, e.g., polypropylene tube 44. At the mouth end 15 of this element there is a low efficiency cellulose acetate filter plug 45. The entire length of the article is wrapped in cigarette-type paper 46. A cork or white ink coating 48 may be used on the mouth end to simulate tipping. A foil strip 50 is located on the inside of the paper, toward the fuel end of the article. This strip preferably extends from the rear portion of the fuel element to the mouth end of the tobacco charge 28. It may be integral with the paper or it may be a separate piece applied before the paper overwrap.

The embodiment of Figure 5 is similar to that of Figure 4. In this embodiment, the aerosol generating means 12 is formed by an aluminum macrocapsule 52 which is filled with a granular substrate or, as shown in the drawing, a mixture of a granular substrate 54, and tobacco 56. The macrocapsule 52 is crimped at its ends 58, 60 to enclose the material and to inhibit migration of the aerosol former. The crimped end 58, at the fuel end, preferably abuts the rear end of the fuel element to provide for conductive heat transfer. A void space 62 formed by end 58 also helps to inhibit migration of the aerosol former to the fuel. Longitudinal passageways 59 and 61 are provided to permit the passage of air and the aerosol forming substance. Macrocapsule 52 and fuel element 10 may be united by a conventional cigarette paper 47, as illustrated in the drawing, by a perforated ceramic paper, or a foil strip. If cigarette paper is used, a strip 64 near the rear end of the fuel should be printed or treated with sodium silicate or other known materials which cause the paper to extinguish. The entire length of the article is overwrapped with conventional cigarette paper 46.

Figure 6 illustrates another embodiment having a carbon fuel plug 10. In this embodiment, the fuel element has a tapered lighting end 11 for easier lighting and a tapered rear end 9 for easy fitting into a tubular foil wrapper 66. Abutting the rear end of the fuel element is an aluminum disc 68 with a center hole 70. A second, optional aluminum disc 72 with hole 74 is located at the mouth end of the aerosol generator 12. In between is a zone 76 of a particulate substrate and a zone 78 of tobacco. The foil wrapper 66 in which the fuel element is moun-

ted extends back beyond the second aluminum disc 72. This embodiment also includes a hollow cellulose acetate rod 42 with an internal polypropylene tube 44, and a cellulose acetate filter plug 45. The entire length of the article is preferably wrapped with cigarette paper 46.

The embodiment shown in Figure 7 illustrates the use of a substrate 80 embedded within a large cavity 82 in fuel element 10. In this embodiment, the fuel element is formed from an extruded carbon, and the substrate 80 usually is a relatively rigid, porous material. The entire length of the article is wrapped with conventional cigarette paper 46. This embodiment may also include a foil strip 84 to couple fuel element 10 to the cellulose acetate tube 40 and to help extinguish the fuel.

The embodiments shown in Figures 8 and 9 include a nonburning insulating jacket 86 around fuel element 10 to insulate and concentrate the heat in the fuel element. These embodiments also help to reduce any fire causing potential of the burning fire cone.

In the embodiment shown in Figure 8, both fuel element 10 and substrate 30 are located within an annular jacket or tube 86 of insulating fibers, such as ceramic (e.g., glass) fibers. Nonburning carbon or graphite fibers may be used in place of ceramic fibers. Fuel element 10 is an extruded carbon plug having a hole 16. In the illustrated embodiment, the lighting end 11 extends slightly beyond the edge of jacket 86 for ease of lighting. Substrate 30 is a solid porous carbon material, although other types of substrates may be used. The substrate and the rear portion of the fuel element are surrounded by a piece of aluminum foil 87. As illustrated, this jacketed fuel/substrate unit is coupled to a mouthend piece, such as the elongated cellulose acetate tube 40 shown in the drawing, with an overwrap of conventional cigarette paper 46. The jacket 86 extends to the mouth end of substrate 30, but may replace cellulose acetate rod 42.

In the embodiment shown in Figure 9, an aluminum macrocapsule 52 of the type shown in Figure 5 is used to enclose a granular substrate 54 and tobacco 56. This macrocapsule is preferably positioned entirely within the insulator jacket 86. In addition, the lighting end 11 of fuel element 10 does not protrude beyond the forward end of jacket 86. Preferably, the macrocapsule and the rear portion of the fuel element are surrounded by a piece of aluminum foil in a manner similar to that shown in Figure 8.

Upon lighting any of the aforesaid embodiments, the fuel element burns, generating the heat used to volatilize the aerosol forming substance or substances present in the aerosol generating means. These volatile materials are then drawn toward the mouthend, especially during puffing,

and into the user's mouth, akin to the smoke of a conventional cigarette. Because the fuel element is relatively short, the hot, burning fire cone is always close to the aerosol generating body, which maximizes heat transfer to the aerosol generating means, and resultant production of aerosol, especially when a heat conducting member is used.

Because of the small size and burning characteristics of the carbonaceous fuel element, the fuel element usually begins burning over substantially all of its exposed length within a few puffs. Thus, the portion of the fuel element adjacent to the aerosol generating means becomes hot quickly, which significantly increases heat transfer to the aerosol generating means, especially during the early and middle puffs. Because the fuel element is short, there is never a long section of nonburning fuel to act as a heat sink, as was common in previous thermal aerosol articles. Heat transfer, and therefore aerosol delivery, also is enhanced by the use of holes through the fuel, which draw hot air to the aerosol generator, especially during puffing.

In the smoking articles the short carbonaceous fuel element, heat conducting member, insulating means, and passages in the fuel cooperate with the aerosol generator to provide a system which is capable of producing substantial quantities of aerosol, on virtually every puff. The close proximity of the fire cone to the aerosol generator after a few puffs, together with the insulating means, results in high heat delivery both during puffing and during the relatively long period of smolder between puffs.

While not wishing to be bound by theory, it is believed that the aerosol generating means is maintained at a relatively high temperature between puffs, and that the additional heat delivered during puffs, which is significantly increased by the hole or holes in the fuel element, is primarily utilized to vaporize the aerosol forming substance. This increased heat transfer makes more efficient use of the available fuel energy, reduces the amount of fuel needed, and helps deliver early aerosol.

In general, the combustible fuel elements according to the present invention are less than about 30 mm long. Advantageously the fuel element is about 20 mm or less, preferably about 15 mm or less in length. Advantageously, the diameter of the fuel element is between about 3 and 8 mm, preferably about 4 to 5 mm. The density of the fuel elements employed herein has ranged from about 0.5 g/cc to about 1.5 g/cc. Preferably, the density is greater than 0.7 g/cc., more preferably greater than 0.8 g/cc. Preferably, the fuel is provided with one or more longitudinally extending holes, such as holes 11 in Figures 1 through 5. These holes provide porosity and increase early heat transfer to the substrate by increasing the amount of hot gas-

es which reach the substrate.

The fuel element is primarily formed of a carbonaceous material. Carbonaceous fuel elements are preferably from about 5 to 15 mm, more preferably, from about 8 to 12 mm in length. Carbonaceous fuel elements having these characteristics are sufficient to provide fuel for at least about 7 to 10 puffs, the normal number of puffs generally obtained by smoking a conventional cigarette under FTC conditions.

Preferably, the carbon content of such a fuel element is at least 60 - 70%, most preferably at least about 80% or more by weight. Excellent results have been achieved with fuel elements having a carbon content of above about 85% by weight. High carbon content fuels are preferred because they produce minimal pyrolysis and incomplete combustion products, little or no visible sidestream smoke, and minimal ash and have high heat capacity. However, lower carbon content fuel elements, e.g., about 50 - 65 weight percent, are within the scope of this invention, especially where a nonburning inert filler is used. The density of the fuel is above about 0.5 g/cc., preferably above about 0.7 g/cc., which is higher than the densities normally used in conventional smoking articles. Besides carbon and a binder the fuel element may comprise other fuel components, including burn modifiers, moisture, etc.

The carbonaceous materials used in or as the preferred fuel may be derived from virtually any of the numerous carbon sources known to those skilled in the art. Preferably, the carbonaceous material is obtained by the pyrolysis or carbonization of cellulosic materials, such as wood, cotton, rayon, tobacco, coconut, paper, and the like, although carbonaceous materials from other sources may be used.

In most instances, the carbonaceous fuel element should be capable of being ignited by a conventional cigarette lighter without the use of an oxidizing agent. Burning characteristics of this type may generally be obtained from a cellulosic material which has been pyrolyzed at temperatures between about 400°C to about 1000°C, preferably between about 500°C to about 950°C, in an inert atmosphere or under a vacuum. The pyrolysis time is not believed to be critical, as long as the temperature at the center of the pyrolyzed mass has reached the aforesaid temperature range for at least a few minutes. However, a slow pyrolysis, employing gradually increasing temperatures over several hours is believed to produce a more uniform material with a higher carbon yield.

While undesirable in most cases, carbonaceous fuel elements which require the addition of an oxidizing agent to render them ignitable by a cigarette lighter are within the scope of this inven-

tion, as are carbonaceous materials which require the use of a glow retardant or other type of combustion modifying agent. Such combustion modifying agents are disclosed in many patents and publications and are known to those of ordinary skill in the art.

The most preferred carbonaceous fuel elements used in practicing the invention are substantially free of volatile organic material. By that, it is meant that the fuel element is not purposely impregnated or mixed with substantial amounts of volatile organic materials, such as volatile aerosol forming or flavoring agents, which could degrade in the burning fuel. However, small amounts of water, which are naturally adsorbed by the fuel, may be present therein. Similarly, small amounts of aerosol forming substances may migrate from the aerosol generating means and thus may also be present in the fuel element.

A preferred carbonaceous fuel element is an extruded carbon mass prepared from activated carbon, namely PCB-G, or from a non-activated carbon, namely PXC, both available from Calgon Carbon Corporation, Pittsburgh, PA. Other preferred carbons for extrusion are prepared from pyrolyzed cotton or pyrolyzed papers.

The binders which may be used in preparing such a fuel element are well known in the art. A preferred binder is sodium carboxymethylcellulose (SCMC), which may be used alone, which is preferred, or in conjunction with materials such as sodium chloride, vermiculite, bentonite, calcium carbonate, and the like. Other useful binders include gums, such as guar gum, and other cellulose derivatives, such as methylcellulose and carboxymethylcellulose (CMC).

A wide range of binder concentrations can be utilized. Preferably, the amount of binder is limited to minimize contribution of the binder to undesirable combustion products. On the other hand, sufficient binder must be included to hold the fuel element together during manufacture and use. The amount used will thus depend on the cohesiveness of the carbon in the fuel element.

The fuel elements according to the present invention also may contain one or more additives to improve burning, such as up to about 5 weight percent sodium chloride to improve smoldering characteristics and as a glow retardant. Also, up to about 5, preferably 1 to 2, weight percent of potassium carbonate may be included to improve lightability. Additives to improve physical characteristics, such as clays like kaolins, serpentines, attapulgites, and the like also may be used.

Another carbonaceous fuel element is a carbon fiber fuel, which may be prepared by carbonizing a fibrous precursor, such as cotton, rayon, paper, polyacrylonitrile, and the like. Generally, pyrolysis at

from about 650°C to 1000°, preferably at about 950°, for about 30 minutes, in an inert atmosphere or vacuum, is sufficient to produce a suitable carbon fiber with good burning characteristics. Combustion modifying additives also may be added to these fibrous fuels.

A further benefit from the present invention is the relative lack of ash produced during use in comparison to ash from a conventional cigarette. As the preferred carbon fuel source is burned, it is essentially converted to oxides of carbon, with relatively little ash generation, and thus there is no need to dispose of ashes while using the article.

Claims

1. A carbonaceous fuel element ~~(10)~~ for a smoking article which has:
 - (a) a diameter between 3 mm and 8 mm;
 - (b) a density of at least 0.5 g/cm³, and
 - (c) a length of less than 30 mm prior to use, and consists of an extruded mass of material comprising carbon as such and a binder prior to extrusion.
2. Fuel element as claimed in claim 1 and having a carbon content of at least about 80 % by weight.
3. Fuel element as claimed in claim 1 or 2 and having at least one longitudinal passageway ~~(16; 82)~~.
4. Fuel element as claimed in one of the preceding claims and having a tapered end ~~(11)~~ for lighting.
5. Fuel element according to one of the preceding claims and having a length of 20 mm or less prior to smoking.
6. Fuel element according to one of the preceding claims and having a length of 15 mm or less prior to smoking.
7. Fuel element according to one of the preceding claims and having a length of about 5 mm to 30 mm prior to smoking.
8. Fuel element according to claim 7 and having a length of about 5 mm to 20 mm prior to smoking.
9. Fuel element according to claim 8 and having a length of from about 5 mm to 15 mm prior to smoking.



tion, as are carbonaceous materials which require the use of a glow retardant or other type of combustion modifying agent. Such combustion modifying agents are disclosed in many patents and publications and are known to those of ordinary skill in the art.

The most preferred carbonaceous fuel elements used in practicing the invention are substantially free of volatile organic material. By that, it is meant that the fuel element is not purposely impregnated or mixed with substantial amounts of volatile organic materials, such as volatile aerosol forming or flavoring agents, which could degrade in the burning fuel. However, small amounts of water, which are naturally adsorbed by the fuel, may be present therein. Similarly, small amounts of aerosol forming substances may migrate from the aerosol generating means and thus may also be present in the fuel element.

A preferred carbonaceous fuel element is an extruded carbon mass prepared from activated carbon, namely PCB-G, or from a non-activated carbon, namely PXC, both available from Calgon Carbon Corporation, Pittsburgh, PA. Other preferred carbons for extrusion are prepared from pyrolyzed cotton or pyrolyzed papers.

The binders which may be used in preparing such a fuel element are well known in the art. A preferred binder is sodium carboxymethylcellulose (SCMC), which may be used alone, which is preferred, or in conjunction with materials such as sodium chloride, vermiculite, bentonite, calcium carbonate, and the like. Other useful binders include gums, such as guar gum, and other cellulose derivatives, such as methylcellulose and carboxymethylcellulose (CMC).

A wide range of binder concentrations can be utilized. Preferably, the amount of binder is limited to minimize contribution of the binder to undesirable combustion products. On the other hand, sufficient binder must be included to hold the fuel element together during manufacture and use. The amount used will thus depend on the cohesiveness of the carbon in the fuel element.

The fuel elements according to the present invention also may contain one or more additives to improve burning, such as up to about 5 weight percent sodium chloride to improve smoldering characteristics and as a glow retardant. Also, up to about 5, preferably 1 to 2, weight percent of potassium carbonate may be included to improve lightability. Additives to improve physical characteristics, such as clays like kaolins, serpentines, attapulgites, and the like also may be used.

Another carbonaceous fuel element is a carbon fiber fuel, which may be prepared by carbonizing a fibrous precursor, such as cotton, rayon, paper, polyacrylonitrile, and the like. Generally, pyrolysis at

from about 650°C to 1000°, preferably at about 950°, for about 30 minutes, in an inert atmosphere or vacuum, is sufficient to produce a suitable carbon fiber with good burning characteristics. Combustion modifying additives also may be added to these fibrous fuels.

A further benefit from the present invention is the relative lack of ash produced during use in comparison to ash from a conventional cigarette. As the preferred carbon fuel source is burned, it is essentially converted to oxides of carbon, with relatively little ash generation, and thus there is no need to dispose of ashes while using the article.

Claims

1. A carbonaceous fuel element ~~(10)~~ for a smoking article which has:
 - (a) a diameter between 3 mm and 8 mm;
 - (b) a density of at least 0.5 g/cm³, and
 - (c) a length of less than 30 mm prior to use, and consists of an extruded mass of material comprising carbon as such and a binder prior to extrusion.
2. Fuel element as claimed in claim 1 and having a carbon content of at least about 80 % by weight.
3. Fuel element as claimed in claim 1 or 2 and having at least one longitudinal passageway ~~(16, 82)~~.
4. Fuel element as claimed in one of the preceding claims and having a tapered end ~~(11)~~ for lighting.
5. Fuel element according to one of the preceding claims and having a length of 20 mm or less prior to smoking.
6. Fuel element according to one of the preceding claims and having a length of 15 mm or less prior to smoking.
7. Fuel element according to one of the preceding claims and having a length of about 5 mm to 30 mm prior to smoking.
8. Fuel element according to claim 7 and having a length of about 5 mm to 20 mm prior to smoking.
9. Fuel element according to claim 8 and having a length of from about 5 mm to 15 mm prior to smoking.



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| <p>10. Fuel element according to one of the preceding claims and having a diameter of from about 4 mm to 5 mm.</p> <p>11. Fuel element according to one of the preceding claims and having a density range from about 0.5 g/cm³ to 1.5 g/cm³.</p> <p>12. Fuel element according to one of the preceding claims and having a density of at least about 0.8 g/cm³.</p> <p>13. Fuel element according to one of the preceding claims and comprising at least 60 % to 80 % by weight carbon as such.</p> <p>14. Fuel element according to claim 13 and having a carbon content of above about 85 % by weight.</p> <p>15. Fuel element according to one of the preceding claims and being substantially free of volatile organic material.</p> <p>16. Fuel element according to one of the preceding claims, wherein the constituents of the mass forming the fuel element are selected to avoid any substantial visible sidestream smoke during smolder.</p> <p>17. Fuel element according to one of the preceding claims, wherein said material comprising carbon as such is a carbon fiber fuel.</p> <p>18. Fuel element according to one of the preceding claims, wherein the constituents of the mass forming the fuel element are selected such that the burning of the fuel element produces no disposable ash during use.</p> | <p>5</p> <p>10</p> <p>15</p> <p>20</p> <p>25</p> <p>30</p> <p>35</p> <p>40</p> | <p>3. Brennstoffelement nach Anspruch 1 oder 2, welches wenigstens einen sich in Längsrichtung erstreckenden Durchlaß (16; 82) aufweist.</p> <p>4. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches zum Anzünden ein sich verjüngendes Ende (11) besitzt.</p> <p>5. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches vor dem Rauchen eine Länge von 20 mm oder weniger hat.</p> <p>6. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches vor dem Rauchen eine Länge von 15 mm oder weniger hat.</p> <p>7. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches vor dem Rauchen eine Länge von ungefähr 5 bis 30 mm hat.</p> <p>8. Brennstoffelement nach Anspruch 7, welches vor dem Rauchen eine Länge von ungefähr 5 bis 20 mm hat.</p> <p>9. Brennstoffelement nach Anspruch 8, welches vor dem Rauchen eine Länge von ungefähr 5 bis 15 mm hat.</p> <p>10. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches einen Durchmesser von ungefähr 4 bis 5 mm hat.</p> <p>11. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches eine Dichte im Bereich von ungefähr 0,5 bis 1,5 g/cm³ hat.</p> <p>12. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches eine Dichte von mindestens ungefähr 0,8 g/cm³ hat.</p> |
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* Patentansprüche

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| <p>1. Kohlenstoff-Brennstoffelement (10) für einen Rauchtartikel, welches</p> <p>(a) einen Durchmesser zwischen 3 mm und 8 mm;</p> <p>(b) eine Dichte von mindestens 0,5 g/cm³, und</p> <p>(c) vor Gebrauch eine Länge von weniger als 30 mm</p> <p>hat und aus einer extrudierten Masse aus einem Material besteht, welches vor dem Extrudieren Kohlenstoff als solchen und ein Bindemittel enthält.</p> <p>2. Brennstoffelement nach Anspruch 1 mit einem Kohlenstoffgehalt von mindestens ungefähr 80 Gew. %.</p> | <p>45</p> <p>50</p> <p>55</p> | <p>13. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches mindestens 60 bis 80 Gew. % Kohlenstoff als solchen enthält.</p> <p>14. Brennstoffelement nach Anspruch 13, welches einen Kohlenstoffgehalt von mehr als ungefähr 85 Gew. % hat.</p> <p>15. Brennstoffelement nach einem der vorhergehenden Ansprüche, welches im wesentlichen frei ist von flüchtigem organischem Material.</p> <p>16. Brennstoffelement nach einem der vorhergehenden Ansprüche, bei dem die Bestandteile der das Brennstoffelement bildenden Masse so ausgewählt sind, daß während des Glöstens kein wesentlicher sichtbarer Nebenstromrauch entsteht.</p> |
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* 19. Fuel element according to claim 17 and substantially as described herein with reference to any of figure 1 to 9 of the drawings.



17. Brennstoffelement nach einem der vorhergehenden Ansprüche, bei dem das Kohlenstoff als solchen enthaltende Material ein Kohlefasers-Brennstoff ist.

18. Brennstoffelement nach einem der vorhergehenden Ansprüche, bei dem die Bestandteile der das Brennstoffelement bildenden Masse so ausgewählt sind, daß während des Gebrauchs das Brennen des Brennstoffelements keine ablösbare Asche erzeugt.

Revendications

1. Élément combustible carboné (10) pour un article à fumer, qui a :

- (a) un diamètre entre 3 mm et 8 mm;
- (b) une masse spécifique d'au moins 0,5 g par cm^3 , et
- (c) une longueur inférieure à 30 mm avant utilisation,

et qui consiste en une masse extrudée d'une matière comprenant du carbone comme tel et un liant, avant extrusion.

2. Élément combustible suivant la revendication 1, et ayant une teneur en carbone d'au moins environ 80% en poids.

3. Élément combustible suivant la revendication 1 ou 2, et ayant au moins une voie de passage longitudinale (16; 82).

4. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant une extrémité conique (11) pour l'allumage.

5. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant une longueur de 20 mm ou moins avant le fumer.

6. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant une longueur de 15 mm ou moins avant le fumer.

7. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant une longueur comprise entre environ 5 mm et 30 mm avant le fumer.

8. Élément combustible suivant la revendication 7, et ayant une longueur comprise entre environ 5 mm et 20 mm avant le fumer.

9. Élément combustible suivant la revendication 8, et ayant une longueur comprise entre environ 5 mm et 15 mm avant le fumer.

10. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant un diamètre compris entre environ 4 mm et 5 mm.

11. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant un intervalle de masse spécifique compris entre environ 0,5 g par cm^3 et 1,5 g par cm^3 .

12. Élément combustible suivant l'une quelconque des revendications précédentes, et ayant une masse spécifique d'au moins environ 0,8 g par cm^3 .

13. Élément combustible suivant l'une quelconque des revendications précédentes, et comprenant au moins 60% à 80% en poids de carbone comme tel.

14. Élément combustible suivant la revendication 13, et ayant une teneur en carbone supérieure à environ 85% en poids.

15. Élément combustible suivant l'une quelconque des revendications précédentes, et étant sensiblement exempt de matière organique volatile.

16. Élément combustible suivant l'une quelconque des revendications précédentes, dans lequel les constituants de la masse formant l'élément combustible sont choisis pour éviter toute fumée latérale sensiblement visible au cours de la consommation.

17. Élément combustible suivant l'une quelconque des revendications précédentes, dans lequel la matière comprenant le carbone comme tel est un combustible en fibres de carbone.

18. Élément combustible suivant l'une quelconque des revendications précédentes, dans lequel les constituants de la masse formant l'élément combustible sont choisis de telle manière que la combustion de l'élément combustible ne produise pas de cendres à éliminer au cours de l'utilisation.