FILTERED SMOKING ARTICLES

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ABSTRACT
A smoking article is provided including (a) a tobacco rod comprising a smokable filler material contained within a circumscribing outer wrapping material, wherein the smokable filler material comprises at least about 45% by weight flue-cured tobacco based on the total dry weight of the smokable filler material; (b) one or more inner wrapping strips positioned between the tobacco rod and the outer wrapping material and extending longitudinally along the tobacco rod and including a burley tobacco; and (c) a filter element connected to the tobacco rod, the filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein the filter element includes at least one fibrous tow section of filter material, a general adsorbent, and an ion exchange resin.
FILTERED SMOKING ARTICLES

FIELD OF THE INVENTION

[0001] The present invention relates to tobacco products, such as smoking articles, and in particular, to cigarettes.

BACKGROUND OF THE INVENTION

[0002] Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a charge, roll or column of smokable material, such as shredded tobacco (e.g., in cut filler form), surrounded by a paper wrapper, thereby forming a so-called "smokable rod" or "tobacco rod." Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relation to the tobacco rod. Typically, a filter element comprises plasticized cellulose acetate tow circumscribed by a paper material known as "plug wrap," and is attached to one end of the tobacco rod using a circumscribing wrapping material known as "tipping paper." It also has become desirable to perforate the tipping material and plug wrap, in order to provide dilution of drawn mainstream smoke with ambient air. Descriptions of cigarettes and the various components thereof are set forth in Tobacco Production, Chemistry and Technology, Davis et al. (Eds.) (1999). A cigarette is employed by a smoker by lighting one end thereof and burning the tobacco rod. The smoker then receives mainstream smoke into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette.

[0003] There are a number of factors that influence the design and structure of a cigarette. Many of these factors are inter-related and, therefore, must be weighed and balanced against one another in order to achieve a successful design. For example, structural elements of the design that are intended to alter the combustion characteristics of the cigarette may also affect the sensory characteristics during smoking. Likewise, the removal or reduction of certain gas phase constituents of the smoke in the filter portion of the cigarette can also alter the sensory characteristics associated with the cigarette. Wrapping materials and adsorbents, which are two elements of certain cigarette designs, are discussed below.

[0004] Numerous references propose various types of cigarettes possessing various types of paper wrapping materials. See, for example, U.S. Pat. Nos. 1,909,924 to Schweitzer; 4,489,650 to Weinert; 3,030,963 to Cohn; 4,146,040 to Cohn; 4,489,738 to Simon; 4,615,345 to Durocher; 4,607,647 to Dashley; 5,060,675 to Milford et al.; 4,924,888 to Perfetti et al.; 5,145,098 to Rogers et al.; 4,998,543 to Goodman; 5,220,930 to Gentry; and 5,271,419 to Arzonicco et al. Source rear wrapping materials are so-called "banded papers" and possess segments defined by the composition, location and properties of the various materials within those wrapping materials. Numerous references contain disclosures suggesting various banded wrapping material configurations. See, for example, U.S. Pat. Nos. 1,996,002 to Seaman; 2,013,508 to Seaman; 4,452,259 to Norman et al.; 5,417,228 to Baldwin et al.; 5,878,753 to Peterson et al.; 5,878,754 to Peterson et al.; and 6,198,537 to Bokelman et al.; and PCT WO 02/37991. Methods for manufacturing banded-type wrapping materials also have been proposed. See, for example, U.S. Pat. Nos. 4,739,775 to Hampf, Jr.; 5,474,095 to Allen et al.; and PCT WO 02/44700 and PCT WO 02/055294. Some references further describe banded papers having segments of paper, fibrous cellulose material or particulate material adhered to a paper web. See, for example, U.S. Pat. Nos. 5,191,906 to Myrneel, Jr.; 5,263,999 to Baldwin et al.; 5,417,228 to Baldwin et al.; 5,450,863 to Collins et al.; and 6,502,613 to Suzuki. See also U.S. Pat. No. 6,609,999 to Crooks et al., which is incorporated herein by reference.

[0005] Reconstituted tobacco materials have been used as a wrapping material, particularly as an inner wrapping material (e.g., in regions that are overwrapped with at least one further layer of wrapping material), and representative reconstituted tobacco materials useful as wrapping materials for smokable rods are set forth in U.S. Pat. Nos. 5,074,321 to Gentry et al.; 5,159,944 to Arzonicco et al.; 5,261,425 to Raker et al.; 5,462,073 to Bowen; and 5,699,812 to Bowen; which are incorporated herein by reference. Reconstituted tobacco sheets, particularly cast reconstituted tobacco sheets, have been proposed for use as a discontinuous inner wrapper for a cigarette as a means for modifying the burn rate of the cigarette. Such sheet materials, smoking articles made therefrom, and methods of forming such sheet materials are described in U.S. Pat. Nos. 6,705,325 to Hicks et al.; 6,827,087 to Wanna et al.; and U.S. Patent Application Publication Nos. 2004/0177856 to Mon-salud, Jr. et al. and 2005/0056294 to Wanna et al., which are all incorporated herein by reference.

[0006] Activated carbon particles or other adsorbent materials, such as silica gel, can be incorporated into a cigarette filter. Exemplary cigarettes and filters therefor are described in U.S. Pat. Nos. 3,353,543 to Sproull et al. and 4,481,958 to Ranier et al. and in PCT WO 02/37990 to Bereman. Certain commercially available filters have particles or granules of carbon (e.g., an activated carbon material or an activated charcoal material) dispersed within a fibrous material, such as described in U.S. Pat. No. 6,584,979 to Xue et al. Other commercially available filters have so-called "compartment filter" or "triple filter" designs, such as those filters described in U.S. Pat. Nos. 4,163,452 to Green et al.; 5,129,408 to Jakob et al.; and 6,537,186 to Veluz; as well as U.S. Patent Application No. 2003/0106562. European Patent Application 0 579 410 A1 describes a filter including an annular section of carbon particles surrounding a cellulose acetate filter section. U.S. Pat. No. 5,360,023 to Blackley et al. describes a filter comprising a gathered paper that includes a carbonaceous material. Adsorbent materials incorporated into a cigarette filter can be used as a substrate for functional groups, such as described in U.S. Pat. Nos. 6,481,442 to Daykondov et al. and 6,959,218 to Koller et al. Flavorants can be added to activated carbon as described in U.S. Patent Application Publication No. 2003/0159703. Exemplary commercially available filters are available as SCS IV Dual Solid Charcoal Filter from American Filtrana Corp.; Triple Solid Charcoal Filter from FIL International, Ltd.; Triple Component Filter from Baumgartner; and ACT from FIL International, Ltd.

[0007] Cigarette filter elements that incorporate carbon have a propensity to remove certain gas phase components from the mainstream smoke that passes through the filter element during draw by the smoker. Interaction of mainstream smoke with adsorbent substances, such as carbon particles, results in a certain degree of removal of certain gas phase compounds from the smoke. As noted above, such a change in the character of the smoke can result in changes in the sensory properties of the smoke. For example, mainstream tobacco smoke that is filtered using a conventional cigarette filter element incorporating carbon can often be characterized as having slightly metallic, drying and powdery flavor characteristics.
It would be desirable to provide a cigarette manufacturer with a manner or method to produce a cigarette that strikes a favorable balance between controlled burn characteristics resulting from alterations to the wrapping material of the tobacco rod of that cigarette, sensory characteristics during smoking, and filtration of certain gas phase compounds from smoke.

SUMMARY OF THE INVENTION

The present invention provides a cigarette or other smoking article comprising (a) a tobacco rod comprising a smokable filler material contained within a circumscibing outer wrapping material, wherein the smokable filler material comprises at least about 45% by weight flue-cured tobacco based on the total dry weight of the smokable filler material; (b) one or more inner wrapping strips positioned between the tobacco rod and the outer wrapping material and extending longitudinally along the tobacco rod, the inner wrapping strips comprising a tobacco material composed predominately of burley tobacco; and (c) a filter element connected to the tobacco rod, the filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein the filter element comprises at least one fibrous tow section of filter material, a general adsorbent, and an ion exchange resin. Certain embodiments, the combination of a relatively high level of flue-cured tobacco with predominately burley tobacco inner wrapping strips and a filter including a general adsorbent (e.g., activated carbon) and an ion exchange material provides an advantageous blend of desirable qualities, such as acceptable sensory characteristics and the ability to remove certain gas phase constituents from mainstream smoke. Certain embodiments also provide the ability to meet certain cigarette extinction criteria.

The general adsorbent and the ion exchange resin can be dispersed in fibrous tow sections (e.g., plasticized cellulose acetate tow) of the filter element or mixed together in granular form in a compartment formed in the filter. For example, in one embodiment, the filter comprises (i) a first longitudinally extending section of fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod; (ii) a second longitudinally extending section of fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material, the two sections of filter material defining a compartment therebetween; and (iii) a granular mixture of a general adsorbent material and an ion exchange resin contained within said compartment.

The ion exchange resin can be, for example, a strong base anion exchange resin or a weak base anion exchange resin. Exemplary general adsorbents include activated carbon, molecular sieves, clays, activated aluminas, silica gels, meerschaum, and mixtures thereof. A preferred adsorbent is activated carbon having an activity of about 60 to about 150 Carbon Tetrachloride Activity. The particle size of the general adsorbent and the ion exchange resin is typically about 8x16 mesh to about 30x70 mesh.

The inner wrapping strips generally comprise tobacco (e.g., a blend of flue-cured and burley tobacco), a binder, wood pulp, glycerin, and water. Exemplary binders include alkali metal salts of alginate or a cellulose derivative or a mixture thereof, with specific embodiments including sodium alginate, potassium alginate, sodium carboxymethyl cellulose, and mixtures thereof. In a preferred embodiment, the inner wrapping strips comprise 1 to about 8 strips, each strip having a width of about 2 to about 10 mm, more preferably 2 to about 5 strips, each strip having a width of about 2 to about 6 mm.

The smokable filler material preferably comprises at least about 60% by weight of flue-cured tobacco, and typically includes at least one flue-cured tobacco characterized by high threonine concentration. For example, the high threonine flue-cured tobacco could be a tobacco having a threonine concentration of at least about 0.5 mmole per milligram of dry leaf weight.

The smokable filler material used in the invention can comprise an expanded and toasted cereal grain, such as expanded and toasted milo, corn, wheat, rice, rye, millet, oats, or barley. Typically, the cereal grain is present in an amount of up to about 25% by weight, based on the total dry weight of the smokable filler material.

A typical overall length for the filter element is about 15 to about 65 mm, more preferably about 20 to about 40 mm. The length of each of the first and second sections of filter material is typically about 5 to about 20 mm, more preferably about 5 to about 15 mm.

In one embodiment of the invention, the filter element further comprises at least one breakable capsule contained within said at least one section of fibrous tow filter material, preferably in the mouth end section of filter material. The breakable capsule may contain, for example, a flavoring agent.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to assist the understanding of embodiments of the invention, reference will now be made to the appended drawings, which are not necessarily drawn to scale. The drawings are exemplary only, and should not be construed as limiting the invention.

FIG. 1 is an exploded perspective view of a smoking article having the form of a cigarette, showing the smokable material, the outer wrapping material components, and the filter element of the cigarette;

FIG. 2 is a perspective view of a smoking article having a form of a cigarette, wherein the smoking article includes at least one inner wrapping strip according to the invention;

FIG. 3 is a cross-sectional view of the cigarette of FIG. 2 taken along line A-A, the cross-section illustrating the presence of two inner wrapping strips according to the invention;

FIG. 4 is a perspective view of an outer wrapping material adapted for circumscibing a tobacco rod and a plurality of inner wrapping strips placed thereon prior to application of the wrapping material to a tobacco rod;

FIG. 5 is a cross-sectional side view of a cigarette of the invention wherein the filter element comprises a mixture of an adsorbent material and an ion exchange resin positioned within a compartment therein;

FIG. 6 is a cross-sectional side view of a cigarette of the invention wherein the filter element includes a compartment divided by a semi-permeable barrier, wherein one compartment of the divided compartment contains an adsorbent and the second compartment contains an ion-exchange resin;

FIG. 7 is a cross-sectional side view of a cigarette of the invention wherein the filter element includes an ion-exchange resin dispersed within a section of filter material; and

FIG. 8 is a cross-sectional side view of a cigarette of the invention wherein the filter element comprises an adsor-
bent-filled compartment and a breakable capsule contained within the mouth end section of filter material.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] The present inventions now will be described more fully hereinafter with reference to the accompanying drawings. The invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout. As used in this specification and the claims, the singular forms “a,” “an,” and “the” include plural refers unless the context clearly dictates otherwise.

[0027] Referring to FIG. 1, there is shown a smoking article 10 in the form of a cigarette and possessing certain representational components of a smoking article of the present invention. The cigarette 10 includes a generally cylindrical rod 12 of a charge or roll of smokable filler material contained in a circumscripting wrapping material 16. The rod 12 is conventionally referred to as a “tobacco rod.” The ends of the tobacco rod 12 are open to expose the smokable filler material. The cigarette 10 is shown as having one optional band 22 (e.g., a printed coating including a film-forming agent, such as starch, ethylcellulose, or sodium alginate) applied to the wrapping material 16, and that band circumscribes the cigarette rod in a direction transverse to the longitudinal axis of the cigarette. That is, the band 22 provides a cross-directional region relative to the longitudinal axis of the cigarette. The band 22 can be printed on the inner surface of the wrapping material (i.e., facing the smokable filler material), or less preferably, on the outer surface of the wrapping material. Although the cigarette can possess a wrapping material having one optional band, the cigarette also can possess wrapping material having further optional spaced bands numbering two, three, or more.

[0028] At one end of the tobacco rod 12 is the lighting end 18, and at the other end is positioned a filter element 20. The filter element 20 is positioned adjacent to one end of the tobacco rod 12 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 20 may have a generally cylindrical shape, and the diameter thereof may be essentially equal to the diameter of the tobacco rod. The ends of the filter element 20 permit the passage of air and smoke therethrough.

[0029] During use, the smoker lights the lighting end 18 of the cigarette 10 using a match or cigarette lighter. As such, the tobacco rod 12 begins to burn. The mouth end of the cigarette 10 is placed in the lips of the smoker. Thermal decomposition products (e.g., components of tobacco smoke) generated by the burning smokable material are drawn through the cigarette 10, through the filter element 20, and into the mouth of the smoker.

[0030] The filter element 20 includes at least one segment or section of filter material (e.g., plasticized cellulose acetate tow) that is overwrapped along the longitudinally extending surface thereof with circumscripting plug wrap material 26. A typical plug wrap material 26 is a paper material, such as a paper that is porous or non-porous to air flow. The filter element 20 can have two or more segments of filter material, and/or flavor additives incorporated therein.

[0031] The filter element 20 is attached to the tobacco rod 12 by tipping material 28, which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 28 is fixedly secured to the outer surface of the plug wrap 26 and the outer surface of the wrapping material 16 of the tobacco rod using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 30, each of which extend through the tipping material 28 and plug wrap 26. When air diluted, the filter element normally is ventilated to provide a cigarette having an air dilution between about 10 and about 75 percent, preferably about 30 to about 40 percent. As used herein, the term “air dilution” is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and smoke drawn through the cigarette and exiting the extreme mouth end portion of the cigarette. See, Selke, et al., Beitr. Zur Tabak, In., Vol. 4, p. 193 (1978). The perforations 30 can be made by various techniques known to those of ordinary skill in the art. For example, the perforations 30 can be made using mechanical or microlaser offline techniques or using online laser perforation. The ventilation holes 30 may be configured as a single line of perforations extending circumferentially around the filter element 20 or may comprise several lines of perforations. As would be understood, the exact count and size of the ventilation holes 30 will vary depending on the desired level of air dilution.

[0032] The plug wrap 26 can vary. See, for example, U.S. Pat. No. 4,174,719 to Martin. Typically, the plug wrap is a porous or non-porous paper material. Plug wrap materials are commercially available. Exemplary porous plug wrap papers are available from Schweitzer-Maudrit International as Porowrap Plug Wrap 17-M1, 33-M1, 45-M1, 65-M9, 95-M9, 150-M4, 260-M4 and 260-M4T. Non-porous plug wraps exhibit porosities of less than about 10 CORESTA units, and preferably less than about 5 CORESTA units. Exemplary non-porous plug wrap papers are available as Ref. No. 646 Grade from Òlsany Facility (OP Papírna) of the Czech Republic (Trierenberg Holding). Plug wrap paper can be coated, particularly on the surface that faces the filter material, with a layer of a film-forming material. Such a coating can be provided using a suitable polymeric film-forming agent (e.g., ethylcellulose, ethylcellulose mixed with calcium carbonate, or a so-called lip release coating composition of the type commonly employed for cigarette manufacture). Alternatively, a plastic film (e.g., a polypropylene film) can be used as a plug wrap material. For example, non-porous polypropylene materials that are available as ZNA-20 and ZNA-25 from Trofeon Germany GmbH & Co. KG can be employed as plug wrap materials.

[0033] The outer wrapping material 16 of the tobacco rod 12 can have a wide range of compositions and properties. The selection of a particular wrapping material will be readily apparent to those skilled in the art of cigarette design and manufacture. Preferably, the outer wrapping material is a paper material, such as the type of paper material typically used in cigarette manufacture. The outer wrapping material can be composed of materials, or be suitably treated, in order that the wrapping material does not experience a visible staining as a result of contact with components of the smokable material (e.g., aerosol forming material). The porosity of the wrapping material can vary, and frequently is between about 5 CORESTA units and about 100 CORESTA units, often is between about 10 CORESTA units and about 90 CORESTA units, and frequently is between about 20 CORESTA units and about 80 CORESTA units. Exemplary types of wrapping

[0034] The dimensions of a representative cigarette 10 can vary. Preferred cigarettes are rod shaped, and can have diameters of about 7.5 mm (e.g., circumferences of about 20 mm to about 27 mm, often about 22.5 mm to about 25 mm); and can have total lengths of about 70 mm to about 120 mm, often about 80 mm to about 100 mm. The length of the filter element 20 can vary. Typical filter elements can have lengths of about 15 mm to about 65 mm, often about 20 mm to about 40 mm.

[0035] Preferred cigarettes of the present invention exhibit desirable resistance to draw. For example, an exemplary cigarette exhibits a pressure drop of between about 50 and about 200 mm water pressure drop at 17.5 cc/sec. air flow. Preferred cigarettes exhibit pressure drop values of between about 60 mm and about 180, more preferably between about 70 to about 150 mm, water pressure drop at 17.5 cc/sec. air flow. Typically, pressure drop values of cigarettes are measured using a Filtrona Cigarette Test Station (CTIS Series) available from Filtrona Instruments and Automation Ltd. or a Quality Test Module (QTM) available from the Cerulean Division of Molins, PLC.

[0036] Cigarettes of the present invention, when smoked, yield an acceptable number of puffs. Such cigarettes normally provide more than about 6 puffs, and generally more than about 8 puffs, per cigarette, when machine smoked under FTC smoking conditions. Such cigarettes normally provide less than about 15 puffs, and generally less than about 12 puffs, per cigarette, when smoked under FTC smoking conditions. FTC smoking conditions consist of 35 ml puffs of 2 second duration separated by 58 seconds of smolder.

[0037] Cigarettes of the present invention, when smoked, yield mainstream aerosol. The amount of mainstream aerosol that is yielded per cigarette can vary. When smoked under FTC smoking conditions, an exemplary cigarette yields an amount of FTC “tar” that normally is at least about 1 mg, often is at least about 3 mg, and frequently is at least about 5 mg. When smoked under FTC smoking conditions, an exemplary cigarette yields an amount of FTC “tar” that normally does not exceed about 20 mg, often does not exceed about 15 mg, and frequently does not exceed about 12 mg.

Inner Wrapping Strips

[0038] In the present invention, the cigarette 10 further includes one or more inner wrapping strips 34 between the tobacco rod and the outer wrapping paper 16, as shown in FIG. 2. The inner wrapping strips 34 preferably extend along the entire length of the tobacco rod. The inner wrapping strip or strips 34 in the cigarette 10 of the invention can extend continuously around the entire circumference of the tobacco rod. However, it is preferable for the inner wrapping strips 34 to be discontinuous. In one embodiment, the inner wrapping strips 34 comprise 1 to about 8 strips spaced along the periphery of the tobacco rod. The exact location of the individual wrapping strips 34 may vary, but is preferably to space one or more of the inner wrapping strips away from the seam 38 of the cigarette, as shown in FIG. 2.

[0039] A cross-sectional view of FIG. 2 is shown in FIG. 3, where two inner wrapping strips 34 are visible between the tobacco rod 12 and the outer wrapping 16. FIG. 4 illustrates one embodiment of the invention wherein four inner wrapping strips (designated 34a, 34b, 34c, and 34d) are utilized. As shown in FIG. 4, prior to placing the outer wrapper 16 around the tobacco rod 12, the inner wrapping strips can be placed at spaced intervals on a surface of the outer wrapper. The use of inner wrapping strips 34 can be incorporated into the cigarette manufacturing process using equipment and methods described, for example, in U.S. Pat. No. 6,705,325 to Hicks et al. The inner wrapping strips 34 are preferably constructed of a reconstituted tobacco sheet material formed using any of various reconstituted tobacco processes known in the art, such as paper-making processes and cast sheet processes. Preferred embodiments of the inner wrapping strips comprise a binder material, a tobacco material, wood pulp, glycerin, and water. Although other types of tobacco can be used, a blend of flue-cured and burley tobacco (e.g., a 60/40 blend of burley and flue-cured tobacco) is preferred. In particular, the preferred embodiments of the inner wrapping strips 34 comprise about 30 to about 50 percent binder (preferably about 5 to about 10 weight percent), based on the total weight of the inner wrapping strips, about 25 to about 65 percent tobacco material (e.g., tobacco scraps or dust), about 10 to about 15 percent wood pulp, about 13 to about 17 percent glycerin, and the balance water. If a cast sheet method of production is used, the binder content will typically be about 10 to about 40 weight percent, more preferably about 30 to about 40 weight percent. If a paper-making process is utilized, the binder content could be as low as about 2 to about 5 weight percent. In certain embodiments, the tobacco material is present in an amount of about 50 to about 65 weight percent, based on the total weight of the inner wrapping strips, and the tobacco is predominantly burley tobacco, meaning more than 50% by weight of the tobacco material is burley tobacco, more preferably at least 55% by weight, and most preferably at least 60% by weight, based on the total weight of the tobacco material in the inner wrapping strips.

[0040] Preferably, the reconstituted sheet material used as the inner wrapping material is constructed using a cast sheet process, such as the process described in U.S. Patent Application Publication No. 2004/0177856 Monsalud, Jr. et al. The process generally involves forming a mixture having the composition described above and optionally subjecting the mixture to a heat treatment process, such as by heating the mixture to a temperature of about 140° F. (60° C.) to about 200° F. (93° C.) for a period of time of about 30 min. to about 60 min. The heating step may further include an addition of about 1.5 to about 3.5 weight percent potassium hydroxide, based on the weight of the tobacco material, which can facilitate the release of pectin from the tobacco material. The release of pectin can be desirable because pectin helps to maintain adequate cohesiveness within the cast sheet material. Following the optional heating step and treatment with potassium hydroxide, the reconstituted sheet mixture is cast
on a steel belt and dried to a desired moisture level, such as about 8 to about 16% moisture. Thereafter, the dried cohesive sheet material can be captured on a roll and cut into desired widths.

[0041] The width of the inner wrapping strips 34 used in the invention can vary. Typically, the width of each strip will be between about 2 and about 10 mm, more preferably between about 2 and about 6 mm. The overall thickness of the inner wrapping materials may vary, but the inner wrapping strips are typically thicker than the outer wrapper 16. Exemplary thicknesses range from about 80 to about 120 µm.

[0042] The inner wrapping strips 34 of the invention, in certain embodiments, are characterized by the use of a binder in the form of an alkali metal salt, such as an alkali metal salt of alginate or a cellulose derivative (e.g., carboxymethyl cellulose). Examples of alkali metal salt binder materials include sodium alginate, potassium alginate, sodium carboxymethyl cellulose and mixtures thereof. The term “alkali metal” is used herein to refer to metallic elements of Group IA of the Periodic Table of the Elements, including lithium, sodium, potassium, rubidium, cesium, and francium.

[0043] The use of the alkali metal salt binder contributes to a desired total level of alkali metal in the inner wrapping strips 34. It is believed that elevated alkali metal content is desirable in the inner wrapping strips 34 in order to achieve desirable self-extinction rates according to certain test criteria in smoking articles incorporating the strips. As indicated by the examples described below, as alkali metal content of the inner wrapping strips 34 increase, self-extinction rates according to certain test criteria also increase. Embedments of the inner wrapping strips 34 of the present invention exhibit a total alkali metal content of at least about 30,000 µg/g, more preferably at least about 32,000, most preferably at least about 34,000 or at least about 36,000 µg/g, based on the total weight of the inner wrapping strips. Expressed in terms of weight percentage based on total weight of the inner wrapping strips, preferred embodiments contain a total alkali metal content of at least about 8% percent, more preferably at least about 10% percent, most preferably at least about 12% and at least about 15% weight percent. In one preferred embodiment, the total alkali metal content is about 30,000 µg/g to 50,000 µg/g (about 3 to about 5 weight percent), more preferably about 32,000 µg/g to 40,000 µg/g (about 3.2 to about 4 weight percent).

[0044] The desired total alkali metal content of the inner wrapping strips 34 can be achieved using the alkali metal salt binder alone, but in certain embodiments, the alkali metal salt binder is supplemented with one or more alkali metal additives that also contribute alkali metal content to the inner wrapping strips. Exemplary additives include sodium phosphate, sodium hydroxide, potassium hydroxide, sodium carbonate, sodium acetate, sodium oxalate, sodium malate, sodium chloride, and sodium levulinate. The exact amount of secondary alkali metal additives added to the inner wrapping strips will vary depending on the amount of alkali metal salt binder that is present and the desired total alkali metal content. In one embodiment, the secondary alkali metal additive is present at a concentration of about 1 to about 20 weight percent, more preferably about 1 to about 10 weight percent, based on the total weight of the strips 34.

[0045] The inner wrapping strips 34 of the invention exhibit, in certain embodiments, a high ignition temperature, which is believed to correlate favorably to high self-extinction rates as measured using certain test criteria described below. In the preferred embodiments, the inner wrapping strips 34 of the invention exhibit an ignition temperature of at least about 625°C., more preferably at least about 650°C., and most preferably at least about 675°C. The examples appended to this application show that inner wrapping materials 34 having higher ignition temperatures also exhibit higher self-extinction rates according to certain test criteria.

[0046] The overall density of the inner wrapping strips 34 may vary, but typically the basis weight of the inner wrapping strip is between about 70 to about 125 g/m², and preferably about 80 to about 100 g/m². The resulting porosity of the inner wrapping strips 34 is typically less than about 10 Coresta, more preferably less than about 8 Coresta, and most preferably less than about 5 Coresta. The porosity of the inner wrapping strips 34 is preferably very low, and most preferably, the inner wrapping strips exhibit essentially no gas transport properties (i.e., a diffusion capacity of essentially zero).

[0047] Inner wrapping materials, smoking articles made therewith, and methods of their manufacture described generally in the following references may find use in certain embodiments of the present invention: U.S. application Ser. No. 11/327,837 to Mua et al.; U.S. Pat. Nos. 6,705,325 to Hicks et al.; 6,827,087 to Wang et al.; and U.S. Patent Appl. No. 2005/0056294 to Wang et al., all of which are incorporated by reference herein.

[0048] Certain preferred inner wrapping strips 34 used in carrying out the present invention are useful for the manufacture of cigarettes designed to exhibit reduced ignition propensity. That is, cigarettes incorporating certain inner wrapping materials, when placed on a flammable substrate, tend to self-extinguish before burning that substrate. Of particular interest are those cigarettes possessing tobacco rods manufactured using an appropriate number and configuration of inner wrapping strips 34, having sufficient sodium or other alkali metal content, so as to have the ability to meet certain cigarette extinction criteria. Certain cigarettes of the present invention possessing tobacco rods manufactured using inner wrapping strips 34 of the present invention, when tested using the methodology set forth in ASTM E 2187-02b, Standard Method for Measuring the Ignition Strength of Cigarettes (ASTM Int. 2002), using 10 layers of Whatman No. 2 filter paper, meet criteria requiring extinction of greater than about 50 percent, preferably greater than about 75 percent, more preferably greater than about 80 percent, most preferably greater than about 85 percent, and in some cases, greater than about 90 or about 95 percent or even about 100 percent, of cigarettes tested. This percentage is also referred to herein as the “self-extinction rate.”

[0049] Both the outer wrapping material and the inner wrapping strips may comprise additives or fillers imbedded or dispersed therein. Exemplary fillers or additives are in the form of essentially water insoluble particles. The filler or additive materials may incorporate inorganic components. The fillers or additives may comprise catalysts or adsorbent materials capable of adsorbing or reacting with vapor phase components of mainstream smoke. Calcium salts are particularly preferred. One exemplary filler material has the form of calcium carbonate, and the calcium carbonate most preferably is used in particulate form. See, for example, U.S. Pat. No. 4,805,644 to Hampf; U.S. Pat. No. 5,161,551 to Sanders; and U.S. Pat. No. 5,263,500 to Baldwin et al.; and PCT WO 01/48,316. Other filler or additive materials include agglomerated calcium carbonate particles, calcium tartrate particles, magnesium oxide particles, iron oxide particles, magnesium
hydroxide gels; magnesium carbonate-type materials, clays, diatomaceous earth materials, titanium dioxide particles, gamma alumina materials and calcium sulfate particles. The filler can be selected so as to impart certain beneficial characteristics to the wrapping material, such as modification of combustion properties or the ability to adjust the character and content of mainstream smoke (e.g., by adsorption of certain compounds).

Smokable Filler Material

[0050] The smokable materials used in the tobacco rod 12 of the smoking article 10 of the invention are typically composed predominantly of tobacco of some form, based on the dry weights of those materials. That is, the majority of the dry weight of those materials, and the majority of the weight of a mixture incorporating those materials (including a blend of materials, or materials having additives applied thereto or otherwise incorporated therein) can be provided by tobacco of some form. For example, those materials can be processed tobaccos that incorporate minor amounts of non-tobacco filler materials (e.g., calcium carbonate particles, carbonaceous materials, grains or wood pulp) and/or binding agents (e.g., guar gum, sodium alginate or ammonium alginate); and/or a blend of those materials can incorporate tobacco substitutes or extenders. Those materials, and blends incorporating those materials, frequently are composed of greater than about 70 percent tobacco, often are greater than about 80 percent tobacco, and generally are greater than about 90 percent tobacco, on a dry weight basis, based on the combined weights of the tobacco, non-tobacco filler material, and non-tobacco substitute or extender. Those materials also can be composed of virtually all tobacco material, and not incorporate any non-tobacco fillers, substitutes or extenders.

[0051] Smokable materials typically are used in forms, and in manners, that are traditional for the manufacture of smoking materials, such as cigarettes. Those materials can incorporate shredded or particulate pieces of tobacco (e.g., as lamina and/or stem), and/or those materials can be tobacco materials that are in processed forms. For example, those materials normally are used in cut filler form (e.g., shreds or strands of tobacco filler cut into widths of about ¼ inch to about ⅛ inch, preferably about ⅛ inch to about ⅛ inch, and in lengths of about ⅛ inch to about 3 inches, usually about ⅛ inch to about 1 inch). Alternatively, though less preferred, those materials, such as processed tobacco materials, can be employed as longitudinally extending strands or as sheets formed into the desired configuration, or as compressed or extruded pieces formed into a desired shape.

[0052] Tobacco materials can include, or can be derived from, various types of tobaccos, such as flue-cured tobacco, burley tobacco, Oriental tobacco or Maryland tobacco, dark tobacco, dark-fired tobacco and Rustica tobaccos, as well as other rare or specialty tobaccos, or blends thereof. Descriptions of various types of tobaccos, growing practices, harvesting practices and curing practices are set forth in Tobacco Production, Chemistry and Technology, Davis et al. (Eds.) (1999). See, also, U.S. Pat. Application No. 2004/0084056 to Lawson et al. Most preferably, the tobacco materials are those that have been appropriately cured and aged.

[0053] Typically, tobacco materials are used in a so-called "blended" form. For example, certain popular tobacco blends, commonly referred to as "American blends," comprise mixtures of flue-cured tobacco, burley tobacco and Oriental tobacco. Such blends, in many cases, contain tobacco materials that have processed forms, such as processed tobacco stems (e.g., cut-rolled stems, cut-rolled-expanded stems or cut-puffed stems), volume expanded tobacco (e.g., puffed tobacco, such as dry ice expanded tobacco (DIE), preferably in cut filler form). Tobacco materials also can have the form of reconstituted tobaccos (e.g., reconstituted tobaccos manufactured using paper-making type or cast sheet type processes). Tobacco reconstitution processes traditionally convert portions of tobacco that normally might be wasted into commercially useful forms. For example, tobacco stems, recyclable pieces of tobacco and tobacco dust can be used to manufacture processed reconstituted tobaccos of fairly uniform consistency. See, for example, Tobacco Encyclopedia, Voges (Ed.) p. 44-45 (1984), Browne, The Design of Cigarettes, 3rd Ed., p. 43 (1990) and Tobacco Production, Chemistry and Technology, Davis et al. (Eds.) p. 346 (1999). Various representative tobacco types, processed types of tobaccos, types of tobacco blends, cigarette components and ingredients, and tobacco rod configurations, also are set forth in U.S. Pat. Nos. 4,836,224 to Lawson et al.; 4,924,885 to Perfetti et al.; 4,924,888 to Perfetti et al.; 5,056,537 to Brown et al.; 5,159,942 to Brinkley et al.; 5,220,390 to Gentry; 5,360,023 to Blakley et al.; 5,714,844 to Young et al.; 6,730,832 to Dominguez et al.; and 6,701,936 to Shafer et al.; U.S. Patent Application Publication Nos. 2003/0075193 to Li et al; 2003/0131859 to Li et al.; 2004/0084056 to Lawson et al.; 2004/025365 to Perfetti et al.; 2005/0066984 to Crooks et al.; and 2005/0066986 to Nestor et al.; PCT WO 02/37990 to Bereman; and Bombick et al., Fund. Appl. Toxicol., 39, p. 11-17 (1997); which are incorporated herein by reference.

[0054] The smokable material can be treated with tobacco additives of the type that are traditionally used for the manufacture of cigarettes, such as casing and/or top dressing components. See, for example, U.S. Pat. Nos. 3,419,015 to Wochowski; 4,054,145 to Berndt et al.; 4,887,619 to Burcham, Jr. et al.; 5,022,416 to Watson; 5,103,842 to Strong et al.; and 5,711,320 to Martin. Typical casing materials include water, sugars and syrups (e.g., sucrose, glucose and high fructose corn syrup), humectants (e.g. glycerin or propylene glycol), flavoring agents (e.g., cocoa and licorice), and C3-C30 organic acids such as levulinic acid, pyruvic acid, and lactic acid. Those added components also include top dressing materials (e.g., flavoring materials, such as menthol). See, for example, U.S. Pat. No. 4,449,541 to Mays et al. Additives also can be added to the smokable materials using the types of equipment described in U.S. Pat. No. 4,995,405 to Lottau, or that are available as Menthol Application System MAS from Kohl Maschinenbau GmbH. The selection of particular casing and top dressing components is dependent upon factors such as the sensory characteristics that are desired, and the selection and use of those components will be readily apparent to those skilled in the art of cigarette design and manufacture. See, Gutcho, Tobacco Flavoring Substances and Methods, Noyes Data Corp. (1972) and Lellingwell et al., Tobacco Flavoring for Smoking Products (1972).

[0055] As noted above, the smokable material can include non-tobacco filler materials, and such materials preferably have general physical characteristics (e.g., size, shape, weight, density, and the like) that are similar to tobacco cut filler traditionally used for cigarette rod manufacture. The filler material may comprise paper, pulp, wood, plants, and mixtures thereof. The filler material may be woven or non-woven, particulate, shredded, or granular.
Various tobacco substitute materials have been proposed. Substantial listings of various types of tobacco substitute materials can be found in U.S. Pat. Nos. 4,079,742 to Rainier et al. and 4,771,795 to White et al. Certain cigarette-type products that employ non-tobacco materials (e.g., dried vegetable leaves, such as lettuce leaves) as filler that is burned to produce smoke that resembles tobacco smoke have been marketed under the trade names “CUBEBAC,” “TRIUMPH,” “JAZZ,” and “BRAVO.” For example, such materials are described in U.S. Pat. No. 4,700,727 to Torigian. Furthermore, tobacco substitute materials having the trade names “CYTREL” and “NSM” were introduced in Europe during the 1970s. Representative types of proposed synthetic tobacco substitute materials, smokable materials incorporating tobacco and other components, and cigarettes incorporating those materials, are described in British Pat. No. 1,431,045; and U.S. Pat. Nos. 3,738,374 to Bennett; 3,844,294 to Webster; 3,878,850 to Gibson et al.; 3,931,824 to Milano et al.; 3,943,941 to Boyd et al.; 4,044,772 to Boyd et al.; 4,233,993 to Milano et al.; 4,286,604 to Ehretmann et al.; 4,326,544 to Hardwick et al.; 4,920,990 to Lawrence et al.; 5,046,514 to Bolt; 5,074,321 to Gentry et al.; 5,092,353 to Montoya et al.; 5,778,899 to Saito et al.; 6,397,852 to McAdam; and 6,408,856 to McAdam. Furthermore, various types of highly processed smokable materials incorporating tobacco and other ingredients are set forth in U.S. Pat. Nos. 4,825,817 to Luke; 4,874,000 to Tamol et al.; 4,977,908 to Luke; 5,072,744 to Luke et al.; 5,829,453 to White et al. and 6,182,670 to White et al. In certain embodiments of the invention, a non-tobacco filler material in the form of puffed (i.e., expanded) and toasted cereal grains are incorporated into the smokable material in a particulate or shredded form, as described in U.S. Pat. No. 4,534,372 to White, which is incorporated by reference herein. Exemplary cereal grains include milo, corn, wheat, rice, rye, millet, oats, or barley. The puffed and toasted grains are typically used in amounts ranging from 0 to about 25% of the overall dry weight of the charge of smokable material in the tobacco rod, more preferably in an amount of about 5 to about 20% by weight (e.g., 5%, 10%, 15%, or 20%).

One exemplary tobacco blend for use in the present invention comprises, on a dry weight basis, about 10 to about 98 weight percent flue-cured tobacco, about 10 to about 30 weight percent burley tobacco, about 10 to about 30 weight percent Oriental tobacco, about 10 to about 30 weight percent reconstituted flue-cured and/or Oriental tobacco leaf, about 10 to about 50 weight percent expanded flue-cured tobacco lamina, optionally about 5 to about 10 weight percent expanded flue-cured tobacco stems, and a casing material in an amount of about 3 to about 5 weight percent.

It is particularly preferred for the total content of flue-cured tobacco, including all processed forms (e.g., reconstituted forms, expanded forms, stems, etc.), to be at least about 45% by weight, based on the total dry weight of the smokable filler materials, more preferably at least about 50% by weight, and most preferably at least about 55% by weight. In certain embodiments, the flue-cured tobacco is present in an amount of at least about 60% by weight. An exemplary total weight percentage range for flue-cured tobacco in all forms is about 45% to about 80%, more preferably about 60 to about 80%. Tobacco blends incorporating certain amounts of flue-cured tobacco are described in U.S. Pat. No. 4,899,765 to Davis et al. and 4,924,888 to Perfetti et al., which are incorporated herein by reference.

In one exemplary embodiment, at least a portion of the flue-cured tobacco content of the tobacco rod comprises a flue-cured tobacco characterized by a relatively high threonine content. For instance, the tobacco could have a threonine content of at least about 0.5 nmole per milligram of dry leaf weight, more preferably at least about 0.7 nmole/mg, and most preferably at least about 1.3 nmole/mg. High threonine tobaccos are described in U.S. Pat. No. 6,730,832 to Dominguez et al., which is incorporated herein by reference.

The filter element typically comprises multiple longitudinally extending segments. Each segment can have varying properties and may include various materials capable of filtration or adsorption of particulate matter and/or vapor phase compounds. Typically, the filter element of the invention includes 2 to 6 segments, frequently 2 to 4 segments. In one preferred embodiment, the filter element includes a mouth-end segment, a tobacco-end segment, and a compartment therebetween. This filter arrangement is sometimes referred to as a “compartment filter” or a “plug/spacer/plug” filter. The compartment may be divided into two or more compartments as described in greater detail below. In each embodiment shown in FIGS. 5-8, at least one general adsorbent and at least one ion exchange resin are incorporated into the filter element, each being capable of removing at least one gas phase component of mainstream smoke.

Preferably, the general adsorbent material is a material with relatively high surface area capable of adsorbing smoke constituents without a high degree of specificity. Exemplary types of adsorbent include activated carbon, molecular sieves (e.g., zeolites and carbon molecular sieves), clays, activated aluminas, silica gels, meerschaum, and mixtures thereof. The amount of general adsorbent within the filter element typically ranges from about 50 to about 250 mg, often about 60 to about 150 mg, and frequently about 70 to about 120 mg.

In one preferred embodiment, the general adsorbent is activated carbon. The level of activity of the carbon may vary. Typically, the carbon has an activity of about 60 to about 150 Carbon Tetrachloride Activity (i.e., weight percent pickup of carbon tetrachloride). Activated carbon most useful herein consists primarily of carbon, and preferably has a carbon content above about 80 weight percent, and more preferably above about 90 weight percent. Preferred carbonaceous materials are provided by carbonizing or pyrolyzing.

In a preferred embodiment, the tobacco blend comprises, on a dry weight basis, about 10 to about 70 weight percent flue-cured tobacco, about 12 to about 20 weight percent burley tobacco, about 15 to about 20 weight percent Oriental tobacco, about 15 to about 20 weight percent reconstituted flue-cured and/or Oriental tobacco leaf, about 20 to about 30 weight percent expanded flue-cured tobacco lamina, optionally about 10 to about 15 weight percent expanded flue-cured tobacco stems, and a casing material in an amount of about 3 to about 5 weight percent.
bituminous coal, tobacco material, softwood pulp, hardwood pulp, coconut shells, almond shells, grape seeds, walnut shells, macadamia shells, kapok fibers, cotton fibers, cotton linters, and the like. Carbon from almond shells, grape seeds, walnut shells, and macadamia nut shells are particularly preferred and are believed to provide greater vapor phase removal of certain compounds as compared to coconut shell carbon. Examples of suitable carbonaceous materials are activated coconut hull based carbons available from Calgon Corp. as PCB and GRC-11 or from PICA as G277, coal-based carbons available from Calgon Corp. as S-Sorb, Sorbite, BPL, CRC-11F, FCA and SGL, wood-based carbons available from Westvaco as WV-B, SA-20 and BSA-20, carbonaceous materials available from Calgon Corp. as HMC, ASC/GR-I and SC II, Witeco Carbon No. 637, and AMBERSORB 572 or AMBERSORB 563 resins available from Rohm and Haas. Other carbonaceous materials are described in U.S. Pat. Nos. 4,771,795 to White, et al. and 5,027,837 to Clearman, et al.; and European Patent Application Nos. 236,922; 419,733 and 419,981. Certain carbonaceous materials can be impregnated with substances, such as transition metals (e.g., silver, gold, copper, platinum, palladium), potassium bicarbonate, tobacco extracts, polyethyleneimine, manganese dioxide, eugenol, and 4-keratinanonic acid. The carbon composition may also include one or more fillers, such as semolina. Grape seed extracts may also be incorporated into the filter element as a free radical scavenger.


The ion exchange resin 50 can comprise any polymer having active groups in the form of electrically charged sites capable of displacement upon interaction with ions of opposite charge. Typically, the ion exchange resin 50 comprises a polymer backbone, such as styrene-divinylbenzene (DVB) copolymers, acrylates, methacrylates, phenol formaldehyde condensates, and epichlorohydrin amine condensates, and a plurality of electrically charged functional groups attached to the polymer backbone. The ion-exchange resin 50 is preferably a weak base anion exchange resin or a strong base anion exchange resin. Exemplary resins include DIAION® ion-exchange resins available from Mitsubishi Chemical Corp. (e.g., WA30 and DCA11), DUOLITE™ ion exchange resins available from Rohm and Haas (e.g., DUOLITE™ A7), and XORBEX resins available from Dalian Trico Chemical Co. of China. The amount of ion exchange resin 50 within the filter element typically ranges from about 20 to about 200 mg, often about 30 to about 120 mg, and frequently about 40 to about 80 mg.

The form of the general adsorbent 48 and the ion exchange resin 50 may vary. Typically, each is used in granular or particulate solid form having a particle size of between about 8x16 mesh to about 30x70 mesh using the U.S. sieve system. However, smaller or larger particles could be used without departing from the invention. The terms “granular” and “particulate” are intended to encompass both non-spherical shaped particles and spherical particles, such as so-called “beaded carbon” described in WO 03/059096 A1, which is incorporated by reference herein.

The manner in which the general adsorbent 48 and ion exchange resin 50 are incorporated into the filter element may vary. As shown in the appended drawings, granulated general adsorbent material 48 and granulated ion exchange resin 50 can be mixed and placed in a compartment within the filter element. However, either of the adsorbent materials could also be imbedded or dispersed within a section of filter material, such as a fibrous filter material (e.g., cellulose acetate tow), or incorporated into a paper, such as the carbon-containing gathered paper described in U.S. Pat. No. 5,360,023 to Blakley et al. The general adsorbent 48 and/or ion exchange resin 50 can also be incorporated into a nonwoven matrix such as described in U.S. Pat. No. 4,807,809 to Pryor et al., which is incorporated herein by reference. In addition, the adsorbent materials can be placed both in a compartment and imbedded in one or more of the sections of filter material, and the adsorbent material in the compartment and the adsorbent imbedded or dispersed in the filter material can be the same or different.

Various flavorants can also be mixed with the general adsorbent 48 or ion exchange resin 50. Suitable flavorants include any particulate material that generates desirable sensory characteristics during smoking of the cigarette 10. An exemplary particulate flavorant is ground coffee beans.

FIG. 5 illustrates one embodiment of the filter element 20 of the invention comprising a first section of filter material 36, such as a fibrous filter material (e.g., plasticize cellulose acetate tow) and a second section of filter material 40 spaced apart from the first section of filter material. As shown, the first section of filter material 36 is positioned at the mouth end of the filter element 20 and the second section of filter material 40 is positioned proximal to the tobacco rod 12. The space between the first section of filter material 36 and the second section of filter material 40 define a compartment 32. At least a portion of the compartment 32 contains a mixture of a general adsorbent material 48 and an ion exchange resin 50, preferably in granular form. Typically, substantially the entire compartment 32 contains the mixture of adsorbers.

FIG. 6 illustrates an embodiment of the filter element including a compartment 32 divided into two sections by a semi-permeable barrier 42. The compartment of the divided compartment 32 downstream from the semi-permeable barrier 42 contains a general adsorbent 48. The upstream compartment of the compartment 32 contains an ion-exchange resin 50. Alternatively, although not shown, the present invention further includes embodiments wherein the ion-exchange resin 50 is placed in the downstream compartment of the compartment 32 and the general adsorbent 48 is placed in the upstream compartment of the compartment. That is to say, the relative placement of the general adsorbent material 48 and the ion-exchange resin 50 may vary in the present invention.
FIG. 7 illustrates an alternate embodiment wherein the ion-exchange resin 50 is dispersed or imbedded within a section of filter material 40 rather than in a portion of the compartment 32. As noted above, the relative placement of the ion-exchange resin 50 and the general absorbent 48 may vary. As a result, the particles of the ion-exchange resin 50 could alternatively be dispersed within the mouth-end section of filter material 36 or both sections of filter material.

A further embodiment of the filter element 20 of the invention is illustrated in FIG. 8. As shown, this embodiment also includes a compartment 32 between two sections of filter material, 36 and 40. The compartment 32 contains the same mixture of adsorbents, 48 and 50, illustrated in FIG. 5. The mouth-end section of filter material 36 comprises at least one breakable capsule 54 contained therein. The capsule 54 can be simply imbedded in the filter material 36. In the embodiment shown in FIG. 8, the section of filter material 36 comprises an annular outer section 56 and an inner portion 58 that includes a compartment 60 therein adapted for receiving the breakable capsule 54. As shown, one or both ends of the inner portion 58 of the filter material 36 may be crimped to retain the breakable capsule 54 within the filter element 20. Each breakable capsule 54 carries a payload incorporating a compound that is intended to introduce some change to the nature or character of mainstream smoke drawn through that filter element (e.g., a flavoring agent). The smoker may selectively rupture the capsule 54 in order to release the flavoring agent. It is believed that the use of a breakable capsule 54 containing a flavoring agent downstream of the adsorbent material 48 will provide the smoker with the ability to compliment taste attributes of the smoking article. Since the flavoring agent contained in the capsule 54 is downstream of the adsorbent 48, there is minimal interaction with the adsorbent material. The filter element shown in FIG. 10 having a breakable capsule 54 therein can be manufactured as described in U.S. 2004/0261807 to Dube et al., which is incorporated by reference herein.

The tipping material 28 connecting the filter element 20 to the tobacco rod 12 can have indicia (not shown) printed thereon. For example, a band (not shown) can indicate to a smoker the general location or position of the capsule 54 within the filter element 20. These indicia may help the smoker to locate the capsule 54 so that it can be more easily ruptured by squeezing the filter element 20 directly outside the position of the capsule. The indicia on the tipping material 28 may also indicate the nature of the payload carried by the capsule 54. For example, the indicia may indicate that the particular payload is a spearmint flavoring by having a particular color, shape, or design.

If desired, the smoker may rupture the capsule 54 at any time before, during, or even after, the smoking experience. Breakage of the capsule 54 acts to release the contents that are contained and sealed therein. Release of the contents of the capsule 54 into the filter element 20 thus enables the smoker to achieve the intended benefit of action of certain of those contents, whether that benefit results from flavoring or scenting the smoke, cooling or moistening the smoke, freshening the scent of the cigarette butt, or achieving some other goal associated with modifying the overall composition of the smoke or altering the performance characteristics of the cigarette. That is, in highly preferred embodiments, a portion of the payload (e.g., portions of a flavoring agent) that has been released into the filter element 20 is incorporated into each subsequent puff of mainstream smoke that is received through that filter element.

Application of tactile pressure to the capsule 54, for example by a squeezing action provided by the fingers of the smoker to the filter element 20, causes relevant regions of the filter element to deform and hence causes the capsule to rupture and release its payload to the compartment interior 60 of the filter element. The rupture of the capsule 54 can be discerned by an audible pop, snap, or a rapid decrease in the resistance to the pressure applied by the smoker. Rupture of the capsule 54 causes contents of its payload to disperse throughout the compartment 60 and throughout the filter tow material in the outer annular filter section 56. Most preferably, the overall cylindrical shape of the filter element 20 returns to essentially its original shape after the application of pressure to the filter element is ceased.

The compartment 60 that houses the capsule 54 preferably possesses a generally circular and/or conical cross-sectional shape and has a diameter of about 3 mm to about 4 mm at its widest point. However, the walls of the compartment 60 may be defined by compressible and deformable material (e.g., plasticized cellulose acetate), and the compartment may be manufactured so as to have a greater or smaller diameter. Accordingly, the compartment 60 may accept one or more capsules 54 having diameters of at least about 1 mm, typically at least about 2 mm, and often at least about 3 mm. Typically, the capsules 54 have diameters that do not exceed about 6 mm, often do not exceed about 5 mm, and frequently do not exceed about 4.5 mm. Certain preferred capsules 54 have diameters in the range of about 3 mm to about 4 mm in diameter, and certain highly preferred capsules are approximately 3.5 mm in diameter.

The capsule 54 is generally spherical in shape and possesses a rigid outer shell that surrounds an internal payload. The outer shell of the capsule 54 is preferably constructed of a food grade material derived from bovine, piscine or porcine stock. The capsule payload can have a form that can vary; and typically, the payload has the form of a liquid, a gel, or a solid (e.g., a crystalline material or a dry powder). The payload can incorporate components that aid in flavoring or scenting mainstream cigarette smoke. Alternatively, the payload may be a breath-freshening agent for the smoker, a deodorizing agent for the cigarette butt, a moistening or cooling agent for the cigarette smoke, or a composition capable of otherwise altering the nature or character of the cigarette.

In one embodiment, the payload is a mixture of a flavoring and a diluting agent or carrier, such as a triglyceride (e.g., a medium chain triglyceride), and more particularly a food grade mixture of medium chain triglycerides. Flavorings of the payload may be natural or synthetic, and the character of these flavors can be described, without limitation, as fresh, sweet, herbal, confectionary, floral, fruity or spice. Specific types of flavors include, but are not limited to, vanilla, coffee, chocolate, cream, mint, spearmint, menthol, peppermint, wintergreen, lavender, cardamon, nutmeg, cinnamon, clove, cascarilla, sandalwood, honey, jasmine, ginger, anise, sage, licorice, lemon, orange, apple, peach, lime, cherry, and strawberry. See also, Leffingwill et al., Tobacco Flavoring for Smoking Products, R. J. Reynolds Tobacco Company (1972). Flavorings also can include components that are considered moistening, cooling or smoothing agents, such as eucalyptus. These flavors may be provided neat (i.e., alone) or in a composite (e.g., spearmint and menthol, or orange and cin-
namon). Composite flavors may be combined in a single capsule as a mixture, or as components of multiple capsules positioned within the filter element.

[0079] The amount of flavoring and diluting agent within the capsule 54 may vary. In some instances, the diluting agent may be eliminated altogether, and the entire payload can be composed of flavoring agent. Alternatively, the payload can be almost entirely comprised of diluting agent, and only contain a very small amount of relatively potent flavoring agent. In the preferred embodiment using a capsule of approximately 3.5 mm in diameter, the weight of the liquid payload (e.g., flavoring agent and diluting agent) is preferably in the range of about 15 mg to about 25 mg, and more preferably in the range of about 20 mg to about 22 mg. The preferred composition of the mixture of flavoring and diluting agent is in the range of about 5 percent to about 25 percent flavoring, and more preferably in the range of about 10 to about 15 percent flavoring, by weight based on the total weight of the payload, with the balance being diluting agent.

[0080] Cigarettes and cigarette filters of the present invention can incorporate those types of capsules set forth in, for example, U.S. Pat. No. 2,755,206 to Statia; Sr.: 3,339,558 to Waterbury; 3,566,121 to Carty; 3,390,686 to Irby, Jr. et al.; 3,428,049 to Leake; 5,547,130 to Harlow et al.; 3,575,180 to Carty; 3,602,231 to Dock; 3,625,228 to Dock; 3,635,226 to Horsewell et al.; 3,685,521 to Dock; 3,916,914 to Brooks et al.; 3,991,773 to Walker; and 4,889,144 to Tatero et al.; U.S. patent application Ser. Nos. 11/234,834 to Thomas et al. and 11/537,812 to Fagg; US Patent Publication Nos. 2006/0272663 to Dube et al., 2006/0293157 to Deal, and 2007/001, 2327 to Karles et al.; PCT WO 2006/136197 and PCT WO 2006/136199, all of which are incorporated by reference herein; as well as those types within filtered cigarettes that have been marketed under the tradenames “Camel Lights with Menthol Boost” by R. J. Reynolds Tobacco Company.

[0081] Certain cigarettes of the invention that include a capsule in the filter element, such as a menthol-containing capsule, produce mainstream smoke following rupture of the capsule (i.e., following release of the payload of the capsule into the filter element) that is characterized by a reduced amount of certain hydroxynbenzenes, such as p-m-cresol and phenol, as compared to cigarettes where the capsule is not ruptured during smoking or cigarettes having flavorings, such as menthol, incorporated into the cigarette in a traditional manner.

[0082] In each embodiment described above, the first section of filter material 36 and the second section of filter material 40 may comprise any filter material capable of filtering particulate matter entrained in mainstream smoke generated by a smoking article. Exemplary filter materials include cellulose acetate tow, gathered cellulose acetate web, polypropylene tow, gathered polypropylene web, gathered polyester web, gathered paper, and strands of reconstituted tobacco. In preferred embodiments, each section of filter material, 36 and 40, comprises a fibrous tow filter material, such as cellulose acetate tow.

[0083] The sections of filter material, 36 and 40, may further include a plasticizing component, such as triacetin or carbowax. In one embodiment, the plasticizer component of the filter material comprises triacetin and carbowax in a 1:1 ratio by weight. The total amount of plasticizer is generally about 4 to about 20 percent by weight, preferably about 6 to about 12 percent by weight.

[0084] Each section or segment of filter material, 36 and 40, can vary in length. Typically, each section of filter material is about 5 to about 20 mm in length, frequently about 5 to about 15 mm in length.

[0085] The particulate removal efficiency of each segment of filter material in the filter element can vary. For fibrous filter materials, particulate removal efficiency is preferably quantified in terms of weight per unit length of the filaments forming the fibers. Exemplary filter materials exhibit a filtration efficiency of about 1.8 to about 10 denier per filament. Each filter segment in a multi-segment filter element can have the same or different filtration efficiency. In one embodiment, the section of filter material 40 proximal to the tobacco rod 12 has a higher particulate removal efficiency than the section of filter material 36 distal from the tobacco rod. For example, the filaments of the tobacco end section of filter material 40 can have a lower weight per unit length than the filaments of the mouth end section of filter material 36. Exemplary filaments for use in the tobacco end section of filter material 40 have a weight per unit length of less than about 2.5 denier per filament, preferably about 1.8 to about 2.5. Exemplary filaments for use in the mouth end section of filter material 36 have a weight per unit length of greater than about 3.0 denier per filament, preferably about 3.0 to about 10.0. Alternatively, the mouth end section of filter material 36 can have higher particular removal efficiency than the tobacco end section of filter material 40.

[0086] In each of the embodiments described above, the compartment 32 formed between the two sections of filter material, 36 and 40, has a length of about 5 to about 50 mm, typically about 5 to about 30 mm, and most typically about 5 to about 10 mm. In those embodiments wherein the compartment 32 is divided into two compartments, the semi-permeable dividing barrier 42 may be any material that is permeable to mainstream smoke, but impermeable to the adsorbent 48 and thus able to retain the adsorbent in a defined portion of the compartment. Exemplary semi-permeable barriers 42 include highly porous paper (e.g., about 100 CORESTA and above) and any of the materials suitable as the sections of filter material, 36 and 40.

[0087] The length of the barrier 42 will vary. Typically, the barrier 42 will have a length of about 0.5 to about 10 mm, more preferably about 0.5 to about 5 mm. Each compartment of the divided compartment 32 will typically have a length of about 5 to about 20 mm, frequently about 5 to about 10 mm.

[0088] If desired, suitable catalytic compounds, e.g., for the conversion of carbon monoxide to carbon dioxide, can be incorporated into one or more segments of the filter element 20. Exemplary catalysts include noble metals (e.g., silver, gold, platinum), metal oxides, ceramics, and mixtures thereof.

[0089] In the embodiment shown in FIG. 2, the ventilation holes 30 are positioned between the approximate midpoint of the adsorbent-containing portion of the compartment 32 and the end of the filter element 20 proximal to the tobacco rod 12. Preferably, ventilation holes 30 are in a position overlying the compartment 32 and preferably positioned between the midpoint of compartment 32 and the end of the compartment adjacent to the second section of filter material 40 upstream from the compartment. Positioning the ventilation holes 30 upstream of at least a portion of the adsorbent-containing compartment 32 can enhance adsorption of certain vapor phase components of mainstream smoke by the adsorbent mixture in the compartment.
The exact distance of the ventilation holes 30 from the end of the filter element 20 proximal to the tobacco rod 12 will vary depending on the length of the individual segments of the filter, such as the segment 40 proximal to the tobacco rod. In certain embodiments, the ventilation holes 30 are about 10 to about 22 mm from the tobacco rod 12, and typically, when the ventilation holes are overlying the adsorbent-containing compartment 32, the holes are within about 5 mm of the section of filter material 40 proximal to the tobacco rod, preferably within about 2 mm.

The production of filter rods, filter rod segments and filter elements, and the manufacture of cigarettes from those filter rods, filter rod segments and filter elements, can be carried out using the types of equipment known in the art for such uses. Multi-segment filter cigarette rods can be manufactured using a cigarette filter rod making device available under the brand name Muli from Hauni-Werke Korber & Co. KG. Six-up rods, four-up filter rods and two-up rods that are conventionally used for the manufacture of filter cigarettes can be handled using conventional-type or suitably modified cigarette rod handling devices, such as tipping devices available as Lab MAX, MAX MAX S or MAX 80 from Hauni-Werke Korber & Co. KG. See, for example, the types of devices set forth in U.S. Pat. Nos. 3,306,606 to Erdmann et al.; 4,281,670 to Heitmann et al.; 4,280,187 to Reuland et al.; and 6,229,115 to Vos et al.

Experimental

The following example is provided to illustrate embodiments of the present invention, and should not be considered to limit the scope thereof. Unless otherwise noted, all parts and percentages are by weight and on a dry basis.

Four filtered cigarettes are constructed and tested to determine the effect of certain design elements on the filtration of certain mainstream smoke components. All four cigarettes have a filter comprising a 2.5 dpf cellulose acetate mouth-end segment having a length of 8 mm, a 7 mm cavity, and a 3.5 dpf cellulose acetate tobacco-end segment having a length of 12 mm. The total rod length for each cigarette is 108 mm.

For Cigarettes A, B, and C, the filter cavity is filled with 70 mg G277 carbon available from PICA (85 Carbon Tetrachloride Activity and 20±50 mesh) and 40 mg of XORBEX resin available from Dalian Tercio Chemical. For Cigarette D, the filter cavity is filled with 110 mg of Sorbite carbon and 40 mg of XORBEX.

For Cigarettes A, B, and D, the tobacco rod comprises a tobacco blend including a total of 63.3% of flue-cured tobacco, 13.4% burley tobacco, and 17.8% of an Oriental tobacco blend. For Cigarette C, the tobacco rod comprises a tobacco blend including a total of 45.5% of flue-cured tobacco, 13.8% burley tobacco, 16.9% of an Oriental tobacco blend, and 20% of a puffed and toasted particulate rice filler. A portion of the flue-cured tobacco in all four cigarettes is a high threonine variety.

Cigarettes B, C, and D all include two diametrically opposed 4 mm strips of an inner wrapping material made using the process described above and including 58.5% by weight of a 60/40 blend of burley and flue-cured tobacco, 15% by weight of binder, 13% by weight glycerin, 12% by weight wood pulp, and 1.5% by weight potassium hydroxide.

Each cigarette is machine smoked to a butt length of about 55 mm. Smoking conditions consist of 45 ml puffs, each of 2 second duration, taking every 40 seconds. Each cigarette yields about 8 to about 10 puffs, on average. For each cigarette, a consistent number of puffs is taken.

All four cigarettes are tested to determine the composition of mainstream smoke during smoking and compared to a commercially available light cigarette (control). The instrumentation and techniques used to identify gas phase components collected under the foregoing smoking conditions are essentially of the type set forth by Gordon, et al., 57th Tobacco Science Research Conference, Vol. 57, Paper No. 65 (Sep. 21-24, 2003).

Surprisingly, the cigarettes combining a burley tobacco-based split inner wrapping material and a combination of an ion exchange resin and activated carbon in the filter reduce certain mainstream smoke components further than the cigarette containing no split inner wrap material. For instance, Cigarettes B, C, and D all reduce nicotine content of the mainstream smoke as compared to Cigarette A and the control cigarette. The cigarettes with the split inner wrapping material also reduce benzo[a]pyrene (BaP) by an average of 19% as compared to the control cigarette, whereas the cigarette without inner wrapping strips does not reduce BaP at all as compared to the control.

Cigarette C containing the puffed and toasted rice component also surprisingly reduces certain smoke components to a greater degree than the other cigarettes. For example, Cigarette C reduces carbon monoxide by about 13% as compared to the control cigarette, while the remaining cigarettes displayed higher CO smoke content. Further, the total amount of hydroxybenzenes (e.g., phenol and cresol) is reduced by Cigarette C, whereas such reduction is not seen with the remaining cigarettes. Additionally, Cigarette C reduces certain nitrosamines to a greater extent than the remaining cigarettes, including a much greater reduction of 4-(methyl)nitrosamine)-1-(3-pyridyl)-1-butanone (NNK) (over 70% as compared to control—whereas remaining cigarettes only reduce by an average of 47%).

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A cigarette comprising:
   (a) a tobacco rod comprising a smokable filler material contained within a circumscribing outer wrapping material, wherein the smokable filler material comprises at least about 45% by weight flue-cured tobacco based on the total dry weight of the smokable filler material;
   (b) one or more inner wrapping strips positioned between said tobacco rod and said outer wrapping material and extending longitudinally along said tobacco rod, said inner wrapping strips comprising a tobacco material, said tobacco material being predominately burley tobacco; and
   (c) a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter...
element comprises at least one fibrous tow section of filter material, a general adsorbent, and an ion exchange resin.

2. The cigarette of claim 1, wherein at least one of said general adsorbent and said ion exchange resin are dispersed in said at least one fibrous tow section of filter material.

3. The cigarette of claim 1, wherein said ion exchange resin is a strong base anion exchange resin or a weak base anion exchange resin.

4. The cigarette of claim 1, wherein said fibrous tow section of filter material is a plasticized cellulose acetate tow.

5. The cigarette of claim 1, wherein said general adsorbent is selected from the group consisting of activated carbon, molecular sieves, clays, activated aluminas, silica gels, meerschaum, and mixtures thereof.

6. The cigarette of claim 1, wherein said general adsorbent is activated carbon.

7. The cigarette of claim 1, wherein said general adsorbent is an activated carbon having an activity of about 60 to about 150 Carbon Tetrachloride Activity.

8. The cigarette of claim 1, wherein said general adsorbent and said ion exchange resin are in granular form.

9. The cigarette of claim 1, wherein each of said general adsorbent and said ion exchange resin has a particle size of about 8x16 mesh to about 30x70 mesh.

10. The cigarette of claim 1, wherein said one or more inner wrapping strips comprise a blend of flue-cured and burley tobacco, a binder, wood pulp, glycerin, and water.

11. The cigarette of claim 10, wherein the binder is an alkali metal salt of alginate or a cellulose derivative or a mixture thereof.

12. The cigarette of claim 11, wherein the binder is selected from the group consisting sodium alginate, potassium alginate, sodium carboxymethyl cellulose, and mixtures thereof.

13. The cigarette of claim 1, wherein said one or more inner wrapping strips comprise 1 to about 8 strips, each strip having a width of about 2 to about 10 mm.

14. The cigarette of claim 13, wherein said one or more inner wrapping strips comprise 2 to about 5 strips, each strip having a width of about 2 to about 6 mm.

15. The cigarette of claim 1, wherein the smokable filler material comprises at least about 55% by weight of flue-cured tobacco.

16. The cigarette of claim 15, wherein the smokable filler material comprises at least about 60% by weight of flue-cured tobacco.

17. The cigarette of claim 1, wherein the smokable filler material comprises at least one flue-cured tobacco characterized by high threonine concentration.

18. The cigarette of claim 17, wherein the high threonine flue-cured tobacco has a threonine concentration of at least about 0.5 milligrams of free threonine per milligram of dry leaf weight.

19. The cigarette of claim 1, wherein the overall length of the filter element is about 15 to about 65 mm.

20. The cigarette of claim 19, wherein the overall length of the filter element is about 20 to about 40 mm.

21. The cigarette of claim 1, wherein said filter element comprises:

(i) a first longitudinally extending section of fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod;

(ii) a second longitudinally extending section of fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material, the two sections of filter material defining a compartment therebetween; and

(iii) a granular mixture of the general adsorbent material and the ion exchange resin contained within said compartment.

22. The cigarette of claim 21, wherein the length of each of the first and second sections of filter material is about 5 to about 20 mm.

23. The cigarette of claim 22, wherein the length of each of the first and second sections of filter material is about 5 to about 15 mm.

24. The cigarette of claim 1, further comprising at least one breakable capsule contained within said at least one section of fibrous tow filter material.

25. The cigarette of claim 24, wherein the breakable capsule contains a flavoring agent.

26. The cigarette of claim 1, wherein the smokable filler material comprises an expanded and toasted cereal grain.

27. The cigarette of claim 26, wherein the cereal grain is selected from the group consisting of milo, corn, wheat, rice, rye, millet, oats, and barley.

28. The cigarette of claim 26, wherein the cereal grain is present in an amount up to about 25% by weight, based on the total dry weight of the smokable filler material.

29. A cigarette comprising:

(a) a tobacco rod comprising a smokable filler material contained within a circumscribing outer wrapping material, wherein the smokable filler material comprises at least about 50% by weight flue-cured tobacco based on the total dry weight of the smokable filler material;

(b) one to about eight inner wrapping strips positioned between said tobacco rod and said outer wrapping material and extending longitudinally along said tobacco rod, each strip having a width of about 2 to about 10 mm and comprising a tobacco material, said tobacco material being predominately burley tobacco; and

(c) a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, said filter element comprising (i) a first longitudinally extending section of fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod; (ii) a second longitudinally extending section of fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod; and (iii) a granular mixture of a general adsorbent material and an ion exchange resin contained within said compartment.

30. The cigarette of claim 29, further comprising at least one breakable capsule contained within said second section of fibrous tow filter material.

31. The cigarette of claim 30, wherein the breakable capsule contains a flavoring agent selected from the group consisting of vanilla, coffee, chocolate, cream, mint, spearmint, menthol, peppermint, wintergreen, lavender, cardamon, nutmeg, cinnamon, clove, cascara, sandalwood, honey, jasmine, ginger, anise, sage, licorice, lemon, orange, apple, peach, lime, cherry, and strawberry.

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