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(54) **AEROSOL-GENERATING ARTICLE WITH TILTED PERFORATION IN VENTILATION ZONE**

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(57) **ABSTRACT**

An aerosol-generating article is provided, including: a rod of aerosol-generating substrate; and a ventilation zone including perforations and being arranged downstream of the rod, the perforations being arranged in a peripheral wall of the ventilation zone, each perforation having a central axis, the aerosol-generating article having a central axis, a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article being between 3% and 15% of an outer diameter of the aerosol-generating article, a thickness of the peripheral wall of the ventilation zone being between 0.1 millimeter and 2.5 millimeters, and the aerosol-generating article having a ventilation level of at least 20%. An aerosol-generating system including an aerosol-generating device having a cavity configured to receive the aerosol-generating article is also provided. A method for manufacturing an aerosol-generating article is also provided.

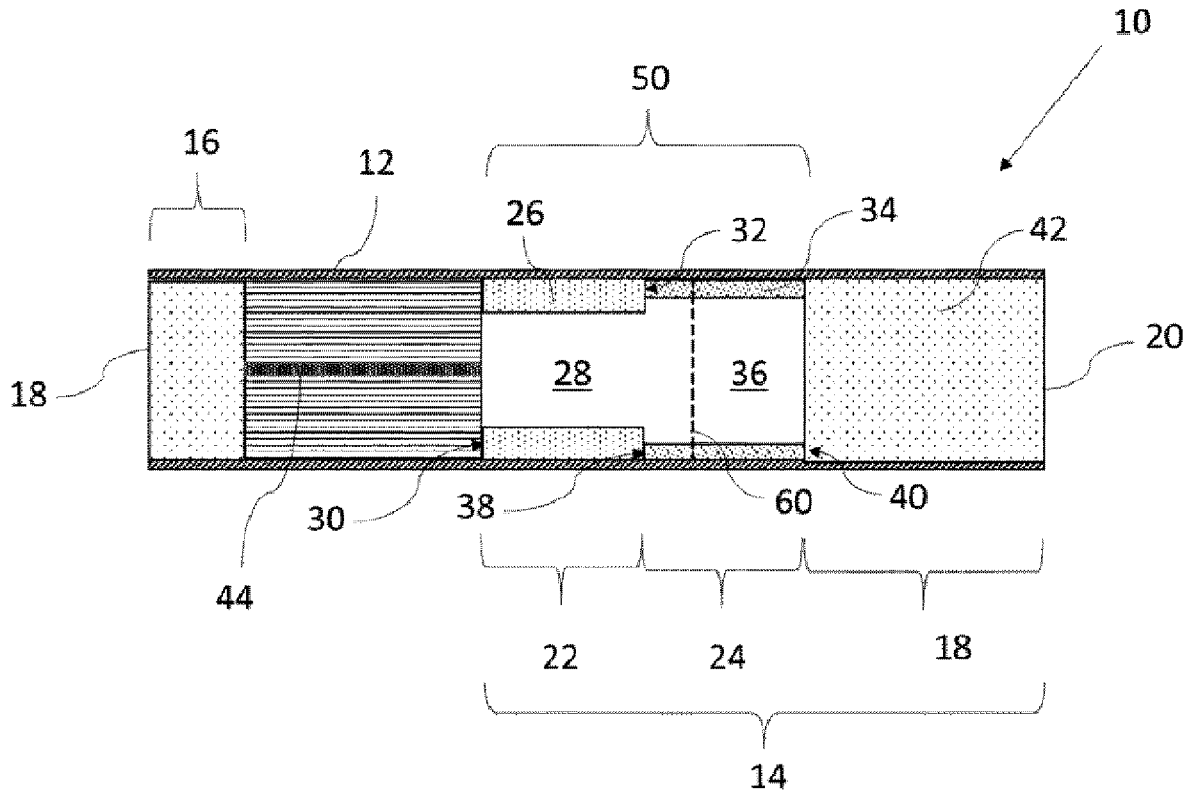


Fig. 1

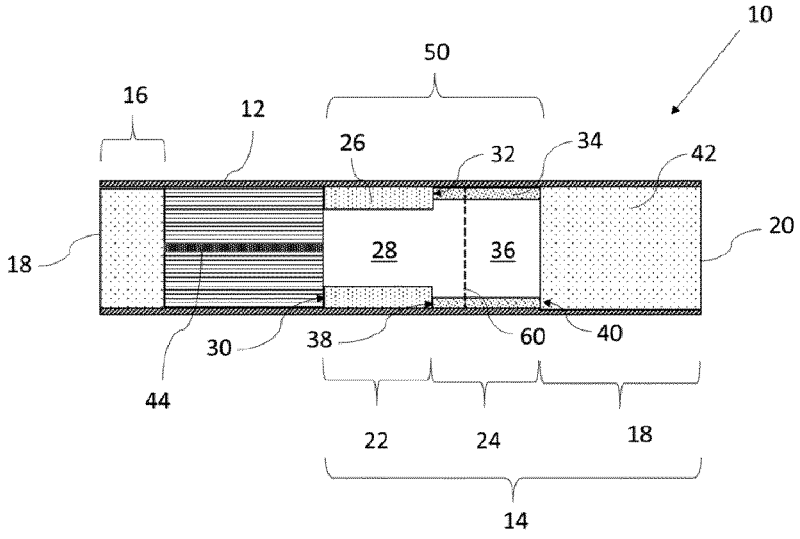
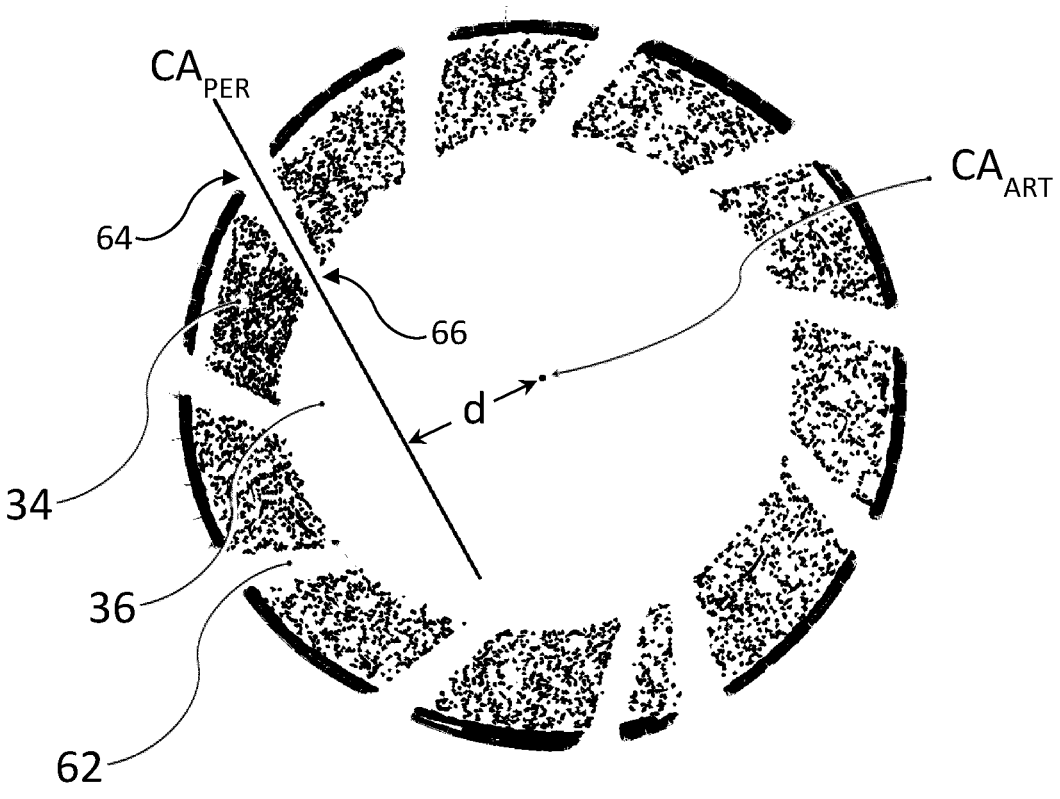


Fig. 2



AEROSOL-GENERATING ARTICLE WITH TILTED PERFORATION IN VENTILATION ZONE

[0001] The present invention relates to an aerosol-generating article. The aerosol-generating article may comprise an aerosol-generating substrate and may be adapted to produce an inhalable aerosol upon heating. The invention further relates to an aerosol-generating system comprising an aerosol-generating device having a cavity for receiving an aerosol-generating article. The invention further relates to a method for manufacturing an aerosol-generating article.

[0002] Aerosol-generating articles in which an aerosol-generating substrate, such as a tobacco-containing substrate, is heated rather than combusted, are known in the art. Typically, in such heated smoking articles an aerosol is generated by the transfer of heat from a heat source to a physically separate aerosol-generating substrate or material, which may be located in contact with, within, around, or downstream of the heat source. During use of the aerosol-generating article, volatile compounds are released from the aerosol-generating substrate by heat transfer from the heat source and are entrained in air drawn through the aerosol-generating article. As the released compounds cool, they condense to form an aerosol.

[0003] A number of prior art documents disclose aerosol-generating devices for consuming aerosol-generating articles. Such devices include, for example, electrically heated aerosol-generating devices in which an aerosol is generated by the transfer of heat from one or more electrical heater elements of the aerosol-generating device to the aerosol-generating substrate of a heated aerosol-generating article. For example, electrically heated aerosol-generating devices have been proposed that comprise an internal heater blade which is adapted to be inserted into the aerosol-generating substrate. As an alternative, inductively heatable aerosol-generating articles comprising an aerosol-generating substrate and a susceptor arranged within the aerosol-generating substrate have been proposed. Alternatively, the susceptor arrangement may be arranged in the aerosol-generating device such as at least partly surrounding a cavity for receiving the aerosol-generating article.

[0004] Aerosol-generating articles in which a tobacco-containing substrate is heated rather than combusted present a number of challenges that were not encountered with conventional smoking articles. First of all, tobacco-containing substrates are typically heated to significantly lower temperatures compared with the temperatures reached by the combustion front in a conventional cigarette. This may have an impact on nicotine release from the tobacco-containing substrate and nicotine delivery to the consumer. At the same time, if the heating temperature is increased in an attempt to boost nicotine delivery, then the aerosol generated typically needs to be cooled to a greater extent and more rapidly before it reaches the consumer. However, technical solutions that were commonly used for cooling the mainstream smoke in conventional smoking articles, such as the provision of a high filtration efficiency segment at the mouth end of a cigarette, may have undesirable effects in an aerosol-generating article wherein a tobacco-containing substrate is heated rather than combusted, as they may reduce nicotine delivery. Secondly, a need is generally felt for aerosol-generating articles that are easy to use and have improved practicality.

[0005] It would be desirable to provide an aerosol-generating article that can be manufactured efficiently and at high speed, preferably with a satisfactory RTD and low RTD variability from one article to another. It would be desirable to provide an aerosol-generating article that provides efficient cooling. It would be desirable to provide an aerosol-generating article that provides efficient cooling of the aerosol. It would be desirable to provide an aerosol-generating article that provides efficient cooling of the vaporized aerosol-forming substrate. It would be desirable to provide an aerosol-generating article that provides efficient mixing of ambient air with the vaporized aerosol-forming substrate.

[0006] It would be desirable to provide a new and improved aerosol-generating article adapted to achieve at least one of the desirable results described above.

[0007] According to an embodiment of the invention there is provided an aerosol-generating article that may comprise a rod of aerosol-generating substrate. The aerosol-generating article may further comprise a ventilation zone arranged downstream the rod of aerosol-generating substrate. The ventilation zone may comprise perforations. The perforations may be arranged in a peripheral wall of the ventilation zone. Each perforation may have a central axis. The aerosol-generating article may have a central axis. A smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article may be between 3% and 15% of the outer diameter of the aerosol-generating article. A thickness of the peripheral wall of the ventilation zone may be between 0.1 millimeter and 2.5 millimeter.

[0008] According to an embodiment of the invention there is provided an aerosol-generating article comprising a rod of aerosol-generating substrate. The aerosol-generating article further comprises a ventilation zone arranged downstream the rod of aerosol-generating substrate. The ventilation zone comprises perforations. The perforations are arranged in a peripheral wall of the ventilation zone. Each perforation has a central axis. The aerosol-generating article has a central axis. A smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article. A thickness of the peripheral wall of the ventilation zone is between 0.1 millimeter and 2.5 millimeter.

[0009] In other words, the extension direction of the perforations may be tilted with respect to the radial extension direction of the aerosol-generating article.

[0010] Having a ventilation zone with perforations may enable that ambient air is drawn into the ventilation zone. This ambient air may mix with air drawn through the rod of aerosol-forming substrate. The rod of aerosol-forming substrate may be heated by an aerosol-generating device so that the aerosol-forming substrate is volatilized. The volatilized aerosol-forming substrate may be entrained in the air flowing through the rod of aerosol-forming substrate. This airflow mixes with the ambient air downstream of the rod of aerosol-forming substrate in the ventilation zone. The mix of ambient air with the air drawn through the rod of aerosol-forming substrate cools down to form an aerosol.

[0011] This tilt of the perforations may lead to a turbulent flow of the ambient air being drawn into the ventilation zone via the perforations. This may improve the mixing of the ambient air with the air being drawn through the rod of aerosol-forming substrate. This, in turn, may lead to an improved aerosol generation.

[0012] A central axis of an individual perforation may be defined by the axis running through a peripheral cross-sectional center of the perforation and an inner cross-sectional center of the perforation. The peripheral cross-sectional center of the perforation may be the cross-sectional center of the perforation at the outermost opening area of the perforation. The inner cross-sectional center of the perforation may be the cross-sectional center of the perforation at the innermost opening area of the perforation.

[0013] The perforations have an extension or length as described herein. The extension is created by a relatively large thickness of the peripheral wall of the ventilation zone, since the perforations perforate the peripheral wall of the ventilation zone. Due to the extension of the perforations, the cross-sectional shape of the perforations may change over the extension of the perforation. Further, the perforations may be tilted due to the extension of the perforation. The extension of the perforations is of the same magnitude than a diameter of the perforations. As a consequence, the direction of extension may influence the airflow through the perforations, particularly change the direction of the airflow through the perforations. As described herein, a turbulent airflow can be created by tilting the extension direction of the perforations with respect to the cross-sectional center of the ventilation zone.

[0014] A smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article may be between 3% and 15% of the outer diameter of the aerosol-generating article, preferably between 4% and 13% of the outer diameter of the aerosol-generating article, more preferably between 5% and 10% of the outer diameter of the aerosol-generating article, most preferably 6% of the outer diameter of the aerosol-generating article.

[0015] Having a larger distance between the central axis of each perforation and the central axis of the aerosol-generating article may increase the turbulence in the ambient air being drawn through the perforations and may therefore increase the mixing of the ambient air with the air drawn through the rod of aerosol-forming substrate.

[0016] Each central axis of each perforation may be angled with respect to a radial direction of the aerosol-generating article by an angle of between 3° and 20°, preferably by an angle of between 4° and 15°, more preferably by an angle of between 5° and 10°, most preferably by an angle of 7°.

[0017] This tilting of the orientation of the perforations with respect to the cross-sectional center of the ventilation area may lead to a turbulent airflow of the ambient air being drawn through the perforations. This turbulent airflow may increase the mixing of ambient air with air drawn through the rod of aerosol-forming substrate.

[0018] Each perforation may have a length or extension measured along the central axis of the perforation. One or more perforations may have a length of at least 0.1 millimeter and 2.7 millimeter, preferably between 0.8 millimeter and 2.4 millimeter, more preferably between 1.2 millimeter and 2.0 millimeter, most preferably around 1.7 millimeter. The length of a perforation is preferably slightly larger than the thickness of the peripheral wall of the ventilation zone due to the tilted extension of the perforation.

[0019] The length of a perforation may result in the perforation influencing the airflow through the perforation. The airflow can be directed by the shape of the perforation. A tilting of the perforation as described herein may lead to a turbulent airflow when the air exits the perforation.

[0020] In one embodiment, all perforations are tilted in the same direction. All perforations may be tilted with the same angle with respect to the radial direction. This may create a spiral turbulent airflow enhancing mixing of ambient air with the air drawn through the rod of aerosol-forming substrate.

[0021] The cross-sectional shape of one or more perforations may be unchanged along the central axis of the perforations. One or more perforations may have a cylindrical shape. One or more perforations may have a hollow cylindrical shape. One or more perforations may have a hollow tubular shape.

[0022] One or more of the perforations may have a non-circular cross-section. One or more of the perforations may be slit-shaped or may have an oval cross-section. Preferably, the one or more of the perforations may have an ovality, the ovality being the ratio of a large diameter of a perforation divided by a small diameter of the perforation, of at least 1.5, preferably at least 2, preferably at least 3, more preferably at least 4, most preferably at least 5.

[0023] One or more of the perforations may be slit-shaped or may have an oval cross-section.

[0024] Having a non-circular cross-section may improve the mixing of ambient air being drawn into the ventilation zone via the perforations with the air being drawn into the ventilation zone via the rod of aerosol-forming substrate. The flow of the ambient air being drawn into the ventilation zone may be influenced by the shape of the perforations. The cross-sectional shape of the perforations may be seen in a plane parallel to a central axis of the ventilation zone. The central axis of the ventilation zone is preferably identical to the central axis of the whole aerosol-generating article.

[0025] Between 5 and 15 perforations may be provided in the ventilation zone. Preferably, between 7 and 14 perforations may be provided in the ventilation zone. Preferably, between 9 and 13 perforations may be provided in the ventilation zone. Preferably, between 10 and 12 perforations may be provided in the ventilation zone. Preferably, the number of perforations is 11.

[0026] Having 10 to 12 perforations may improve the mixing of ambient air drawn through the perforations into the ventilation zone with the air drawn into the ventilation zone through the rod of aerosol-forming substrate. This improved mixing may result in an improved aerosol generation. Without being bound to any theory, a number of 10 to 12 perforations have been found to lead to the best mixture of ambient air and air carrying volatilized aerosol-forming substrate. The reason may be that this relatively small number of perforations necessitate relatively large perforations to enable a sufficient amount of ambient air being drawn into the ventilation zone. Relatively large perforation may lead to relatively strong turbulences between the two airflows and thus to an improved mixing of the two airflows.

[0027] The ventilation zone may be arranged in a second hollow tubular segment of an aerosol-cooling element. The second hollow tubular segment may have an inner volume of between 130 mm^3 and 200 mm^3, preferably between 155 mm^3 and 185 mm^3, more preferably of 170 mm^3.

[0028] The second hollow tubular segment may be a hollow inner part of the ventilation zone or adjacent the ventilation zone. air may be drawn through the second

hollow tubular segment. The second hollow tubular segment may be the area in which ambient air is mixed with air drawn through the rod of aerosol-forming substrate. The second hollow tubular segment is preferably the peripheral wall of the ventilation zone.

[0029] The perforations may be arranged in a peripheral wall of the ventilation zone. The perforations may have a non-constant pitch with a coefficient of variation of the pitch of above 5%, preferably above 10%, more preferably above 15%. The coefficient of variation is the ratio of the standard deviation to the mean. The non-constant pitch arrangement of the perforations may be an arrangement with a coefficient of variation of the pitch of below 40%, preferably below 35%, more preferably below 30%.

[0030] In other words, a first pair of adjacent perforations may have a first distance between each other measured along the arc length of the peripheral wall, a second pair of adjacent perforations, different from the first pair, may have a second distance between each other measured along the arc length of the peripheral wall and a third pair of adjacent perforations, different from the first pair and the second pair, may have a third distance between each other measured along the arc length of the peripheral wall. The first distance, the second distance and the third distance may all be different.

[0031] In one embodiment, more than half of the perforations may be arranged in one half of the peripheral wall of the ventilation zone and less than half of the perforations may be arranged in the other half of the peripheral wall of the ventilation zone. In a preferred embodiment, more than two thirds of the perforations may be arranged in one half of the peripheral wall of the ventilation zone and less than one third of the perforations may be arranged in the other half of the peripheral wall of the ventilation zone.

[0032] Having a non-symmetrically arrangement of the perforations may achieve the same quality of mixing of ambient air with air drawn through the rod of aerosol-forming substrate. However, a non-symmetrical arrangement of the perforations may be easier to manufacture or may facilitate higher manufacturing speeds. In more detail, it is difficult to increase the manufacturing speed while maintaining a symmetrical arrangement of the perforations with high quality. It has been found that having perforations with a non-symmetrical arrangement as described herein does not lead to a decrease in quality of the mixing of air or a decrease in quality of aerosol generation.

[0033] The perforations may perforate the peripheral wall. The perforations may penetrate through the peripheral wall.

[0034] The peripheral wall may at least partially surround the ventilation zone. The peripheral wall may fully surround the ventilation zone. The hollow tubular shape of the ventilation zone may be facilitated by the peripheral wall of the ventilation zone. The peripheral wall may abut the ambient environment surrounding the aerosol-generating article. The peripheral wall may abut the hollow interior of the ventilation zone.

[0035] An inner diameter of the hollow tubular ventilation zone may be between 2.5 millimeter and 7.5 millimeter, preferably between 3.5 millimeter and 6.5 millimeter, more preferably between 4.0 millimeter and 6.0 millimeter, more preferably between 4.5 millimeter and 5.5 millimeter, most preferably 5.0 millimeter.

[0036] A thickness of the peripheral wall of the ventilation zone may be between 0.8 millimeter and 2.2 millimeter, more preferably between 1.2 millimeter and 1.8 millimeter, most preferably around 1.5 millimeter.

[0037] The perforations may be arranged in a row. The perforations may be arranged like pearls on a string. The row of perforations may be a ring-shaped arrangement. The row of perforations may be a ring-shaped arrangement with the center being the central axis of the ventilation zone.

[0038] A distance between the perforations of the ventilation zone and a downstream end of the rod of aerosol-generating substrate may be between 1 millimeter and 6 millimeter, preferably between 2 millimeter and 5 millimeter, more preferably between 3 millimeter and 4 millimeter.

[0039] A distance between the perforations of the ventilation zone and a downstream end of the aerosol-generating article may be between 10 millimeter and 26 millimeter, preferably between 12 millimeter and 24 millimeter, more preferably between 14 millimeter and 22 millimeter, most preferably between 16 millimeter and 20 millimeter.

[0040] The arrangement of the perforations in this area of the ventilation zone may improve the aerosol generation. The aerosol generation may be improved by placing the perforations such that an optimized mixing is achieved between the ambient air being drawn in to the ventilation zone through the perforations and the air being drawn into the perforations through the rod of aerosol-forming substrate.

[0041] The perforations may be configured to allow ambient air to be drawn into the ventilation zone.

[0042] A ratio of ambient air drawn into the ventilation zone through the perforations and air drawn into the ventilation zone through the rod of aerosol-forming substrate may be between 5 percent and 75 percent, preferably between 20 percent and 65 percent, more preferably between 30 percent and 60 percent, more preferably between 40 percent and 55 percent, most preferably 50 percent.

[0043] This ration may improve the aerosol formation by achieving a thorough mix of ambient air and air being drawn through the rod of aerosol-forming substrate. This ration may improve the aerosol formation by achieving an optimized cooling of the air being drawn through the rod of aerosol-forming substrate due to mixing this air with ambient air.

[0044] The aerosol-generating article may further comprise a filter plug downstream of the ventilation zone. The resistance to draw (RTD) of the filter plug may be between 5 millimetres H_2O and 80 millimetres H_2O, preferably between 10 millimetres H_2O and 65 millimetres H_2O, more preferably between 15 millimetres H_2O and 50 millimetres H_2O, more preferably between 20 millimetres H_2O and 40 millimetres H_2O, most preferably 30 millimetres H_2O. Generally, the RTD may be measured with one of ISO 6565: 2002 and coresta recommended method Nr. 41.

[0045] The invention further relates to an aerosol-generating system comprising an aerosol-generating device having a cavity for receiving an aerosol-generating article as described herein.

[0046] The invention further relates to a method for manufacturing an aerosol-generating article, wherein the method may comprise the steps of:

[0047] providing a rod of aerosol-generating substrate;

[0048] providing a ventilation zone downstream of the rod of the aerosol-generating substrate; and

[0049] creating perforations in a peripheral wall of the ventilation zone, wherein each perforation has a central

axis, wherein the aerosol-generating article has a central axis, and wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article.

[0050] The invention further relates to a method for manufacturing an aerosol-generating article, wherein the method comprises the steps of:

[0051] providing a rod of aerosol-generating substrate;

[0052] providing a ventilation zone downstream of the rod of the aerosol-generating substrate; and

[0053] creating perforations in a peripheral wall of the ventilation zone, wherein each perforation has a central axis, wherein the aerosol-generating article has a central axis, and wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article.

[0054] The term "aerosol generating article" is used herein to denote an article wherein an aerosol generating substrate is heated to produce and deliver inhalable aerosol to a consumer. As used herein, the term "aerosol generating substrate" denotes a substrate capable of releasing volatile compounds upon heating to generate an aerosol.

[0055] As used herein, the term "aerosol generating device" refers to a device comprising a heater element that interacts with the aerosol generating substrate of the aerosol generating article to generate an aerosol.

[0056] As used herein with reference to the present invention, the term "rod" is used to denote a generally cylindrical element of substantially circular, oval or elliptical cross-section.

[0057] As used herein, the term "longitudinal" refers to the direction corresponding to the main longitudinal axis of the aerosol-generating article, which extends between the upstream and downstream ends of the aerosol-generating article. As used herein, the terms "upstream" and "downstream" describe the relative positions of elements, or portions of elements, of the aerosol-generating article in relation to the direction in which the aerosol is transported through the aerosol-generating article during use.

[0058] During use, air is drawn through the aerosol-generating article in the longitudinal direction. The term "transverse" refers to the direction that is perpendicular to the longitudinal axis. Any reference to the "cross-section" of the aerosol-generating article or a component of the aerosol-generating article refers to the transverse cross-section unless stated otherwise.

[0059] The term "length" denotes the dimension of a component of the aerosol-generating article in the longitudinal direction. For example, it may be used to denote the dimension of the rod or of the elongate tubular segments in the longitudinal direction.

[0060] The aerosol-forming substrate may be a solid aerosol-forming substrate.

[0061] In certain preferred embodiments, the aerosol-forming substrate comprises homogenised plant material, preferably a homogenised tobacco material.

[0062] As used herein, the term "homogenised plant material" encompasses any plant material formed by the agglomeration of particles of plant. For example, sheets or webs of homogenised tobacco material for the aerosol-forming substrates of the present invention may be formed by agglomerating particles of tobacco material obtained by pulverising, grinding or comminuting plant material and optionally one or more of tobacco leaf lamina and tobacco leaf stems. The homogenised plant material may be produced by casting, extrusion, paper making processes or other any other suitable processes known in the art.

[0063] The homogenised plant material can be provided in any suitable form. For example, the homogenised plant material may be in the form of one or more sheets. As used herein with reference to the invention, the term "sheet" describes a laminar element having a width and length substantially greater than the thickness thereof.

[0064] The homogenised plant material may be in the form of a plurality of pellets or granules.

[0065] The homogenised plant material may be in the form of a plurality of strands, strips or shreds. As used herein, the term "strand" describes an elongate element of material having a length that is substantially greater than the width and thickness thereof. The term "strand" should be considered to encompass strips, shreds and any other homogenised plant material having a similar form. The strands of homogenised plant material may be formed from a sheet of homogenised plant material, for example by cutting or shredding, or by other methods, for example, by an extrusion method.

[0066] The tobacco particles may have a nicotine content of at least about 2.5 percent by weight, based on dry weight. More preferably, the tobacco particles may have a nicotine content of at least about 3 percent, even more preferably at least about 3.2 percent, even more preferably at least about 3.5 percent, most preferably at least about 4 percent by weight, based on dry weight.

[0067] The aerosol-forming substrate may further comprise one or more aerosol formers. Upon volatilisation, an aerosol former can convey other vaporised compounds released from the aerosol-forming substrate upon heating, such as nicotine and flavourants, in an aerosol. Suitable aerosol formers for inclusion in the homogenised plant material are known in the art and include, but are not limited to: polyhydric alcohols, such as triethylene glycol, propylene glycol, 1,3-butanediol and glycerol; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate.

[0068] The aerosol-forming substrate may have an aerosol former content of between about 5 percent and about 30 percent by weight on a dry weight basis, such as between about 10 percent and about 25 percent by weight on a dry weight basis, or between about 15 percent and about 20 percent by weight on a dry weight basis.

[0069] For example, if the substrate is intended for use in an aerosol-generating article for an electrically-operated aerosol-generating system having a heating element, it may preferably include an aerosol former content of between about 5 percent to about 30 percent by weight on a dry weight basis. If the substrate is intended for use in an aerosol-generating article for an electrically-operated aerosol-generating system having a heating element, the aerosol former is preferably glycerol.

[0070] The aerosol-forming substrate may comprise a gel composition that includes an alkaloid compound, or a cannabinoid compound, or both an alkaloid compound and a cannabinoid compound. In particularly preferred embodiments, the aerosol-forming substrate comprises a gel composition that includes nicotine.

[0071] Preferably the gel composition includes nicotine.

[0072] The aerosol-generating article may comprise a substrate wrapper at least partly circumscribing the aerosol-forming substrate. The substrate wrapper may comprise one or more layers having the same length in a longitudinal direction of the aerosol-generating article. The substrate wrapper may have a thickness of between 30 and 45 micrometers. Preferably, however, the substrate wrapper may have a thickness of 50 micrometers or more.

[0073] The substrate wrapper may have a thickness of 60 micrometers or more, preferably 65 micrometers or more, more preferably 75 micrometers or more, more preferably 80 micrometers or more, more preferably 90 micrometers or more, more preferably 100 micrometers or more, more preferably 110 micrometers or more, more preferably 120 micrometers or more, more preferably 130 micrometers or more, more preferably 140 micrometers or more, more preferably 145 micrometers or more, more preferably 150 micrometers or more. The substrate wrapper may have a thickness of about 148 micrometers. The substrate wrapper may have a thickness of between 143 micrometers and 153 micrometers. The substrate wrapper may have a thickness of between 140 micrometers and 160 micrometers.

[0074] The orientation of the perforation according to the present invention may be preferred when the tobacco plug is thin (i.e. when the rod of aerosol-forming substrate has a relatively low radial thickness) compared to the external diameter of the aerosol-generating article. This is particularly the case when the substrate wrapper is thick as described herein (i.e. when the substrate wrapper has a thickness of 50 micrometres or more). This may be because when the airflow is linear while the aerosol-generating substrate does not take the whole diameter of the stick a different mixing with the air coming from the ventilation may be needed.

[0075] The substrate wrapper may have a density of 800 kilograms per cubic meter or less.

[0076] Preferably, in an aerosol-generating article in accordance with the present invention a susceptor is arranged within the rod of aerosol-forming substrate, and is in thermal contact with the aerosol-forming substrate. Preferably the susceptor is an elongate susceptor.

[0077] As used herein with reference to the present invention, the term "susceptor" refers to a material that can convert electromagnetic energy into heat. When located within a fluctuating electromagnetic field, eddy currents induced in the susceptor cause heating of the susceptor. As the elongate susceptor is located in thermal contact with the aerosol-forming substrate, the aerosol-forming substrate is heated by the susceptor.

[0078] When used for describing the susceptor, the term "elongate" means that the susceptor has a length dimension that is greater than its width dimension or its thickness dimension, for example greater than twice its width dimension or its thickness dimension.

[0079] The susceptor is preferably arranged substantially longitudinally within the rod. This means that the length dimension of the elongate susceptor is arranged to be approximately parallel to the longitudinal direction of the rod, for example within plus or minus 10 degrees of parallel to the longitudinal direction of the rod. In preferred embodiments, the elongate susceptor may be positioned in a radially central position within the rod, and extends along the longitudinal axis of the rod.

[0080] Preferably, the susceptor extends all the way to a downstream end of the rod of aerosol-generating article. In some embodiments, the susceptor may extend all the way to an upstream end of the rod of aerosol-generating article. In particularly preferred embodiments, the susceptor has substantially the same length as the rod of aerosol-forming substrate, and extends from the upstream end of the rod to the downstream end of the rod.

[0081] The susceptor is preferably in the form of a pin, rod, strip or blade.

[0082] The susceptor preferably has a length from about 5 millimetres to about 15 millimetres, for example from about 6 millimetres to about 12 millimetres, or from about 8 millimetres to about 10 millimetres.

[0083] A ratio between the length of the susceptor and the overall length of the aerosol-generating article substrate may be from about 0.2 to about 0.35.

[0084] The susceptor may be formed from any material that can be inductively heated to a temperature sufficient to generate an aerosol from the aerosol-forming substrate. Preferred susceptors comprise a metal or carbon.

[0085] A preferred susceptor may comprise or consist of a ferromagnetic material, for example a ferromagnetic alloy, ferritic iron, or a ferromagnetic steel or stainless steel. A suitable susceptor may be, or comprise, aluminium. Preferred susceptors may be formed from 400 series stainless steels, for example grade 410, or grade 420, or grade 430 stainless steel. Different materials will dissipate different amounts of energy when positioned within electromagnetic fields having similar values of frequency and field strength.

[0086] Thus, parameters of the susceptor such as material type, length, width, and thickness may all be altered to provide a desired power dissipation within a known electromagnetic field. Preferred susceptors may be heated to a temperature in excess of 250 degrees Celsius.

[0087] Suitable susceptors may comprise a non-metallic core with a metal layer disposed on the non-metallic core, for example metallic tracks formed on a surface of a ceramic core. A susceptor may have a protective external layer, for example a protective ceramic layer or protective glass layer encapsulating the susceptor. The susceptor may comprise a protective coating formed by a glass, a ceramic, or an inert metal, formed over a core of susceptor material.

[0088] The susceptor is arranged in thermal contact with the aerosol-forming substrate. Thus, when the susceptor heats up the aerosol-forming substrate is heated up and an aerosol is formed. Preferably the susceptor is arranged in direct physical contact with the aerosol-forming substrate, for example within the aerosol-forming substrate.

[0089] The aerosol-generating article may further comprise a downstream section at a location downstream of the rod of aerosol-forming substrate. The downstream section may comprise an intermediate hollow section comprising an aerosol-cooling element arranged in alignment with, and downstream of the rod of aerosol-forming substrate.

[0090] The downstream section may further comprise one or more downstream elements on top of the aerosol-cooling element. By way of example, the intermediate hollow section may further comprise a support element positioned immediately downstream of the rod of aerosol-forming substrate, and the aerosol-cooling element may be located between the support element and the downstream end (or mouth end) of the aerosol-generating article. In more detail, the aerosol-cooling element may be positioned immediately

downstream of the support element. In some preferred embodiments, the aerosol-cooling element may abut the support element. As will be described below, the downstream section may further comprise one or more elements on top of the intermediate hollow section at a location downstream of the intermediate hollow section.

[0091] The aerosol-cooling element may comprise a hollow tubular segment that defines a cavity extending all the way from an upstream end of the aerosol-cooling element to a downstream end of the aerosol-cooling element and the ventilation zone may be provided at a location along the hollow tubular segment.

[0092] As used herein, the term "hollow tubular segment" is used to denote a generally elongate element defining a lumen or airflow passage along a longitudinal axis thereof. In particular, the term "tubular" will be used in the following with reference to a tubular element having a substantially cylindrical cross-section and defining at least one airflow conduit establishing an uninterrupted fluid communication between an upstream end of the tubular element and a downstream end of the tubular element. However, it will be understood that alternative geometries (for example, alternative cross-sectional shapes) of the tubular element may be possible.

[0093] In the context of the present invention a hollow tubular segment provides an unrestricted flow channel. This means that the hollow tubular segment provides a negligible level of resistance to draw (RTD). The flow channel should therefore be free from any components that would obstruct the flow of air in a longitudinal direction. Preferably, the flow channel is substantially empty.

[0094] When used for describing an aerosol-cooling element, the term "elongate" means that the aerosol-cooling element has a length dimension that is greater than its width dimension or its diameter dimension, for example twice or more its width dimension or its diameter dimension.

[0095] The inventors have found that a satisfactory cooling of the stream of aerosol generated upon heating the aerosol-forming substrate and drawn through one such aerosol-cooling element is achieved by providing a ventilation zone at a location along the hollow tubular segment. Further, the inventors have found that, as will be described in more detail below, especially by arranging the ventilation zone at a precisely defined location along the length of the aerosol-cooling element and by preferably utilising a hollow tubular segment having a predetermined peripheral wall thickness or internal volume, it may be possible to counter the effects of the increased aerosol dilution caused by the admission of ventilation air into the article.

[0096] Without wishing to be bound by theory, it is hypothesised that, because the temperature of the aerosol stream is rapidly lowered by the introduction of ventilation air as the aerosol is travelling towards the mouthpiece segment, the ventilation air being admitted into the aerosol stream at a location relatively close to the upstream end of the aerosol-cooling element (that is, sufficiently close to the susceptor extending within the rod of aerosol-forming substrate, which is the heat source during use), a dramatic cooling of the aerosol stream is achieved, which has a favourable impact on the condensation and nucleation of the aerosol particles. Accordingly, the overall proportion of the aerosol particulate phase to the aerosol gas phase may be enhanced compared with existing, non-ventilated aerosol-generating articles.

[0097] The aerosol-cooling element is arranged substantially in alignment with the rod. This means that the length dimension of the aerosol-cooling element is arranged to be approximately parallel to the longitudinal direction of the rod and of the article, for example within plus or minus 10 degrees of parallel to the longitudinal direction of the rod. In preferred embodiments, the aerosol-cooling element extends along the longitudinal axis of the rod. The longitudinal axis of the rod is preferably identical with the longitudinal axis of the aerosol-generating article. The longitudinal axis of the aerosol-generating article is preferably identical with the central axis of the aerosol-generating article.

[0098] The aerosol-cooling element preferably has an outer diameter that is approximately equal to the outer diameter of the rod of aerosol-forming substrate and to the outer diameter of the aerosol-generating article.

[0099] The aerosol-cooling element may have an outer diameter of between 5 millimetres and 12 millimetres, for example of between 5 millimetres and 10 millimetres or of between 6 millimetres and 8 millimetres. In a preferred embodiment, the aerosol-cooling element has an external diameter of 7.2 millimetres plus or minus 10 percent.

[0100] Preferably, the hollow tubular segment of the aerosol-cooling element has an internal diameter of at least about 2 millimetres. More preferably, the hollow tubular segment of the aerosol-cooling element has an internal diameter of at least about 3.5 millimetres. Even more preferably, the hollow tubular segment of the aerosol-cooling element has an internal diameter of at least about 5 millimetres.

[0101] A peripheral wall of the aerosol-cooling element may have a thickness of less than about 2.5 millimetres, preferably less than 22 millimetres. In particularly preferred embodiments, the peripheral wall of the aerosol-cooling element has a thickness of between 1.2 millimetres and 1.8 millimetres.

[0102] In an embodiment, a peripheral wall of the aerosol-cooling element has a thickness of about 1.5 millimetres.

[0103] the aerosol-cooling element may have a length of less than about 10 millimetres.

[0104] The aerosol-cooling element may have a length of at least about 5 millimetres. Preferably, the aerosol-cooling element has a length of at least about 6 millimetres, more preferably at least about 7 millimetres.

[0105] The aerosol-cooling element may have a length from about 5 millimetres to about 10 millimetres, preferably from about 6 millimetres to about 10 millimetres, more preferably from about 7 millimetres to about 10 millimetres.

[0106] The aerosol-cooling element therefore may have a relatively short length compared to the aerosol-cooling elements of prior art aerosol-generating articles. A reduction in the length of the aerosol-cooling element is possible due to the optimised effectiveness of the hollow tubular segment forming the aerosol-cooling element in the cooling and nucleation of the aerosol. The reduction of the length of the aerosol-cooling element advantageously reduces the risk of deformation of the aerosol-generating article due to compression during use, since the aerosol-cooling element typically has a lower resistance to deformation than the mouthpiece. Furthermore, the reduction of the length of the aerosol-cooling element may provide a cost benefit to the manufacturer since the cost of a hollow tubular segment is typically higher per unit length than the cost of other elements such as a mouthpiece element.

[0107] A ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate may be from about 0.25 to about 1.

[0108] Preferably, a ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate is at least about 0.3, more preferably at least about 0.4, even more preferably at least about 0.5. In preferred embodiments, a ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate is less than about 0.9, more preferably less than about 0.8, even more preferably less than about 0.7.

[0109] A ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate may be from about 0.3 to about 0.9, preferably from about 0.4 to about 0.9, more preferably from about 0.5 to about 0.9. In other embodiments, a ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate is from about 0.3 to about 0.8, preferably from about 0.4 to about 0.8, more preferably from about 0.5 to about 0.8. A ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate is from about 0.3 to about 0.7, preferably from about 0.4 to about 0.7, more preferably from about 0.5 to about 0.7.

[0110] A ratio between the length of the aerosol-cooling element and the length of the rod of aerosol-forming substrate may be about 0.66.

[0111] A ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate may be from about 0.125 to about 0.375.

[0112] Preferably, a ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is at least about 0.13, more preferably at least about 0.14, even more preferably at least about 0.15. A ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is preferably less than about 0.3, more preferably less than about 0.25, even more preferably less than about 0.20.

[0113] A ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.3, more preferably from about 0.14 to about 0.3, even more preferably from about 0.15 to about 0.3. In other embodiments, a ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.25, more preferably from about 0.14 to about 0.25, even more preferably from about 0.15 to about 0.25. In further embodiments, a ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.2, more preferably from about 0.14 to about 0.2, even more preferably from about 0.15 to about 0.2.

[0114] A ratio between the length of the aerosol-cooling element and the overall length of the aerosol-generating article substrate is about 0.18.

[0115] Preferably, the length of the mouthpiece element is at least 1 millimetre greater than the length of the aerosol-cooling element, more preferably at least 2 millimetres greater than the length of the aerosol-cooling element, more preferably at least 3 millimetres greater than the length of the aerosol-cooling element. A reduction in the length of the aerosol-cooling element, as described above, can advantageously allow for an increase in the length of other elements of the aerosol-generating article, such as the mouthpiece element. The potential technical benefits of providing a relatively long mouthpiece element are described above.

[0116] Preferably, in aerosol-generating articles in accordance with the present invention the aerosol-cooling element has an average radial hardness of at least about 80 percent, more preferably at least about 85 percent, even more preferably at least about 90 percent. The aerosol-cooling element is therefore able to provide a desirable level of hardness to the aerosol-generating article.

[0117] If desired, the radial hardness of the aerosol-cooling element of aerosol-generating articles in accordance with the invention may be further increased by circumscribing the aerosol-cooling element by a stiff plug wrap, for example, a plug wrap having a basis weight of at least about 80 grams per square metre (gsm), or at least about 100 gsm, or at least about 110 gsm.

[0118] The aerosol-cooling element may be formed from any suitable material or combination of materials. For example, the aerosol-cooling element may be formed from one or more materials selected from the group consisting of: cellulose acetate; cardboard; crimped paper, such as crimped heat resistant paper or crimped parchment paper; and polymeric materials, such density polyethylene (LDPE). Other suitable materials include as low polyhydroxyalkanoate (PHA) fibres.

[0119] In a preferred embodiment, the aerosol-cooling element is formed from cellulose acetate.

[0120] The ventilation zone comprises a plurality of perforations through the peripheral wall of the aerosol-cooling element. Preferably, the ventilation zone comprises at least one circumferential row of perforations. In some embodiments, the ventilation zone may comprise two circumferential rows of perforations. For example, the perforations may be formed online during manufacturing of the aerosol-generating article. Preferably, each circumferential row of perforations comprises from 8 to 30 perforations. However, it has been found that the specific number of 5 to 15 perforations, 7 to 14 perforations, 9 to 13 perforations, 10 to 12 perforations, particularly the number of 11 perforations, leads to improved aerosol generation.

[0121] Where the aerosol-generating article comprises a combining plug for affixing the aerosol-cooling element to one or more of the other components of the aerosol-generating article, the ventilation zone preferably comprises at least one corresponding circumferential row of perforations provided through a portion of the combining plug wrap. These may also be formed online during manufacture of the smoking article. Preferably, the circumferential row or rows of perforations provided through a portion of the combining plug wrap are in substantial alignment with the row or rows of perforations through the peripheral wall of the aerosol-cooling element. In some embodiments, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is at least about 1 millimetre. Preferably, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is at least about 2 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is at least about 3 millimetres.

[0122] In some embodiments, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is less than or equal to about 6 millimetres. Preferably, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is less than or equal to about 5 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the hollow tubular segment of the aerosol-cooling element is less than or equal to about 4 millimetres.

[0123] A distance between the ventilation zone and a mouth end of the aerosol-generating article is preferably at least about 10 millimetres. More preferably, a distance between the ventilation zone and a mouth end of the aerosol-generating article is at least about 12 millimetres. Even more preferably, a distance between the ventilation zone and a mouth end of the aerosol-generating article is at least about 16 millimetres.

[0124] A distance between the ventilation zone and a mouth end of the aerosol-generating article is preferably less than or equal to about 26 millimetres. More preferably, a distance between the ventilation zone and a mouth end of the aerosol-generating article is less than or equal to about 24 millimetres. Even more preferably, a distance between the ventilation zone and a mouth end of the aerosol-generating article is less than or equal to about 22 millimetres. In particularly preferred embodiments, a distance between the ventilation zone and a mouth end of the aerosol-generating article is less than or equal to about 20 millimetres.

[0125] A distance between the ventilation zone and an upstream end of the downstream section is preferably at least about 6 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the downstream section is at least about 8 millimetres. Even more preferably, a distance between the ventilation zone and an upstream end of the downstream section is at least about 10 millimetres.

[0126] A distance between the ventilation zone and an upstream end of the downstream section is preferably less than or equal to about 20 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the downstream section is less than or equal to about 18 millimetres. Even more preferably, a distance between the ventilation zone and an upstream end of the downstream section is less than or equal to about 16 millimetres.

[0127] A distance between the ventilation zone and a downstream end of the susceptor is preferably at least about 6 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the susceptor is at least about 8 millimetres. Even more preferably, a distance between the ventilation zone and a downstream end of the susceptor is at least about 10 millimetres.

[0128] A distance between the ventilation zone and a downstream end of the susceptor may be between 9 millimetres and 10 millimetres.

[0129] A distance between the ventilation zone and a downstream end of the aerosol-forming substrate may be between 9 millimetres and 10 millimetres.

[0130] A distance between the ventilation zone and a downstream end of the susceptor is preferably less than or equal to about 20 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the susceptor is less than or equal to about 18 millimetres. Even more preferably, a distance between the ventilation zone and a downstream end of the susceptor is less than or equal to about 16 millimetres.

[0131] An aerosol-generating article in accordance with the present invention may have a ventilation level of at least about 5 percent. The term "ventilation level" may also be denoted as "ventilation percentage".

[0132] The term "ventilation level" is used throughout the present specification to denote a volume ratio between the airflow admitted into the aerosol-generating article via the ventilation zone (ventilation airflow) and the sum of the aerosol airflow and the ventilation airflow. The greater the ventilation level, the higher the dilution of the aerosol flow delivered to the consumer.

[0133] Preferably, an aerosol-generating article in accordance with the present invention may have a ventilation level of at least about 10 percent, preferably of at least about 15 percent, more preferably of at least about 20 percent, more preferably of at least about 30 percent, most preferably of at least about 40 percent. In particularly preferred embodiments, an aerosol-generating article in accordance with the present invention has a ventilation level of at least about 25 percent.

[0134] The aerosol-generating article preferably has a ventilation level of less than about 75 percent, preferably of less than about 65 percent, more preferably of less than about 60 percent.

[0135] An aerosol-generating article in accordance with the present invention preferably has a ventilation level of less than or equal to about 45 percent. More preferably, an aerosol-generating article in accordance with the present invention has a ventilation level of less than or equal to about 40 percent, even more preferably less than or equal to about 35 percent.

[0136] In a particularly preferred embodiments, the aerosol-generating article has a ventilation level of about 30 percent.

[0137] In particularly preferred embodiments, the aerosol-generating article has a ventilation level from about 28 percent to about 42 percent. In some particularly preferred embodiments, the aerosol-generating article has a ventilation level of about 30 percent.

[0138] Without wishing to be bound by theory, the inventors have found that the temperature drop caused by the admission of cooler, external air into the hollow tubular segment via the ventilation zone may have an advantageous effect on the nucleation and growth of aerosol particles.

[0139] Formation of an aerosol from a gaseous mixture containing various chemical species depends on a delicate interplay between nucleation, evaporation, and condensation, as well as coalescence, all the while accounting for variations in vapour concentration, temperature, and velocity fields. The so-called classical nucleation theory is based on the assumption that a fraction of the molecules in the gas phase are large enough to stay coherent for long times with sufficient probability (for example, a probability of one half). These molecules represent some kind of a critical, threshold molecule clusters among transient molecular aggregates, meaning that, on average, smaller molecule clusters are likely to disintegrate rather quickly into the gas phase, while larger clusters are, on average, likely to grow. Such critical cluster is identified as the key nucleation core from which droplets are expected to grow due to condensation of molecules from the vapour. It is assumed that virgin

droplets that just nucleated emerge with a certain original diameter, and then may grow by several orders of magnitude. This is facilitated and may be enhanced by rapid cooling of the surrounding vapour, which induces condensation. In this connection, it helps to bear in mind that evaporation and condensation are two sides of one same mechanism, namely gas-liquid mass transfer. While evaporation relates to net mass transfer from the liquid droplets to the gas phase, condensation is net mass transfer from the gas phase to the droplet phase. Evaporation (or condensation) will make the droplets shrink (or grow), but it will not change the number of droplets.

[0140] In this scenario, which may be further complicated by coalescence phenomena, the temperature and rate of cooling can play a critical role in determining how the system responds. In general, different cooling rates may lead to significantly different temporal behaviours as concerns the formation of the liquid phase (droplets), because the nucleation process is typically nonlinear. Without wishing to be bound by theory, it is hypothesised that cooling can cause a rapid increase in the number concentration of droplets, which is followed by a strong, short-lived increase in this growth (nucleation burst). This nucleation burst would appear to be more significant at lower temperatures. Further, it would appear that higher cooling rates may favour an earlier onset of nucleation. By contrast, a reduction of the cooling rate would appear to have a favourable effect on the final size that the aerosol droplets ultimately reach.

[0141] Therefore, the rapid cooling induced by the admission of external air into the hollow tubular segment via the ventilation zone can be favourably used to favour nucleation and growth of aerosol droplets. However, at the same time, the admission of external air into the hollow tubular segment has the immediate drawback of diluting the aerosol stream delivered to the consumer.

[0142] The inventors have surprisingly found that the diluting effect on the aerosol-which can be assessed by measuring, in particular, the effect on the delivery of aerosol former (such as glycerol) included in the aerosol-forming substrate) is advantageously minimised when the ventilation level is within the ranges described above. In particular, ventilation levels between 20 percent and 70 percent, preferably between 25 percent and 50 percent, and even more preferably between 28 and 42 percent, have been found to lead to particularly satisfactory values of glycerin delivery. At the same time, the extent of nucleation and, as a consequence, the delivery of nicotine and aerosol-former (for example, glycerol) are enhanced.

[0143] The inventors have surprisingly found how the favourable effect of enhanced nucleation promoted by the rapid cooling induced by the introduction of ventilation air into the article is capable of significantly countering the less desirable effects of dilution. As such, satisfactory values of aerosol delivery are consistently achieved with aerosol-generating articles in accordance with the invention.

[0144] This is particularly advantageous with "short" aerosol-generating articles, such as ones wherein a length of the rod of aerosol-forming substrate is less than about 40 millimetres, preferably less than 25 millimetres, even more preferably less than 20 millimetres, or wherein an overall length of the aerosol-generating article is less than about 70 millimetres, preferably less than about 60 millimetres, even more preferably less than 50 millimetres. As will be appreciated, in such aerosol-generating articles, there is little time and space for the aerosol to form and for the particulate phase of the aerosol to become available for delivery to the consumer.

[0145] Further, because the ventilated hollow tubular element substantially does not contribute to the overall RTD of the aerosol-generating article, in aerosol-generating articles in accordance with the invention the overall RTD of the article can advantageously be fine-tuned by adjusting the length and density of the rod of aerosol-forming substrate or the length and optionally the length and density of a segment of filtration material forming part of the mouthpiece or the length and density of a segment of filtration material provided upstream of the aerosol-forming substrate and the susceptor. Thus, aerosol-generating articles that have a predetermined RTD can be manufactured consistently and with great precision, such that satisfactory levels of RTD can be provided for the consumer even in the presence of ventilation.

[0146] In aerosol-generating articles in accordance with the present invention the overall RTD of the article depends essentially on the RTD of the rod and optionally on the RTD of the mouthpiece and or upstream plug. This is because the hollow tubular segment of the aerosol-cooling element and the hollow tubular segment of the support element are substantially empty and, as such, substantially only marginally contribute to the overall RTD of the aerosol-generating article.

[0147] In practice, the hollow tubular segment of the aerosol-cooling element may be adapted to generate a RTD in the range of approximately 0 millimetre H_2O (about 0 Pa) to approximately 20 millimetres H_2O (about 200 Pa). Preferably, the hollow tubular segment of the aerosol-cooling element is adapted to generate a RTD between approximately 0 millimetres H_2O (about 0 Pa) to approximately 10 millimetres H_2O (about 100 Pa).

[0148] The downstream section of aerosol-generating articles in accordance with the present invention preferably comprises an intermediate hollow section comprising a support element arranged in alignment with, and downstream of the rod of aerosol-forming substrate. In particular, the support element may be located immediately downstream of the rod of aerosol-forming substrate and may abut the rod of aerosol-forming substrate.

[0149] The support element may be formed from any suitable material or combination of materials. For example, the support element may be formed from one or more materials selected from the group consisting of: cellulose acetate; cardboard; crimped paper, such as crimped heat resistant paper or crimped parchment paper; and polymeric materials, such as low density polyethylene (LDPE). In a preferred embodiment, the support element is formed from cellulose acetate. Other suitable materials include polyhydroxyalkanoate (PHA) fibres.

[0150] The support element may comprise a hollow tubular element. In a preferred embodiment, the support element comprises a hollow cellulose acetate tube.

[0151] The support element is arranged substantially in alignment with the rod. This means that the length dimension of the support element is arranged to be approximately parallel to the longitudinal direction of the rod and of the article, for example within plus or minus 10 degrees of parallel to the longitudinal direction of the rod. In preferred embodiments, the support element extends along the longitudinal axis of the rod.

[0152] The support element preferably has an outer diameter that is approximately equal to the outer diameter of the rod of aerosol-forming substrate and to the outer diameter of the aerosol-generating article.

[0153] The support element may have an outer diameter of between 5 millimetres and 12 millimetres, for example of between 5 millimetres and 10 millimetres or of between 6 millimetres and 8 millimetres. In a preferred embodiment, the support element has an external diameter of 7.2 millimetres plus or minus 10 percent. The support element may have a length of between 5 millimetres and 15 millimetres. In a preferred embodiment, the support element has a length of 8 millimetres.

[0154] A peripheral wall of the support element may have a thickness of at least 1 millimetre, preferably at least about 1.5 millimetres, more preferably at least about 2 millimetres.

[0155] The support element may have a length of between about 5 millimetres and about 15 millimetres.

[0156] Preferably, the support element has a length of at least about 6 millimetres, more preferably at least about 7 millimetres.

[0157] In preferred embodiments, the support element has a length of less than about 12 millimetres, more preferably less than about 10 millimetres.

[0158] In some embodiments, the support element has a length from about 5 millimetres to about 15 millimetres, preferably from about 6 millimetres to about 15 millimetres, more preferably from about 7 millimetres to about 15 millimetres. In other embodiments, the support element has a length from about 5 millimetres to about 12 millimetres, preferably from about 6 millimetres to about 12 millimetres, more preferably from about 7 millimetres to about 12 millimetres. In further embodiments, the support element has a length from about 5 millimetres to about 10 millimetres, preferably from about 6 millimetres to about 10 millimetres, more preferably from about 7 millimetres to about 10 millimetres.

[0159] In a preferred embodiment, the support element has a length of about 8 millimetres. A ratio between the length of the support element and the length of the rod of aerosol-forming substrate may be from about 0.25 to about 1.

[0160] Preferably, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is at least about 0.3, more preferably at least about 0.4, even more preferably at least about 0.5. In preferred embodiments, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is less than about 0.9, more preferably less than about 0.8, even more preferably less than about 0.7.

[0161] In some embodiments, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is from about 0.3 to about 0.9, preferably from about 0.4 to about 0.9, more preferably from about 0.5 to about 0.9. In other embodiments, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is from about 0.3 to about 0.8, preferably from about 0.4 to about 0.8, more preferably from about 0.5 to about 0.8. In further embodiments, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is from about 0.3 to about 0.7, preferably from about 0.4 to about 0.7, more preferably from about 0.5 to about 0.7.

[0162] In a particularly preferred embodiments, a ratio between the length of the support element and the length of the rod of aerosol-forming substrate is about 0.66.

[0163] A ratio between the length of the support element and the overall length of the aerosol-generating article substrate may be from about 0.125 to about 0.375.

[0164] Preferably, a ratio between the length of the support element and the overall length of the aerosol-generating article substrate is at least about 0.13, more preferably at least about 0.14, even more preferably at least about 0.15. A ratio between the length of the support element and the overall length of the aerosol-generating article substrate is preferably less than about 0.3, more preferably less than about 0.25, even more preferably less than about 0.20.

[0165] In some embodiments, a ratio between the length of the support element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.3, more preferably from about 0.14 to about 0.3, even more preferably from about 0.15 to about 0.3. In other embodiments, a ratio between the length of the support element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.25, more preferably from about 0.14 to about 0.25, even more preferably from about 0.15 to about 0.25. In further embodiments, a ratio between the length of the support element and the overall length of the aerosol-generating article substrate is preferably from about 0.13 to about 0.2, more preferably from about 0.14 to about 0.2, even more preferably from about 0.15 to about 0.2.

[0166] In a particularly preferred embodiment, a ratio between the length of the support element and the overall length of the aerosol-generating article substrate is about 0.18.

[0167] Preferably, in aerosol-generating articles in accordance with the present invention the support element has an average radial hardness of at least about 80 percent, more preferably at least about 85 percent, even more preferably at least about 90 percent. The support element is therefore able to provide a desirable level of hardness to the aerosol-generating article.

[0168] If desired, the radial hardness of the support element of aerosol-generating articles in accordance with the invention may be further increased by circumscribing the support element by a stiff plug wrap, for example, a plug wrap having a basis weight of at least about 80 grams per square metre (gsm), or at least about 100 gsm, or at least about 110 gsm.

[0169] During insertion of an aerosol-generating article in accordance with the invention into an aerosol-generating device for heating the aerosol-forming substrate, a user may be required to apply some force in order to overcome the resistance of the aerosol-forming substrate of the aerosol-generating article to insertion. This may damage one or both of the aerosol-generating article and the aerosol-generating device. In addition, the application of force during insertion of the aerosol-generating article into the aerosol-generating device may displace the aerosol-forming substrate within the aerosol-generating article. This may result in the heating element of the aerosol-generating device not being properly aligned with the susceptor provided within the aerosol-forming substrate, which may lead to uneven and inefficient heating of the aerosol-forming substrate of the aerosol-generating article. The support element is advantageously

configured to resist downstream movement of the aerosol-forming substrate during insertion of the article into the aerosol-generating device.

[0170] In aerosol-generating articles in accordance with the present invention the overall RTD of the article depends essentially on the RTD of the rod and optionally on the RTD of the mouthpiece and or upstream plug. This is because the hollow tubular segment of the aerosol-cooling element and the hollow tubular segment of the support element are substantially empty and, as such, substantially only marginally contribute to the overall RTD of the aerosol-generating article.

[0171] In practice, the hollow tubular segment of the support element may be adapted to generate a RTD in the range of approximately 0 millimetre H_2O (about 0 Pa) to approximately 20 millimetres H_2O (about 200 Pa). Preferably, the hollow tubular segment of the support element is adapted to generate a RTD between approximately 0 millimetres H_2O (about 0 Pa) to approximately 10 millimetres H_2O (about 100 Pa).

[0172] In some embodiments wherein the downstream section comprises both a support element comprising a first hollow tube segment and an aerosol-cooling element comprising a second hollow tubular segment, such that the support element and the aerosol-cooling element together define an intermediate hollow section, the internal diameter (D_{STS}) of the second hollow tubular segment is preferably greater than the internal diameter (D_{FTS}) of the first hollow tubular segment.

[0173] In more detail, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably at least about 1.25. More preferably, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably at least about 1.3. Even more preferably, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably at least about 1.4. In particularly preferred embodiments, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is at least about 1.5, more preferably at least about 1.6.

[0174] A ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably less than or equal to about 2.5. More preferably, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably less than or equal to about 2.25. Even more preferably, ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and the internal diameter (D_{FTS}) of the first hollow tubular segment is preferably less than or equal to about 2.

[0175] In those embodiments wherein the article further comprises an elongate susceptor arranged longitudinally within the aerosol-forming substrate, a ratio between the internal diameter (D_{FTS}) of the first hollow tubular segment and a width of the susceptor is preferably at least about 0.2. More preferably, a ratio between the internal diameter (D_{FTS}) of the first hollow tubular segment and a width of the susceptor is at least about 0.3. Even more preferably, a ratio between the internal diameter (D_{FTS}) of the first hollow tubular segment and a width of the susceptor is at least about 0.4.

[0176] In addition, or as an alternative, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and a width of the susceptor is preferably at least about 0.2. More preferably, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and a width of the susceptor is at least about 0.5. Even more preferably, a ratio between the internal diameter (D_{STS}) of the second hollow tubular segment and a width of the susceptor is at least about 0.8.

[0177] Preferably, a ratio between a volume of the cavity of the first hollow tubular segment and a volume of the cavity of the second hollow tubular segment is at least about 0.1. More preferably, a ratio between a volume of the cavity of the first hollow tubular segment and a volume of the cavity of second hollow tubular segment is at least about 0.2. Even more preferably, a ratio between a volume of the cavity of first hollow tubular segment and a volume of the cavity of second hollow tubular segment is at least about 0.3.

[0178] A ratio between a volume of the cavity of the first hollow tubular segment and a volume of the cavity of the second hollow tubular segment is preferably less than or equal to about 0.9. More preferably, a ratio between a volume of the cavity of the first hollow tubular segment and a volume of the cavity of the second hollow tubular segment is preferably less than or equal to about 0.7. Even more preferably, a ratio between a volume of the cavity of the first hollow tubular segment and a volume of the cavity of the second hollow tubular segment is preferably less than or equal to about 0.5.

[0179] In preferred embodiments, the downstream section of aerosol-generating articles according to the invention comprises an intermediate hollow section having both an aerosol-cooling element as described above and a support element, as described above.

[0180] Preferably, the length of the mouthpiece element is at least 0.4 times the total length of the intermediate hollow section, more preferably at least 0.5 times the length of the intermediate hollow section, more preferably at least 0.6 times the length of the intermediate hollow section, more preferably at least 0.7 times the length of the intermediate hollow section.

[0181] The downstream section of the aerosol-generating article of the present invention preferably comprises a mouthpiece element. The mouthpiece element is preferably located at the downstream end or mouth end of the aerosol-generating article. The mouthpiece element preferably comprises at least one mouthpiece filter segment for filtering the aerosol that is generated from the aerosol-forming substrate. For example, the mouthpiece element may comprise one or more segments of a fibrous filtration material. Suitable fibrous filtration materials would be known to the skilled person. Particularly preferably, the at least one mouthpiece filter segment comprises a cellulose acetate filter segment formed of cellulose acetate tow.

[0182] In certain preferred embodiments, the mouthpiece element consists of a single mouthpiece filter segment. In alternative embodiments, the mouthpiece element includes two or more mouthpiece filter segments axially aligned in an abutting end to end relationship with each other.

[0183] In certain embodiments of the invention, the downstream section may comprise a mouth end cavity at the

downstream end, downstream of the mouthpiece element as described above. The mouth end cavity may be defined by a hollow tubular element provided at the downstream end of the mouthpiece. Alternatively, the mouth end cavity may be defined by the outer wrapper of the mouthpiece element, wherein the outer wrapper extends in a downstream direction from the mouthpiece element.

[0184] The mouthpiece element may optionally comprise a flavourant, which may be provided in any suitable form. For example, the mouthpiece element may comprise one or more capsules, beads or granules of a flavourant, or one or more flavour loaded threads or filaments.

[0185] In an aerosol-generating article in accordance with the present invention the mouthpiece element forms a part of the downstream section and is therefore located downstream of the rod of aerosol-forming substrate.

[0186] In certain preferred embodiments, the downstream section of the aerosol-generating article further comprises a support element located immediately downstream of the rod of aerosol-forming substrate. The mouthpiece element is located downstream of the support element. Preferably, the downstream section further comprises an aerosol-cooling element located immediately downstream of the support element. The mouthpiece element is preferably located downstream of both the support element and the aerosol-cooling element. Particularly preferably, the mouthpiece element is located immediately downstream of the aerosol-cooling element. By way of example, the mouthpiece element may abut the downstream end of the aerosol-cooling element.

[0187] Preferably, the mouthpiece element has a low particulate filtration efficiency.

[0188] Preferably, the mouthpiece is formed of a segment of a fibrous filtration material.

[0189] Preferably, the mouthpiece element is circumscribed by a plug wrap. Preferably, the mouthpiece element is unventilated such that air does not enter the aerosol-generating article along the mouthpiece element.

[0190] The mouthpiece element is preferably connected to one or more of the adjacent upstream components of the aerosol-generating article by means of a tipping wrapper.

[0191] Preferably, the mouthpiece element has an RTD of less than about 25 millimetres H_2O. More preferably, the mouthpiece element has an RTD of less than about 20 millimetres H_2O. Even more preferably, the mouthpiece element has an RTD of less than about 15 millimetres H_2O.

[0192] Values of RTD from about 10 millimetres H_2O to about to about 15 millimetres H_2O are particularly preferred because a mouthpiece element having one such RTD is expected to contribute minimally to the overall RTD of the aerosol-generating article substantially does not exert a filtration action on the aerosol being delivered to the consumer.

[0193] The mouthpiece element preferably has an external diameter that is approximately equal to the external diameter of the aerosol-generating article. The mouthpiece element may have an external diameter of between about 5 millimetres and about 10 millimetres, or between about 6 millimetres and about 8 millimetres. In a preferred embodiment, the mouthpiece element has an external diameter of approximately 7.2 millimetres.

[0194] The mouthpiece element preferably has a length of at least about 5 millimetres, more preferably at least about 8 millimetres, more preferably at least about 10 millimetres. Alternatively or in addition, the mouthpiece element preferably has a length of less than about 25 millimetres, more preferably less than about 20 millimetres, more preferably less than about 15 millimetres.

[0195] In some embodiments, the mouthpiece element preferably has a length from about 5 millimetres to about 25 millimetres, more preferably from about 8 millimetres to about 25 millimetres, even more preferably from about 10 millimetres to about 25 millimetres. In other embodiments, the mouthpiece element preferably has a length from about 5 millimetres to about 10 millimetres, more preferably from about 8 millimetres to about 20 millimetres, even more preferably from about 10 millimetres to about 20 millimetres. In further embodiments, the mouthpiece element preferably has a length from about 5 millimetres to about 15 millimetres, more preferably from about 8 millimetres to about 15 millimetres, even more preferably from about 10 millimetres to about 15 millimetres.

[0196] For example, the mouthpiece element may have a length of between about 5 millimetres and about 25 millimetres, or between about 8 millimetres and about 20 millimetres, or between about 10 millimetres and about 15 millimetres. In a preferred embodiment, the mouthpiece element has a length of approximately 12 millimetres.

[0197] In certain preferred embodiments of the invention, the mouthpiece element has a length of at least 10 millimetres. In such embodiments, the mouthpiece element is therefore relatively long compared to the mouthpiece element provided in prior art articles. The provision of a relatively long mouthpiece element in the aerosol-generating articles of the present invention may provide several benefits to the consumer. The mouthpiece element is typically more resilient to deformation or better adapted to recover its initial shape after deformation than other elements that may be provided downstream of the rod of aerosol-forming substrate, such as an aerosol-cooling element or support element. Increasing the length of the mouthpiece element is therefore found to provide for improved grip by the consumer and to facilitate insertion of the aerosol-generating article into a heating device. A longer mouthpiece may additionally be used to provide a higher level of filtration and removal of undesirable aerosol constituents such as phenols, so that a higher quality aerosol can be delivered. In addition, the use of a longer mouthpiece element enables a more complex mouthpiece to be provided since there is more space for the incorporation of mouthpiece components such as capsules, threads and restrictors.

[0198] In particularly preferred embodiments of the invention, a mouthpiece having a length of at least 10 millimetres is combined with a relatively short aerosol-cooling element, for example, an aerosol-cooling element having a length of less than 10 millimetres. This combination has been found to provide a more rigid mouthpiece which reduces the risk of deformation of the aerosol-cooling element during use and to contribute to a more efficient puffing action by the consumer.

[0199] A ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate may be from about 0.5 to about 1.5.

[0200] Preferably, a ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate is at least about 0.6, more preferably at least about 0.7, even more preferably at least about 0.8. In preferred embodiments, a ratio between the length of the mouthpiece

element and the length of the rod of aerosol-forming substrate is less than about 1.4, more preferably less than about 1.3, even more preferably less than about 1.2.

[0201] In some embodiments, a ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate is from about 0.6 to about 1.4, preferably from about 0.7 to about 1.4, more preferably from about 0.8 to about 1.4. In other embodiments, a ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate is from about 0.6 to about 1.3, preferably from about 0.7 to about 1.3, more preferably from about 0.8 to about 1.3. In further embodiments, a ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate is from about 0.6 to about 1.2, preferably from about 0.7 to about 1.2, more preferably from about 0.8 to about 1.2.

[0202] In a particularly preferred embodiments, a ratio between the length of the mouthpiece element and the length of the rod of aerosol-forming substrate is about 1.

[0203] A ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate may be from about 0.2 to about 0.35.

[0204] Preferably, a ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is at least about 0.22, more preferably at least about 0.24, even more preferably at least about 0.26. A ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is preferably less than about 0.34, more preferably less than about 0.32, even more preferably less than about 0.3.

[0205] In some embodiments, a ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is preferably from about 0.22 to about 0.34, more preferably from about 0.24 to about 0.34, even more preferably from about 0.26 to about 0.34. In other embodiments, a ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is preferably from about 0.22 to about 0.32, more preferably from about 0.24 to about 0.32, even more preferably from about 0.26 to about 0.32. In further embodiments, a ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is preferably from about 0.22 to about 0.3, more preferably from about 0.24 to about 0.3, even more preferably from about 0.26 to about 0.3.

[0206] In a particularly preferred embodiment, a ratio between the length of the mouthpiece element and the overall length of the aerosol-generating article substrate is about 0.27.

[0207] The aerosol-generating article may further comprise an upstream section at a location upstream of the rod of aerosol-forming substrate. The upstream section may comprise one or more upstream elements. In some embodiments, the upstream section may comprise an upstream element arranged immediately upstream of the rod of aerosol-forming substrate.

[0208] The aerosol-generating article of the present invention preferably comprise an upstream element located upstream of and adjacent to the aerosol-forming substrate, wherein the upstream section comprises at least one upstream element. The upstream element advantageously prevents direct physical contact with the upstream end of the aerosol-forming substrate. In particular, where the aerosol-forming substrate comprises a susceptor element, the upstream element may prevent direct physical contact with the upstream end of the susceptor element. This helps to prevent the displacement or deformation of the susceptor element during handling or transport of the aerosol-generating article. This in turn helps to secure the form and position of the susceptor element. Furthermore, the presence of an upstream element helps to prevent any loss of the substrate, which may be advantageous, for example, if the substrate contains particulate plant material.

[0209] The upstream element may also provide an improved appearance to the upstream end of the aerosol-generating article. Furthermore, if desired, the upstream element may be used to provide information on the aerosol-generating article, such as information on brand, flavour, content, or details of the aerosol-generating device that the article is intended to be used with.

[0210] The upstream element may be a porous plug element. Preferably, a porous plug element does not alter the resistance to draw of the aerosol-generating article. Preferably, the upstream element has a porosity of at least about 50 percent in the longitudinal direction of the aerosol-generating article. More preferably, the upstream element has a porosity of between about 50 percent and about 90 percent in the longitudinal direction. The porosity of the upstream element in the longitudinal direction is defined by the ratio of the cross-sectional area of material forming the upstream element and the internal cross-sectional area of the aerosol-generating article at the position of the upstream element.

[0211] The upstream element may be made of a porous material or may comprise a plurality of openings. This may, for example, be achieved through laser perforation. Preferably, the plurality of openings is distributed homogeneously over the cross-section of the upstream element.

[0212] The porosity or permeability of the upstream element may advantageously be varied in order to provide a desirable overall resistance to draw of the aerosol-generating article.

[0213] Preferably, the RTD of the upstream element is at least about 5 millimetres H_2O. More preferably, the RTD of the upstream element is at least about 10 millimetres H_2O. Even more preferably, the RTD of the upstream element is at least about 15 millimetres H_2O. In particularly preferred embodiments, the RTD of the upstream element is at least about 20 millimetres H_2O.

[0214] The RTD of the upstream element is preferably less than or equal to about 80 millimetres H_2O. More preferably, the RTD of the upstream element is less than or equal to about 60 millimetres H_2O. Even more preferably, the RTD of the upstream element is less than or equal to about 40 millimetres H_2O.

[0215] In some embodiments, the RTD of the upstream element is from about 5 millimetres H_2O to about 80 millimetres H_2O, preferably from about 10 millimetres H_2O to about 80 millimetres H_2O, more preferably from about 15 millimetres H_2O to about 80 millimetres H_2O, even more preferably from about 20 millimetres H_2O to about 80 millimetres H_2O. In other embodiments, the RTD of the upstream element is from about 5 millimetres H_2O to about 60 millimetres H_2O, preferably from about 10 millimetres H_2O to about 60 millimetres H_2O, more preferably from about 15 millimetres H_2O to about 60 millimetres H_2O, even more preferably from about 20 millimetres H_2O to about 60 millimetres H_2O. In further embodiments, the RTD of the upstream element is from about 5 millimetres H_2O to about

40 millimetres H_2O, preferably from about 10 millimetres H_2O to about 40 millimetres H_2O, more preferably from about 15 millimetres H_2O to about 40 millimetres H_2O, even more preferably from about 20 millimetres H_2O to about 40 millimetres H_2O.

[0216] In alternative embodiments, the upstream element may be formed from a material that is impermeable to air. In such embodiments, the aerosol-generating article may be configured such that air flows into the rod of aerosol-forming substrate through suitable ventilation means provided in a wrapper.

[0217] The upstream element may be made of any material suitable for use in an aerosol-generating article. The upstream element may, for example, be made of a same material as used for one of the other components of the aerosol-generating article, such as the mouthpiece, the cooling element or the support element. Suitable materials for forming the upstream element include filter materials, ceramic, polymer material, cellulose acetate, cardboard, zeolite or aerosol-forming substrate. Preferably, the upstream element is formed from a plug of cellulose acetate.

[0218] Preferably, the upstream element is formed of a heat resistant material. For example, preferably the upstream element is formed of a material that resists temperatures of up to 350 degrees Celsius. This ensures that the upstream element is not adversely affected by the heating means for heating the aerosol-forming substrate.

[0219] Preferably, the upstream element has a diameter that is approximately equal to the diameter of the aerosol-generating article.

[0220] Preferably, the upstream element has a length of between about 1 millimetre and about 10 millimetres, more preferably between about 3 millimetres and about 8 millimetres, more preferably between about 4 millimetres and about 6 millimetres. In a particularly preferred embodiment, the upstream element has a length of about 5 millimetres. The length of the upstream element can advantageously be varied in order to provide the desired total length of the aerosol-generating article. For example, where it is desired to reduce the length of one of the other components of the aerosol-generating article, the length of the upstream element may be increased in order to maintain the same overall length of the article.

[0221] The upstream element preferably has a substantially homogeneous structure. For example, the upstream element may be substantially homogeneous in texture and appearance. The upstream element may, for example, have a continuous, regular surface over its entire cross section. The upstream element may, for example, have no recognisable symmetries.

[0222] The upstream element is preferably circumscribed by a wrapper. The wrapper circumscribing the upstream element is preferably a stiff plug wrap, for example, a plug wrap having a basis weight of at least about 80 grams per square metre (gsm), or at least about 100 gsm, or at least about 110 gsm. This provides structural rigidity to the upstream element.

[0223] The aerosol-generating article may have a length from about 35 millimetres to about 100 millimetres.

[0224] Preferably, an overall length of an aerosol-generating article in accordance with the invention is at least about 38 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is at least about 40 millimetres. Even more preferably, an overall length of an aerosol-generating article in accordance with the invention is at least about 42 millimetres.

[0225] An overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 70 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 60 millimetres. Even more preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 50 millimetres.

[0226] In some embodiments, an overall length of the aerosol-generating article is preferably from about 38 millimetres to about 70 millimetres, more preferably from about 40 millimetres to about 70 millimetres, even more preferably from about 42 millimetres to about 70 millimetres. In other embodiments, an overall length of the aerosol-generating article is preferably from about 38 millimetres to about 60 millimetres, more preferably from about 40 millimetres to about 60 millimetres, even more preferably from about 42 millimetres to about 60 millimetres. In further embodiments, an overall length of the aerosol-generating article is preferably from about 38 millimetres to about 50 millimetres, more preferably from about 40 millimetres to about 50 millimetres, even more preferably from about 42 millimetres to about 50 millimetres. In an exemplary embodiment, an overall length of the aerosol-generating article is about 45 millimetres.

[0227] The aerosol-generating article has an external diameter of at least 5 millimetres. Preferably, the aerosol-generating article has an external diameter of at least 6 millimetres. More preferably, the aerosol-generating article has an external diameter of at least 7 millimetres.

[0228] Preferably, the aerosol-generating article has an external diameter of less than or equal to about 12 millimetres. More preferably, the aerosol-generating article has an external diameter of less than or equal to about 10 millimetres. Even more preferably, the aerosol-generating article has an external diameter of less than or equal to about 8 millimetres.

[0229] In some embodiments, the aerosol-generating article has an external diameter from about 5 millimetres to about 12 millimetres, preferably from about 6 millimetres to about 12 millimetres, more preferably from about 7 millimetres to about 12 millimetres. In other embodiments, the aerosol-generating article has an external diameter from about 5 millimetres to about 10 millimetres, preferably from about 6 millimetres to about 10 millimetres, more preferably from about 7 millimetres to about 10 millimetres. In further embodiments, the aerosol-generating article has an external diameter from about 5 millimetres to about 8 millimetres, preferably from about 6 millimetres to about 8 millimetres, more preferably from about 7 millimetres to about 8 millimetres.

[0230] In certain preferred embodiments of the invention, a diameter (DME) of the aerosol-generating article at the mouth end is (preferably) greater than a diameter (DDE) of the aerosol-generating article at the distal end. In more detail, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is (preferably) at least about 1.005.

[0231] Preferably, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal

end is (preferably) at least about 1.01. More preferably, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is at least about 1.02. Even more preferably, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is at least about 1.05.

[0232] A ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is preferably less than or equal to about 1.30. More preferably, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is less than or equal to about 1.25. Even more preferably, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is less than or equal to about 1.20. In particularly preferred embodiments, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is less than or equal to 1.15 or 1.10.

[0233] In some preferred embodiments, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is from about 1.01 to 1.30, more preferably from 1.02 to 1.30, even more preferably from 1.05 to 1.30.

[0234] In other embodiments, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is from about 1.01 to 1.25, more preferably from 1.02 to 1.25, even more preferably from 1.05 to 1.25. In further embodiments, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is from about 1.01 to 1.20, more preferably from 1.02 to 1.20, even more preferably from 1.05 to 1.20. In yet further embodiments, a ratio (DME/DDE) between the diameter of the aerosol-generating article at the mouth end and the diameter of the aerosol-generating article at the distal end is from about 1.01 to 1.15, more preferably from 1.02 to 1.15, even more preferably from 1.05 to 1.15.

[0235] By way of example, the external diameter of the article may be substantially constant over a distal portion of the article extending from the distal end of the aerosol-generating article for at least about 5 millimetres or at least about 10 millimetres. As an alternative, the external diameter of the article may taper over a distal portion of the article extending from the distal end for at least about 5 millimetres or at least about 10 millimetres.

[0236] In certain preferred embodiments of the present invention, the elements of the aerosol-generating article, as described above, are arranged such that the centre of mass of the aerosol-generating article is at least about 60 percent of the way along the length of the aerosol-generating article from the downstream end. More preferably, the elements of the aerosol-generating article are arranged such that the centre of mass of the aerosol-generating article is at least about 62 percent of the way along the length of the aerosol-generating article from the downstream end, more preferably at least about 65 percent of the way along the length of the aerosol-generating article from the downstream end.

[0237] Preferably, the centre of mass is no more than about 70 percent of the way along the length of the aerosol-generating article from the downstream end.

[0238] Providing an arrangement of elements that gives a centre of mass that is closer to the upstream end than the downstream end results in an aerosol-generating article having a weight imbalance, with a heavier upstream end. This weight imbalance may advantageously provide haptic feedback to the consumer to enable them to distinguish between the upstream and downstream ends so that the correct end can be inserted into an aerosol-generating device. This may be particularly beneficial where an upstream element is provided such that the upstream and downstream ends of the aerosol-generating article are visually similar to each other.

[0239] In embodiments of aerosol-generating articles in accordance with the invention, wherein both aerosol-cooling element and support element are present, these are preferably wrapped together in a combined wrapper. The combined wrapper circumscribes the aerosol-cooling element and the support element, but does not circumscribe a further downstream, such as a mouthpiece element.

[0240] In these embodiments, the aerosol-cooling element and the support element are combined prior to being circumscribed by the combined wrapper, before they are further combined with the mouthpiece segment.

[0241] From a manufacturing viewpoint, this is advantageous in that it enables shorter aerosol-generating articles to be assembled.

[0242] In general, it may be difficult to handle individual elements that have a length smaller than their diameter. For example, for elements with a diameter of 7 millimetres, a length of about 7 millimetres represents a threshold value close to which it is preferable not to go. However, an aerosol-cooling element of 10 millimetres can be combined with a pair of support elements of 7 millimetres on each side (and potentially with other elements like the rod of aerosol-forming substrate, etc.) to provide a hollow segment of 24 millimetres, which is subsequently cut into two intermediate hollow sections of 12 millimetres.

[0243] In particularly preferred embodiments, the other components of the aerosol-generating article are individually circumscribed by their own wrapper. In other words, the upstream element, the rod of aerosol-forming substrate, the support element, and the aerosol-cooling element are all individually wrapped. The support element and the aerosol-cooling element are combined to form the intermediate hollow section. This is achieved by wrapping the support element and the aerosol-cooling element by means of a combined wrapper. The upstream element, the rod of aerosol-forming substrate, and the intermediate hollow section are then combined together with an outer wrapper. Subsequently, they are combined with the mouthpiece element-which has a wrapper of its own—by means of tipping paper.

[0244] Preferably, at least one of the components of the aerosol-generating article is wrapped in a hydrophobic wrapper.

[0245] The term "hydrophobic" refers to a surface exhibiting water repelling properties. One useful way to determine this is to measure the water contact angle. The "water contact angle" is the angle, conventionally measured through the liquid, where a liquid/vapour interface meets a solid surface. It quantifies the wettability of a solid surface by a liquid via the Young equation. Hydrophobicity or water

contact angle may be determined by utilizing TAPPI T558 test method and the result is presented as an interfacial contact angle and reported in "degrees" and can range from near zero to near 180 degrees.

[0246] In preferred embodiments, the hydrophobic wrapper is one including a paper layer having a water contact angle of about 30 degrees or greater, and preferably about 35 degrees or greater, or about 40 degrees or greater, or about 45 degrees or greater.

[0247] By way of example, the paper layer may comprise PVOH (polyvinyl alcohol) or silicon. The PVOH may be applied to the paper layer as a surface coating, or the the paper layer may comprise a surface treatment comprising PVOH or silicon.

[0248] In a particularly preferred embodiment, an aerosol-generating article in accordance with the present invention comprises, in linear sequential arrangement, an upstream element, a rod of aerosol-forming substrate located immediately downstream of the upstream element, a support element located immediately downstream of the rod of aerosol-forming substrate, an aerosol-cooling element located immediately downstream of the support element, a mouthpiece element located immediately downstream of the aerosol-cooling element, and an outer wrapper circumscribing the upstream element, the support element, the aerosol-cooling element and the mouthpiece element.

[0249] In more detail, the rod of aerosol-forming substrate may abut the upstream element. The support element may abut the rod of aerosol-forming substrate. The aerosol-cooling element may abut the support element. The mouthpiece element may abut the aerosol-cooling element.

[0250] The aerosol-generating article has a substantially cylindrical shape and an outer diameter of about 7.25 millimetres. The perimeter of the aerosol-generating article is preferably between 20 millimetres and 23 millimetres, more preferably between 21 millimetres and 22 millimetres.

[0251] The upstream element has a length of about 5 millimetres, the rod of aerosol-generating article has a length of about 12 millimetres, the support element has a length of about 8 millimetres, the mouthpiece element has a length of about 12 millimetres. Thus, an overall length of the aerosol-generating article is about 45 millimetres.

[0252] The upstream element is in the form of a plug of cellulose acetate wrapped in stiff plug wrap.

[0253] The aerosol-generating article comprises an elongate susceptor arranged substantially longitudinally within the rod of aerosol-forming substrate and is in thermal contact with the aerosol-forming substrate. The susceptor is in the form of a strip or blade, has a length substantially equal to the length of the rod of aerosol-forming substrate and a thickness of about 60 micrometres.

[0254] The support element is in the form of a hollow cellulose acetate tube and has an internal diameter of about 1.9 millimetres. Thus, a thickness of a peripheral wall of the support element is about 2.675 millimetres.

[0255] The aerosol-cooling element is in the form of a finer hollow cellulose acetate tube and has an internal diameter of about 3.25 millimetres. Thus, a thickness of a peripheral wall of the aerosol-cooling element is about 2 millimetres.

[0256] The mouthpiece is in the form of a low-density cellulose acetate filter segment.

[0257] The rod of aerosol-forming substrate comprises at least one of the types of aerosol-forming substrate described above, such as homogenised tobacco, a gel formulation or a homogenised plant material comprising particles of a plant other than tobacco.

[0258] Below, there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

[0259] Example A: Aerosol-generating article comprising:

[0260] a rod of aerosol-generating substrate;

[0261] a ventilation zone arranged downstream the rod of aerosol-generating substrate;

[0262] wherein the ventilation zone comprises perforations, wherein the perforations are arranged in a peripheral wall of the ventilation zone, wherein each perforation has a central axis, wherein the aerosol-generating article has a central axis, wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article, and wherein a thickness of the peripheral wall of the ventilation zone is between 0.1 millimeter and 2.5 millimeter.

[0263] Example B: Aerosol-generating article according to example A, wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article, preferably between 4% and 13% of the outer diameter of the aerosol-generating article, more preferably between 5% and 10% of the outer diameter of the aerosol-generating article, most preferably 6% of the outer diameter of the aerosol-generating article.

[0264] Example C: Aerosol-generating article according to any of the preceding examples, wherein each central axis of each perforation is angled with respect to a radial direction of the aerosol-generating article by an angle of between 3° and 20°, preferably by an angle of between 4° and 15°, more preferably by an angle of between 5° and 10°, most preferably by an angle of 7°.

[0265] Example D: Aerosol-generating article according to any of the preceding examples, wherein each perforation has a length measured along the central axis of the perforation, and wherein one or more perforations have a length of at least 0.1 millimeter and 2.7 millimeter, preferably between 0.8 millimeter and 2.4 millimeter, more preferably between 1.2 millimeter and 2.0 millimeter, most preferably around 1.7 millimeter.

[0266] Example E: Aerosol-generating article according to any of the preceding examples, wherein the cross-sectional shape of one or more perforations is unchanged along the central axis of the perforations.

[0267] Example F: Aerosol-generating article according to any of the preceding examples, wherein one or more of the perforations have a non-circular cross-section.

[0268] Example G: Aerosol-generating article according to any of the preceding examples, wherein one or more of the perforations are slit-shaped or have an oval cross-section.

[0269] Example H: Aerosol-generating article according to any of the preceding examples, wherein between 10 and 12 perforations are provided, preferably wherein the number of perforations is 11.

[0270] Example I: Aerosol-generating article according to any of the preceding examples, wherein the ventilation zone is arranged in a second hollow tubular segment of an aerosol-cooling element, and wherein the second hollow tubular segment has an inner volume of between 130 mm^3 and 200 mm^3, preferably between 155 mm^3 and 185 mm^3, more preferably of 170 mm^3.

[0271] Example J: Aerosol-generating article according to any of the preceding examples, wherein the perforations are arranged in a peripheral wall of the ventilation zone, preferably wherein the perforations have a non-constant pitch with a coefficient of variation of the pitch of above 5%.

[0272] Example K: Aerosol-generating article according to the preceding example, wherein the ventilation zone is configured as a hollow tubular ventilation zone, and wherein an inner diameter of the hollow tubular ventilation zone is between 2.5 millimeter and 5.0 millimeter, preferably between 3.0 millimeter and 4.0 millimeter, more preferably between 3.1 millimeter and 3.5 millimeter, most preferably 3.3 millimeter.

[0273] Example L: Aerosol-generating article according to the preceding example, wherein a thickness of the peripheral wall of the ventilation zone is between 0.8 millimeter and 2.2 millimeter, more preferably between 1.2 millimeter and 1.8 millimeter, most preferably around 1.5 millimeter.

[0274] Example M: Aerosol-generating article according to any of the preceding examples, wherein the perforations are arranged in a row.

[0275] Example N: Aerosol-generating article according to any of the preceding examples, wherein a distance between the perforations of the ventilation zone and a downstream end of the rod of aerosol-generating substrate is between 1 millimeter and 6 millimeter, preferably between 2 millimeter and 5 millimeter, more preferably between 3 millimeter and 4 millimeter.

[0276] Example O: Aerosol-generating article according to any of the preceding examples, wherein a distance between the perforations of the ventilation zone and a downstream end of the aerosol-generating article is between 10 millimeter and 26 millimeter, preferably between 12 millimeter and 24 millimeter, more preferably between 14 millimeter and 22 millimeter, most preferably between 16 millimeter and 20 millimeter.

[0277] Example P: Aerosol-generating article according to any of the preceding examples, wherein the perforations are configured to allow ambient air to be drawn into the ventilation zone.

[0278] Example Q: Aerosol-generating article according to the preceding example, wherein a ratio of ambient air drawn into the ventilation zone through the perforations and air drawn into the ventilation zone through the rod of aerosol-forming substrate is between 5 percent and 75 percent, preferably between 20 percent and 65 percent, more preferably between 30 percent and 60 percent, more preferably between 40 percent and 55 percent, most preferably 50 percent.

[0279] Example V: Aerosol-generating article according to any of the preceding examples, wherein the aerosol-generating article further comprises a filter plug downstream of the ventilation zone, wherein the resistance to draw of the filter plug is between 5 millimetres H_2O and 80 millimetres H_2O, preferably between 10 millimetres H2O and 65 millimetres H_2O, more preferably between 15 millimetres H2O and 50 millimetres H_2O, more preferably between 20 millimetres H2O and 40 millimetres H_2O, most preferably 30 millimetres H_2O.

[0280] Example W: Aerosol-generating system comprising an aerosol-generating device having a cavity for receiving an aerosol-generating article according to any of the preceding examples.

[0281] Example X: Method for manufacturing an aerosol-generating article, wherein the method comprises the steps of:

[0282] providing a rod of aerosol-generating substrate;

[0283] providing a ventilation zone downstream of the rod of the aerosol-generating substrate; and

[0284] creating perforations in a peripheral wall of the ventilation zone, wherein each perforation has a central axis, wherein the aerosol-generating article has a central axis, and wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of the outer diameter of the aerosol-generating article

[0285] In the following, the invention will be further described with reference to

[0286] FIG. **1**, which shows a schematic side sectional view of an aerosol-generating article in accordance with the invention; and

[0287] FIG. **2** shows a cross-sectional view through a ventilation zone of the aerosol-generating article.

[0288] The aerosol-generating article **10** shown in FIG. **1** comprises a rod **12** of aerosol-forming substrate **12** and a downstream section **14** at a location downstream of the rod **12** of aerosol-forming substrate. Further, the aerosol-generating article **10** comprises an upstream section **16** at a location upstream of the rod **12** of aerosol-forming substrate. Thus, the aerosol-generating article **10** extends from an upstream or distal end **18** to a downstream or mouth end **20**.

[0289] The aerosol-generating article has an overall length of about 45 millimetres.

[0290] The downstream section **14** comprises a support element **22** located immediately downstream of the rod **12** of aerosol-forming substrate, the support element **22** being in longitudinal alignment with the rod **12**. In the embodiment of FIG. **1**, the upstream end of the support element **18** abuts the downstream end of the rod **12** of aerosol-forming substrate. In addition, the downstream section **14** comprises an aerosol-cooling element **24** located immediately downstream of the support element **22**, the aerosol-cooling element **24** being in longitudinal alignment with the rod **12** and the support element **22**. In the embodiment of FIG. **1**, the upstream end of the aerosol-cooling element **24** abuts the downstream end of the support element **22**.

[0291] As will become apparent from the following description, the support element **22** and the aerosol-cooling element **24** together define an intermediate hollow section **50** of the aerosol-generating article **10**. As a whole, the intermediate hollow section **50** does not substantially contribute to the overall RTD of the aerosol-generating article. An RTD of the intermediate hollow section **26** as a whole is substantially 0 millimetres H_2O.

[0292] The support element **22** comprises a first hollow tubular segment **26**. The first hollow tubular segment **26** is provided in the form of a hollow cylindrical tube made of cellulose acetate. The first hollow tubular segment **26** defines an internal cavity **28** that extends all the way from an upstream end **30** of the first hollow tubular segment to a

downstream end **32** of the first hollow tubular segment **20**. The internal cavity **28** is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity **28**. The first hollow tubular segment **26**—and, as a consequence, the support element **22**—does not substantially contribute to the overall RTD of the aerosol-generating article **10**. In more detail, the RTD of the first hollow tubular segment **26** (which is essentially the RTD of the support element **22**) is substantially 0 millimetres H_2O.

[0293] The first hollow tubular segment **26** has a length of about 8 millimetres, an external diameter of about 7.25 millimetres, and an internal diameter (D_{FTS}) of about 1.9 millimetres. Thus, a thickness of a peripheral wall of the first hollow tubular segment **26** is about 2.67 millimetres.

[0294] The aerosol-cooling element **24** comprises a second hollow tubular segment **34**. The second hollow tubular segment **34** is provided in the form of a hollow cylindrical tube made of cellulose acetate. The second hollow tubular segment **34** defines an internal cavity **36** that extends all the way from an upstream end **38** of the second hollow tubular segment to a downstream end **40** of the second hollow tubular segment **34**. The internal cavity **36** is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity **36**. The second hollow tubular segment **28**—and, as a consequence, the aerosol-cooling element **24**—does not substantially contribute to the overall RTD of the aerosol-generating article **10**. In more detail, the RTD of the second hollow tubular segment **34** (which is essentially the RTD of the aerosol-cooling element **24**) is substantially 0 millimetres H_2O.

[0295] The second hollow tubular segment **34** has a length of about 8 millimetres, an external diameter of about 7.25 millimetres, and an internal diameter (D_{STS}) of about 3.25 millimetres. Thus, a thickness of a peripheral wall of the second hollow tubular segment **34** is about 2 millimetres. Thus, a ratio between the internal diameter (D_{FTS}) of the first hollow tubular segment **26** and the internal diameter (D_{STS}) of the second hollow tubular segment **34** is about 0.75.

[0296] The aerosol-generating article **10** comprises a ventilation zone **60** provided at a location along the second hollow tubular segment **34**. In more detail, the ventilation zone is provided at about 2 millimetres from the upstream end of the second hollow tubular segment **34**. A ventilation level of the aerosol-generating article **10** is about 25 percent.

[0297] In the embodiment of FIG. **1**, the downstream section **14** further comprises a mouthpiece element **42** at a location downstream of the intermediate hollow section **50**. In more detail, the mouthpiece element **42** is positioned immediately downstream of the aerosol-cooling element **24**. As shown in the drawing of FIG. **1**, an upstream end of the mouthpiece element **42** abuts the downstream end **40** of the aerosol-cooling element **18**.

[0298] The mouthpiece element **42** is provided in the form of a cylindrical plug of low-density cellulose acetate.

[0299] The mouthpiece element **42** has a length of about 12 millimetres and an external diameter of about 7.25 millimetres. The RTD of the mouthpiece element **42** is about 12 millimetres H_2O.

[0300] The rod **12** comprises an aerosol-forming substrate of one of the types described above.

[0301] The rod **12** of aerosol-forming substrate has an external diameter of about 7.25 millimetres and a length of about 12 millimetres.

[0302] The aerosol-generating article **10** further comprises an elongate susceptor **44** within the rod **12** of aerosol-forming substrate. In more detail, the susceptor **44** is arranged substantially longitudinally within the aerosol-forming substrate, such as to be approximately parallel to the longitudinal direction of the rod **12**. As shown in the drawing of FIG. **1**, the susceptor **44** is positioned in a radially central position within the rod and extends effectively along the longitudinal axis of the rod **12**.

[0303] The susceptor **44** extends all the way from an upstream end to a downstream end of the rod **12**. In effect, the susceptor **44** has substantially the same length as the rod **12** of aerosol-forming substrate.

[0304] In the embodiment of FIG. **1**, the susceptor **44** is provided in the form of a strip and has a length of about 12 millimetres, a thickness of about 60 micrometres, and a width of about 4 millimetres. The upstream section **16** comprises an upstream element **46** located immediately upstream of the rod **12** of aerosol-forming substrate, the upstream element **46** being in longitudinal alignment with the rod **12**. In the embodiment of FIG. **1**, the downstream end of the upstream element **46** abuts the upstream end of the rod **12** of aerosol-forming substrate. This advantageously prevents the susceptor **44** from being dislodged. Further, this ensures that the consumer cannot accidentally contact the heated susceptor **44** after use.

[0305] The upstream element **46** is provided in the form of a cylindrical plug of cellulose acetate circumscribed by a stiff wrapper. The upstream element **46** has a length of about 5 millimetres. The RTD of the upstream element **46** is about 30 millimetres H_2O.

[0306] FIG. **2** shows the ventilation zone **60** of the aerosol-generating article, more particularly a cross-sectional view of the ventilation zone **60**. Multiple perforations **62** are provided in the ventilation zone **60**. The perforation **62** are provided in the hollow tubular segment **34**. 11 perforations **62** are provided. The perforations **62** penetrate the hollow tubular segment **34** such that ambient air can flow into the hollow tubular segment **34** through the perforations **62**. Ambient air can flow through the perforations **62** into the internal cavity **36** of the hollow tubular segment **34**.

[0307] As can be seen in FIG. **2**, the perforations are tilted. Exemplarily, a central axis CAPER of a perforation is shown in FIG. **2**. The central axis CAPER of the perforation runs through a peripheral cross-sectional center of the perforation and an inner cross-sectional center of the perforation. The peripheral cross-sectional center of the perforation may be the cross-sectional center of the perforation at the outermost opening area **64** of the perforation shown in FIG. **2**. The inner cross-sectional center of the perforation may be the cross-sectional center of the perforation at the innermost opening area **66** of the perforation shown in FIG. **2**. FIG. **2** further shows a central axis CAART of the aerosol-generating article. The central axis CAART of the aerosol-generating article is a central longitudinal axis of the aerosol-generating article. As can be seen in FIG. **2**, the central axis CAPER of a perforation is arranged distanced, by the distance d, from the central axis CAART of the aerosol-generating article. The same is true for all of the perforations **62**. All perforations **62** are tilted so that the central axis of the perforations **62** are distanced from the central axis CAART of the aerosol-generating article.

[0308] Features described in relation to one embodiment may equally be applied to other embodiments of the invention.

1.-16. (canceled)

17. An aerosol-generating article, comprising:

a rod of aerosol-generating substrate; and

a ventilation zone comprising perforations, the ventilation zone being arranged downstream of the rod of aerosol-generating substrate,

wherein the perforations are arranged in a peripheral wall of the ventilation zone,

wherein each perforation has a central axis,

wherein the aerosol-generating article has a central axis,

wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of an outer diameter of the aerosol-generating article,

wherein a thickness of the peripheral wall of the ventilation zone is between 0.1 millimeter and 2.5 millimeters, and

wherein the aerosol-generating article has a ventilation level of at least 20%.

18. The aerosol-generating article according to claim **17**, wherein the smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 4% and 13% of the outer diameter of the aerosol-generating article.

19. The aerosol-generating article according to claim **17**, wherein the smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is 6% of the outer diameter of the aerosol-generating article.

20. The aerosol-generating article according to claim **17**, wherein each central axis of each perforation is angled with respect to a radial direction of the aerosol-generating article by an angle of between 3° and 20°.

21. The aerosol-generating article according to claim **17**, wherein each central axis of each perforation is angled with respect to a radial direction of the aerosol-generating article by an angle of 7°.

22. The aerosol-generating article according to claim **17**, wherein each perforation has a length measured along the central axis of the perforation, and

wherein one or more perforations have a length of at least 0.1 millimeter and 2.7 millimeters.

23. The aerosol-generating article according to claim **17**, wherein each perforation has a length measured along the central axis of the perforation, and

wherein one or more perforations have a length of around 1.7 millimeter.

24. The aerosol-generating article according to claim **17**, wherein a cross-sectional shape of one or more of the perforations is unchanged along the central axis of the perforations.

25. The aerosol-generating article according to claim **17**, wherein one or more of the perforations has a non-circular cross-section.

26. The aerosol-generating article according to claim **17**, wherein one or more of the perforations are slit-shaped or have an oval cross-section.

27. The aerosol-generating article according to claim **17**, wherein between 10 perforations and 12 perforations are provided.

28. The aerosol-generating article according to claim **17**, wherein the ventilation zone is arranged in a hollow tubular segment of an aerosol-cooling element, and

wherein the hollow tubular segment has an inner volume of between 130 mm^3 and 200 mm^3.

29. The aerosol-generating article according to claim **17**, wherein the ventilation zone is arranged in a hollow tubular segment of an aerosol-cooling element, and

wherein the hollow tubular segment has an inner volume of 170 mm^3.

30. The aerosol-generating article according to claim **17**, wherein a distance between the perforations of the ventilation zone and a downstream end of the rod of aerosol-generating substrate is between 1 millimeter and 6 millimeters.

31. The aerosol-generating article according to claim **17**, wherein a distance between the perforations of the ventilation zone and a downstream end of the aerosol-generating article is between 10 millimeters and 26 millimeters.

32. The aerosol-generating article according to claim **31**, wherein a ratio of ambient air drawn into the ventilation zone through the perforations and air drawn into the ventilation zone through the rod of aerosol-generating substrate is between 5 percent and 75 percent.

33. The aerosol-generating article according to claim **17**, further comprising a filter plug downstream of the ventilation zone,

wherein a resistance to draw of the filter plug is between 5 millimeters H_2O and 80 millimeters H_2O.

34. The aerosol-generating article according to claim **17**, further comprising a substrate wrapper at least partly circumscribing the rod of aerosol-generating substrate,

wherein the substrate wrapper has a thickness of 50 micrometers or more.

35. An aerosol-generating system comprising an aerosol-generating device having a cavity configured to receive the aerosol-generating article according to claim **17**.

36. A method for manufacturing an aerosol-generating article, the method comprising the steps of:

providing a rod of aerosol-generating substrate;

providing a ventilation zone downstream of the rod of the aerosol-generating substrate; and

creating perforations in a peripheral wall of the ventilation zone,

wherein each perforation has a central axis,

wherein the aerosol-generating article has a central axis,

wherein a smallest distance between the central axis of each perforation and the central axis of the aerosol-generating article is between 3% and 15% of an outer diameter of the aerosol-generating article, and

wherein the aerosol-generating article has a ventilation level of at least 20%.

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