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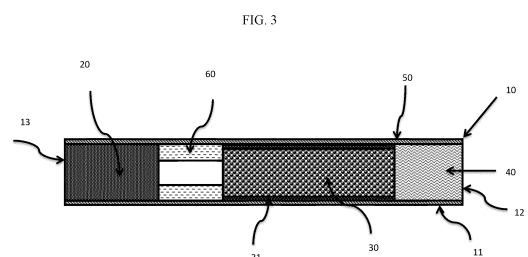
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(54) **AEROSOL GENERATED PRODUCT, PREPARATION METHOD THEREFOR, AND APPLICATION THEREOF**

(57) An aerosol generating product comprising an aerosol atomizing element and a smoke cooling element, and the smoke cooling element is located downstream of the flow direction of the smoke generated by the aerosol atomizing element. Furthermore, a filter element is located downstream of the flow direction of the smoke through which the smoke cooling element passes; or a hollow element located upstream of the flow direction of the smoke through which the smoke cooling element passes. The smoke cooling element is composed of particles, and the structure comprises a gap for smoke of a cigarette to pass through. The gap through which cigarette smoke can pass is a three-dimensional and non-linear gap. The structure is in the form of rods. When the smoke aerosol passes through the cooling element, ensuring the smoke to pass through smoothly. It has a large

area for the smoke cooling and maintains a low pressure drop at the same time because of the through holes arranged in the porous material, so as to ensure enough flux of smoke and enhance the experience of cigarette consumers.



Description

FIELD OF TECHNOLOGY

5 **[0001]** The invention belongs to the technical field of tobacco and relates to smoke treatment, in particular to products for reducing the temperature of cigarette smoke.

BACKGROUND

10 **[0002]** With the increasingly severe global tobacco control and consumers' increasing concern for health, novel tobacco products that significantly reduce the release of harmful components of tobacco have gradually become the focus of tobacco industry in the world. Heat-not-Burn cigarette is a new type of tobacco product which uses special heat source to heat cut tobacco (below 400 °C or even lower) without burning, which can significantly reduce the release of harmful components in smoke. At present, there is a common problem that the smoke temperature is high in Heat-not-Burn cigarette, which brings smoke stimulation and burning sensation, and reduces the suction comfort of cigarettes. If the
15 traditional technology of enhancing filtration and ventilation dilution is used to reduce the smoke temperature, the smoke volume of the product will be further reduced, which will further affect the suction feeling of the product. Therefore, it is a key technology to reduce the temperature of Heat-not-Burn cigarette smoke. Chinese patent CN104203015 disclosed an aerosol generating product with an aerosol cooling element which is composed of a folded polylactide acid film; Chinese patent CN107259638A disclosed a low-temperature cigarette with the function of reducing smoke temperature and enhancing aroma, which included a film coated rod filter made of PVC, PLA and other materials. The rod filter reduces the smoke temperature of smoking products mainly by absorbing heat through the glass transition of polymer materials, that is, the transition from glass state to high elastic state. However, the problem is that there will be melting or melting bonding when the polymer undergoes glass transition. Then, the polymer material at the end of the aerosol
20 cooling element that first contacts the smoke will immediately have serious adhesion and collapse, and block the channels, making the smoke unable to flow smoothly through the folded polymer, thus reducing the cooling surface area and causing the smoke temperature to be too high.

SUMMARY OF THE INVENTION

30 **[0003]** In view of the above technical requirements and the defects existing in the prior art, the invention aims to provide an aerosol generating product capable of rapidly reducing the temperature of cigarette smoke and the related methods.
[0004] In order to achieve the above purpose, the technical solution of the invention is as follows.
[0005] An aerosol generating product which comprises an aerosol atomizing element and a smoke cooling element,
35 and the smoke cooling element is located downstream of the flow direction of the smoke generated by the aerosol atomizing element.
[0006] Furthermore, it includes a filter element which is located downstream of the flow direction of the smoke which passes through the smoke cooling element.
[0007] Alternatively, it also includes a hollow element, which is located upstream of the flow direction of the smoke which through the smoke cooling element passes.
40 **[0008]** Alternatively, the smoke cooling element is composed of particles, and the smoke cooling element comprises gaps for cigarette smoke to pass through and at least one continuous smoke passageway.
[0009] Alternatively, the gap of the smoke cooling element for cigarette smoke to pass through is a three-dimensional and non-linear network gap.
45 **[0010]** Alternatively, the smoke cooling element is in the form of a rod.
[0011] Alternatively, the porosity of the smoke cooling element is 40%-90%.
[0012] Alternatively, the smoke cooling element comprises basic particles, a binder and a wrapping material; the contact points formed between the binder particles, and between the binder particles and the basic particles, and between the basic particles, being physically bonded at multiple places, and the wrapping material is wrapped outside to form a
50 rod with a porous structure.
[0013] Alternatively, the particles can reduce the temperature of cigarette smoke and have low adsorption for effective components of cigarette smoke.
[0014] Alternatively, the basic particles are inactive particles or inactive particles made from active particles by coating with an outer film layer.
55 **[0015]** Alternatively, if the basic particles are inactive particles, they can also have an outer film layer. The thickness of the outer film layer is 0-0.2mm, and the outer coating layer accounts for 0-50% of the mass of the whole particles. Obviously, when the thickness of the outer coating layer or the mass of the whole particles is 0, it means that the inactive particles are not coated.

[0016] If the basic particles are active particles, it needs non activation treatment. The thickness of the outer coating layer is 0.001-0.2mm, accounting for 0.001-50% of the mass of the whole particle.

[0017] Alternatively, the inactive particles are particles with nicotine adsorption less than 3.0 mg/cm³ of the smoke aerosol.

[0018] Alternatively, the inactive particles include organic or inorganic particles. The inorganic particles include aluminum oxide, zirconia, calcium carbonate ball, glass bead, silicon dioxide, iron, copper, aluminum, gold, platinum, magnesium silicate ball or calcium sulfate. The organic particles include cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, microcrystalline cellulose, sucrose powder, dextrin, lactose, sugar powder, glucose, mannitol, starch, methylcellulose, ethyl cellulose, polylactic acid, polyethylene, polypropylene, polyhydroxybutyrate, poly ϵ -caprolactone, polyglycolic acid, polyhydroxyalkanoate and thermoplastic resin based of starch. Alternatively, the active particles are particles with nicotine adsorption of 3.0mg/cm³ or more in the smoke aerosol.

[0019] Alternatively, the active particles include molecular sieve, activated carbon, diatomite, zeolite, perlite, ceramics, sepiolite, bleached soil and ion exchange resin. The inactive particles include aluminum oxide, zirconia, calcium carbonate ball, glass bead, silica, iron, copper, aluminum, gold, platinum, magnesium silicate ball or calcium sulfate.

[0020] Alternatively, the film layer is made of a film forming material.

[0021] Alternatively, the film-forming materials include cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, hydroxypropyl cellulose, hydroxypropyl methylcellulose, methylcellulose, ethyl cellulose, polyvinylpyrrolidone, polyethylene glycol diethylamine acetate, styrene maleic acid copolymer, styrene vinylpyridine copolymer, cellulose acetate phthalate, and phthalic acid Formic acid, cellulose acetate/polyethylene glycol, methyl cellulose/polyethylene glycol, carboxymethyl cellulose/polyethylene glycol, hydroxypropyl methyl cellulose/polyethylene glycol, ethyl cellulose/polyethylene glycol or acrylic resin/polyethylene glycol, polylactic acid.

[0022] Alternatively, the basic particle shapes include spherical, quasi spherical, cake, sheet, bonding, needle-like, multilateral, faceted or random shape.

[0023] Alternatively, the base particles have an average diameter from a lower limit of 50 μ m, 100 μ m, 150 μ m, 200 μ m or 250 μ m, to an upper limit of 5000 μ m, 2000 μ m, 1000 μ m, 900 μ m or 700 μ m in at least one dimension.

[0024] Alternatively, the binder particles are selected at least of one of polyolefin, polyester, polyamide, polyacrylic acid, polyethylene compound, polytetrafluoroethylene, polyether ether ketone, polyethylene terephthalate, polybutylene terephthalate, poly (cyclohexylene terephthalate), poly (propylene terephthalate), polyacrylic acid, poly (methyl methacrylate), acrylonitrile dibutylene terephthalate, olefin styrene, styrene acrylonitrile, styrene butadiene, styrene maleic acid, cellulose acetate, cellulose acetate butyrate, plasticized cellulose plastic, cellulose propionate, ethyl cellulose, any derivative thereof, any copolymer thereof, and any combination thereof.

[0025] Alternatively, the binder particles can be in any shape. These shapes include sphere, star, granule, potato, irregular shapes and any combination.

[0026] Alternatively, the binder particles have an average diameter from a lower limit of 5 μ m, 10 μ m, 50 μ m, 100 μ m or 150 μ m to an upper limit of 500 μ m, 400 μ m, 300 μ m, 250 μ m or 200 μ m in at least one dimension.

[0027] Alternatively, the binder particles can have a bulk density of approximately 0.10g/cm³ to approximately 0.55g/cm³, including any subset (e.g., approximately 0.17g/cm³ to approximately 0.50g/cm³, or approximately 0.20g/cm³ to approximately 0.47g/cm³).

[0028] The wrapping material is filter plug wrapping paper with gram weight of 20-40g and thickness of 0.08-0.12mm.

[0029] The above-mentioned aerosol generating products are applied to Heat-not-Burn cigarette.

[0030] Compared with reference aerosol products containing cellulose acetate rod, the aerosol generation product containing smoke cooling element of the present invention has good cooling effect and the temperature is reduced by at least 2°C.

[0031] Compared with the reference cigarette 3R4F, the aerosol generating product containing the smoke cooling element of the present invention has a good adsorption effect on phenol, and the reduction rate reaches 93.2%.

[0032] The present invention provides an aerosol generating product containing a smoke cooling element, which is composed of a plurality of elements and assembled into rods in the form of rod composite molding. The aerosol generating product comprises an aerosol atomizing element and an element for reducing the smoke temperature located downstream of the aerosol atomizing element in the composite molding product. In some applications, the smoke cooling element is composed of encapsulated porous material containing basic particles with a porosity of 40% to 90% and a sealed pressure drop of less than 2mmH₂O/mm. The smoke cooling element comprises basic particles and polymer binder. After mixing polymer binder and base particle, the heating is carried out to make the basic particle and binder, binder and binder bond at multiple contact points to form a long strip porous material that is wrapped. When the smoke of the Heat-not-Burn cigarette smoke passing through the cooling element, phase transformation of the surface film layer of the basic particle and the binder and occurs with decalescence. Due to the three-dimensional arrangement structure in the cooling element, it is convenient for the transverse conduction of heat energy, thus achieving better cooling effect. The porous material keeps the original shape to ensure the smooth passage of smoke. The porous material with through holes has a large area for cooling and maintains a low pressure drop at the same time, so as to ensure enough flux of

smoke and enhance the experience of cigarette consumers.

BRIEF DISCRIPTION OF THE DRAWINGS

[0033]

Fig.1 is a schematic diagram of a two-stage aerosol generating product with a smoke cooling element of the present invention.

Fig.2 is a schematic diagram of a three-stage aerosol generating product with a smoke cooling element of the present invention.

Fig.3 is a schematic diagram of a four-stage aerosol generating product with a smoke temperature reducing element of the present invention.

Fig.4 is a schematic diagram of another four-stage aerosol generating product structure with a smoke temperature reducing element of the present invention.

Fig.5 is the structure diagram of a four-stage aerosol generating product in the prior art (reference sample containing cellulose acetate tow).

DETAILED DISCRIPTION

[0034] The invention relates to an aerosol generating product capable of rapidly reducing the temperature of smoke of cigarette and related methods.

[0035] The aerosol generating product is composed of a plurality of units in the form of rod composed by rod molding. The pluralities of units include an aerosol atomization element and an element for cooling the smoke downstream of the aerosol atomization element. In some applications, the smoke cooling element is composed of encapsulated porous material containing cellulose acetate particles, which has longitudinal and transverse through holes. It has a porosity of 40% to 90% and at least 5mg/mm of cellulose acetate particle loading, less than 2mmH₂O/mm of sealing pressure drop. The aerosol passing through the smoke cooling element is cooled. The void volume of porous material is the free space left among the cellulose acetate particles. In order to determine the void volume, first the average value of the upper and lower diameters based on the particle size of cellulose acetate is calculated, and then the volume is calculated using the density of cellulose acetate (assuming that the sphere is based on the average diameter) is calculated. The porosity is calculated according to the porosity calculation formula in Chinese patent CN103330283.

[0036] The term "sealed pressure drop" used in this invention refers to the static pressure difference between the two ends of a sample when the sample is passed through by air flow at the outlet end under stable conditions with a volume flow rate of 17.5ml/s and when it is completely sealed in a measuring device so that air cannot pass through the package. In this invention, the sealed pressure drop has been measured according to recommended method 41 of CORESTA ("Cooperation Centre for Scientific Research Relative to Tobacco") published in June 2007. The higher sealing pressure drop indicates that the smoker has to use more force to suck the smoking device.

[0037] The invention will be further described in combination with the embodiments shown in the attached drawings.

Example 1

[0038] As shown in Fig.1, a two-stage aerosol generating product 10 has an element for reducing the temperature of smoke and comprises two elements, an aerosol atomizing element20 and a smoke cooling element30. The two elements are coaxially assembled into a rod 11 with cigarette paper 50 by a rod compound forming machine in sequence.

[0039] The aerosol atomizing element20 is located at the farthest end of the rod13; the smoke cooling element30 is located at the downstream of the aerosol atomizing element, and the rod 11 has a nozzle end 12. When assembled by the compound forming machine, the rod 11 has a length of approximately 45 mm with an outer diameter of approximately 7.2 mm and an inner diameter of approximately 6.9 mm.

[0040] The aerosol atomization element20 comprises a filamentous or folded tobacco material rolled by a cigarette machine and wrapped in a filter paper (not shown) to form a rod. The tobacco material comprises an additive which comprises an aerosol forming additive glycerol and propylene glycol.

[0041] The smoke cooling element 30, a porous rod containing cellulose acetate particles wrapped by molding paper 31, is located downstream of the aerosol atomization element. The porous rod has a length of approximately 33 mm with an outer diameter of approximately 7.2 mm and an inner diameter of approximately 6.9 mm. In the embodiment, the smoke cooling element is made of cellulose acetate particles coated with a film and ultra-high molecular weight polyethylene (UHMWPE) binder by heating and bonding under certain conditions. UHMWPE binder can mechanically bond particles and binder particles at multiple contact points at its melting temperature. The binder hardly flows at its melting temperature, which ensured the continuity of the voids formed between the particles and formed a plurality of channels

extending along the length of the smoke cooling element 30. The porous rod was made of 25% of GUR2105 of Ticona or LLC and 75% of cellulose acetate particles with an average diameter of 1.2mm coated with polyethylene glycol/hydroxypropyl methylcellulose film. The porous rod is manufactured by mixing GUR2015 binder and cellulose acetate particles and then filling the mold (free sintering) with the mixture without applying pressure to the heated mixture. After the mold was heated to 200°C for 40 minutes, the porous rod was taken out from the mold and cooled, and was wrapped with molding paper 31 with a weight of 20g and a thickness of 0.08mm. The rod is cut into equal length segments.

[0042] The smoke cooling element contains 10mg/mm cellulose acetate particles. Its sealing pressure drop is 5.5mmH₂O and the porosity is 72%.

[0043] As the aerosol generating product shown in Fig.1, a heating element is inserted at the side of the aerosol atomizing element to heat the tobacco material in the aerosol atomizing element to release volatile compounds from the tobacco material. When a consumer sucks on the mouth end 12 of the aerosol generating product 10, these volatile compounds are condensed and atomized to form an aerosol which is transmitted to the consumer's mouth through the rod 11. The aerosol is sucked and heat is exchanged through the smoke cooling element 30 and its temperature is reduced.

[0044] Simulating smoking is according to the national standard GB/T19609-2004 cigarette smoking model under Canadian Intense smoking regime (HCI). The influence of setting the smoke cooling element on the temperature of the mainstream aerosol sucked by each suction was investigated and compared with the reference aerosol product containing cellulose acetate tow (see Fig.5). The thermocouple temperature probe is located at the center of filter 40, 5mm away from the tip. The test results are shown in Table 1.

Table 1 Test Results of Mainstream Aerosol Temperature

SAMPLE	PUFFNUMBER	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12
REFERENCE SAMPLE	MAXIMUM PUFFTEMPERAT URE, °C	57.5	63.2	62.8	58.5	57.9	54.8	52.5	48.9	48.6	47.8	47.4	46.5
SAMPLE		39.5	53.5	53.0	50.0	49.7	48.6	47.6	45.2	45.0	44.2	43.8	43.5
DIFFERENCEOF TEMPERATURE, °C		18.0	9.7	9.8	8.5	8.2	6.2	4.9	3.7	3.6	3.6	3.6	3.0

Example 2

[0045] As shown in Fig.2, a three-stage aerosol generating product 10 has a smoke cooling element and comprises an aerosol atomizing element 20, a smoke cooling element 30 and a filter nozzle 40. The aerosol atomizing element 20 is located at the farthest end 13 of the rod, the smoke cooling element 30 is located at the downstream of the aerosol atomizing element, the filter 40 is located at the downstream of the smoke cooling element, and the rod 11 has a nozzle end 12. The three elements are wrapped tightly with cigarette paper 50 in order to form a rod 11. When assembled, the rod 11 has a length of approximately 45 mm, an outer diameter of approximately 7.2 mm, and an inner diameter of approximately 6.9 mm.

[0046] The aerosol atomization element 20 comprises a filamentous or folded tobacco material rolled by a cigarette machine and wrapped in a filter paper (not shown) to form a rod. The tobacco material comprises an additive which comprises an aerosol forming additive glycerol and propylene glycol.

[0047] The smoke cooling element 30, downstream of the aerosol atomization element 20, is a porous rod containing cellulose acetate particles, wrapped by molding paper 31. In this embodiment, the smoke cooling element 30 is made of cellulose acetate particles coated with a film and UHMWPE binder by heating and bonding under certain conditions. UHMWPE binder can mechanically bond particles and binder particles at multiple contact points at its melting temperature. The binder hardly flows at its melting temperature, which ensured the continuity of the voids formed between the particles and formed a plurality of channels extending along the length of the smoke cooling element 30. The porous rod was made of 25% of GUR2105 from Ticona or LLC and 75% of cellulose acetate particles with an average diameter of 1.2 mm coated with polyethylene glycol/hydroxypropyl methylcellulose film. The porous rod is manufactured by mixing GUR2015 binder and cellulose acetate particles and then filling the mold (free sintering) with the mixture without applying pressure to the heated mixture. After the mold was heated to 200°C for 40 minutes, the porous rod was taken out from the mold and cooled, wrapped by molding paper 31 with a weight of 20g and a thickness of 0.08mm. The rod is cut into equal length segments.

[0048] The porous rod smoke cooling element contains 10mg/mm cellulose acetate particles with a length of approximately 25mm, an outer diameter of approximately 7.2mm, an inner diameter of approximately 6.9mm, a sealing pressure drop of 4.2mmH₂O and the porosity of 72%.

[0049] The traditional cellulose acetate tow rod is used in filter 40 with a length of 8 mm, an outer diameter of 7.2mm and an inner diameter of 6.9mm.

[0050] As the aerosol generating product shown in Fig.2, a heating element is inserted at the side of the aerosol atomizing element to heat the tobacco material in the aerosol atomizing element to release volatile compounds from the tobacco material. When the consumer sucks on the mouth end 12 of the aerosol generating product 10, these volatile compounds are condensed and atomized to form an aerosol which is transmitted to the consumer's mouth through the rod 11.

[0051] The aerosol is sucked and heat is exchanged through the smoke cooling element 30, so as to reduce the temperature, to intercept the moisture, and to improve the filtration efficiency of phenol in the aerosol.

[0052] Simulating smoking is according to the national standard GB/T19609-2004 cigarette smoking model under Canadian Intense smoking regime (HCI). The classified substances were intercepted using Cambridge filters and the quantitative determination of phenol was carried out by HPLC Fluorescence. The effects of the smoke cooling element on the temperature of the mainstream aerosol and the total phenol content of the mainstream aerosol were investigated and compared with the reference aerosol products containing cellulose acetate tow cooling element and the reference cigarette 3R4F (see Fig.5). The thermocouple temperature probe is located at the center of filter 40 and 5mm away from the tip. The test results are shown in Table 2 and Table 3.

Table 2 Test Results of Mainstream Aerosol Temperature.

SAMPLE	PUFF NUMBER		No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
REFEREN CE SAMPLE	MAXIMUM PUFFTEMPERATURE, °C		57. 5	63. 2	62. 8	58. 5	57. 9	54. 8	52. 5	48. 9	48. 6	47. 8	47. 4	46. 5
SAMPLE			40. 1	55. 9	56. 9	52. 7	52. 1	49. 4	47. 8	44. 3	44. 0	43. 3	42. 9	42. 5
DIFFERENCEOF TEMPERATURE,°C				7. 3	5. 9	3. 5	5. 8	5. 4	4. 7	4. 6	4. 6	4. 5	4. 5	4. 0

Table 3 Comparison of Phenol Content in Mainstream Aerosols

SAMPLE NAME	PHENOL ($\mu\text{g/piece}$)	%REDUCED AMOUNT
CIGARETTE REFERENCE 3R4F	11.7 (data quoted from Chinese patent CN104203015 A)	/
TEST SAMPLE	0.80	93.2

Example 3

[0053] As shown in Fig.3, a four stage aerosol generating product 10 has a smoke cooling element and comprises an aerosol atomizing element 20, a hollow cellulose acetate tube 60, a smoke cooling element 30 and a filter nozzle 40. The four elements are coaxially wrapped with cigarette paper 50 to form a rod 11. The aerosol atomization element 20 is located at the farthest end 13 of the rod; the hollow cellulose acetate tube 60 is located at the downstream of the aerosol atomization element; the smoke cooling element 30 is located at the downstream of the hollow cellulose acetate tube; the filter 40 is located at the downstream of the smoke cooling element and the rod 11 has a nozzle end 12. After assembled by the cigarette maker, the rod 11 has a length of approximately 45mm, an outer diameter of approximately 7.2mm, and an inner diameter of approximately 6.9mm. The aerosol atomization unit 20 comprises a filamentous or folded tobacco material rolled by a cigarette maker and wrapped in a filter paper (not shown) to form a rod. The tobacco material comprises an additive which comprises an aerosol forming additive glycerol and/or propylene glycol. The hollow acetate fiber tube 60 is downstream of the aerosol atomization element and is made of cellulose acetate. The aerosols are mixed firstly in the hollow section, buffered and cooled.

[0054] The smoke cooling element 30 is located downstream of the hollow tube 60 and is a porous rod containing cellulose acetate particles. In this embodiment, the smoke cooling element 30 is made of cellulose acetate particles coated with a film and UHMWPE binder by heating and bonding under certain conditions. UHMWPE binder can mechanically bond particles and binder particles at multiple contact points at its melting temperature. The binder hardly flows at its melting temperature, which ensures the continuity of the voids formed between the particles and formed a plurality of channels extending along the length of the smoke cooling element 30. The porous rod was made of 25% of GUR2105 from Ticona and/or LLC and 75% of cellulose acetate particles coated with polyethylene glycol/hydroxypropyl methylcellulose film. The porous rod is manufactured by mixing GUR2015 binder and cellulose acetate particles and then filling the mold (free sintering) with the mixture without applying pressure to the heated mixture. After the mold was heated to 200°C for 40 minutes, the porous rod was taken out from the mold and cooled, and was wrapped with molding paper 31 with a weight of 20g and a thickness of 0.08mm. The rod is cut into equal length segments.

[0055] The smoke cooling element contains 10mg/mm cellulose acetate particles. Its sealing pressure drop is 3mmH₂O and the porosity is 72%.

[0056] The filter 40 is a traditional cellulose acetate rod with a length of 8mm. The outer diameter of the rod is approximately 7.12mm and the inner diameter is approximately 6.9mm.

[0057] The hollow tube 60 is made of cellulose acetate. The length of the hollow tube is 7mm. The outer diameter of the hollow tube is 7.12mm, and the inner diameter is 3.5mm.

[0058] As the aerosol generating product shown in Fig.3, a heating element is inserted at the side of the aerosol atomizing element to heat the tobacco material in the aerosol atomizing element to release volatile compounds from the tobacco material. The consumer sucks on the mouth end 12 of the aerosol generating product 10 and these volatile compounds are condensed and atomized to form an aerosol which is transmitted to the consumer's mouth through the rod 11.

[0059] The aerosol is sucked and heat is exchanged through the smoke cooling element 30. Then the temperature of the aerosol is reduced and the moisture in the aerosol is also intercepted, which improves the filtration efficiency of phenol in the aerosol.

[0060] Simulating smoking goes according to the national standard GB/T19609-2004 cigarette smoking model under Canadian Intense smoking regime (HCI). The classified substances were intercepted through Cambridge filter and the quantitative determination of phenol was carried out by HPLC Fluorescence. The effects of the smoke cooling element on the temperature of the mainstream aerosol and the total phenol content of the mainstream aerosol were investigated and compared with the reference aerosol products containing cellulose acetate tow cooling element and the reference cigarette 3R4F (see Fig.5). The thermocouple temperature probe is located at the center of filter 40 and 5mm away from the tip. The test results are shown in Table 4 and Table 5.

Table 4 Test Results of Mainstream Aerosol Temperature

SAMPLE	PUFFNUM BER												No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
REFERENCE SAMPLE	MAXIMU M PUFFTEMP ERATURE, °C												57.5	63.2	62.8	58.5	57.9	54.8	52.5	48.9	48.6	47.8	47.4	46.5
SAMPLE													49.0	57.6	57.2	55.2	54.7	51.8	49.9	46.8	46.6	46.2	45.9	45.2
DIFERENCE OF TEMPERATURE,°C														5.6	5.6	3.3	3.2	3.0	2.6	2.1	2.0	1.6	1.5	1.3

Table 5 Comparison of Phenol Content in Mainstream Aerosols

SAMPLE NAME	PHENOL ($\mu\text{g}/\text{piece}$)	%REDUCED AMOUNT
CIGARETTE REFERENCE 3R4F	11.7 (quoted from CN104203015 A)	/
TEST SAMPLE	1.26	89.2

Example 4

[0061] As shown in Fig.4, another four stage aerosol generating product 10 has a smoke cooling element smoke and comprises an aerosol atomizing element20, a smoke cooling element30, a folded Polylactic acid film sheet 70 and a filter nozzle 40. The four elements are coaxially assembled into a rod 11 using a rod compound forming machine and cigarette paper 50 in sequence. The aerosol atomizing element20 is located at the farthest end 13 of the rod; the smoke cooling element30 is located at the downstream of the aerosol atomizing element; the folded and gathered Polylactic acid film sheet 70 is located at the downstream of the smoke cooling element; the filter 40 is located at the downstream of the gathered Polylactic acid film sheet. The rod 11 has a mouth end 12. After assembled by the molding machine, the rod 11 has a length of approximately 45 mm, an outer diameter of approximately 7.2 mm, and an inner diameter of approximately 6.9 mm.

[0062] The aerosol atomization element20 comprises a filamentous or folded tobacco material rolled by a cigarette machine and wrapped in a filter paper (not shown) to form a rod. The tobacco material comprises an additive which comprises an aerosol forming additive glycerol and propylene glycol.

[0063] The smoke cooling element 30 is located downstream of the aerosol atomization element and is a porous rod containing cellulose acetate particles. The porous rod has a length of approximately 7 mm, an outer diameter of approximately 7.2mm and an inner diameter of approximately 6.9mm. In the embodiment, the smoke cooling element is made of cellulose acetate particles coated with a film and UHMWPE binder by heating and bonding under certain conditions. UHMWPE binder can mechanically bond particles and binder particles at multiple contact points at its melting temperature. The binder hardly flows at its melting temperature, which ensures the continuity of the voids formed between the particles and forms a plurality of channels extending along the length of the smoke cooling element30. The porous rod was made of 25% of GUR2105 from Ticona and/or LLC and 75% of cellulose acetate particles coated with polyethylene glycol/hydroxypropyl methylcellulose film. The porous rod is manufactured by mixing GUR2015binderand cellulose acetate particles and then filling the mold (free sintering) with the mixture without applying pressure to the heated mixture. The mold was then heated to 200°C for 40 minutes. After that, the porous rod was taken out from the mold and cooled, and wrapped with 20g molding paper 71 with a thickness of 0.08 mm. The rod is cut into equal length segments.

[0064] The smoke cooling element contains 10mg/mm cellulose acetate particles with a length of 7mm, a sealed pressure drop of 1.2mmH₂O and a porosity of 72%.

[0065] The folded and assembled Polylactic acid film sheet 70 has a length of approximately 18mm, an outer diameter of 7.2mm and an inner diameter of approximately 6.9mm. The thickness of PLA film is 50 μm .

[0066] The filter 40 is a traditional cellulose acetate rod with a length of 8mm. The outer diameter of the rod is approximately 7.12mm and the inner diameter is approximately 6.9mm.

[0067] As the aerosol generating product shown in Fig.4, a heating element is inserted at the side of the aerosol atomizing element to heat the tobacco material in the aerosol atomizing element to release volatile compounds from the tobacco material. When the consumer sucks on the mouth end 12 of the aerosol generating product 10, these volatile compounds are condensed and atomized to form an aerosol which is transmitted to the consumer's mouth through the rod 11. The aerosol is sucked and heat is exchanged through the smokecoolingelement30and the temperature of the aerosol is reduced.

[0068] Simulating smoking is according to the national standard GB/T19609-2004 cigarette smoking model under Canadian Intense smoking regime (HCI). The effect of the cooling element on the temperature of the main stream aerosol was investigated and compared with the reference aerosol product containing cellulose acetate tow cooling element. The thermocouple temperature probe is located at the center of filter 40 and 5mm away from the tip. The test results are shown in Table 6.

Table 6 Test Results of Mainstream Aerosol Temperature

SAMPLE	PUFFNUMBER	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
REFERENCE SAMPLE	MAXIMUM PUFFTEMPERATURE, °C	57.5	63.2	62.8	58.5	57.9	54.8	52.5	48.9	48.6	47.8	47.4	46.5
SAMPLE		45.7	55.3	55.2	50.9	50.5	48.8	46.5	44.2	43.9	43.7	43.5	42.7
DIFFERENCEOF TEMPERATURE, °C			7.9	7.6	7.6	7.4	6.0	6.0	4.7	4.7	4.1	3.9	3.8

Example 5

[0069] As shown in Fig. 3, a four stage aerosol generating product 10 has a smoke cooling element and comprises an aerosol atomizing element 20, a hollow cellulose acetate tube 60, a smoke cooling element 30 and a filter nozzle 40. The four elements are coaxially wrapped with cigarette paper 50 to form a rod 11. The aerosol atomization element 20 is located at the farthest end 13 of the rod; the hollow cellulose acetate tube 60 is located at the downstream of the aerosol atomization element; the smoke cooling element 30 is located at the downstream of the hollow cellulose acetate tube; the filter 40 is located at the downstream of the smoke cooling element, and the rod 11 has a nozzle end 12. After assembled by the cigarette maker, the rod 11 has a length of approximately 45mm, an outer diameter of approximately 7.2mm and an inner diameter of approximately 6.9mm. The aerosol atomization element 20 comprises a filamentous or folded tobacco material rolled by a cigarette machine and wrapped in a filter paper (not shown) to form a rod. The tobacco material comprises an additive which comprises an aerosol forming additive glycerol and propylene glycol. The hollow acetate fiber tube 60 is located at the downstream of the aerosol atomization element and is made of cellulose acetate. The aerosols are firstly mixed in the hollow section, buffered and cooled.

[0070] The smoke cooling element 30 is located at the downstream of the hollow tube 60 and is a porous rod containing cellulose acetate particles with a film layer. In this embodiment, the smoke cooling element 30 is made of cellulose acetate particles coated with a film and UHMWPE binder by heating and bonding under certain conditions. UHMWPE binder can mechanically bond particles and binder particles at multiple contact points at its melting temperature. The binder hardly flows at its melting temperature which ensures the continuity of the voids formed between the particles and forms a plurality of channels extending along the length of the smoke cooling element 30. The porous rod was made of 25% of GUR2105 from Ticona and/or LLC and 75% of cellulose acetate particles with an average diameter of 1.2mm coated with hydroxypropyl methylcellulose film. The porous rod is manufactured by mixing GUR2015 binder and cellulose acetate particles and then filling the mold (free sintering) with the mixture without applying pressure to the heated mixture. After the mold was heated to 200°C for 40 minutes, the porous rod was taken out from the mold and cooled, and was wrapped with molding paper 31 with a weight of 20g and a thickness of 0.08mm. The rod is cut into equal length segments.

[0071] The smoke cooling element contains 8.6mg/mm cellulose acetate particles, the sealing pressure drop is 4.7mmH₂O, and the porosity is 73.6%.

[0072] The filter 40 is a traditional cellulose acetate rod with a length of 8mm. The outer diameter of the rod is approximately 7.12mm and the inner diameter is approximately 6.9mm.

[0073] The hollow tube 60 is made of cellulose acetate. The length of the hollow tube is 7mm, the outer diameter of the hollow tube is 7.12mm, and the inner diameter is 3.5mm.

[0074] As the aerosol generating product shown in Fig.3, a heating element is inserted at the side of the aerosol atomizing element to heat the tobacco material in the aerosol atomizing element to release volatile compounds from the tobacco material. When the consumer sucks on the mouth end 12 of the aerosol generating product 10, these volatile compounds are condensed and atomized to form an aerosol which is transmitted to the consumer's mouth through the rod 11.

[0075] The aerosol is sucked and heat is exchanged through the smoke cooling element 30, and the temperature of the aerosol is reduced.

[0076] Simulating smoking goes according to the national standard GB/T19609-2004 cigarette smoking model to under Canadian Intense smoking regime (HCI). The main stream aerosol temperature of the smoke cooling element was investigated and compared with the reference aerosol product containing cellulose acetate tow cooling element (see Fig.5). The thermocouple temperature probe is located at the center of filter 40 and 5mm away from the tip. The test results are shown in Table 7.

Table 7 Test Results of Mainstream Aerosol Temperature

SAMPLE	PUFF NUMBER	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
REFEREN CE SAMPLE	MAXIMUM PUFF TEMPERATURE, °C	57.5	63.2	62.8	58.5	57.9	54.8	52.5	48.9	48.6	47.8	47.4	46.5
SAMPLE		49.6	58.1	57.8	54.2	53.8	52.1	49.8	48.0	47.8	47.2	46.9	46.1
DIFFERENCE OF TEMPERATURE, °C			5.1	5.0	4.3	4.1	2.7	2.7	0.9	0.8	0.6	0.5	0.47

[0077] As shown in Fig.5, the four stage aerosol generation product 10 (reference sample) of the prior art includes four elements: aerosol atomization element 20, hollow cellulose acetate tube 60, Ultra high denier cellulose acetate filter rod 72 and filter nozzle 40. The aerosol atomization element 20 is located at the farthest end 13 of the rod; the hollow cellulose acetate tube 60 is located at the downstream of the aerosol atomization element; the Ultra high denier cellulose acetate filter rod 72 is located at the downstream of the hollow cellulose acetate tube 60; the filter tip 40 is located at the downstream of the Ultra high denier cellulose acetate filter rod 72 and the nozzle end 12 of the rod 11. The four elements are wrapped tightly with cigarette paper 50 in order to form a rod 11.

[0078] The above description of the embodiment is for the convenience of ordinary technicians in the technical field to understand and apply the invention. It is obvious that those skilled in the art can easily make various modifications to these embodiments and apply the general principles described herein to other embodiments without creative work. Therefore, the invention is not limited to the embodiments here.

[0079] According to the disclosure of the invention, the improvements and modifications made by those skilled in the art that are not divorced from the scope of the invention should be within the protection scope of the invention.

Claims

1. An aerosol generating product, wherein the aerosol generating product comprises an aerosol atomizing element and a smoke cooling element, wherein the smoke cooling element is located downstream of the smokeflow generated by the aerosol atomizing element.
2. The aerosol generating product of claim 1, further comprising a filtering element located downstream of the smokeflow which passes through the smoke cooling element.
3. The aerosol generating product of claim 2, further comprising a hollow element located upstream of the smoke which passes through the smoke cooling element.
4. The aerosol generating product of any one of claim 1 to 3, wherein the smoke cooling element is a structure of aggregated particles, the structure including gaps for smoke of a cigarette to pass through at least one continuous smoke passageway.
5. The aerosol generating product of claim 4, wherein the gap is a three-dimensional and nonlinear network.
6. The aerosol generating product of claim 4, wherein the smoke cooling element is in the form of a rod.
7. The aerosol generating product of claim 6, wherein the porosity of the smoke cooling element is 40%-90%.
8. The aerosol generating product of claim 4, wherein the smoke cooling element comprises basic particles, a binder and a wrapping material; the contact points formed between the binder particles, and between the binder particles and the basic particles, and between the basic particles, being physically bonded at multiple places, and the wrapping material is wrapped outside to form a rod with a porous structure.
9. The aerosol generating product of claim 4, wherein the particles can reduce the temperature of the smoke and have low adsorption for effective components of the smoke.
10. The aerosol generating product of claim 8, wherein the basic particles are inactive particles or inactive particles made from active particles by coating with an outer film layer.
11. The aerosol generating product of claim 10, wherein the thickness of the outer film layer of the inactive particles is 0-0.2mm, and the film layer accounts for 0-50% of the mass of the whole particle mass; the thickness of the outer coating layer of the inactive particles made from active particles by coating with an outer film layer is 0.001-0.2mm, and accounts for 0.001-50% of the mass of the whole particle mass.
12. The aerosol generating product of claim 10, wherein the inactive particles adsorb less than 3.0 mg/cm³ of nicotine from the smoke aerosol.
13. The aerosol generating product of claim 10, wherein the inactive particles include organic or inorganic particles;

the inorganic particles include aluminum oxide, zirconia, calcium carbonate ball, glass bead, silicon dioxide, iron, copper, aluminum, gold, platinum, magnesium silicate ball or calcium sulfate;
the organic particles include cellulose acetate, cellulose acetate propionate and acetic acid, cellulose butyrate, microcrystalline cellulose, sucrose powder, dextrin, lactose, sugar powder, glucose, mannitol, starch, methyl cellulose, ethyl cellulose, polylactic acid, polyethylene, polypropylene, polyhydroxybutyrate, poly ϵ -caprolactone, polyglycolic acid, polyhydroxyalkanoate or starch based thermoplastic resin.

14. The particles that can reduce the temperature of smoke of claim 10, wherein the active particles adsorb 3.0 mg/cm³ or more nicotine from the smoke aerosol.

15. The aerosol generating product of claim 10, wherein:

the active particles include molecular sieve, activated carbon, diatomite, zeolite, perlite, ceramics, sepiolite, bleaching earth or ion exchange resin;

the inactive particles include aluminum oxide, zirconium oxide, calcium carbonate ball, glass bead, silica, iron, copper, aluminum, gold, platinum and magnesium silicate ball or calcium sulfate.

16. The aerosol generating product of claim 10, wherein the film layer is made of film material.

17. The aerosol generating product of claim 16, wherein the film forming material comprises cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, hydroxypropyl cellulose, hydroxypropyl methylcellulose, methylcellulose, ethyl cellulose, polyvinylpyrrolidone, polyethylene glycol diethylamine acetate, styrene maleic acid copolymer and styrene-Vinylpyridine copolymer, cellulose acetate phthalate, propyl methylcellulose phthalate, cellulose acetate/polyethylene glycol, methyl cellulose/polyethylene glycol, carboxymethyl cellulose/polyethylene glycol, hydroxypropyl methylcellulose/polyethylene glycol, ethyl cellulose/polyethylene glycol or acrylic resin/polyethylene glycol, or polylactic acid.

18. The aerosol generating product of claim 10, wherein the shapes of the basic particles includes sphere, quasi-sphere, cake, sheet, banding, needle-like, multilateral, facet or random.

19. The aerosol generating product of claim 10, wherein the basic particles have an average diameter from the lower limit of 50 μm , 100 μm , 150 μm , 200 μm or 250 μm to the upper limit of 5000 μm , 2000 μm , 1000 μm , 900 μm or 700 μm in at least one dimension.

20. The aerosol generating product of claim 8, wherein the binder particles are selected from: polyethylene, polypropylene, polylactic acid, polyolefin, polyester, polyamide, polyacrylic acid, polyethylene compounds, polytetrafluoroethylene, polyetheretherketone, polyethylene terephthalate, poly butylene terephthalate, poly cyclohexylene terephthalate, poly propylene terephthalate, polyacrylic acid, poly methyl methacrylate, acrylonitrile butadiene styrene, styrene acrylonitrile, styrene butadiene, styrene maleic acid, cellulose acetate, cellulose acetate butyrate, plasticized cellulose plastics, cellulose propionate, ethyl cellulose, any derivatives thereof, any copolymers thereof and combinations thereof.

21. The aerosol generating product of claim 8, wherein the shapes of the binder particles include spherical, star shaped, granular, potato shaped, irregular shape and their combinations.

22. The aerosol generating product of claim 8, wherein the binder particles have an average diameter from the lower limit of 5 μm , 10 μm , 50 μm , 100 μm or 150 μm to the upper limit of 500 μm , 400 μm , 300 μm , 250 μm or 200 μm in at least one dimension.

23. The aerosol generating product of claim 8, wherein the proportion of the binder particles in the porous cooling section is 0.1% to 99% and the content of the basic particles is 1% to 99%.

24. The aerosol generating product of claim 8, wherein the proportion of the binder particles in the porous cooling section is 15%-33%.

25. The aerosol generating product of claim 8, wherein the content of the basic particles is 67%-85%.

26. The aerosol generating product of claim 8, wherein the wrapping material is plug wrapping paper with a gram weight

of 20-40g and a thickness of 0.08-0.12mm.

27. Use of the aerosol generating product mentioned in any one of claims 1 to 26 in heat-not-burn cigarettes.

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FIG.1

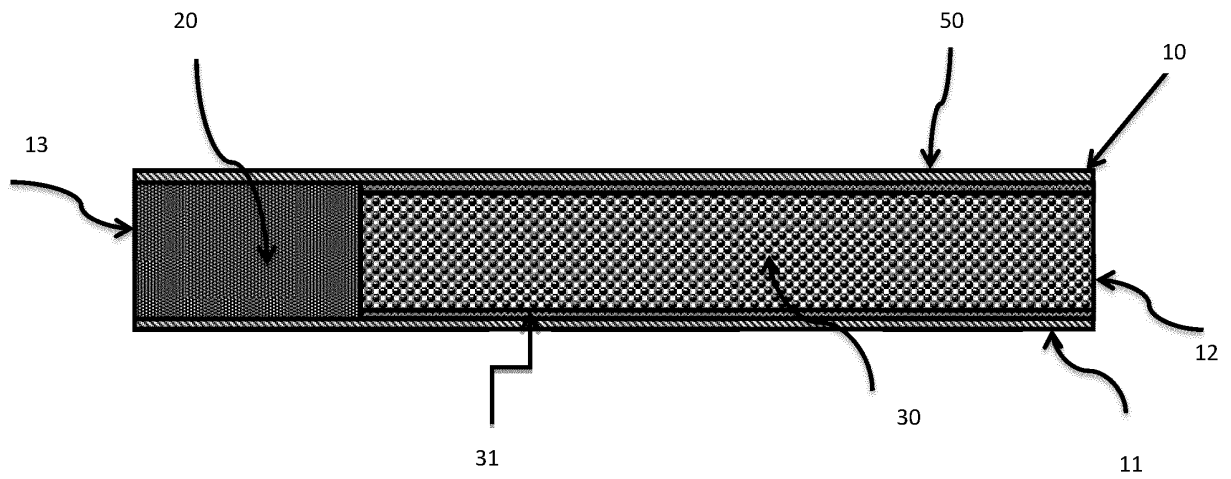


FIG.2

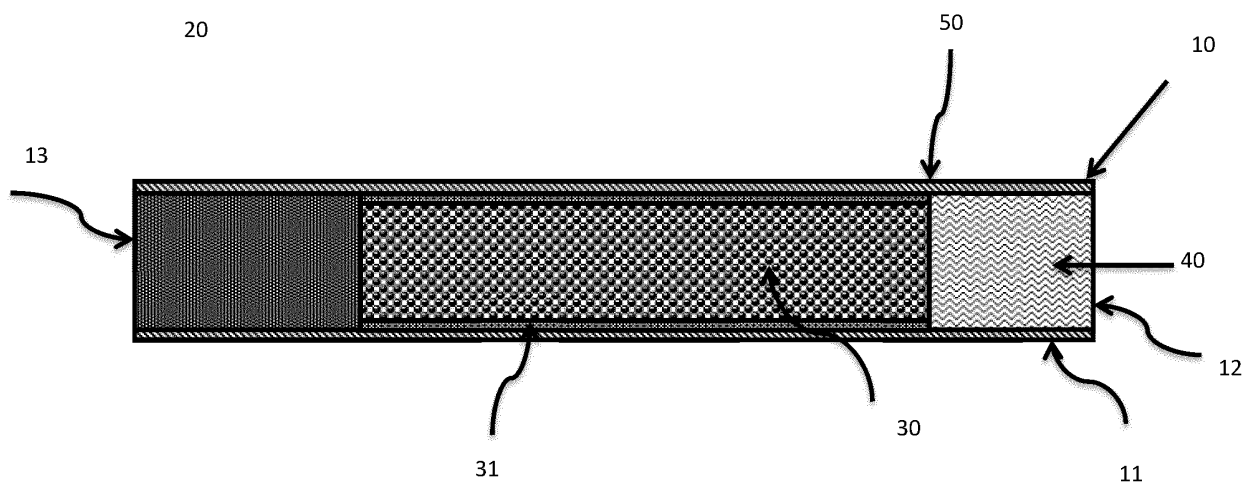


FIG. 3

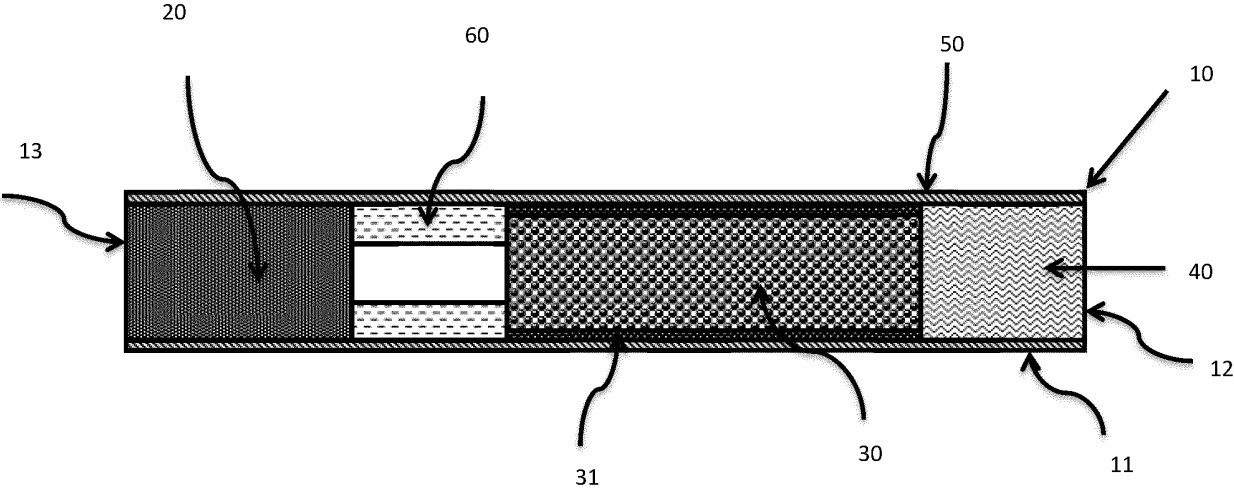


FIG. 4

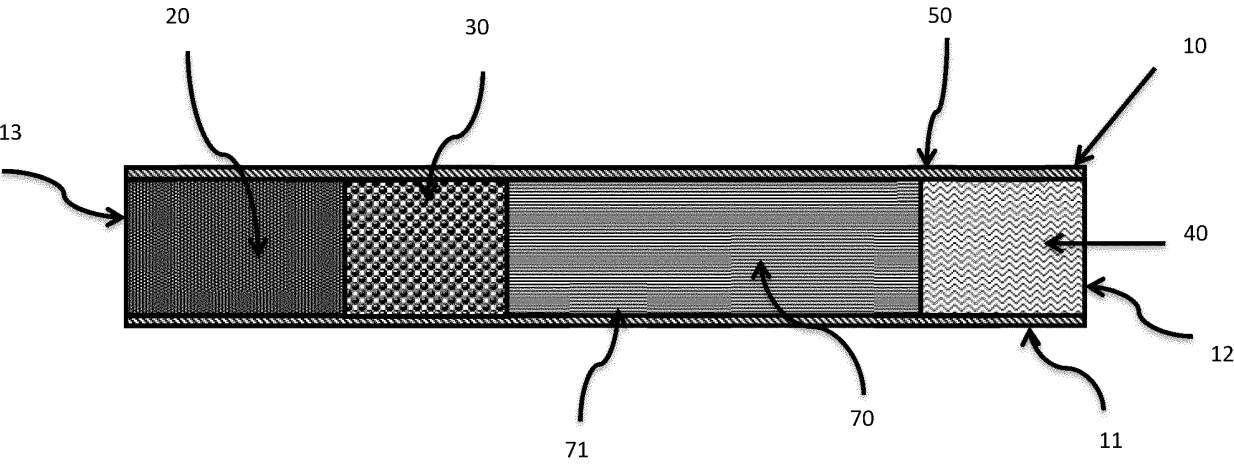
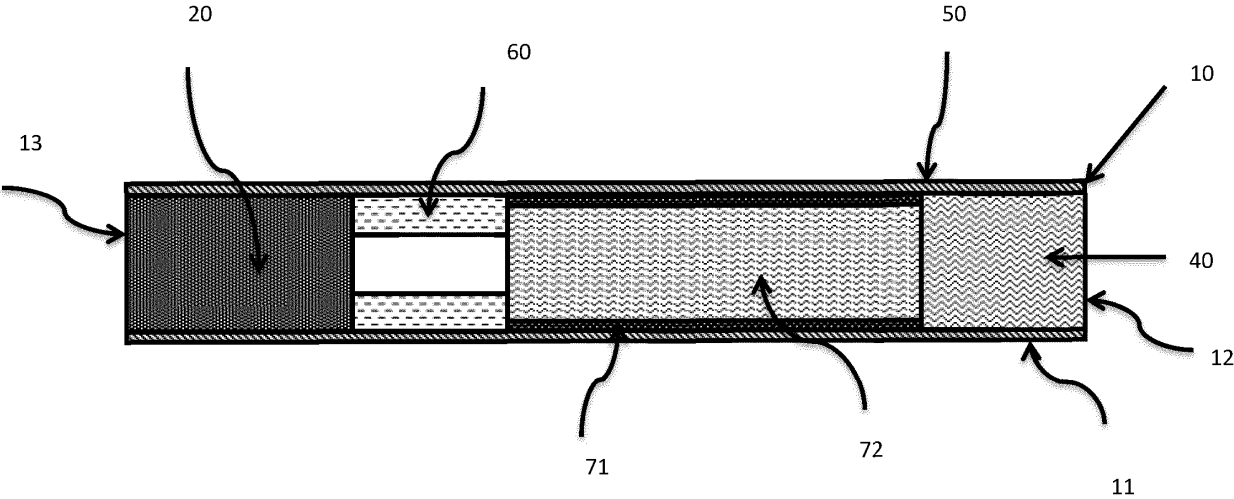


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/115101

5	A. CLASSIFICATION OF SUBJECT MATTER A24F 47/00(2020.01)i According to International Patent Classification (IPC) or to both national classification and IPC				
	B. FIELDS SEARCHED				
10	Minimum documentation searched (classification system followed by classification symbols) A24F				
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNPAT, EPODOC, WPI, CNKI: 气溶胶, 生成, 烟气, 雾化, 降温, 中空, 相变, 吸热, 保持, 维持, 颗粒, 多孔, 加热, 不燃烧; aerosol, generat??, gas, atomiz??, hollow, particulate?, porous, heat??, unburned, cigarette				
	C. DOCUMENTS CONSIDERED TO BE RELEVANT				
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
	PX	CN 109691697 A (NANTONG CELLULOSE FIBERS CO., LTD. et al.) 30 April 2019 (2019-04-30) description, paragraphs [0003]-[0033], and figures 1-5	1-27		
25	PX	CN 109998158 A (CHINA TOBACCO YUNNAN INDUSTRIAL CO., LTD.) 12 July 2019 (2019-07-12) description, paragraphs [0026]-[0048], and figures 1 and 2	1-7, 27		
	PX	CN 109527639 A (CHINA TOBACCO ANHUI INDUSTRIAL CO., LTD.) 29 March 2019 (2019-03-29) description, paragraphs [0037]-[0054], and figures 1 and 2	1-7, 9, 27		
30	X	CN 108143004 A (CHINA TOBACCO ANHUI INDUSTRIAL CO., LTD.) 12 June 2018 (2018-06-12) description, paragraphs [0005]-[0039], and figures 1-3	1-27		
35	X	CN 108523220 A (HUBEI CHINA TOBACCO INDUSTRY CO., LTD.) 14 September 2018 (2018-09-14) description, paragraphs [0023] and [0030]-[0044], and figures 1-3	1-3, 27		
	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.				
40	<table border="0"> <tr> <td style="vertical-align: top;"> * Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed </td> <td style="vertical-align: top;"> “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family </td> </tr> </table>			* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family
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45					
	Date of the actual completion of the international search		Date of mailing of the international search report		
	19 January 2020		06 February 2020		
50	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451		Authorized officer Telephone No.		

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INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2019/115101

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 2018201123 A1 (CELANESE INT. CORPORATION) 01 November 2018 (2018-11-01) description, paragraphs [0014]-[0053], and figures 1 and 2	1-7, 27

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/115101

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Patent document cited in search report			Publication date (day/month/year)		Patent family member(s)		Publication date (day/month/year)	
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CN	109998158	A	12 July 2019		None			
CN	109527639	A	29 March 2019		None			
CN	108143004	A	12 June 2018		None			
CN	108523220	A	14 September 2018		None			
CN	109007972	A	18 December 2018		None			
WO	2018201123	A1	01 November 2018	US	2018310624	A1	01 November 2018	

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REFERENCES CITED IN THE DESCRIPTION

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- CN 107259638 A [0002]
- CN 103330283 [0035]
- CN 104203015 A [0052] [0060]