

HEATING NON-COMBUSTION DEVICE AND ELECTRONIC CIGARETTE

TECHNICAL FIELD

[0001] The present invention relates to the field of heating devices, specifically to a heating non-combustion device and its electronic cigarette.

TECHNICAL BACKGROUND

[0002] Existing heating non-combustion devices have significant heat transfer loss from the heating element (especially circumferential heating type heating elements) to the outside, resulting in the problem of the heating device's casing being hot to the touch, as well as low battery efficiency.

[0003] Currently, the industry uses aerogel for thermal insulation, but it can only partially alleviate the problem of the casing being hot to the touch. When two or more cigarette sticks are consecutively smoked, the casing of the heating device still becomes hot, and the battery efficiency utilization rate is low.

SUMMARY

[0004] According to a first aspect, in one embodiment, a heating non-combustion device is provided, including a cigarette stick, an outer pipe, and a heating element.

[0005] The cigarette stick is at least partially located within the heating element, the heating element is located within the outer pipe, and there is a first gap between the heating element and the outer pipe.

[0006] The inner wall of the outer pipe is provided with a thermal insulation layer, and there is or is not a gap between the thermal insulation layer and the inner wall of the outer pipe.

[0007] In one embodiment, the thermal insulation layer is an aluminum reflective layer.

[0008] In one embodiment, the thermal insulation layer is a hollow glass microsphere layer.

[0009] In one embodiment, the thermal insulation layer includes a first thermal insulation layer and a second thermal insulation layer.

[0010] In one embodiment, the first thermal insulation layer and the second thermal insulation layer are sequentially stacked on the inner wall of the outer pipe.

[0011] In one embodiment, the first thermal insulation layer is an aluminum reflective layer, and the second thermal insulation layer is a hollow glass microsphere layer.

[0012] In one embodiment, a plurality of pillars is provided between the outer pipe and the thermal insulation layer, and there is a second gap between pillars.

[0013] In one embodiment, the first thermal insulation layer is an aluminum reflective layer, and the second thermal insulation layer is an upconversion material coating.

[0014] In one embodiment, the first thermal insulation layer is an aluminum-coated glass film, an aluminum-coated resin film, or an aluminum-coated polyimide film, and the second thermal insulation layer is an upconversion material coating. One side of the glass film, resin film, or polyimide film is coated with aluminum, and the other side is provided with the upconversion material coating.

[0015] In one embodiment, the first thermal insulation layer is an aluminum reflective layer, and the second thermal insulation layer is a polyether ether ketone film layer, and there is or is not a gap between the first thermal insulation layer and the second thermal insulation layer.

[0016] In one embodiment, the first thermal insulation layer is an aluminum reflective layer, and the second thermal insulation layer is a stainless steel film layer, and there is or is not a gap between the first thermal insulation layer and the second thermal insulation layer.

[0017] In one embodiment, the thermal insulation layer is an aluminum tube, and there is or is not a gap between the aluminum tube and the inner wall of the outer pipe.

[0018] According to a second aspect, in one embodiment, an electronic cigarette is provided, including the heating non-combustion device according to any one of the first aspect.

[0019] Based on the above embodiments of the heating non-combustion device and its electronic cigarette, the present invention significantly improves the thermal insulation effect by setting a thermal insulation layer, effectively preventing the casing from being hot to the touch.

BRIEF DESCRIPTION OF DRAWINGS

[0020] FIG. 1 is a schematic structural diagram of a heating non-combustion device in one embodiment;

[0021] FIG. 2 is an exploded structural diagram of a heating non-combustion device in one embodiment;

[0022] FIG. 3 is an A-A sectional view of FIG. 1 in one embodiment;

[0023] FIG. 4 is an A-A sectional view of FIG. 1 in another embodiment;

[0024] FIG. 5 is an A-A sectional view of FIG. 1 in another embodiment;

[0025] FIG. 6 is an enlarged view of part B of FIG. 4;

[0026] FIG. 7 is an enlarged view of part C of FIG. 5;

[0027] FIG. 8 is a front view of a heating non-combustion device in one embodiment;

[0028] FIG. 9 is a D-D sectional view of FIG. 8.

[0029] Reference numerals: 1, cigarette stick; 2, outer pipe; 3, first gap; 4, heating element; 5, thermal insulation layer; 51, first thermal insulation layer; 52, second thermal insulation layer; 6, pillar; 7, second gap.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] The present application will be further described in detail below in conjunction with specific embodiments and accompanying drawings. In the following embodiments, many details are described to enable a better understanding of the present application. However, those skilled in the art can easily recognize that some features can be omitted or replaced by other materials or methods in different situations. In certain cases, some operations related to the present application are not shown or described in the specification to avoid overwhelming the core part of the present application with excessive descriptions. For those skilled in the art, it is not necessary to describe these related operations in detail, as they can fully understand the related operations based on the description in the specification and general technical knowledge in the field.

[0031] Furthermore, the features, operations, or characteristics described in the specification can be combined in any suitable manner to form various embodiments. Also, the steps or actions in the method description can be reordered or adjusted in a manner that is apparent to those skilled in the art. Therefore, the various sequences in the specification and drawings are only for clearly describing a particular embodiment and do not imply that the sequence is necessary unless otherwise specified.

[0032] The numbering of components in this document, such as “first,” “second,” etc., is only used to distinguish the described objects and does not have any sequential or technical meaning.

[0033] In one embodiment, the present invention achieves the transfer of thermal radiation from a lower temperature area to a higher temperature area by setting a thermal insulation layer, thereby reducing the heat transfer loss from the heating element (especially the circumferential heating type heating element) to the outside.

[0034] In one embodiment, one specific implementation method is as follows: by using specific reflective materials (including metal foils or coatings) and setting an appropriately sized (not too small) air gap layer distance (the energy transfer from the heating tube to the outside is mainly through air conduction and thermal radiation; however, when the gap distance exceeds the free path of air, e.g., the average free path of air is about 0.183 microns at 300°C, and the heat flux transfer is inversely proportional to the air gap layer distance). This method reverses the propagation path of part of the heat radiated outward by the heating tube to a certain extent.

[0035] When using metal foil as a reflective material, the foil additionally provides a heat equalizing effect, which can improve the temperature uniformity of the outer layer parts (including the outer wall of the PEEK tube, the outer casing of the whole machine, etc.); when using a coating reflective material, especially a vacuum glass bead reflective material, the vacuum glass beads (with a high vacuum or semi-vacuum state inside the glass beads) provide an additional thermal insulation effect.

[0036] In one embodiment, another specific implementation method is as follows: by setting an

infrared upconversion material around the periphery of the heating element, the infrared wavelength emitted by the heating element is converted into shorter wavelength near-infrared light or even visible light scattered photons. Since the energy of the incident photons is lower than the energy of the emitted scattered photons, a fluorescence cooling effect occurs. Moreover, the incident direction of the scattered photon light waves converted is independent of the original infrared light incident direction, and about half of the scattered photons are directed towards the heating element, achieving a reversal of the original transmission direction. The other half of the scattered photons and the unabsorbed incident photons still reverse the transmission direction by setting a mirror aluminum reflective layer on the outside of the upconversion material as described in the first implementation method.

[0037] In one embodiment, the type of heating tube is not limited and can be an ordinary metal tube, such as a thick film heating element based on a metal substrate or a thick film heating element based on a ceramic substrate.

[0038] According to the first aspect, in one embodiment, as shown in FIG. 1, FIG. 2, FIG. 3, FIG. 8, and FIG. 9, a heating non-combustion device is provided, including a cigarette stick 1, an outer pipe 2, and a heating element 4.

[0039] The cigarette stick 1 is at least partially located within the heating element 4, the heating element 4 is located within the outer pipe 2, and there is a first gap 3 between the heating element 4 and the outer pipe 2.

[0040] The inner wall of the outer pipe 2 is provided with a thermal insulation layer 5. The thermal insulation layer 5 serves the purpose of thermal insulation, preventing the outer wall of the outer pipe 2 from overheating. There is or is not a gap between the thermal insulation layer 5 and the inner wall of the outer pipe 2, preferably with a gap, which can further provide good thermal insulation.

[0041] In one embodiment, the thermal insulation layer 5 can be an aluminum reflective layer.

[0042] In one embodiment, the thermal insulation layer 5 can be a hollow glass microsphere layer.

[0043] The material of the thermal insulation layer 5 is an existing material, specifically, it can be aluminum foil, hollow glass microspheres, and other reflective materials, serving the purpose of thermal insulation.

[0044] In one embodiment, there is a gap between the thermal insulation layer 5 and the heating element 4, which further provides thermal insulation.

[0045] In one embodiment, as shown in FIG. 4 and FIG. 6, the thermal insulation layer 5 includes a first thermal insulation layer 51 and a second thermal insulation layer 52.

[0046] In one embodiment, as shown in FIG. 4 and FIG. 6, the first thermal insulation layer 51 and the second thermal insulation layer 52 are sequentially stacked on the inner wall of the outer

pipe 2.

[0047] In one embodiment, the first thermal insulation layer 51 is an aluminum reflective layer, and the second thermal insulation layer 52 is a hollow glass microsphere layer.

[0048] In one embodiment, as shown in FIG. 5 and FIG. 7, a plurality of pillars 6 (two or more) are provided between the outer pipe 2 and the thermal insulation layer 5, and a second gap 7 is provided between pillars 6, which further provides thermal insulation. The material of the pillars 6 is the same as that of the outer pipe 2. The pillars 6 and the outer pipe 2 can be of an integrated structure.

[0049] In one embodiment, the first thermal insulation layer 51 is an aluminum reflective layer, and the second thermal insulation layer 52 is an upconversion material coating.

[0050] In one embodiment, the first thermal insulation layer 51 is an aluminum-coated glass film, an aluminum-coated resin film, or an aluminum-coated polyimide film, and the second thermal insulation layer 52 is an infrared upconversion material coating. One side of the glass film, resin film, or polyimide film is coated with aluminum, and the other side is provided with the infrared upconversion material coating.

[0051] In one embodiment, as shown in FIG. 4 and FIG. 6, the first thermal insulation layer 51 is an aluminum reflective layer, and the second thermal insulation layer 52 is a polyether ether ketone film layer. There is or is not a gap between the first thermal insulation layer 51 and the second thermal insulation layer 52, which can be continuous or discontinuous. In one embodiment, wrinkles can be set on the surface of the polyether ether ketone film layer that is at least partially connected to the aluminum reflective layer, so that there is a partial air gap between the polyether ether ketone film layer and the aluminum reflective layer, further providing thermal insulation.

[0052] In one embodiment, as shown in FIG. 4 and FIG. 6, the first thermal insulation layer 51 is a polyether ether ketone film layer, and the second thermal insulation layer 52 is an aluminum reflective layer. There is or is not a gap between the first thermal insulation layer 51 and the second thermal insulation layer 52, which can be continuous or discontinuous.

[0053] In one embodiment, as shown in FIG. 4 and FIG. 6, the first thermal insulation layer 51 is an aluminum reflective layer, and the second thermal insulation layer 52 is a stainless steel film layer. There is or is not a gap between the first thermal insulation layer 51 and the second thermal insulation layer 52, which can be continuous or discontinuous.

[0054] In one embodiment, as shown in FIG. 4 and FIG. 6, the first thermal insulation layer 51 is a stainless steel film layer, and the second thermal insulation layer 52 is an aluminum reflective layer. There is or is not a gap between the first thermal insulation layer 51 and the second thermal insulation layer 52, which can be continuous or discontinuous.

[0055] In one embodiment, the thermal insulation layer 5 is a layered composite material of

aluminum foil and stainless steel film.

[0056] In one embodiment, the thermal insulation layer 5 is an aluminum tube, and there is or is not a gap between the aluminum tube and the inner wall of the outer pipe 2, preferably with a gap.

[0057] In one embodiment, the outer pipe 2 can be made of polyether ether ketone or polyimide. The material of the outer pipe 2 is an existing material.

[0058] According to the second aspect, in one embodiment, an electronic cigarette is provided, including the heating non-combustion device according to any one of the first aspect.

[0059] Embodiment 1

[0060] As shown in FIG. 1, in this embodiment, the outer pipe is a PEEK (polyether ether ketone, abbreviated as PEEK) tube, and the inner wall of the PEEK tube is lined with high-reflectivity aluminum foil (with a purity not less than 99.6%) for thermal insulation.

[0061] The thickness of the aluminum foil is 5~200 microns, in this embodiment, it is 20 microns, with a reflectivity of $\leq 95\%$. The aluminum foil does not use an organic adhesive layer, and there will be partial contact with the PEEK inner wall, but there will still be a large part with a slight gap or air layer. The aluminum foil is fixed by its own tension and constraint at one or both ends. The thickness of the air gap layer between the aluminum foil and the heating element is 1~5 microns, in this embodiment, it is 2.5 microns.

[0062] In this embodiment, the aluminum foil is used for thermal insulation on the inner wall of the PEEK tube. Compared with the control group (including the blank control group), the power consumption and the highest temperature of the PEEK outer wall during an unloaded heating cycle (4 minutes) are shown in Table 1. During the test, the PEEK tube outer wall was exposed to room temperature air and was not installed in the whole machine casing.

Table 1

Group Number	Combination of Thermal Insulation Measures	Power Consumption/mWh	Highest Temperature of PEEK Outer Wall/°C	Description
1	Aluminum foil thermal insulation on PEEK tube inner wall	321.7	88	This embodiment
2	Air insulation inside PEEK tube	374.5	130	Blank control group
3	Aluminum foil on PEEK tube inner wall + aerogel blanket inside aluminum foil	361	94	Control group
4	Aerogel blanket inside PEEK tube + aluminum foil inside aerogel blanket	374.5	96	Control group
5	Aerogel blanket insulation inside	344.7	120	Control group

	PEEK tube			
6	Glass microsphere insulation inside PEEK tube	360~375	120	Control group

[0063] It can be seen that compared to the blank control group, applying a layer of aluminum foil on the inner wall of the PEEK tube for thermal insulation has the best effect in reducing power consumption (decrease of 14.1% = 1-321.7/374.5) and reducing the temperature of the PEEK outer wall (decrease of 42°C = 130°C-88°C).

[0064] Furthermore, the PEEK tube was installed in the machine, and the highest temperature of the whole machine casing (artificial leather wrapped aluminum casing) was measured, as shown in Table 2.

Table 2

Whole Machine Casing Temperature (°C)	Whole Machine Casing Temperature (°C)
One puff	39.5-42.0
Two consecutive puffs	44.0-47.0
Three consecutive puffs	47.0-49.5

[0065] Embodiment 2.

[0066] The inner wall of the PEEK tube is provided with a hollow glass microsphere reflective coating flexible material, and the thickness of the air gap layer between the aluminum foil and the heating element is 1~5 microns, preferably 2~2.5 microns.

[0067] The size of the hollow glass microspheres is 150~500 mesh (23~106 microns), in this embodiment, 300 mesh (48 microns) is selected.

[0068] The thickness of the aluminum reflective coating layer is 1~20 microns, in this embodiment, it is 6~10 microns.

[0069] This embodiment can also set pillars on the substrate of the hollow glass microsphere reflective coating flexible material, forming an air gap layer between the pillars, so that when the hollow glass microsphere reflective coating flexible material is set on the inner wall of the PEEK tube, even if the material is in partial contact with the PEEK tube inner wall, there will be a stable distribution of air gap layers for thermal insulation (the thermal conductivity of air is much lower than that of the substrate).

[0070] Embodiment 3.

[0071] The inner wall of the PEEK tube is provided with aluminum foil coated with an infrared upconversion material coating (with a purity not less than 99.6%) or an ultra-thin aluminum-coated flexible transparent glass film/flexible transparent high-temperature resistant (250 degrees Celsius or above) resin film (the infrared upconversion material coating is applied on the side of the transparent substrate that is not aluminum-coated) for thermal insulation.

[0072] The upconversion material coating functions as a fluorescent refrigerant functional material, exhibiting a certain degree of fluorescence cooling effect under the excitation of infrared light from the heating element. The chemical composition is a rare earth-doped fluoride material (YF₃:ErYb) or a rare earth-doped sulfide material, with a grain size of 10~100 nm, capable of converting infrared light into shorter wavelength near-infrared light or visible light. The upconversion material can be purchased from the market.

[0073] The upconversion material coating is combined with the aluminum foil, glass film, or resin film to form a thermal insulation layer, and multiple pillars can be set between the thermal insulation layer and the inner wall of the outer pipe, with gaps between pillars, further providing thermal insulation.

[0074] Embodiment 4.

[0075] Based on Embodiment 1, the aluminum foil is replaced with a layered composite material of aluminum foil (i.e., aluminum film layer, also known as aluminum reflective layer) and PEEK film (PEEK film thickness is 5~20 microns, preferably a model with a thermal expansion coefficient close to that of aluminum, such as inorganic fiber-reinforced PEEK film), and the inner wall of the PEEK film is wrinkled, forming a more uniformly distributed bubble distribution between the PEEK film and the aluminum foil, i.e., introducing an air gap bubble between the PEEK film layer and the aluminum film layer, which helps with thermal insulation.

[0076] Refer to FIG. 4 and FIG. 6, the first thermal insulation layer 51 is a PEEK film, and the second thermal insulation layer 52 is aluminum foil. Alternatively, the first thermal insulation layer 51 is aluminum foil, and the second thermal insulation layer 52 is a PEEK film.

[0077] Alternatively, based on Embodiment 1, the aluminum foil is replaced with a layered composite material of aluminum foil and a stainless steel film with poor thermal conductivity (thickness 5~20 microns, SUS430 or SUS304 or SUS316, etc.). Refer to FIG. 4 and FIG. 6, the first thermal insulation layer 51 is aluminum foil, and the second thermal insulation layer 52 is a stainless steel film. Alternatively, the first thermal insulation layer 51 is a stainless steel film, and the second thermal insulation layer 52 is aluminum foil.

[0078] Alternatively, based on Embodiment 1, the aluminum foil is replaced with an aluminum tube (thickness 20~300 microns). In this scheme, the aluminum tube has relatively good rigidity, allowing for a stable distance (1~5 microns) between the aluminum tube and the heating element, and also allowing for a stable distance (about 1~2 millimeters) between the aluminum tube and the inner wall of the PEEK tube, which helps to demonstrate the thermal insulation effect of the air layer.

[0079] In one embodiment, two methods using reflective materials (metal reflective aluminum foil, hollow glass microsphere reflective coating material) and upconversion materials (fluorescent refrigerant coating) achieve the transfer of thermal radiation from a lower

temperature area to a higher temperature area.

[0080] In one embodiment, an air gap layer is set, achieving a good thermal insulation effect.

[0081] The above specific examples are used to illustrate the present invention and are only for helping to understand the present invention, and are not intended to limit the present invention. For those skilled in the technical field of the present invention, based on the idea of the present invention, several simple deductions, deformations, or replacements can be made.

WHAT IS CLAIMED IS:

1. A heating non-combustion device, comprising a cigarette stick (1), an outer pipe (2), and a heating element (4),

wherein the cigarette stick (1) is at least partially located within the heating element (4), the heating element (4) is located within the outer pipe (2), and there is a first gap (3) between the heating element (4) and the outer pipe (2); and

wherein an inner wall of the outer pipe (2) is provided with a thermal insulation layer (5), and there is a gap or no gap between the thermal insulation layer (5) and the inner wall of the outer pipe (2).

2. The heating non-combustion device according to claim 1, wherein the thermal insulation layer (5) is an aluminum reflective layer.

3. The heating non-combustion device according to claim 1, wherein the thermal insulation layer (5) is a hollow glass microsphere layer.

4. The heating non-combustion device according to claim 1, wherein the thermal insulation layer (5) comprises a first thermal insulation layer (51) and a second thermal insulation layer (52).

5. The heating non-combustion device according to claim 4, wherein the first thermal insulation layer (51) and the second thermal insulation layer (52) are sequentially stacked on the inner wall of the outer pipe (2).

6. The heating non-combustion device according to claim 5, wherein the first thermal insulation layer (51) is an aluminum reflective layer, and the second thermal insulation layer (52) is a hollow glass microsphere layer.

7. The heating non-combustion device according to claim 6, wherein a plurality of pillars (6) are provided between the outer pipe (2) and the thermal insulation layer (5), and a second gap (7) is present between pillars (6).

8. The heating non-combustion device according to claim 5, wherein the first thermal insulation layer (51) is an aluminum reflective layer, and the second thermal insulation layer (52) is an upconversion material coating.

9. The heating non-combustion device according to claim 8, wherein the first thermal insulation layer (51) is an aluminum-coated glass film, an aluminum-coated resin film, or an aluminum-coated polyimide film, the second thermal insulation layer (52) is an upconversion material coating, and one side of the glass film, resin film, or polyimide film is coated with aluminum, and the other side is provided with the upconversion material coating.

10. The heating non-combustion device according to claim 4, wherein the first thermal insulation layer (51) is an aluminum reflective layer, the second thermal insulation layer (52) is a

polyether ether ketone film layer, and there is a gap or no gap between the first thermal insulation layer (51) and the second thermal insulation layer (52).

11. The heating non-combustion device according to claim 4, wherein the first thermal insulation layer (51) is an aluminum reflective layer, the second thermal insulation layer (52) is a stainless steel film layer, and there is a gap or no gap between the first thermal insulation layer (51) and the second thermal insulation layer (52).

12. The heating non-combustion device according to claim 1, wherein the thermal insulation layer (5) is an aluminum tube, and there is a gap or no gap between the aluminum tube and the inner wall of the outer pipe (2).

13. An electronic cigarette, comprising the heating non-combustion device according to any one of claims 1 to 12.