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(54) CONTROL METHOD AND AEROSOL GENERATING DEVICE

(57) Embodiments of the present application relate to the technical field of electronic atomization, and disclosed are a control method and an aerosol generating device. On the basis of energy demand characteristics in the baking process of an aerosol-forming substrate, the entire baking process is divided into multiple time periods, and corresponding energy supply is set for each period, such that the aerosol-forming substrate receives heat output by a heater in time periods, and the aerosol generated after baking can rapidly reach an inhalable state and maintain the inhalable state. In addition, on the basis of heat conduction characteristics, for each first time period, energy is continuously supplied in a first time interval and the supply of energy is stopped in a second time interval, such that the temperature first rises to the highest temperature and then falls to the lowest temperature within the first time period, and a temperature difference between the highest temperature and the lowest temperature is above 15 °C, and thus, the heat provided by the heater can be absorbed in a relatively large proportion by the aerosol-forming substrate when energy is supplied in the next time period. Therefore, the effects of improving the energy utilization efficiency and reducing the energy consumption are achieved.

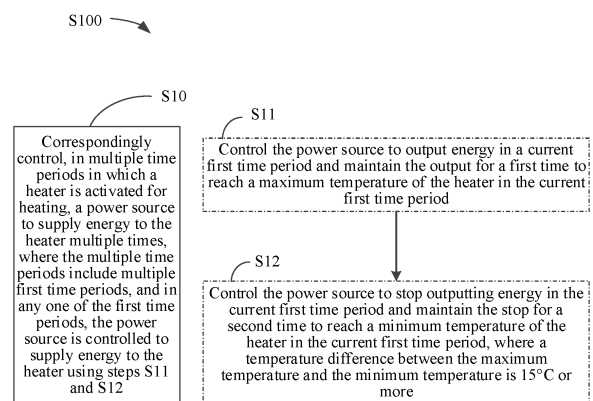


FIG. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202311441612.X, entitled "CONTROL METHOD AND AEROSOL GENERATING DEVICE", filed with the China National Intellectual Property Administration on October 31, 2023, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of the present application relate to the field of electronic atomization, and in particular, to a control method and an aerosol generating device.

BACKGROUND

[0003] An aerosol generating device uses a heater to heat and bake an aerosol generating substrate, thereby generating an aerosol for use by a user. Typically, the existing aerosol generating devices adjust the temperature of the heater by varying the power output from a power supply and control the temperature according to a predetermined temperature curve.

[0004] In some solutions known to the inventors of the present application, the temperature curve is substantially linear, that is, the temperature of the heater is controlled to remain substantially constant at each stage of puffing, resulting in heat waste and relatively high energy consumption.

SUMMARY

[0005] Accordingly, some embodiments of the present application provide a control method applied to an aerosol generating device. Based on energy demand and thermal conduction characteristics, energy is supplied in different time periods, such that a greater proportion of the energy provided by a heater can be absorbed by an aerosol generating substrate, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0006] In a first aspect, some embodiments of the present application provide a control method applied to an aerosol generating device, where the aerosol generating device includes a heater configured to heat an aerosol generating substrate to generate an aerosol and a power source configured to supply energy to the heater, and the control method includes:

correspondingly controlling, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, where the multiple time periods include multiple first time periods; and
controlling, in each of the first time periods, the power source to supply energy to the heater, including:

controlling the power source to output energy in a current first time period and maintaining the output for a first time to reach a maximum temperature of the heater in the current first time period; and

controlling the power source to stop outputting energy in the current first time period and maintaining the stop for a second time to reach a minimum temperature of the heater in the current first time period,
where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.

[0007] In some embodiments, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C.

[0008] In some embodiments, the first time is 4 s or less.

[0009] In some embodiments, a temperature rise rate of the heater within the first time is greater than 40°C/s.

[0010] In some embodiments, a temperature rise rate of the heater during the first time is different from a temperature decrease rate of the heater during the second time.

[0011] In some embodiments, a temperature rise rate of the heater during the first time is greater than a temperature decrease rate of the heater during the second time.

[0012] In some embodiments, after the controlling the power source to stop outputting energy in the current first time period and maintaining the stop for a second time, the method includes:

entering a next time period, and controlling the power source to output energy in the next time period.

[0013] In some embodiments, before the controlling, in each of the first time periods, the power source to supply energy to the heater, the method includes:

detecting an operating duration of the heater after the heater is activated for heating; and
when the operating duration satisfies a first time threshold, entering at least one of the first time periods.

[0014] In some embodiments, the first time threshold is greater than 60 s.

[0015] In some embodiments, the method further includes:

while controlling the power source to output energy in the current first time period, determining the supplied energy in the current first time period; and
when the supplied energy reaches a preset energy corresponding to the current first time period, controlling the power source to stop outputting energy in the current first time period.

[0016] In some embodiments, the method further includes:

while controlling the power source to stop outputting energy in the current first time period, determining a duration for which the power source stops outputting energy in the current time period; and
when the duration satisfies a preset natural cooling time of the current first time period, ending the current first time period and entering a next time period.

[0017] In some embodiments, the method further includes:

while controlling the power source to stop outputting energy in the current first time period, detecting a real-time temperature of the heater; and
when the real-time temperature decreases to a preset low-temperature threshold, ending the current first time period and entering a next time period.

[0018] In some embodiments, the controlling the power source to output energy in a current first time period includes: controlling the power source to continuously output energy in the current first time period.

[0019] In some embodiments, the multiple time periods further include multiple second time periods; and controlling, in each of the second time periods, the power source to supply energy to the heater, including:

controlling the power source to output energy in a current second time period and maintaining the output for a third time to reach a maximum temperature of the heater in the current second time period; and
controlling the power source to stop outputting energy in the current second time period and maintaining the stop for a fourth time to reach a minimum temperature of the heater in the current second time period,
where a temperature difference between the maximum temperature and the minimum temperature is less than 10°C.

[0020] In some embodiments, the multiple second time periods operate in an early stage of a puffing operation stage, and the multiple first time periods operate in a middle stage and/or a late stage of the puffing operation stage.

[0021] In some embodiments, the multiple second time periods operate in a heat-preservation operation stage, and the multiple first time periods operate in a puffing operation stage.

[0022] In a second aspect, some embodiments of the present application provide an aerosol generating device, including:

a heater, configured to heat an aerosol generating substrate to generate an aerosol;

a power source, configured to supply energy to the heater; and

a controller, configured to: correspondingly control, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, where the multiple time periods include multiple first time periods; control, in each of the first time periods, the power source to output energy in a current first time period and maintain the output for a first time to reach a maximum temperature of the heater in the current first time period; and control the power source to stop outputting energy in the current first time period and maintain the stop for a second time to reach a minimum temperature of the heater in the current first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.

[0023] In some embodiments, the heater is made of a metal with a thermal conductivity greater than 10 W/(m·K).

[0024] In some embodiments, the heater is made of stainless steel, permalloy, or ferritic stainless steel; and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 20°C.

[0025] In some embodiments, the heater is made of an aluminum alloy; and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C.

[0026] In some embodiments, the heater further includes an energy storage layer, the energy storage layer being disposed between a heating element and an aerosol generating article, and where a thermal conductivity of the energy storage layer is greater than a thermal conductivity of the heating element.

[0027] In some embodiments, the heating element is made of stainless steel, permalloy, or ferritic stainless steel, and the energy storage layer is made of an aluminum alloy.

[0028] The control method provided in the embodiments of the present application is applied to an aerosol generating device, the aerosol generating device including a heater configured to heat an aerosol generating substrate to generate an aerosol and a power source configured to supply energy to the heater. The control method includes: correspondingly controlling, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, where the multiple time periods include multiple first time periods. Taking one of the first time periods as an example, the control method includes: controlling the power source to output energy in a current first time period and maintaining the output for a first time to reach a maximum temperature of the heater in the current first time period; and controlling the power source to stop outputting energy in the current first time period and

maintaining the stop for a second time to reach a minimum temperature of the heater in the current first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.

[0029] In this embodiment, based on the energy demand characteristics in the baking process of the aerosol generating substrate, the entire baking process is divided into multiple time periods, and a corresponding energy supply is configured for each time period, such that the aerosol generating substrate receives heat from the heater in different time periods, and the generated aerosol after baking can quickly reach an inhalable state and maintain the inhalable state. In another aspect, from the perspective of thermal conduction characteristics, for each first time period, energy is continuously supplied during the first time and the supply of energy is stopped during the second time, such that the temperature first rises to a maximum temperature and then decreases to a minimum temperature within the first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. This facilitates that, during the next time period, a greater proportion of heat provided by the heater can be absorbed by the aerosol generating substrate when energy is supplied, thereby enhancing energy utilization efficiency and reducing energy consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] One or more embodiments are exemplarily illustrated with reference to the drawings. These exemplary illustrations do not constitute limitations to the embodiments. Elements with the same reference numerals in the drawings represent similar elements. Unless otherwise specified, the drawings are not drawn to scale.

FIG. 1 is a schematic structural diagram of an aerosol generating article according to some embodiments of the present application;

FIG. 2 is a schematic structural diagram of an aerosol generating device according to some embodiments of the present application;

FIG. 3 is a schematic flow diagram of a control method applied to an aerosol generating device according to some embodiments of the present application;

FIG. 4 is a schematic diagram of a temperature curve of a heater according to some embodiments of the present application;

FIG. 5 is a schematic diagram of a temperature curve of a heater according to some embodiments of the present application;

FIG. 6 is a schematic diagram of a temperature curve of a heater according to some embodiments of the present application;

FIG. 7 is a schematic diagram of a temperature curve of a heater according to some embodiments of the

present application;

FIG. 8 is a schematic diagram of a temperature curve of a heater according to some embodiments of the present application; and

FIG. 9 is a schematic diagram of a temperature curve of a heater according to some embodiments of the present application.

DETAILED DESCRIPTION

[0031] The present application is described in detail below with reference to specific embodiments. The following embodiments are provided to further enable a person skilled in the art to understand the present application, and do not limit the present application in any manner. It is to be noted that a person of ordinary skill in the art may make various modifications and improvements without departing from the concept of the present application. All such modifications and improvements fall within the scope of protection of the present application.

[0032] To make objectives, technical solutions, and advantages of the present application clearer, the present application is further described in detail below with reference to the drawings and the embodiments. It is to be understood that the specific embodiments described herein are provided only for explaining the present application and are not intended to limit the present application.

[0033] It is to be noted that, unless there is a conflict, features in the embodiments of the present application may be combined, and all such combinations fall within the scope of protection of the present application. In addition, although the division of functional modules is illustrated in the schematic diagrams of the device and a logical sequence is shown in the flowcharts, in some cases, the illustrated or described steps may be performed in a manner different from the module division in the device or the sequence shown in the flowcharts. In addition, the terms "first", "second", "third", and the like used herein do not limit the data or the execution order, but are merely used to distinguish the same items or similar items having substantially the same function or effect.

[0034] Unless otherwise defined, all technical and scientific terms used in this specification have the same meanings as those commonly understood by a person skilled in the art to which the present application pertains. The terms used in this specification of the present application are intended solely for describing specific implementations and are not intended to limit the present application. The term "and/or" as used in this specification includes any and all possible combinations of one or more of the relevant listed items.

[0035] In addition, the technical features disclosed in the various implementations of the present application described below may be combined as long as they are not mutually conflicting.

[0036] FIG. 1 is a schematic structural diagram of an

aerosol generating article according to an implementation of the present application.

[0037] As shown in FIG. 1, the aerosol generating article 20 includes a mouthpiece section 21 and a substrate section 22.

[0038] The substrate section 22 includes an aerosol generating substrate. The aerosol generating substrate is a substrate capable of releasing volatile compounds that can form an aerosol, and the volatile compounds can be released by heating the aerosol generating substrate.

[0039] The aerosol generating substrate may be a solid aerosol generating substrate. Alternatively, the aerosol generating substrate may include solid and liquid components. The aerosol generating substrate may include a tobacco material, which includes volatile tobacco flavor compounds that are released from the aerosol generating substrate upon heating. Alternatively, the aerosol generating substrate may include a non-tobacco material. The aerosol generating substrate may further include an aerosol-forming material. Examples of suitable aerosol-forming materials include glycerol and propylene glycol.

[0040] The aerosol generated from the substrate section 22 upon heating is delivered to a user via the mouthpiece section 21, and the mouthpiece section 21 may be an acetate fiber mouthpiece. The mouthpiece section 21 may be sprayed with a flavoring liquid to provide aroma, or a separate fiber coated with a flavoring liquid may be inserted into the mouthpiece section 21, thereby enhancing the persistence of the flavor delivered to the user. The mouthpiece section 21 may further include a capsule having a spherical or cylindrical shape, and the capsule may include a content with a flavoring substance.

[0041] The aerosol generating article 20 may further include a cooling section 23 disposed between the substrate section 22 and the mouthpiece section 21, configured to cool the aerosol generated from the substrate section 22 upon heating, so that the user can inhale the aerosol cooled to an appropriate temperature.

[0042] FIG. 2 is a schematic structural diagram of an aerosol generating device according to an implementation of the present application.

[0043] As shown in FIG. 1 and FIG. 2, the aerosol generating device 10 includes a cell 101, a controller 102, and a heater 103. In addition, the aerosol generating device 10 has an internal space defined by a housing, and the aerosol generating article 20 can be inserted into the internal space of the aerosol generating device 10.

[0044] The cell 101, serving as a power source, is configured to supply the electrical power for operating the aerosol generating device 10. For example, the cell 101 can supply electrical power to heat the heater 103 and to supply the electrical power required for operating the controller 102. In addition, the cell 101 can supply the electrical power required for operating a display device, sensors, a motor, and the like provided in the aerosol generating device 10.

[0045] The cell 101 may be, but is not limited to, a

lithium iron phosphate (LiFePO₄) battery. For example, the cell 101 may be a lithium cobalt oxide (LiCoO₂) battery or a lithium titanate battery. The cell 101 may further be a rechargeable battery or a primary battery.

[0046] When the aerosol generating article 20 is inserted into the interior of the aerosol generating device 10, the aerosol generating device 10 can heat the heater 103 using electrical power supplied by the cell 101. The heater 103 increases the temperature of the aerosol generating substrate in the aerosol generating article 20 to generate an aerosol. The generated aerosol is delivered to the user via the mouthpiece section 21 of the aerosol generating article 20 for inhalation.

[0047] The heater 103 and the aerosol generating substrate may employ various heating configurations. For example, the heater may employ a central heating configuration, in which the heater, in the form of a pin, plate, rod, or the like, is inserted into the interior of the aerosol generating substrate so that the periphery of the heater is in contact with or is in close proximity to (as closely as possible) the aerosol generating substrate, thereby enabling heat transfer. In a peripheral heating configuration, the heater is typically in the form of a hollow cylinder, with the aerosol generating substrate disposed inside the hollow cylinder of the heater, so that the inner wall of the heater is in contact with or is in close proximity to (as closely as possible) the periphery of the aerosol generating substrate, thereby enabling heat transfer.

[0048] The heater 103 may employ various heating platforms, for example, a resistive heat conduction heating platform or an electromagnetic induction heat conduction heating platform.

[0049] The controller 102 can control the operation of the main components of the aerosol generating device 10. In particular, the controller 102 can control the operation of the cell 101 and the heater 103, and can control the operation of other components of the aerosol generating device 10.

[0050] The controller 102 is further configured to perform a control method for an aerosol generating device 10.

[0051] The controller 102 includes at least one processor. The controller may include a logic gate array, or may include a combination of a general-purpose microprocessor and a memory storing programs executable by the microprocessor.

[0052] For example, the controller 102 controls the operation of the heater 103. The controller 102 can control the amount of electrical power supplied to the heater 103, the duration for which electrical power is continuously supplied to the heater 103, and the cessation of power supply to the heater 103. In addition, the controller 102 can monitor the status of the cell 101 (for example, the remaining charge of the cell 101), and/or monitor the operating status of the heater 103 (for example, changes in the resistance of the heater 103), and, if necessary, generate a notification signal to alert the user.

[0053] In addition to the cell 101, the controller 102, and

the heater 103, the aerosol generating device 10 may further include other general-purpose components. For example, the aerosol generating device 10 may include a display device for outputting visual information, and the display device can be a visual display component such as a display screen, a touchscreen, or a lighting assembly. The controller 102 can transmit information to the user regarding the status of the aerosol generating device 10 (for example, whether the aerosol generating device 10 is operable), information regarding the heater 103 (for example, preheating started, preheating in progress, or preheating completed), information regarding the cell 101 (for example, the remaining charge of the cell 101 or whether the cell 101 is operable), information related to resetting of the aerosol generating device 10 (for example, reset time, reset in progress, or reset completed), information related to cleaning of the aerosol generating device 10 (for example, cleaning time, cleaning required, cleaning in progress, or cleaning completed), information related to charging of the aerosol generating device 10 (for example, charging required, charging in progress, or charging completed), information related to puffing (for example, the number of puffs, puff completed notification), or information related to safety (for example, usage time). For example, the aerosol generating device 10 may further include a vibration motor for outputting haptic feedback information. The controller 102 can generate a vibration feedback signal using the vibration motor and can transmit the above information to the user. For example, the aerosol generating device 10 may further include an airflow sensor for detecting whether the user is puffing and/or the puffing intensity. For example, the aerosol generating device 10 may include at least one input device to control the functions of the aerosol generating device 10. In particular, the input device may include a button, a touchscreen, or the like, through which the user can perform various functions. For example, the user can adjust the number of presses on the input device (for example, one or two presses) or the duration for which the input device is continuously pressed (for example, 0.1 s or 0.2 s) to perform a desired function of multiple functions of the aerosol generating device 10. The user can also use the input device to perform functions such as heating the heater 103, adjusting the temperature of the heater 103, cleaning the space into which the aerosol generating article is inserted, checking whether the aerosol generating device 10 is operable, displaying the remaining charge of the cell 101 (available electrical power), and resetting the aerosol generating device 10. However, the functions of the aerosol generating device 10 are not limited thereto.

[0054] FIG. 3 is a flowchart of a control method for an aerosol generating device according to some embodiments of the present application. As shown in FIG. 3, the controller 102 is configured to perform the control method for an aerosol generating device 10. The method S100 includes:

S10: Correspondingly control, in multiple time periods in

which the heater is activated for heating, the power source to supply energy to the heater multiple times.

[0055] After receiving a heating start instruction, the controller may control the heater to initiate heating, where the heating process of the heater includes multiple time periods. The multiple time periods may be distributed throughout the entire puffing operation stage of the aerosol generating substrate, or may be distributed within a portion of the puffing operation stage. The puffing operation stage refers to a stage during which aerosol can be generated by the aerosol generating device at a satisfactory rate and inhaled by a user.

[0056] The heating start instruction may be a signal generated by a user operating an input element, or may be obtained based on a detection signal of a sensor. For example, a pressure sensor or an electrical parameter sensor may be used to detect a positioning trigger signal indicating that an aerosol generating article has been inserted into the aerosol generating device, or an airflow sensor may be used to detect a start signal triggered by user puffing.

[0057] The controller controls the power source to supply energy to the heater multiple times, each time being strictly performed in accordance with a preset energy supply corresponding to each time period (also referred to as preset energy). The energy supply corresponding to the multiple time periods may be pre-stored in a memory inside the aerosol generating device for retrieval by the controller. The energy supply corresponding to the multiple time periods may be stored in an external device connected to the aerosol generating device, such as a cloud server, a storage unit of a charging case, or a memory of another aerosol generating device connected thereto, and the controller may retrieve and utilize the energy from the external storage device or the server during operation.

[0058] The preset energy corresponding to each time period is determined according to the energy demand characteristics during the baking process of the aerosol generating substrate. In some embodiments, the preset energy may be an experimental value obtained based on a large number of tests conducted by the applicant after the completion of the design of the aerosol generating device, in combination with specific materials of the aerosol generating substrate, or may be an empirical value. It can be understood that the preset energy may be adjusted based on the thermal insulation performance of the heating module, and may be adjusted based on the heat transfer rate between the aerosol generating substrate and the heater, etc.

[0059] Accordingly, after receiving the heating start instruction, the controller retrieves, from the memory, the energy supply corresponding to the multiple time periods, and controls the power source to supply energy in different time periods according to the multiple time periods and corresponding energy supply in a one-to-one correspondence, such that the heater provides heat to the aerosol generating substrate in different time periods.

[0060] The multiple time periods include multiple first time periods. That is, each first time period is one of the multiple time periods, and each first time period corresponds to an energy supply. In other embodiments, the other time periods correspond to another type of energy supply. The energy supply during the first time periods is different from the energy supply during the other time periods.

[0061] Taking one of the first time periods as an example, the control method includes: S11: Control the power source to output energy in a current first time period and maintain the output for a first time to reach a maximum temperature of the heater in the current first time period; S12: Control the power source to stop outputting energy in the current first time period and maintain the stop for a second time to reach a minimum temperature of the heater in the current first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.

[0062] It can be understood that the first time period is divided into two portions: a first time and a second time. Within the first time, the power source is controlled to output energy so that the temperature of the heater rapidly rises to the maximum temperature. The first time is also referred to as the heating time. Within the second time, the power source is controlled to stop supplying energy so that the temperature of the heater decreases to the minimum temperature. The second time is also referred to as the natural cooling time. Due to the thermal insulation performance of the aerosol generating device, even in the absence of an energy supply, the temperature gradually decreases within the second time without dropping too quickly. Thus, throughout the entire first time period, the average temperature satisfies the baking temperature of the aerosol generating substrate, so that the aerosol generated after the aerosol generating substrate is baked can quickly reach an inhalable state and maintain the inhalable state.

[0063] For example, upon entering the current first time period, timing is started, and the power source is controlled to output energy for the current first time period. When the timing reaches the first time, the power source is controlled to stop outputting energy for the current first time period, at which point the temperature of the heater rises to the maximum temperature. Then, timing is restarted, and when the timing reaches the second time, the current first time period is ended, and the next time period is entered, at which point the temperature of the heater decreases to the minimum temperature.

[0064] In some embodiments, within the second time (i.e., the natural cooling time) of the first time period, the power source is controlled to output a relatively small amount of energy, which is much smaller than the energy supply within the first time. In one aspect, this does not affect the temperature of the heater from decreasing to the minimum temperature within the second time; in another aspect, maintaining this energy supply facilitates the subsequent transition to the energy supply of the next

time period.

[0065] It can be understood that, in the embodiments of the present application, the maximum temperature refers to the highest temperature within a time period, and the minimum temperature refers to the lowest temperature within the time period.

[0066] Within the first time period, a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. When the heater is at the minimum temperature, the aerosol generating substrate is at a relatively low temperature, close to the minimum temperature. In the next time period, when the heater is rapidly heated to the maximum temperature, the aerosol generating substrate remains at a relatively low temperature due to the lag in heat transfer. Accordingly, the temperature difference between the surface of the heater and the surface of the aerosol generating substrate is increased, thereby disrupting thermal equilibrium. Based on the characteristics of heat conduction (i.e., heat is transferred from a higher-temperature object to a lower-temperature object, and the larger the temperature difference, the greater the amount of heat transferred), under a relatively large temperature difference, a larger proportion of the heat provided by the heater is absorbed by the aerosol generating substrate, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0067] In some embodiments, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C. For example, within the first time period, the temperature amplitude is within a range of $\pm 25^\circ\text{C}$. That is, within the first time period, the temperature curve exhibits a wave-like shape with an amplitude of $\pm 25^\circ\text{C}$. A temperature difference ranging from 15°C to 50°C can effectively disrupt the thermal equilibrium between the heater and the aerosol generating substrate. As a result, more heat provided by the heater can be conducted to and absorbed by the aerosol generating substrate, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0068] In some embodiments, the first time is 4 s or less. Since the power source outputs the energy of the current first time period within the first time, that is, the power source is required to output the preset energy corresponding to the current first time period within the first time. When the preset energy is constant, the shorter the first time, the greater the output power per unit time, and the faster the heater temperature rises.

[0069] In this embodiment, the first time is 4 s or less, such that the heater can be rapidly heated to the maximum temperature to compensate for the temperature decrease in the previous time period, thereby enabling the temperature to rise quickly. In this case, based on the relatively large temperature difference between the aerosol generating substrate and the heater, the aerosol generating substrate can absorb more heat from the heater, thereby enhancing energy utilization efficiency.

[0070] In some embodiments, a temperature rise rate

of the heater within the first time is greater than 40°C/s. For example, the temperature rise rate of the heater may be greater than 50°C/s.

[0071] It can be understood that the temperature rise rate refers to the amount of temperature increase per unit time (for example, within 1 s). The temperature rise rate of the heater is greater than 40°C/s, and optionally 50°C/s or more. With such a temperature rise rate, the heater can reach the maximum temperature within a relatively short time, thereby reducing the first time. This facilitates increasing the temperature difference between the aerosol generating substrate and the heater, enabling a greater proportion of heat provided by the heater to be absorbed by the aerosol generating substrate, and thus enhancing energy utilization efficiency and reducing energy consumption.

[0072] In some embodiments, a temperature rise rate of the heater during the first time is different from a temperature decrease rate of the heater during the second time. It can be understood that the temperature rise rate of the heater during the first time depends on the output power of the power source, and the temperature rise rate is positively proportional to the output power. During the second time, the power source does not supply energy to the heater, and the temperature decrease rate is related to the thermal insulation performance of the aerosol generating device. Accordingly, the temperature rise rate of the heater during the first time is different from the temperature decrease rate during the second time.

[0073] Exemplarily, the temperature rise rate of the heater during the first time is greater than the temperature decrease rate during the second time. It can be understood that, due to the relatively good thermal insulation performance of the aerosol generating device, heat dissipation is slow, and therefore, the temperature decrease rate during the second time is relatively low and is lower than the temperature rise rate of the heater during the first time.

[0074] Due to the relatively low temperature decrease rate of the heater during the second time, the aerosol generating substrate can continue to absorb heat from the heater, thereby maintaining the temperature and satisfying the baking conditions. That is, during the second time, even if the power source does not supply energy to the heater or supplies only a relatively small amount of energy, baking of the aerosol generating substrate can still be maintained to generate aerosol. Compared with a configuration in which the power source continuously supplies energy to the heater (where the heater continuously generates heat at a stable power), in the embodiments of the present application, energy is intermittently supplied to the heater. Such intermittent energy supply can break the thermal equilibrium between the heater and the aerosol generating substrate, enabling a greater proportion of the heat provided by the heater to be absorbed by the aerosol generating substrate, thereby enhancing energy utilization efficiency

and reducing energy consumption.

[0075] It can be seen from the above that in the embodiments of the present application, based on the energy demand characteristics in the baking process of the aerosol generating substrate, the entire baking process is divided into multiple time periods, and a corresponding energy supply is configured for each time period, such that the aerosol generating substrate receives heat from the heater in different time periods, and the generated aerosol after baking can quickly reach an inhalable state and maintain the inhalable state. In another aspect, from the perspective of thermal conduction characteristics, for each first time period, energy is continuously supplied during the first time, and the supply of energy is stopped or only a relatively small amount of energy is supplied during the second time, such that the temperature first rises to a maximum temperature and then decreases to a minimum temperature within the first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. This facilitates that, during the next time period, a greater proportion of heat provided by the heater can be absorbed by the aerosol generating substrate when energy is supplied, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0076] In some embodiments, after the controlling the power source to stop outputting energy in the current first time period and maintaining the stop for a second time, the method includes: entering a next time period, and controlling the power source to output energy in the next time period.

[0077] The next time period may be a first time period, and the energy supply mode thereof is the same as the energy supply mode of the current first time period. Exemplarily, when the current first time period is the eighth first time period in the multiple first time periods, the next time period is the ninth first time period in the multiple first time periods. It can be understood that the ninth first time period corresponds to a preset energy. After the eighth first time period (i.e., the current first time period) ends, the ninth first time period is entered, and the power source is controlled to output energy in the ninth first time period.

[0078] In other embodiments, the next time period may be a time period corresponding to another energy supply mode. Exemplarily, in the next time period, when the temperature reaches a threshold, energy is supplied. Exemplarily, in the next time period, the power source is controlled to output energy for a portion of the time and to stop outputting energy for the remaining portion of the time, where the energy supply is different from the preset energy corresponding to the first time period.

[0079] In this embodiment, the multiple first time periods form part of the baking process of the aerosol generating substrate. After the aerosol generating device is activated for heating, the power source outputs energy according to a preset correspondence between time periods and energy supply. Based on the energy demand

characteristics in the baking process of the aerosol generating substrate, the entire baking process is divided into multiple time periods, and the corresponding energy supply is configured for each time period, such that the aerosol generating substrate receives heat from the heater in different time periods, and the generated aerosol after baking can quickly reach an inhalable state and maintain the inhalable state.

[0080] In some embodiments, before the controlling, in each of the first time periods, the power source to supply energy to the heater, the method includes: detecting an operating duration of the heater after the heater is activated for heating; and when the operating duration satisfies a first time threshold, entering at least one of the first time periods.

[0081] The first time threshold is a time threshold for determining whether to enter the first time period. The first time threshold may be used to indicate a late stage of a heat-preservation operation stage, the beginning of a puffing operation stage, or a late stage of the puffing operation stage.

[0082] Exemplarily, if the first time threshold is the duration of a preheating operation stage (e.g., 8 s), then after the preheating operation stage ends and the puffing operation stage begins, at least one first time period is entered. In the puffing operation stage, multiple first time periods may be included throughout the entire stage, and the power source is controlled to supply energy to the heater according to the energy supply mode corresponding to the first time period. That is, in the puffing operation stage, the temperature of the heater fluctuates in a wave-like manner between a maximum temperature and a minimum temperature with each first time period as a cycle, for example, within a temperature difference range of $\pm 25^{\circ}\text{C}$.

[0083] It can be understood that the preheating operation stage refers to an operation stage in which the temperature of the aerosol generating substrate is increased to a temperature sufficient to generate a satisfactory amount of aerosol. Aerosol may be generated in this stage; however, it is generally unlikely to be drawn by a user out of the aerosol generating device. For example, at the end of the preheating operation stage, the aerosol generating substrate may have reached a temperature at which volatile components contained in tobacco can be released.

[0084] The puffing operation stage refers to an operation stage during which aerosol can be generated by the aerosol generating device at a satisfactory rate and inhaled by a user. The end time of the preheating operation stage corresponds to the start time of the puffing operation stage. The aerosol generating device may provide a reminder to the user via a vibration motor, a visual display assembly, or other components, indicating that the aerosol generating device has entered the puffing operation stage and that puffing may be performed.

[0085] Exemplarily, the first time threshold is greater than 60 s. It can be understood that if the operating

duration of the heater after being activated for heating is greater than 60 s, this indicates that at least one first time period is entered at an early stage or a middle stage of the puffing operation stage. In an early stage or a middle stage of the puffing operation stage, the temperature of the heater fluctuates in a wave-like manner between a maximum temperature and a minimum temperature with each first time period as a cycle, for example, within a temperature difference range of $\pm 25^{\circ}\text{C}$.

[0086] In some embodiments, after heating is initiated and before the accumulated heating time reaches a first time threshold, the temperature of the heater is controlled using a PID control algorithm. After the accumulated heating time reaches the first time threshold, at least one first time period is entered, energy is supplied according to time periods, and the temperature of the heater fluctuates in a wave-like manner during heating.

[0087] It can be understood that, as the heater continuously conducts heat, the aerosol generating article gradually increases in temperature, starting from the portion in contact with the heater. From the foregoing heat conduction process in which the heater heats the aerosol generating article, it can be understood that, in the early stage after heating is initiated, thermal equilibrium has not been established between the aerosol generating article and the heater. That is, the aerosol generating article has not been fully heated, and temperature non-uniformity may exist. If at least one first time period is entered too early to perform wave-like heating, a significant temperature drop of the aerosol generating article may occur, making it difficult to maintain the aerosol in an inhalable state.

[0088] Accordingly, in this embodiment, the first time threshold is greater than 60 s. When the aerosol generating article has been sufficiently heated, the heater performs wave-like heating, which can effectively prevent a rapid temperature drop of the aerosol generating article and maintain the aerosol in an inhalable state.

[0089] In some embodiments, before the controlling, in each of the first time periods, the power source to supply energy to the heater, the method includes: detecting a status flag of an operation stage; and, when the status flag satisfies a preset status flag, entering at least one first time period.

[0090] It can be understood that different operation stages correspond to different status flags. The operation stages include a preheating operation stage, a heat-preservation operation stage, and a puffing operation stage. The heat-preservation operation stage refers to a stage in which the temperature is maintained at the preheating temperature or slightly below the preheating temperature, and aerosol continues to be generated in this stage.

[0091] The status flag may be a level parameter, a character parameter, or the like. For example, taking a level parameter as an example for exemplary illustration, the level parameter of the preheating operation stage is 0 V, the level parameter of the heat-preservation operation

stage is 5 V, and the level parameter of the puffing operation stage is 10 V. The preset status flag may be "10 V". When a level of 10 V is detected and the condition is satisfied, at least one first time period is entered, and the power source is controlled to output power according to the energy supply mode corresponding to the first time period.

[0092] In some embodiments, based on the detected status flag of an operation stage, a motor or a visual assembly may be controlled to operate in a manner corresponding to the operation stage. For example, when entry into the preheating operation stage is detected, the visual assembly displays a red light; when entry into the heat-preservation operation stage is detected, the visual assembly displays a yellow light; and when entry into the puffing operation stage is detected, the visual assembly displays a green light.

[0093] In this embodiment, based on the status flag, the aerosol generating device can be accurately controlled to enter at least one first time period, thereby compensating for the reduction in aerosol output, increasing the aerosol output, and conforming to the puffing habits of the user without causing the waste of aerosol output.

[0094] In some embodiments, the method S100 further includes:

S20: While controlling the power source to output energy in the current first time period, determine the supplied energy in the current first time period.

S30: When the supplied energy reaches a preset energy corresponding to the current first time period, control the power source to stop outputting energy in the current first time period.

[0095] The controller retrieves a preset energy of a current first time period, and controls the cell to supply power according to the preset energy to supply the preset energy to the heater.

[0096] The power provided by the controller may be a maximum real-time power that can be supplied by the cell; in this case, as the capacity of the cell decreases, the duration during which energy is supplied from the cell to the heater is correspondingly prolonged.

[0097] The power provided by the controller may alternatively be a stable power output by the cell after passing through a voltage regulation circuit. The specific aerosol generating device 10 further includes a voltage regulation circuit coupled between the heater 103 and the cell 101, where the voltage regulation circuit includes a boost circuit and/or a buck circuit, for example, a buck-boost conversion circuit. It can be understood that the voltage regulation circuit is not limited to a buck-boost conversion circuit, and may alternatively include at least one of a boost conversion circuit, a buck conversion circuit, a Cuk conversion circuit, a Zeta conversion circuit, or a SEPIC conversion circuit.

[0098] In some embodiments, the controlling the

power source to output energy in a current first time period includes: controlling the power source to continuously output energy in the current first time period.

[0099] That is, the process in which the controller 102 supplies power may be a continuous and uninterrupted output, to better compensate for the heat loss of the heater 103 and the aerosol generating substrate. Taking a first time period as an example, the duration during which the controller 102 continuously outputs power only accounts for a portion of the current first time period, and this portion is referred to herein as a first time (energy supply time). In some embodiments, the first time (energy supply time) is variable, and the controller 102 controls the energy supply according to the preset energy of the current first time period and the real-time output power, without limiting the energy supply time. In some embodiments, when the output power of the power source 102 is stable, the first time (energy supply time) may be preset. Therefore, the controller 102 may determine the output power according to the preset energy of the current first time period and the preset first time (energy supply time).

[0100] It can be understood that, when the heater is a resistive heater, the cell continuously outputs current to the heater during the first time (energy supply time), and the heater continuously generates heat. If the heater is an electromagnetic induction heater, during the first time (energy supply time), the cell outputs a pulsed voltage at a predetermined frequency, and the heater continuously generates heat through electromagnetic induction under the pulsed voltage.

[0101] During the first time (energy supply time), under energy supply, the temperature of the heater 103 generally begins to increase, and the rate of temperature increase is determined by the preset energy, the actual power output, and the like.

[0102] During the puffing operation stage, when the current first time period occurs in synchronization with the puffing action of the user, due to the frequency settings of the multiple time periods in the puffing operation stage, at least one first time period for energy supply is present within the duration of one puff action (approximately 5 s). The heat removed by the puffing action is minimal and only causes minor fluctuations in the temperature variation of the heater 103. The heat of the heater 103 and the aerosol generating substrate can still be replenished promptly. Therefore, the temperature of the heater 103 can remain within a temperature range without a significant temperature drop.

[0103] In some embodiments, electrical parameters of the heater 103, such as voltage, current, and/or resistance, as well as the duration of energy supply (energy supply time), may be detected by a detection circuit. Then, according to the formula $Q = P \times t = U^2/R \times t = I^2R \times t = U \times I \times t$, the energy supplied to the heater can be calculated.

[0104] In some embodiments, during the heating process of the heater 103, in a case that part electrical parameters remain constant, for example, under a con-

stant voltage supply of the heater 103, a constant current supply, or in a case that the resistance of the heater 103 remains constant, the supplied energy may be indirectly characterized by monitoring only part of the electrical parameters or the duration of continuous supply.

[0105] By comparing whether the supplied energy has reached the preset energy, if it has not been reached, the energy supply is continued; if it has been reached, the power source is controlled to stop energy supply during the first time period.

[0106] The controller 102 stops supplying energy to the heater 103 and maintains this state for a period of time, which is referred to herein as a natural cooling time (second time). In some embodiments, the natural cooling time is preset and is related to factors such as the thermal insulation performance of the heating module or the heat transfer requirements between the heater and the aerosol generating substrate. Therefore, after completing energy supply for the current first time period, the controller 102 stops supplying energy to the heater 103 during the preset natural cooling time, and determines, by timing, whether the natural cooling time has reached an end time. In some embodiments, the natural cooling time may alternatively not be directly preset. For example, whether the natural cooling time is to be ended may be determined by detecting the real-time temperature of the heater 103. In this case, the natural cooling time may vary among different time periods.

[0107] During the natural cooling time, since no energy or only a reduced amount of energy is supplied to the heater 103, the temperature of the heater 103 naturally begins to decrease. This temperature loss is caused by heat dissipation between the heater 103 and the external environment and/or the aerosol generating substrate, and may further be superimposed with heat loss resulting from the puffing action during the puffing operation stage.

[0108] Upon completion of the natural cooling time, the current first time period is ended. After multiple first time periods are repeated, when the total operating duration of the aerosol generating device 10 (or the preset number of puffs) reaches a preset threshold, or when the controller 102 receives a command to end heating, the operation of the aerosol generating device is ended, and no subsequent time period is entered.

[0109] In some embodiments, the aerosol generating device further includes a temperature sensor configured to determine a real-time temperature of the heater.

[0110] The method S100 further includes:

S40: While controlling the power source to stop outputting energy in the current first time period, detect a real-time temperature of the heater.

S50: When the real-time temperature decreases to a preset low-temperature threshold, end the current first time period and enter a next time period.

[0111] The preset low-temperature threshold is a lower limit of the temperature of the heater. In some embodi-

ments, a person skilled in the art may set the low-temperature threshold according to the preheating temperature and/or the thermal insulation performance of the heater assembly.

[0112] In particular, during the natural cooling time (corresponding to the second time described above), if the real-time temperature of the heater is detected to be lower than the preset low-temperature threshold, it indicates excessive heat loss, which may affect whether the heater can reach or maintain a target temperature (e.g., a heat-preservation temperature or a puffing temperature). In this case, the cell is controlled to initiate energy supply in the next time period to the heater, to ensure the temperature of the heater. In this case, the current first time period is ended, and the next time period is entered.

[0113] In this embodiment, by setting the low-temperature threshold as a trigger threshold for ending the natural cooling stage and initiating the next time period, time-segmented heating of the heater is implemented, thereby providing an aerosol with good taste.

[0114] In some embodiments, the multiple time periods further include multiple second time periods. The controlling, in each of the second time periods, the power source to supply energy to the heater includes: controlling the power source to output energy in a current second time period and maintaining the output for a third time to reach a maximum temperature of the heater in the current second time period; and controlling the power source to stop outputting energy in the current second time period and maintaining the stop for a fourth time to reach a minimum temperature of the heater in the current second time period, where a temperature difference between the maximum temperature and the minimum temperature is less than 10°C.

[0115] The second time period is one of the multiple time periods and corresponds to an energy supply mode. That is, the energy supply mode in the second time period is different from the energy supply mode in the first time period.

[0116] In this embodiment, the second time period is a time period different from the first time period. In particular, the third time (i.e., the energy supply time within the second time period) is less than the first time (i.e., the energy supply time within the first time period), and the fourth time (i.e., the natural cooling time within the second time period) is less than the second time (i.e., the natural cooling time within the first time period).

[0117] It can be understood that the energy supply corresponding to each second time period is pre-stored in a memory inside the aerosol generating device for retrieval by the controller. Within each second time period, the controller controls the power source to supply energy to the heater strictly according to the preset energy corresponding to the second time period.

[0118] The preset energy corresponding to each second time period is determined according to the energy demand characteristics during the baking process of the

aerosol generating substrate. In some embodiments, the preset energy may be an experimental value obtained based on a large number of tests conducted by the applicant after the completion of the design of the aerosol generating device, in combination with specific materials of the aerosol generating substrate, or may be an empirical value. It can be understood that the preset energy may be adjusted based on the thermal insulation performance of the heating module, and may be adjusted based on the heat transfer rate between the aerosol generating substrate and the heater, etc.

[0119] Taking one of the second time periods as an example, the control method includes: controlling the power source to output energy in a current second time period and maintaining the output for a third time to reach a maximum temperature of the heater in the current second time period; and controlling the power source to stop outputting energy in the current second time period and maintaining the stop for a fourth time to reach a minimum temperature of the heater in the current second time period, where a temperature difference between the maximum temperature and the minimum temperature is less than 10°C.

[0120] It can be understood that the second time period is divided into two portions: a third time and a fourth time. Within the third time, the power source is controlled to supply energy so that the temperature of the heater rapidly rises to the maximum temperature. The third time is also referred to as the heating time. Within the fourth time, the power source is controlled to stop supplying energy so that the temperature of the heater decreases to the minimum temperature. The fourth time is also referred to as the natural cooling time. Due to the thermal insulation performance of the aerosol generating device, even in the absence of an energy supply, the temperature gradually decreases within the fourth time without dropping too quickly. Thus, throughout the entire second time period, the average temperature satisfies the baking temperature of the aerosol generating substrate, so that the aerosol generated after the aerosol generating substrate is baked can quickly reach an inhalable state and maintain the inhalable state.

[0121] For example, upon entering the current second time period, timing is started, and the power source is controlled to supply energy corresponding to the current second time period. When the timing reaches the third time, the power source is controlled to stop supplying energy for the current second time period, at which point the temperature of the heater rises to the maximum temperature. Then, timing is restarted, and when the timing reaches the fourth time, the current second time period is ended, and the next time period is entered, at which point the temperature of the heater decreases to the minimum temperature.

[0122] In some embodiments, within the fourth time (i.e., the natural cooling time) of the second time period, the power source is controlled to output a relatively small amount of energy, which is much smaller than the energy

supplied within the third time, and the temperature of the heater still decreases to a minimum temperature within the fourth time.

[0123] It can be understood that, here, the maximum temperature refers to the highest temperature within a second time period, and the minimum temperature refers to the lowest temperature within a second time period.

[0124] Within the second time period, the temperature difference between the maximum temperature and the minimum temperature is within 10°C. It can be understood that the temperature difference within the second time period is smaller than the temperature difference within the first time period. Similar to the function of disrupting thermal equilibrium in the first time period, the temperature difference in the second time period can also break the thermal equilibrium between the heater and the aerosol generating substrate. Accordingly, the heat provided by the heater can be absorbed by the aerosol generating substrate, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0125] It can be understood that, since the temperature difference within the second time period is relatively small, it may be applied to the stage in which sufficient aerosol is present, such that a relatively small energy supply can be used to heat and activate the aerosol generating substrate to generate sufficient aerosol. Exemplarily, the multiple second time periods operate in an early stage of a puffing operation stage, and the multiple first time periods operate in a middle stage and/or a late stage of the puffing operation stage.

[0126] Referring to FIG. 4, the temperature curve is a wave curve that fluctuates above and below a center temperature, and the center temperature is the fluctuation center of the temperature wave curve. In this embodiment, based on a control strategy in which the center temperature of the temperature wave curve remains constant, the energy supply amount for each time period is set so that the wave curve fluctuates above and below the center temperature.

[0127] As shown in FIG. 4, after the aerosol generating device is activated for heating, it first enters a preheating operation stage and then enters a puffing operation stage. During the preheating operation stage, the controller controls the power source to output at maximum power for a predetermined period of time, so that the temperature rises rapidly. After completion of the preheating operation stage, the early stage of the puffing operation stage is entered. During the early stage of the puffing operation stage, multiple second time periods are included. The controller controls the power source to output power according to the energy supply mode corresponding to each second time period, and the temperature of the heater exhibits small wave fluctuations within $\pm 5^\circ\text{C}$. It can be understood that, during the early stage of the puffing operation stage, the aerosol generating substrate is sufficient, and a relatively small amount of energy is supplied each time. With small-wave temperature fluctuations, sufficient aerosol can be generated

through baking. Compared with continuously supplying energy during the early stage of the puffing operation stage, this approach can enhance energy utilization efficiency and reduce energy consumption.

[0128] After completion of the early stage of the puffing operation stage, the puffing operation stage enters the middle-to-late stage. The middle and late stages of the puffing operation stage include multiple first time periods. The controller controls the power source to output power according to the energy supply mode corresponding to each first time period, and the temperature of the heater exhibits large-wave fluctuations within $\pm 25^{\circ}\text{C}$. During the middle and late stages of the puffing operation stage, the power source is controlled to output power according to the energy supply mode corresponding to the first time period. The energy supply corresponding to the first time period is relatively greater, resulting in a higher maximum temperature compared with the early stage of the puffing operation stage. The amplitude of the temperature wave is within $\pm 25^{\circ}\text{C}$, thereby increasing the aerosol output. In addition, intermittently increasing the temperature conforms to the puffing habit and does not cause waste of aerosol due to continuous high-temperature heating of the aerosol generating substrate. Compared with continuously outputting energy during the middle or late stage of the puffing operation stage, this approach can enhance energy utilization efficiency and reduce energy consumption.

[0129] In some embodiments, as shown in FIG. 5, the temperature curve is a wave curve that fluctuates above and below a center temperature, and the center temperature is the fluctuation center of the temperature wave curve. The difference from the embodiment shown in FIG. 4 lies in that the center temperature in the early stage of puffing and that in the middle-to-late stage of puffing are different, where the center temperature in the middle-to-late stage of puffing is lower than the center temperature in the early stage of puffing, to adapt to the taste requirements of different aerosol generating articles. The maximum temperature in the early stage of puffing may be the same as the maximum temperature in the middle-to-late stage of puffing. In other embodiments, the maximum temperature in the early stage of puffing may be different from the maximum temperature in the middle-to-late stage of puffing. For example, the maximum temperature in the early stage of puffing may be higher than the maximum temperature in the middle-to-late stage of puffing, which is conducive to reducing energy consumption. For example, the maximum temperature in the early stage of puffing may be lower than the maximum temperature in the middle-to-late stage of puffing, which is conducive to increasing the aerosol output in the middle-to-late stage of puffing.

[0130] In some embodiments, as shown in FIG. 6, the temperature curve is a wave curve that fluctuates upward starting from a minimum temperature, where the minimum temperature serves as the lower limit of the temperature wave curve. In this embodiment, based on a

control strategy in which the lower limit of the temperature wave curve remains constant, the energy supply for each time period is set such that the wave curve fluctuates upward starting from the minimum temperature. It can be understood that the energy supply mode shown in FIG. 6 is the same as the above energy supply mode shown in FIG. 4, and both can achieve the same function. Therefore, details are not repeated herein.

[0131] In some embodiments, as shown in FIG. 7, the temperature curve is a wave curve that fluctuates upward starting from a minimum temperature, where the minimum temperature serves as the lower limit of the temperature wave curve. The difference from the embodiment shown in FIG. 6 lies in that the minimum temperature in the early stage of puffing and that in the middle-to-late stage of puffing are different, where the minimum temperature in the middle-to-late stage of puffing is lower than the minimum temperature in the early stage of puffing, to adapt to the taste of different aerosol generating articles.

[0132] In some embodiments, referring to FIG. 8, the temperature curve is a wave curve that fluctuates upward starting from a minimum temperature, where the minimum temperature serves as the lower limit of the temperature wave curve. During the puffing operation stage, the temperature wave curve has three fluctuation amplitudes.

[0133] During the preheating operation stage, the controller controls the power source to output at maximum power for a predetermined period of time, so that the temperature rises rapidly. The early stage of the puffing operation stage includes multiple second time periods a. The controller controls the power source to output power according to the energy supply mode corresponding to each second time period a, and the temperature of the heater exhibits small-wave fluctuations within $\pm 3^{\circ}\text{C}$. The middle stage of the puffing operation stage includes multiple second time periods b. The controller controls the power source to output power according to the energy supply mode corresponding to each second time period b, and the temperature of the heater exhibits small-wave fluctuations within $\pm 5^{\circ}\text{C}$. The second time period b and the second time period a are different types of second time periods, and the preset energy corresponding to the second time period b is greater than the preset energy corresponding to the second time period a.

[0134] The late stage of the puffing operation stage includes multiple first time periods. The controller controls the power source to output power according to the energy supply mode corresponding to each first time period, and the temperature of the heater exhibits large-wave fluctuations within $\pm 25^{\circ}\text{C}$, thereby heating and activating the aerosol generating substrate to generate sufficient aerosol.

[0135] In some embodiments, referring to FIG. 9, the temperature curve is a wave curve that fluctuates upward starting from a minimum temperature, where the minimum temperature serves as the lower limit of the tem-

perature wave curve. During the puffing operation stage, the temperature wave curve has three fluctuation amplitudes. The difference from the embodiment shown in FIG. 8 lies in that the minimum temperatures in the early stage, the middle stage, and the late stage of puffing are different, where the minimum temperature in the middle stage of puffing is lower than the minimum temperature in the early stage of puffing, and the minimum temperature in the late stage of puffing is lower than the minimum temperature in the middle stage of puffing, to adapt to the taste of different aerosol generating articles.

[0136] In some embodiments, the multiple second time periods operate in a heat-preservation operation stage, and the multiple first time periods operate in a puffing operation stage. The heat-preservation operation stage refers to a stage in which the temperature is maintained at the preheating temperature or slightly below the preheating temperature, and aerosol continues to be generated in this stage.

[0137] The heat-preservation operation stage includes multiple second time periods. The controller controls the power source to output power according to the energy supply mode corresponding to each second time period, and the temperature of the heater exhibits small-wave fluctuations within $\pm 5^{\circ}\text{C}$.

[0138] The puffing operation stage includes multiple first time periods. The controller controls the power source to output power according to the energy supply mode corresponding to each first time period, and the temperature of the heater exhibits large-wave fluctuations within $\pm 25^{\circ}\text{C}$.

[0139] In summary, in the control method provided in the embodiments of the present application, based on the energy demand characteristics in the baking process of the aerosol generating substrate, the entire baking process is divided into multiple time periods, and a corresponding energy supply is configured for each time period, such that the aerosol generating substrate receives heat from the heater in different time periods, and the generated aerosol after baking can quickly reach an inhalable state and maintain the inhalable state. In another aspect, from the perspective of thermal conduction characteristics, for each first time period, energy is continuously supplied during the first time, and the supply of energy is stopped or only a relatively small amount of energy is supplied during the second time, such that the temperature first rises to a maximum temperature and then decreases to a minimum temperature within the first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. This facilitates that, during the next time period, a greater proportion of heat provided by the heater can be absorbed by the aerosol generating substrate when energy is supplied, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0140] In some embodiments of the present application, an aerosol generating device is further provided.

The aerosol generating device includes a heater, a power source, and a controller. The heater and the power source are communicatively connected to the controller.

[0141] The heater is configured to heat an aerosol generating substrate to generate an aerosol. Exemplarily, in terms of appearance, the heater may be a needle-shaped or tubular heater; in terms of heating principles, the heater may be a resistive heater or an electromagnetic induction heater. The power source is a cell configured to supply energy to the heater.

[0142] The controller is configured to: correspondingly control, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, where the multiple time periods include multiple first time periods; control, in each of the first time periods, the power source to output energy in a current first time period and maintain the output for a first time to reach a maximum temperature of the heater in the current first time period; and control the power source to stop outputting energy in the current first time period and maintain the stop for a second time to reach a minimum temperature of the heater in the current first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.

[0143] In this embodiment, based on the energy demand characteristics in the baking process of the aerosol generating substrate, the entire baking process is divided into multiple time periods, and a corresponding energy supply is configured for each time period, such that the aerosol generating substrate receives heat from the heater in different time periods, and the generated aerosol after baking can quickly reach an inhalable state and maintain the inhalable state. In another aspect, from the perspective of thermal conduction characteristics, for each first time period, energy is continuously supplied during the first time and the supply of energy is stopped during the second time, such that the temperature first rises to a maximum temperature and then decreases to a minimum temperature within the first time period, where a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. This facilitates that, during the next time period, a greater proportion of heat provided by the heater can be absorbed by the aerosol generating substrate when energy is supplied, thereby enhancing energy utilization efficiency and reducing energy consumption.

[0144] In some embodiments, the controller is configured to perform the control method according to any one of the above method embodiments, so that the aerosol generating device is capable of implementing the functions realized by the control method according to any one of the above method embodiments, and details thereof are not repeated herein.

[0145] In some embodiments, the heater is made of a metal with a thermal conductivity greater than $10 \text{ W}/(\text{m}\cdot\text{K})$. It can be understood that the greater the thermal conductivity, the better the heat transfer perfor-

mance, and the heat of the heater can be rapidly transferred to the aerosol generating substrate. Thus, during the heating time (for example, the first time or the third time described above), the temperature of the heater can rapidly increase, thereby forming a relatively large temperature difference between the heater and the aerosol generating substrate. It can be understood that the magnitude of the temperature difference is positively correlated with the thermal conductivity. For example, the magnitude of the temperature difference within the first time period may reach 50°C. For example, in the first time period, the temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C.

[0146] Exemplarily, the heater is made of stainless steel, permalloy, or ferritic stainless steel, and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 20°C. A heater made of stainless steel, permalloy, or ferritic stainless steel is suitable for use as a resistive heater or an electromagnetic induction heater.

[0147] Exemplarily, the heater is made of an aluminum alloy; and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C. It can be understood that a heater made of aluminum alloy is suitable for use as a resistive heater and is not suitable for use as an electromagnetic induction heater.

[0148] In this embodiment, the heater is made of a metal having a thermal conductivity greater than 10 W/(m·K). The thermal conductivity is positively correlated with the temperature rise rate. Accordingly, the heater can rapidly increase its temperature within a short period of time.

[0149] In some embodiments, the heater further includes an energy storage layer, the energy storage layer being disposed between a heating element and an aerosol generating article, and a thermal conductivity of the energy storage layer is greater than a thermal conductivity of the heating element. It can be understood that the heating element is an assembly of the heater configured to generate heat, and may be in the form of a metal needle-shaped, sheet-shaped, or tubular structure, for example.

[0150] Exemplarily, the heating element is made of stainless steel, permalloy, or ferritic stainless steel, and the energy storage layer is made of an aluminum alloy. The thermal conductivity of aluminum alloy is higher than the thermal conductivity of stainless steel, permalloy, or ferritic stainless steel.

[0151] It can be understood that the heat generated by the heating element is first conducted to the energy storage layer, and then from the energy storage layer to the aerosol generating article. Since the thermal conductivity of the energy storage layer is higher than the thermal conductivity of the heating element, the aerosol generating article in contact with the energy storage layer

for heat transfer can be rapidly heated.

[0152] Therefore, during the preheating operation stage, since the energy storage layer needs to absorb heat, the overall temperature rise rate of the heater is lower than the overall temperature rise rate of a heater without the energy storage layer. When the energy storage layer reaches a temperature, in the subsequent heat-preservation operation stage and puffing operation stage, due to the high thermal conductivity of the energy storage layer, the rate of heat transfer from the heater to the exterior of the device can be effectively reduced, thereby effectively reducing the overall heat loss of the device.

[0153] It is to be noted that the device embodiments described above are merely illustrative. The units described as separate components may or may not be physically separate. The components shown as units may or may not be physical units, and may be located in one place or distributed across multiple network units. Part or all of the modules may be selected as required to achieve the objectives of the solution of this embodiment.

[0154] Finally, it is to be noted that the above embodiments are merely intended to illustrate the technical solutions of the present application, and are not intended to limit the present application. Under the concept of the present application, the technical features in the above embodiments or different embodiments may be combined, and the steps may be performed in any order. Numerous other variations in various aspects of the present application as described above also exist, and for the sake of brevity, they are not described in detail. Although the present application has been described in detail with reference to the foregoing embodiments, a person of ordinary skill in the art shall understand that modifications may be made to the technical solutions described in the foregoing embodiments, or equivalent substitutions may be made for part of the technical features therein. Such modifications or substitutions do not cause the essence of the corresponding technical solutions to depart from the scope of the technical solutions of the embodiments of the present application.

Claims

1. A control method applied to an aerosol generating device, wherein the aerosol generating device comprises a heater configured to heat an aerosol generating substrate to generate an aerosol and a power source configured to supply energy to the heater, and the method comprises:

correspondingly controlling, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, wherein the multiple time periods comprise multiple first time periods; and controlling, in each of the first time periods, the

power source to supply energy to the heater, comprising:

- controlling the power source to output energy in a current first time period and maintaining the output for a first time to reach a maximum temperature of the heater in the current first time period; and
controlling the power source to stop outputting energy in the current first time period and maintaining the stop for a second time to reach a minimum temperature of the heater in the current first time period, wherein a temperature difference between the maximum temperature and the minimum temperature is 15°C or more. 5 10 15
2. The method of claim 1, wherein a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C. 20
3. The method of claim 1, wherein the first time is 4 s or less.
4. The method of claim 1, wherein a temperature rise rate of the heater within the first time is greater than 40°C/s. 25
5. The method of claim 1, wherein a temperature rise rate of the heater during the first time is different from a temperature decrease rate of the heater during the second time. 30
6. The method of claim 5, wherein a temperature rise rate of the heater during the first time is greater than a temperature decrease rate of the heater during the second time. 35
7. The method of claim 1, after the controlling the power source to stop outputting energy in the current first time period and maintaining the stop for a second time, comprising:
entering a next time period, and controlling the power source to output energy in the next time period. 40 45
8. The method of claim 1, before the controlling, in each of the first time periods, the power source to supply energy to the heater, comprising:
detecting an operating duration of the heater after the heater is activated for heating; and
when the operating duration satisfies a first time threshold, entering at least one of the first time periods. 50 55
9. The method of claim 8, wherein the first time threshold is greater than 60 s.

10. The method of claim 1, further comprising:

while controlling the power source to output energy in the current first time period, determining the supplied energy in the current first time period; and
when the supplied energy reaches a preset energy corresponding to the current first time period, controlling the power source to stop outputting energy in the current first time period.

11. The method of claim 1, further comprising:

while controlling the power source to stop outputting energy in the current first time period, determining a duration for which the power source stops outputting energy in the current time period; and
when the duration satisfies a preset natural cooling time of the current first time period, ending the current first time period and entering a next time period.

12. The method of claim 1, further comprising:

while controlling the power source to stop outputting energy in the current first time period, detecting a real-time temperature of the heater; and
when the real-time temperature decreases to a preset low-temperature threshold, ending the current first time period and entering a next time period.

13. The method of claim 1, wherein the controlling the power source to output energy in a current first time period comprises:

controlling the power source to continuously output energy in the current first time period.

14. The method of claim 1, wherein the multiple time periods further comprise multiple second time periods; and

controlling, in each of the second time periods, the power source to supply energy to the heater, comprising:

controlling the power source to output energy in a current second time period and maintaining the output for a third time to reach a maximum temperature of the heater in the current second time period; and
controlling the power source to stop outputting energy in the current second time period and maintaining the stop for a fourth time to reach a minimum temperature of the heater in the current second time period,
wherein a temperature difference between the

- maximum temperature and the minimum temperature is less than 10°C.
15. The method of claim 14, wherein the multiple second time periods operate in an early stage of a puffing operation stage, and the multiple first time periods operate in a middle stage and/or a late stage of the puffing operation stage.
16. The method of claim 14, wherein the multiple second time periods operate in a heat-preservation operation stage, and the multiple first time periods operate in a puffing operation stage.
17. An aerosol generating device, comprising:
- a heater, configured to heat an aerosol generating substrate to generate an aerosol;
 - a power source, configured to supply energy to the heater; and
 - a controller, configured to: correspondingly control, in multiple time periods in which the heater is activated for heating, the power source to supply energy to the heater multiple times, wherein the multiple time periods comprise multiple first time periods; control, in each of the first time periods, the power source to output energy in a current first time period and maintain the output for a first time to reach a maximum temperature of the heater in the current first time period; and control the power source to stop outputting energy in the current first time period and maintain the stop for a second time to reach a minimum temperature of the heater in the current first time period, wherein a temperature difference between the maximum temperature and the minimum temperature is 15°C or more.
18. The device of claim 1, wherein the heater is made of a metal with a thermal conductivity greater than 10 W/(m·K).
19. The device of claim 18, wherein the heater is made of stainless steel, permalloy, or ferritic stainless steel; and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 20°C.
20. The device of claim 18, wherein the heater is made of an aluminum alloy; and within the first time period, a temperature difference between the maximum temperature and the minimum temperature ranges from 15°C to 50°C.
21. The device of claim 18, wherein the heater further comprises an energy storage layer, the energy storage layer being disposed between a heating element and an aerosol generating article, and wherein
- a thermal conductivity of the energy storage layer is greater than a thermal conductivity of the heating element.
22. The device of claim 18, wherein the heating element is made of stainless steel, permalloy, or ferritic stainless steel, and the energy storage layer is made of an aluminum alloy.

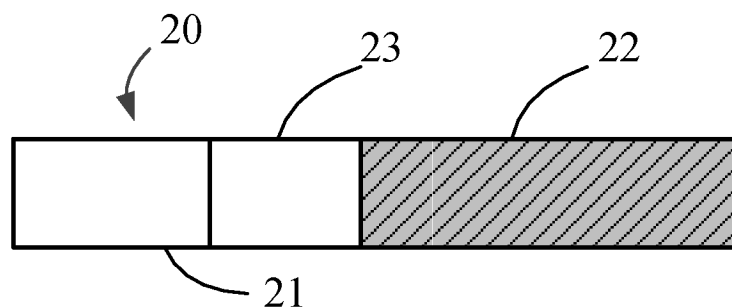


FIG. 1

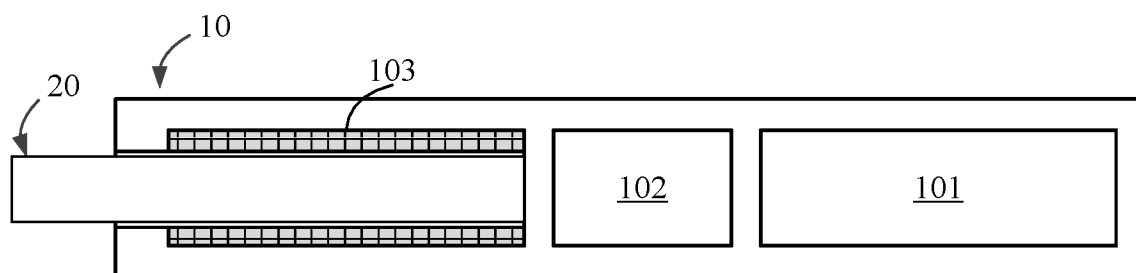


FIG. 2

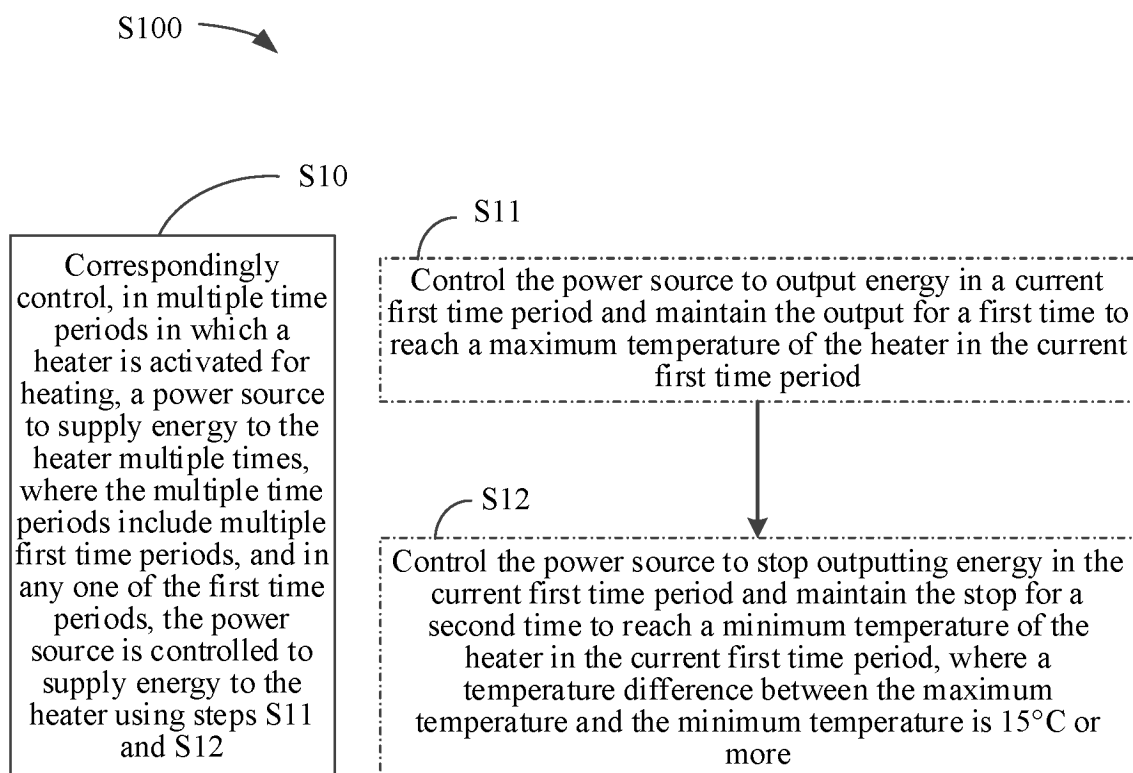


FIG. 3

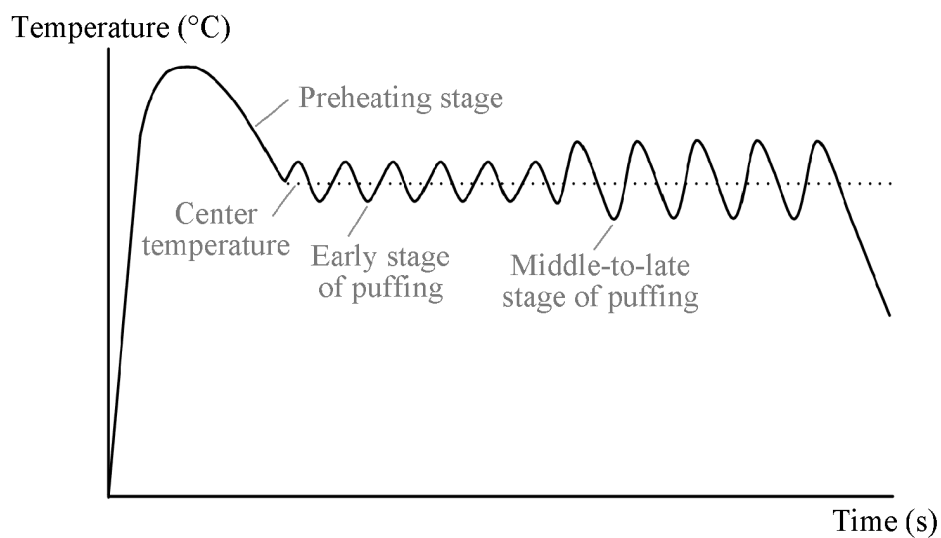


FIG. 4

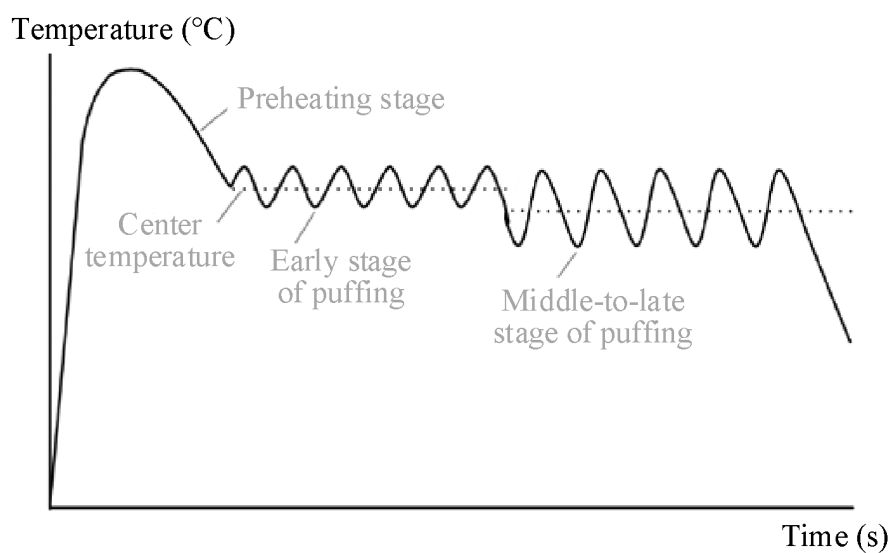


FIG. 5

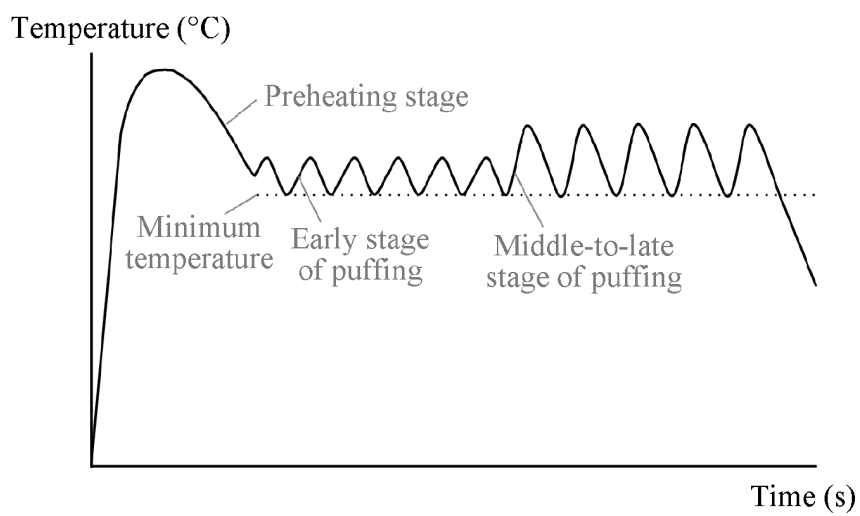


FIG. 6

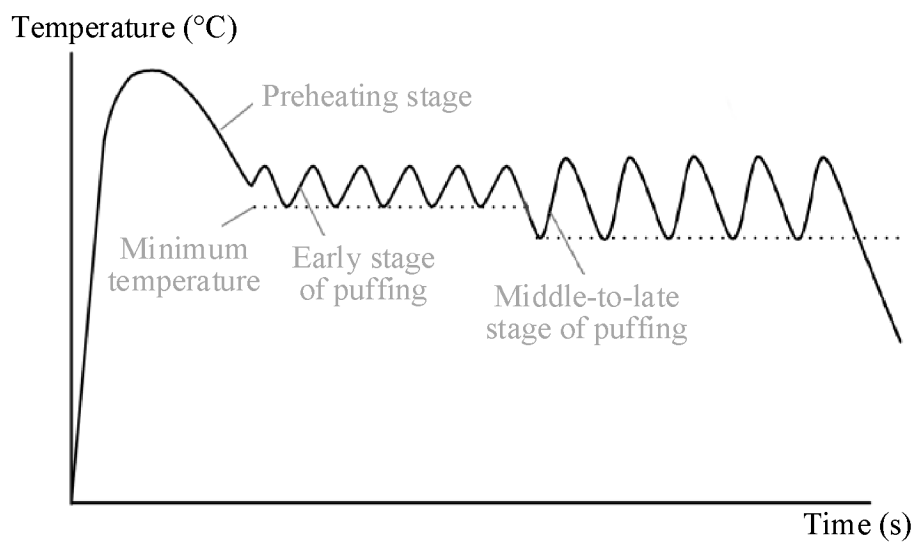


FIG. 7

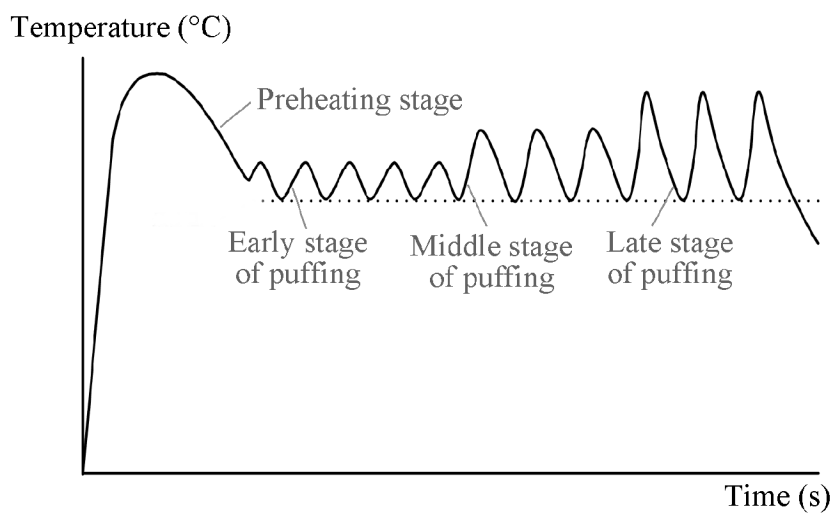


FIG. 8

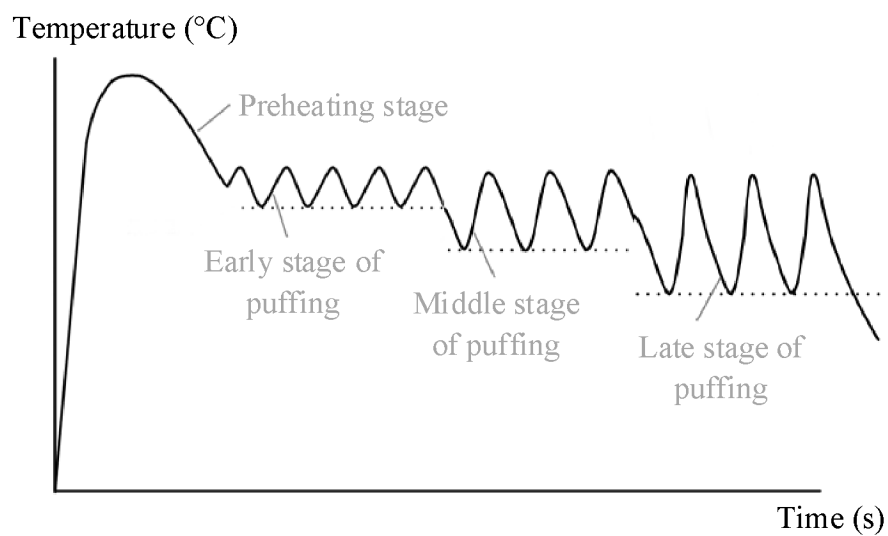


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/127344

A. CLASSIFICATION OF SUBJECT MATTER

A24F40/40(2020.01)i; A24F40/46(2020.01)i; A24F40/50(2020.01)i; A24F40/57(2020.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:A24F 40/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXTC, DWPI, CNKI: 雾化, 气溶胶, 加热, 时间, 温度, 温差, 功率, 阈值, atomiz+, aerosol, heating, time, temperature, difference, power, threshold

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 116135058 A (SHANGHAI TOBACCO GROUP CO., LTD. et al.) 19 May 2023 (2023-05-19) description, paragraphs [0057]-[0104], and figures 1-4	1-4, 7-13, 17-22
Y	CN 116135058 A (SHANGHAI TOBACCO GROUP CO., LTD. et al.) 19 May 2023 (2023-05-19) description, paragraphs [0057]-[0104], and figures 1-4	5, 6, 14-16
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
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"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

27 December 2024

Date of mailing of the international search report

13 February 2025

Name and mailing address of the ISA/CN

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Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/127344

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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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A	WO 2023285458 A1 (PHILIP MORRIS PRODUCTS S.A.) 19 January 2023 (2023-01-19) entire document	1-22

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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Information on patent family members

International application No.

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