AN ELECTRICALLY HEATED AEROSOL GENERATING SYSTEM HAVING IMPROVED HEATER CONTROL

The present invention relates to a method for controlling at least one electric heating element of an electrically heated aerosol generating system. The present invention further relates to an electrically heated aerosol generating system. The present invention finds particular application as a method for controlling at least one electric heating element of an electrically heated smoking system and as an electrically heated smoking system.

WO-A-2009/132793 discloses an electrically heated smoking system. A liquid is stored in a liquid storage portion, and a capillary wick has a first end which extends into the liquid storage portion for contact with the liquid therein, and a second end which extends out of the liquid storage portion. A heating element heats the second end of the capillary wick. The heating element is in the form of a spirally wound electric heating element in electrical connection with a power supply, and surrounding the second end of the capillary wick. In use, the heating element may be activated by the user to switch on the power supply. Suction on a mouthpiece by the user causes air to be drawn into the electrically heated smoking system over the capillary wick and heating element and subsequently into the mouth of the user.

It is an objective of the invention to provide an improved method of controlling the electric heating element of such an electrically heated aerosol generating system.

According to a first aspect of the invention, there is provided a method for controlling at least one electric heating element of an electrically heated aerosol generating system for heating an aerosol-forming substrate, the system having a sensor for detecting airflow indicative of a user taking a puff having an airflow duration, the method comprising the steps of: increasing the heating power for the at least one heating element from zero to a power p1 when the sensor detects that the airflow rate has increased to a first threshold; maintaining the heating power at power p1 for at least some of the airflow duration; and decreasing the heating power for the at least one heating element from power p1 to zero when the sensor detects that the airflow rate has decreased to a second threshold, wherein the first airflow rate threshold is smaller than the second airflow rate threshold.

The at least one electric heating element is arranged to heat the aerosol-forming substrate to form the aerosol. The electrically heated aerosol generating system may include the aerosol-forming substrate or may be adapted to receive the aerosol-forming substrate. As known to those skilled in the art, an aerosol is a suspension of solid particles or liquid droplets in a gas, such as air. By controlling the heating power supplied to the at least one heating element, energy usage can be optimised. The heating power may be tailored to the particular puff profile so that the desired aerosol properties, for example aerosol concentration or particle size, can be achieved.

Overheating or underheating can be avoided, particularly towards the start or end of the puff. The decrease of power towards the end of the puff affects the cooling of the heating element and hence the temperature of the heating element and its vicinity. This, in turn, affects how much condensation is able to form in the system, which may affect liquid leakage.

Preferably, the electrically heated aerosol generating system comprises a power supply for supplying power to the at least one electric heating element. Preferably, the electrically heated aerosol generating system comprises electric circuitry for controlling supply of power from the power supply to the at least one electric heating element. Preferably, the electric circuitry comprises the sensor.

Preferably, the electric circuitry is arranged to perform the method steps of the first aspect of the invention. The electric circuitry may be hardwired to perform the method steps of the first aspect of the invention. More preferably, however, the electric circuitry is programmable to perform the method steps of the first aspect of the invention.

The sensor may be any sensor which can detect airflow indicative of a user taking a puff. The sensor may be an electro-mechanical device. Alternatively, the sensor may be any of: a mechanical device, an optical device, an opto-mechanical device, a micro electro mechanical systems (MEMS) based sensor and an acoustic sensor.

Typically, the airflow rate (which may also be known as the puff-flow rate), during the airflow duration (which may be the same as the puff duration), increases from zero to the first threshold to a maximum, and then decreases from the maximum to the second threshold and then to zero. The airflow rate may form a Gaussian or normal distribution (also known as a bell shaped curve). More usually, however, the airflow rate may form a non-perfect Gaussian distribution. The airflow duration may be defined in a number of ways. For example, the airflow duration may be defined as the time period during which the airflow rate is non-zero. Alternatively, the airflow duration may be defined as the time period during which the airflow rate is greater than a pre-defined level. Preferably, the power p1 is pre-defined. The power p1 may depend on a number of factors including, but not limited to, the form of electric heating element, the type of aerosol forming substrate, the amount of aerosol desired to be formed and the particle size required for the aerosol.

In one embodiment, the first airflow rate threshold is equal to the second airflow rate threshold. This embodiment is advantageous, because the operation of the method is relatively simple.

In the first aspect~~another embodiment~~, the first airflow rate threshold is smaller than the second airflow rate threshold. This ~~embodiment~~ is advantageous because it may contribute to avoiding overheating towards the end of the puff which, in turn, affects condensation formation. Because the second airflow rate threshold, at which the heating power is decreased, is greater than the first airflow rate

controlling supply of power from the power supply to the at least one electric heating element, the electric circuitry including a sensor for detecting airflow indicative of a user taking a puff having an airflow duration; wherein the electric circuitry is arranged to increase the heating power for the at least one heating element from zero to a power p1 when the sensor detects that the airflow rate has increased to a first threshold; to maintain the heating power at power p1 for at least some of the airflow duration; and to decrease the heating power for the at least one heating element from power p1 to zero when the sensor detects that the airflow rate has decreased to a second threshold, wherein the first threshold is smaller than the second threshold.

In one embodiment, the aerosol-forming substrate is a liquid substrate and the electrically heated aerosol generating system further comprises a capillary wick for conveying the liquid substrate to the at least one electric heating element. As will be discussed further below, the heating element in combination with a capillary wick may provide a fast response and therefore improved control of the heating profile.

According to a third aspect of the invention, there is provided electric circuitry for an electrically heated aerosol generating system, the electric circuitry being arranged to perform the method of the first aspect of the invention.

Preferably, the electric circuitry is programmable to perform the method of the first aspect of the invention. Alternatively, the electric circuitry may be hardwired to perform the method of the first aspect of the invention.

According to a fourth aspect of the invention, there is provided a computer program which, when run on programmable electric circuitry for an electrically heated aerosol generating system, causes the programmable electric circuitry to perform the method of the first aspect of the invention.

According a fifth aspect of the invention, there is provided a computer readable storage medium having stored thereon a computer program according to the fourth aspect of the invention.

The at least one electric heating element may comprise a single heating element. Alternatively, the at least one electric heating element may comprise more than one heating element for example two, or three, or four, or five, or six or more heating elements. The heating element or heating elements may be arranged appropriately so as to most effectively heat the aerosol-forming substrate.

The at least one electric heating element preferably comprises an electrically resistive material. Suitable electrically resistive materials include but are not limited to: semiconductors such as doped ceramics, electrically "conductive" ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may comprise doped or undoped