Study on Smoke Temperature Variation and Heat Field of Soundable CYO

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Abstract. In order to solve the shortcomings of cigarette auditory stimulation, this paper focuses on the design of soundable connector components, and studies the influence of the connector on smoke temperature. The smoke temperature change of the splicer and filter are simulated by using ISO smoking model and ANSYS simulation software. The simulation results show that the temperature of CO and nicotine decreases sharply after going through the connector, and the temperature drops to room temperature when it arrives at the filter rod. The connector has the effect of reducing the temperature of smoke.

1. Introduction
Although the current mechanism cigarettes have the advantages of stable smoking quality and minimal differences in appearance between cigarettes, consumers still buy traditional cigarettes as a kind of "combined consumption", and they cannot choose the free combination of filter sticks and cigarette sticks with personal preferences and tastes, and cannot meet the diversified and personalized consumption needs of consumers. For example, some consumers will choose external filter rods to reduce the harm of cigarettes. Cigarette products need to conform to group personality and consumption characteristics, offering the product a stronger sense of innovation, technology and uniqueness, making more choices, more independent choice types of cigarettes, which allows young and middle-aged consumers love hands-on, innovative personality in cigarette products to be released and reflected[1-5].

Cigarette products could provide consumers perfect experience of smoking, but with a lack of consumer demand for good-looking, fun and pleasant. Existing products fail to meet the auditory and sensory needs of consumers. Some consumers have the need to record the number of suction ports and prompts by sounding during suction. With the diversification and individualization of the cigarette consumption market, it is an urgent need and trend for the innovation and development of cigarettes to develop cigarette products which can produce sound and bring consumers multiple consumption experiences such as hearing, touch, DIY, smoke change, self-flavoring and so on. This paper provides a soundable connector and CYO cigarettes, which solves the problem that cigarettes in the existing technology can not satisfy consumers' auditory perception. This paper focuses on the influence of this splicing device on smoke temperature[6-9].

2. Simulation & calculation
This paper mainly simulates the influence of flue gas passing through connector and filter on smoke temperature. The results of simulation are mainly affected by the combustion of cigarette, the structure
of connector and the characteristics of filter, especially the combustion process of cigarette has many uncertainties.

2.1 Suction mode
According to GB/T 19609-2004, under ISO suction mode, the velocity expression of ISO suction mode.

2.2 Establishment of connector model and simulation technology route
(1) Establishment and meshing of geometric model of flue gas passage and filter nozzle of splicer.
(2) Fluent software simulation of connector and filter model.

3. Experimental results and discussions

3.1 Temperature variation of connector and filter
The three-dimensional graph of the soundable connector and filter is shown in Fig. 1. Based on this, the temperature variation and temperature field of the soundable connector and filter rod are calculated in this paper.

![Three-dimensional mesh of a soundable connector and filter](image)

As can be seen from Fig. 2, at Z=30, the temperature of CO almost does not change before 1.8 seconds at different initial temperatures, and drops sharply after 1.8 seconds. However, at Z=15, Z=7, Z=0, the temperature of different initial temperatures almost does not change with time, and at Z=15, Z=7, Z=0, the temperature of different initial temperatures is almost the same, and they drop to the room temperature. This indicates the temperature of CO has decreased to a certain extent after model-1 splicer, and the temperature of CO has dropped to room temperature after heat exchange from Z=30 to Z=15.

![Temperature variation of CO at different cross sections with time](image)

From Fig. 3, it can be seen that the temperature of nicotine increases first and then decreases with time at different cross sections and initial temperatures, which is consistent with the trend of the change of smoking pressure and speed of nicotine, and is also related to the heat exchange rate of nicotine slower than that of CO, but with the change from Z=30 to Z=0 this trend is getting lower and lower. At Z = 0, almost all nicotine with different initial temperatures eventually falls to room temperature.

![Temperature variation of nicotine at different cross sections with time](image)

3.2 Simulated cloud map of connector and filter
The flow rate, temperature and smoke resistance of flue gas and nicotine at different time (0.4 s, 0.8 s, 1.2 s, 1.6 s) along the axis of splicer and filter were observed during the 2 s suction at 355 K.
As shown in Fig. 4, CO temperature drops sharply after passing through the connector, and it drops to room temperature when it reaches the filter. During the connector stage, CO undergoes intense heat exchange.

![Fig. 4 CO Temperature Distribution (X = 0) (t=0.4s,0.8s,1.2s,1.6s)](image)

As shown in Fig. 5, in the first 0.4 seconds, nicotine enters the filter and immediately transfers heat with acetic acid fiber, which greatly reduces the nicotine temperature in the flue gas and increases the temperature in the filter. Nicotine flows into the filter in a conical shape, and the temperature changes in a conical shape. The central temperature is the highest and decreases continuously along the radial direction. At 0.8 seconds, the flue gas continued to enter the filter but did not penetrate the filter completely, and the nicotine temperature continued to drop, showing a stratified phenomenon. At 1.2 s, the smoke continued to diffuse through the filter to the suction end, and heat transfer occurred in the filter, and the nicotine temperature continued to decline.

![Fig. 5 Nicotine temperature distribution (X = 0)(t=0.4s,0.8s,1.2s,1.6s)](image)

As shown in Fig. 6, CO temperature drops sharply after passing through the splicer, and it drops to room temperature when it reaches the filter rod.

![Fig. 6 Temperature distribution of CO at different cross sections (t=0.4s,0.8s,1.2s,1.6s)](image)

As shown in Fig. 7, CO temperature drops sharply after passing through the connector, and it drops to room temperature when it reaches the end of the filter rod.

![Fig. 7 Temperature Distribution of Nicotine at Different Cross Sections (t=0.4s,0.8s,1.2s,1.6s)](image)
4. Conclusions

(1) At different cross sections and initial temperatures, the temperature of nicotine increases first and then decreases with time, which is consistent with the change trend of smoking pressure and speed of nicotine, and is also related to the slower heat exchange rate of nicotine than that of CO.

(2) The change of temperature field can be divided into three stages. Firstly, as soon as nicotine enters the filter, it immediately transfers heat with acetic acid fiber. Nicotine flows into the filter in a conical shape, and the temperature changes in a conical shape. Secondly, the flue gas continued to enter the filter but did not penetrate the filter completely, and the nicotine temperature continued to decline, and presented a stratified phenomenon. Finally, the smoke continues to diffuse to the suction end through the filter, and heat transfer occurs in the filter, and the nicotine temperature continues to decline.

(3) The temperature of CO and nicotine decreases sharply after passing through the connector, and the temperature drops to room temperature when reaching the filter rod, which proves that the connector has the effect of reducing the temperature of flue gas.

Acknowledgments

Financial supports of China Tobacco Yunnan Industrial Co., Ltd. (Grant No. 2017CP03), Science and Technology Project of Yunnan Provincial Science and Technology Department (2018BA083) are greatly acknowledged. Authors also give sincere gratitude to Dr. Yang Fei and Dr. Feng Yucheng for technical support in simulation.

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