Study on the Draw Resistance Variation of CYO Connectors and Filter Rods

Hao Wang, Han Zheng, Jianbo Zhan, Geng Li, Xu Wang, Tingting Yu, Yao Yu, Jiao Xie and Liang Cheng
R&D Centre, China Tobacco Yunnan Industrial Co., Ltd. Kunming, Yunnan, 650231, P. R. China
*Corresponding author’s e-mail: wanghai0999@126.com

Abstract. In order to study the law of draw resistance variation in the key parts of CYO (Connect Your Own) cigarettes, the draw resistance at the connectors and the filter rods was measured under ISO suction mode, and the relevant data were fitted. The equation of the suction resistance at the connector outlet (Z=30) was $y=87344+87945\sin(\pi*(x+38.5)/26.36)$. The equation of the draw resistance at the end of the filter rod (Z=0) was $y=79879+80480\sin(\pi*(x+36.8)/25.24)$. The trend of fitting curve is consistent with UDF equation. The suction resistance curves of the four connector models coincide with those of the blank filter rod model. It shows that the increase of splicer has no obvious effect on the draw resistance of smoke in the filter rod. In this paper, the smoking draw resistance equation of CYO cigarettes is proposed for the first time. It is of great theoretical significance for the further study of the law of smoking draw resistance variation between CYO cigarettes and key positions of filter rods and its influence on temperature change.

1. Introduction

Although the current mechanism cigarettes have the advantages of stable smoking quality and minimal differences in appearance between cigarettes, consumers can only purchase traditional cigarettes as a kind of "combined consumption", and can not choose the free combination according to individual preferences and tastes of filter sticks and cigarette sticks, which can not meet the diversified and personalized consumption needs of consumers. For example, some consumers will choose external filter sticks to reduce the harm of cigarettes. Cigarette products need to conform to group personality and consumption characteristics, giving the product a stronger sense of innovation, technology and uniqueness. Cigarette products are ought to allow consumers to make more choices, more independent choice types of cigarettes, which lets young and middle-aged consumers love to involve innovative personality in cigarette products to be released and reflected.

Cigarette products in the smoking process can achieve good smoking experience, but can not meet consumer demand for good-looking, fun and pleasant to hear. Existing products fail to meet the auditory and sensory needs of consumers. With the diversification and individualization of the cigarette consumer market, it is an urgent need and trend for the innovation and development of cigarettes to develop cigarette products with variable colours which can bring consumers visual, DIY and other diversified consumption experiences.

At present, CYO cigarettes are still in the stage of development, so there is no related report or research on the changes of pressure drop and suction resistance at both ends of splicing components.
and cigarette strips and filter rods. This paper intends to carry out in-depth study on the law of draw resistance variation at connectors and filter rods.

2. Experiment and calculation methods
In this simulation, ISO suction mode is applied to simulate. The velocity of flue gas at the inlet of connector varies with time: \(v = 0.61 \sin(\frac{\pi t}{2})\). The corresponding outlet pressure also varies with time. UDF program is used to program the relationship between loading speed and pressure with time. Fluent calculates the splicer and filter according to the characteristic parameters of smoke, the characteristic parameters of filter and the temperature of cigarette end.

3. Results and discussion

3.1. Pressure drop equation at connector outlets(Z=30)
In the ISO mode, the time of each puff is 2 seconds, and the puff capacity is 35 ml. The velocity expression of the inlet flue gas of the splicer in the ISO mode is as follows:

\[ v = 0.61 \sin(\frac{\pi t}{2}) \]  \hspace{1cm} (1)

Fig. 1 shows the draw resistance curves of four connector models and filters at Z=30mm position under ISO suction mode. It can be seen from the figure that the draw resistance curves of connector model and blank control sample filter models basically coincide, which shows that the addition of connector has no obvious effect on the filter resistance of flue gas in the filter. Fitting the curve of Fig. 1, as shown in Fig. 2, the resistance equation of the connector outlet position (Z = 30) under ISO suction mode is obtained.

\[ Y = 87344 + 87945 \ast \sin (\pi \ast (x + 38.5) / 26.36) \]  \hspace{1cm} (2)

It can be seen from equation (2) that the equation is Sine function equation, which is consistent with the change of UDF equation (1) of suction velocity.

![Fig.1 Pressure drop of connector and filter rods at Z=30 mm](image1)

![Fig.2 Pressure drop fitting equation at Z=30 mm](image2)
3.2. Pressure drop equation at filter rod end (Z=0)

Fig. 3 shows the draw resistance curves of connector model and filter at Z=0mm position in ISO puff mode. It can be seen from the figure that the draw resistance curves of connector and blank contrast sample filter models basically coincide, which shows that the addition of the connector has no obvious effect on the draw resistance of smoke in the filter. Fitting the curve of Fig. 3, as shown in Fig. 4, the absorption equation at the end of the filter (Z = 0) under ISO puff mode is obtained,

$$y=79879+80480 \times \sin \left(\pi \times \frac{x+36.8}{25.24}\right)$$  \hspace{1cm} (3)

It can be seen from equation (3) that the equation is Sine function equation, which is consistent with the change of UDF equation (1) of puff velocity.

![Fig.3 Pressure drop of connector and filter rods at Z=0 mm](image1.png)

**Fig.4 Pressure drop fitting equation at Z=0 mm**

4. Conclusion

(1) Draw resistance of connector and filter rod under ISO suction mode was measured, and the relevant data was fitted, the draw resistance equation of connector outlet location (Z=30) is $y=87344+87945 \times \sin \left(\pi \times \frac{x+38.5}{26.36}\right)$. The suction equation of filter end (Z=0) is $y=79879+80480 \times \sin \left(\pi \times \frac{x+36.8}{25.24}\right)$.

(2) The trend of fitting curve is consistent with UDF equation. The draw resistance curves of the connector models coincide with those of the blank control filter rod model, which shows that the addition of connector has no obvious effect on the suction resistance of smoke in filter rod.
Acknowledgments

Financial supports of China Tobacco Yunnan Industrial Co., Ltd. (Grant No. 2017CP03) are greatly acknowledged. Authors also give sincere gratitude to Dr. Yang Fei and Dr. Feng Yucheng from South China University of Technology for their technical support in simulation.

References

[1] Wu J., Tao Y., Zhang W., etc. (2015) Online customer view: positive effect of consumer complaint in domestic appliance purchase, ICEMAESS, 560-566.
[2] Hastie, T., Tibshirani, R., Friedman, J. (2009) The elements of statistical learning, second edition: Data Mining, Inference, and Prediction. Springer.
[3] Chen Z., Dubinsky A. J. (2003) A conceptual code of perceived customer value in e-commerce; a preliminary investigation. Psychology &Marketing, 20: 323.
[4] Bum N. D., Hanna V., Backhouse C. J. (2004) Linking employee behaviour to external customer satisfaction using quality function deployment. Engineering Manufacture, 218: 1167-1177.
[5] Parasuraman A, Grewal D. (2000) The impact of technology on the quality-value-loyalty chain: a research agenda, Journal of the Academy of Marketing Science, 28: 168-174.
[6] Zhan J. B., Wang H., Yu T.T., et al. (2018) Study on the consumption Characteristics of CYO[J] The Journal of New Industrialization, 8: 98-101, 117.
[7] Fei X., Chen L.; Shi L., et al. A production device and method of rotary filter rod, CN105495683A [P] 2016-04-20.