Study on the Preparation of Water-storage Capsules and its Effect on the Quality of Cigarettes

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Abstract. The contents of existing cigarette capsules are basically the storage of ester soluble flavors and fragrances. In this paper, several new kinds of water-storage cigarette capsules were prepared. The influence of the new water-storage cigarette capsules before and after break on the quality of cigarette smoke has been comparably studied with usual samples without capsules. The experimental results show that the moisture content of the smoke increases significantly after water-storage cigarette capsules are pinched, the closer the placement position is to the suction end, the longer the moisture continues. Once the position of capsules in the filter rods is settled, moisture content of the smoke is related to capsule size and moisture keeping. The larger the size of the cigarette capsules is, the higher the moisture content of the smoke is. In the case of total particle content, samples with capsules after pinching is higher than that before pinching, and the content of tar of samples with capsules after pinching is lower than that before pinching, and there was no significant difference in the indexes of CO and suction times. Water-storage capsules are an effective way to reduce harmful smoke and tar, and that to improve the sensory quality of smoking. Water-storage capsules will have broad development and application prospects in the future.

1. Introduction

As a filling carrier, capsule has been widely used in medicine, beverage, cosmetics and other fields. In recent years, the capsule used in the tobacco industry is the "capsule", which is a fragrant capsule added to the filter tip or granules to release the contents by kneading and releasing, so as to achieve the controlled release of the characteristic fragrance in the process of cigarette smoking, reduce the influence of the external environment on the absorption of the flavor, and cause the loss of flavor, thereby enriching the taste of cigarette smoking, and achieving the aroma enhancing and moisturizing in the process of sucking. Equal action [1-3]. The consumption education and value cognition guided by product supply are still changing in the explosive pearl cigarette category in the stage of contact growth, and there is no conclusion yet. It also provides a development space for a new round of product style feature shaping and upgrading relying on the development of tobacco carrying fragrance.

The content of pop capsule cigarette on the market is mainly composed of long-chain oil soluble solvent and non-polar aromatic substance, which is not suitable for storage of water and ethanol. Its hydrophilic wall material will swell in the way of H-bond combination. The basic principle of the preparation of the capsule system for smoke is that the water phase wraps the oil phase, and the
hydrophilic wall material forms a film through the water loss, so as to wrap the oil phase [4,5]. Therefore, it is not technically feasible to transplant the existing exploding capsules for cigarette to the functional components with high polarity or water storage. At the same time, the moisture content of mainstream smoke has an important impact on the sensory quality of Chinese cigarettes. The research shows that when the moisture content of mainstream smoke is increased to about 4 mg, it can effectively improve the sensory comfort of cigarettes, and has little impact on other performance of smoke quality[6,7]. The strong polar substances in the contents migrate and expand into the rubber shell, and the wall materials of the explosion will react with the aldehyde containing compounds and destroy the structure, thus limiting the application of [8-10] to different types of tobacco flavors and fragrances. Therefore, it is of great practical significance to develop water-based capsules for tobacco, which have no selectivity for the type of contents.

The special requirements of cigarette filter rod for the small-scale processing and stress extrusion of water-based explosive capsules make it more difficult to select materials, structure design and packaging methods of water-based explosive capsules. Bio-based materials refer to the products manufactured by using renewable materials, including crops, trees and other plants, through biological, chemical and physical transformation technologies. They can be used in pharmaceutical, cosmetics, food additives and other industrial fields, as well as biogas and ethanol fuels. Among them, soybean oil, castor oil and rapeseed oil are used as raw materials to prepare bio-based trees. Resin (polyurethane, acrylate) is a new renewable energy material. UV curing technology is a new coating curing technology, which has the characteristics of "5E" principle, high efficiency, environmental protection, energy saving, environmental friendliness and wide applicability. The combination of bio-based materials and UV curing technology is considered as a "green + green" coating technology. Therefore, the preparation of new water storage capsules based on biological materials is of great significance.

2. Materials & methods

2.1 Materials
An oil-based UV curable resin was selected to prepare the protective coating of the microspheres. The color of the resin is light, almost colorless and transparent, which does not affect the appearance of the microspheres. Moreover, the raw materials of an oil-based UV curable resin are widely sourced, green and natural, which also meet the basic requirements of no toxic effect on human body.

2.2 Instruments:
Constant temperature and humidity box (model: kb720 manufacturer: binder), 100g 100000 level electronic balance: explosive weight, explosive core material weight and explosive wall material weight weighing, electric mixer: material liquid mixing, 3500 electromagnetic furnace: boiling water, material liquid heating, ndj-8s digital rotary viscometer: material liquid viscosity measurement, dropping equipment: cigarette explosive drop system, drying equipment: cigarette explosive capsule Drying and so on.

After 48 hours of equilibrium in constant temperature and humidity box (22 ℃± 2, 60% ± 5), samples with different numbers were tested for physical and chemical parameters such as flue gas moisture and total particles. In this paper, the physical and chemical parameters were tested according to national standards or tobacco industry standards.

3. Results & Discussion

3.1 Preparation of capsule samples
After the prepared water storage capsule burst sample is put into the filter rod end, the rolling experiment is carried out on the cigarette machine. The number and description of the rolled cigarette sample are shown in Table 1.
Table 1 Different types of experimental cigarettes and their numbers

| Sample No. | Status | Details of position and size |
|------------|--------|------------------------------|
| Original   | No capsule | Normal cigarette control samples without capsules produced by normal machine |
| YSB-D-1#   | Unbroken | Transparent hollow filter rod sample (the water retention factor contained, the embedding position is 15.0mm from the mouth end, capsule size 4.0-4.4mm) |
| YSB-D-2#   | Broken   | Transparent hollow filter rod sample (the water retention factor contained, the embedding position is 15.0mm from the mouth end, capsule size 4.0-4.4mm) |
| YS-DD-1#   | Unbroken | Transparent hollow filter rod sample (the pure water contained, the embedding position is 15.0mm from the mouth end, capsule size 4.2-4.6mm) |
| YS-DD-2#   | Broken   | Transparent hollow filter rod sample (the pure water contained, the embedding position is 15.0mm from the mouth end, capsule size 4.2-4.6mm) |
| YS-S-T-1#  | Unbroken | Transparent hollow filter rod sample (the pure water contained, the embedding position is 15.0mm from the mouth end, capsule size 3.5-3.8mm) |
| YS-S-T-2#  | Broken   | Transparent hollow filter rod sample (the pure water contained, the embedding position is 15.0mm from the mouth end, capsule size 3.5-3.8mm) |

3.2 Effect of water-storage capsules on smoke moisture

The comparison of water content between each sample of air transparent filter rod and that embedded in ordinary acetate fiber is shown in Fig. 1.

![Fig.1 Moisture content comparison of each sample embedded in hollow transparent filter rods](image)

It is not difficult to see from Fig. 1 that the same kind of sample has significant difference in smoke moisture under the condition of pinching and not pinching the water capsules. After pinching and breaking the capsules, the moisture content of the smoke increases significantly, with the highest proportion of 173.5%. This kind of water increase is common ester soluble. It can not achieve a very favorable effect of water lifting in the flue gas during the suction process, greatly improving the burr feeling and other oral uncomfortable feelings during the suction process.

The difference of flue gas moisture is related to the placement position of the capsules in the filter rod. The closer to the nozzle end, the higher the flue gas moisture is, and the closer to the tobacco end, the lower the flue gas moisture is. Under certain conditions of the position of the capsules in the filter rod, the flue gas moisture is related to the size of the capsules and the water retention effect. The larger the capsules size is, the higher the flue gas water separation is, which is mainly due to the larger the size of the water storage capsules, the more water is stored. It is not difficult to see that the position and size of the capsules are the main factors determining the moisture content of the flue gas. According to the analysis of the test results, the moisture content of the flue gas in the small size near the nozzle is higher than that in the large size far nozzle, indicating that the location of the capsule is the main factor determining the moisture content of the flue gas.

In the aspect of water retention factor, the test results show that the water content of the water-soluble particles is better than that of the water-soluble particles with the diameter of 4.2-4.6 mm, but the water content of the particles with the diameter of 4.0-4.4 mm is less than that of the particles with the diameter of 4.2-4.6 mm. At the same time, the application of anti-seepage forming paper in the development of cigarette is conducive to the improvement of the smoke water content.
3.3 Effect of water storage explosion on total particles, nicotine, tar and CO in flue gas
The influence of total particles, nicotine, tar and CO in the flue gas were analyzed.

3.3.1 Effect of water storage explosion on total particles in flue gas
The comparison of the total particle content in the flue gas of different samples is shown in Fig. 2. Compared with the total particle content of the same sample, the samples pinched by the blasting capsules are higher than the samples not pinched by the blasting capsules. The main reason may be that the water released after the crushing of the blasting capsules is not fully filtered in the flue gas flow.

![Fig.2 Comparison on total granular matter in smoke of different samples](image)

3.3.2 Effect of water storage and bead explosion on nicotine, tar and CO in flue gas
The comparison of nicotine and tar in the flue gas of different samples is shown in Fig. 3 and Fig. 4 respectively. It can be seen that in terms of nicotine, except YSB-S-P#, the nicotine content in the flue gas of the same kind of sample after the bead burst is lower than that before the bead burst, but the difference is not significant; in terms of tar content, except YSB-S# equal, the tar content in the flue gas of the same kind of sample after the bead burst is lower than that before the bead burst, in which YS-DD# is the most significant difference, with a difference of 1.0 mg. The experimental results show that water storage and bead blasting can reduce nicotine and tar in flue gas to a certain extent.

![Fig.3 Comparison on nicotine in smoke of different samples](image)

![Fig.4 Comparison on tar in smoke of different samples](image)

The comparison of CO in the flue gas of different samples is shown in Fig. 5. It can be seen that the difference of CO content in the flue gas is not obvious, high or low, but the difference of ys-dd# sample is relatively obvious, with a difference of 1.0 mg.
3.3.3 Effect of water storage capsule on the number of cigarette suction ports

The comparison of the number of suction ports of different samples is shown in Fig. 6. It can be seen from Fig. 7 that there is no significant difference in the number of suction ports of the sample after the bead is pinched, which means that the number of suction ports before and after the bead has little impact on the number of suction ports. Compared with the number of suction ports with or without the bead, it can be seen that the number of suction ports with the bead is higher than that of the normal sample, which is mainly because the placement of the bead causes the "blocking" effect on the flow path of the flue gas. However, this phenomenon also exists in the common ester soluble beads.

4. Conclusion

For the first time, the water storage capsules for application and cigarette were prepared, and the effect of water storage capsules on smoke was studied. The moisture content of flue gas increases significantly after the water storage capsule is pinched and broken. The closer to the suction end, the higher the moisture content of flue gas. In a certain position, the moisture content of flue gas is related to the size of capsules and the effect of water retention. The larger the size of capsules is, the higher the water distribution of flue gas is. The total content of the particles in the crushed samples was higher than that in the uncut samples, and the tar content in the flue gas after the crushed samples was lower than that before the crushed samples. Water storage capsule blasting is an effective way to reduce harm, improve moisture and moistening of flue gas, and improve sensory quality of cigarette suction. The preparation technology of water storage capsule blasting still has room for improvement, and the development and application prospect of water storage capsule blasting is good.

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