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THE EFFECT OF TYPE AND QUANTITY OF SILICATE MATERIALS DIRECTLY ADDED TO THE MIXTURE ON PHYSICAL CHARACTERISTICS OF CIGARETTES

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ABSTRACT

Investigations were made on the effect of type and amount of silicate materials directly added to tobacco cigarette mixtures on the major physical properties of cigarettes. Four types of silicate materials (type-Y zeolite, ultra stable type-Y zeolite, pentasile-type zeolite and amorphic silicon - carbon dioxide) were added directly to tobacco mixtures in amounts of 3% and 5% of the total mass of tobacco mixture. Cigarettes were made industrially, on cigarette making machine. Zeolites were synthesized and their physical-chemical characteristics were assessed at the Faculty of Physical Chemistry in Belgrade. Physical characteristics of cigarettes were made on SODIMAT and statistic analysis of the results was performed on the same device. Based on investigations it was concluded that direct addition of silicate materials in cigarette mixture has no effect on mass and diameter of the investigated cigarettes.

In contrast to that, it was determined that resistance to draw is significantly affected by the type and quantity of silicate material added in the mixture. All four types of silicate materials cause changes of the resistance to draw. The level of change is proportional to the amount of applied silicate material.

Key words: tobacco, cigaretess, test-cigarette, Y zeolite, tobacco mixtures

ЕФЕКТОТ НА ТИПОТ И КОЛИЧИНАТА НА СИЛИКАТЕН МАТЕРИЈАЛ ДИРЕКТНО ДОДАДЕН НА МЕШАВИНАТА ВРЗ ФИЗИЧКИТЕ КАРАКТЕРИСТИКИ НА ЦИГАРИТЕ

Испитуван е ефектот на типот и количината на силикатен материјал директно додаден на мешавината за цигари врз најважните физички својства на цигарите. Четири типови силикатен материјал (зеолит тип Y , ултрастабилен зеолит тип Y, зеолит тип пентасил и аморфен силициум диоксид) се додадени директно на тутунската мешавина во количества 3% и 5% на вкупната маса на тутунската мешавина. Цигарите се направени индустриски на машина за правење на цигари. Зеолитите се синтетизирани на Факултетот за Физичка хемија во Белград, каде се одредени и нивните физички својтва. Физичките карактеристики на цигарите се направени на СОДИМАТ а статистичката анализа е добиена од софтверот на самиот апарат. Од спроведените испитувања може да се заклучи дека директното додавање на силикатни материјали во тутунската мешавина нема ефект врз масата и дијаметарот на испитуваните цигари.

Спротивно на ова, отпорот на повлекување на цигарите се зголемува значително во зависност од типот и од количината на силикатен материјал. Сите четири типа на силикатен материјал предизвикуваат промени врз отпорот на повлекување. Влијанието е пропорционално на количината додаден силикатен материјал.

Клучни зборови: тутун, цигари, тестирање на цигари, Y- зеолит, тутунска мешавина

INTRODUCTION

Tobacco industry in the past 50 years was characterized by rapid growth of the production and consumption of cigarettes (5). For this reason, various technical-technological measures have been made to reduce the amount of harmful matters in cigarette smoke (4, 7). The most recent but insufficiently investigated approach of modification of tobacco smoke is addition of various catalysts directly in tobacco mixture. Although the obtained results indicate the possibility to reduce the harmful elements in tobacco smoke (10), it is necessary to determine the effect of this type of application on the essential physical properties of cigarettes, having in mind that silicate materials, in a form of powder, are directly added to tobacco mixture.

Physical characteristics of cigarettes have a significant effect on smoke quantity (1, 3). In this paper the most important physical characteristics of cigarettes (mass, diameter, resistance to draw) were investigated. Each group of cigarettes has a standard mass and any change in it will result in changes of the raw material required for one cigarette and will affect the uniformity of filling and smoking characteristics. In designing a cigarette all parameters are constant and the increase of cigarette mass will increase the amount of cigarette filling, which will result in higher yields of cigarette smoke.

Also, every cigarette brand has its constant diameter. The increase of diameter results in increased mass burning rate (SBRm) and reduced linear burning rate of cigarettes (SBRl). Thereby the rate of smoke movement is reduced and the yield of tars is increased.

Resistance to draw refers to the difference in static pressure between the two ends of sample cigarette at a fixed airflow rate. The increased resistance to draw leads to reduced flow of gases through the cigarette, which significantly affects the conditions of burning and creation of smoke. Beside this, resistance to draw is a property of cigarette which change is recognized by the smoker (8).

Silicate materials were selected for catalysts because of their availability, suitable prices and the possibility to be added in lower amounts and to be synthesized (2, 6).

Another, and probably more important reason from the aspect of smokers protection is that silicate materials remain in the ash after burning, so that they do not come into direct contact with smokers and have no effect on smoke properties.

MATERIAL AND METHODS

Four types of silicate materials were applied for the aims of this study:

1. Amorphic silicon - carbon dioxide (SiO2)
2. Type-Y zeolite
3. Ultra stable type-Y zeolite
4. Pentasile-type zeolite (ZSM-5)

All silicate materials used were synthesized and their chemical-physical characteristics were determined at the Faculty of physical Chemistry in Belgrade.

Tobacco mixture prepared in Tobacco Factory - Vranje was used as a starting material. The graphical presentation of the process for production of American-type of cigarettes is presented in Fig.1.

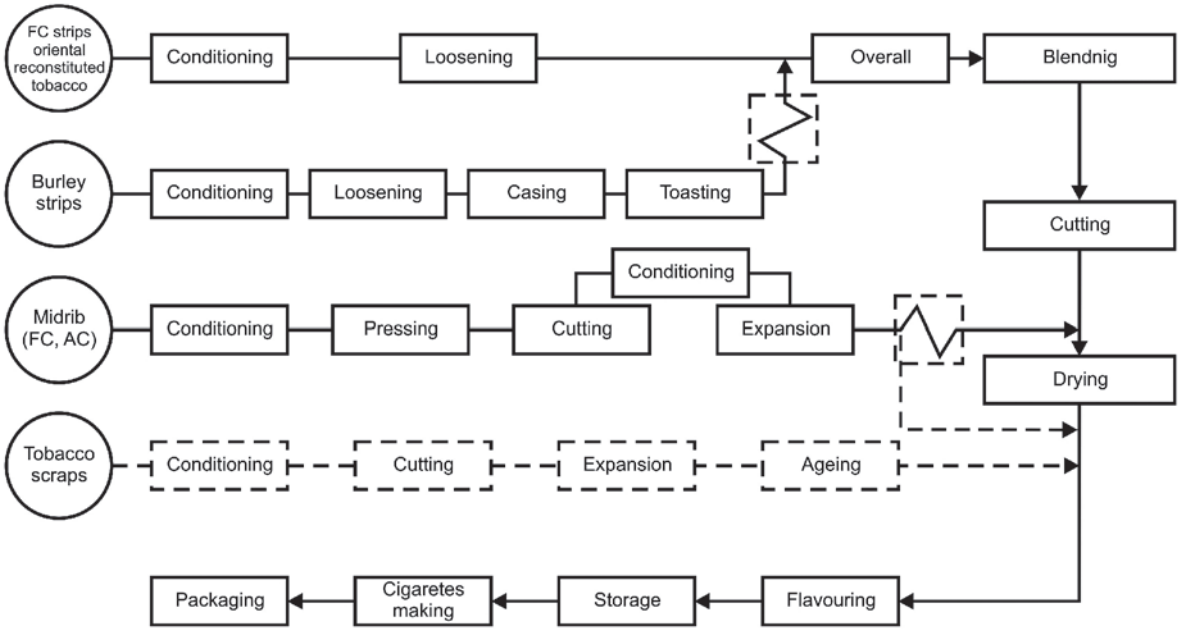

Fig.1 Schematic presentation of the process of cigarette making

After completing the process of cigarette making, 9 X 0.5 kg tobacco mixtures were sampled from the transport track at the mixture machine outlet. In four of the samples silicate materials of 3% concentration were added. The concentration of silicate materials added in all other samples was 5% (Table 1).

Table 1. Tabelar presentation of test-cigarette making

Type of silicate material	Silicate material concentration	Cigarette label
Amorphic silicon dioxide (SiO_2)	3%	S_1
Y-type zeolite	3%	L_1
Ultra stable Y-type zeolite	3%	Z_1
Pentasile-type zeolite (ZSM-5)	3%	C_1
Amorphic silicon dioxide (SiO_2)	5%	S_2
Y-type zeolite	5%	L_2
Ultra stable Y-type zeolite	5%	Z_2
Pentasile-type zeolite (ZSM-5)	5%	C_2

Silicate materials were added manually in a form of powder, with constant mixing. After 3-hours storage at room temperature in plastic bags, American blend cigarettes were made on Molins-9 cigarette making machine. In this way, a total number of nine samples were obtained, i.e. eight samples of test-cigarettes and one check cigarette (Ø).

The check cigarette was made from the same tobacco mixture as other samples, but without addition of silicate material, and its purpose was to compare all other cigarettes with it.

The same raw materials were applied in all cigarettes: filter rod made of 120 mm long acetate fibers type 2.1 Y/42000, nonporous cork and porous filter with 40 ± 2.5 CU ventilation. The filter rod was 20 mm long and the length of the cork-paper was 24mm. The total cigarette length was 84 mm.

Prior to the analysis of physical parameters, the cigarettes were conditioned for 48 hours in a Borgwaldt chamber at a temperature of 22 ± 2 ^{0}C and relative humidity of 60 ± 55, in accordance with ISO 3402 method.

Determination of cigarette mass, resistance to draw, cigarettes diameter, hardness and statistical processing of the results were made on SODIMAT (9). This device makes automatic processing of data and estimates the medium, minimum and maximum values, standard deviation and variation coefficient for the selected group of cigarettes. Resistance to draw was determined in accordance with ISO 6565.

RESULTS AND DISCUSSION

All cigarettes used in the investigation were made of the same material. Only cigarettes which mass was similar to the average (970 mg±0.5) were sampled.

Values of the three most important physical parameters investigated in this experiment (mass, resistance to draw and diameter) are presented in Tables 2 and 3. As was expected, the direct addition of silicate materials to tobacco mixture had no effect on the work of cigarette making machine.

It could be seen from the results that mass and diameter of the investigated cigarettes were ranging in tolerant limits (Table 2).

Table 2. Physical parameters of cigarettes

Test-cigarette	Cigarette mass (mg)	Cigarette diameter (mm)
Ø	970.00	7.839
S_1	971.15	7.830
Z_1	971.05	7.834
L_1	970.35	7.843
C_1	971.10	7.830
S_2	971.85	7.841
Z_2	971.75	7.837
L_2	971.60	7.835
C_2	971.65	7.847

Having in mind that cigarettes were sampled according to their mass, it was expected that their air permeability will change. This effect was determined by measuring the resistance to draw.

Table 3. The values for draw resistance of test-cigarette

Test-cigarette	Ø	S_1	Z_1	L_1	C_1	S_2	Z_2	L_2	C_2
Resistance to draw (mm WG)	93	105	105	106	107	111	109	112	114
Change (%)		12.90	12.90	13.98	15.05	19.35	17.20	20.43	22.58

The values for draw resistance are somewhat higher in all test-cigarettes compared to the check (Table 3). In test-cigarettes where 3% silicate materials were added (S_1, Z_1, L_1, C_1), the increase of resistance to draw ranged from 12.90% to 15.05%. In test-cigarettes where 5% silicate materials were added (S_2, Z_2, L_2, C_2), resistance to draw were increased from 17.20% to 22.58.05%. It can be concluded that the increase of resistance to draw is proportional to the amount of silicate material added. Results obtained during investigation confirmed the hypothesis of the experiment, because the silicate materials were applied in tobacco mixture in a form of powder. The added particles are much smaller than tobacco material. For this reason, the air movement around silicate particles is different from the movement around tobacco material. Smaller particles increase the air resistance to draw, which slows down the airflow through the cigarette. In other words, the reduced airflow through cigarette column increases the pressure and thereby the time of retention of smoke components on silicate materials particles. As a result of this, there is a high number of realized reactions, which can be proved by analysis of chemical content of the smoke. If higher amounts of silicate materials in a form of powder are added, the air combustibility through cigarette increases.

CONCLUSION

Based on investigations it can be concluded that direct addition of silicate materials in cigarette mixture has no effect on mass and diameter of the investigated cigarettes. On the contrary, it was determined that the type and quantity of added silicate materials significantly affect the resistance to draw. The addition of all four types of silicate materials caused changes of the values of resistance to draw. The level of change is proportional to the amount of applied silicate material.

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