VISCOSE CELLOPHANE AS A BASE FOR A SMOKING PRODUCT

by

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I. INTRODUCTION

The English adventurers who colonized America in 1607 came in search of gold. They found tobacco. This tender leaf, now smoked by millions of men and women over the face of the earth, has since yielded greater riches than all the gold mines in Spain. Some comprehension of the vastness of the tobacco industry may be gained by considering the production rate of one factory in Richmond. This average sized plant produces 10,000,000 cigarettes an hour.

The production of a modern cigarette is a complex process, for the smoking ingredient of a cigarette is not pure, untreated tobacco. Pure, dried tobacco has many undesireable properties and qualities that the smoker will not accept. Among these are; the harsh, irritating taste, yellow staining of the fingers, and the habit forming properties.

To eliminate these undesireable properties of tobacco, the manufacturers have developed a processing and blending technique that has, in some measure, eliminated many undesireable qualities of smoking tobacco. They have not, however, been successful in producing a completely satisfactory smoking product.

Considering the great development of the technique of organic synthesis in recent years, that has made possible the synthesis of numerous organic compounds from the basic organic elements, it seems entirely feasible that a smoking product, having all the properties essential to a perfect tobacco and devoid of those undesireable qualities present in natural tobacco, could be developed. This product would be essentially a synthetic tobacco.

It is probable that a project of this size and scope would require years to complete. Recognizing this, the purpose of this thesis is limited to making a preliminary investigation of the properties, organic structure, and processing of tobacco; and perhaps to discover a cellulose base for the synthesis of a smoking product. It is hoped that this investigation may furnish a starting point for future work on a synthetic tobacco.

II. THE REVIEW OF LITERATURE

In reviewing literature no material bearing directly on a tobacco substitute was found. However, valuable information on smoking experiments and the construction of a smoking apparatus was discovered and utilized.

Bradford, Harlan, and Hanmen (1) suggest the criteria of a successful smoking experiment as being:

1. The experiment should be reproducible.
2. The smoking procedure, cigarettes smoked, and the environment while smoking should be definitely characterized.
3. It should sufficiently approximate the conditions of human smoking for conclusions from experiments "in vitro" to admit interpretation "in vivo".

Unfortunately, the authors did not publish any data on actual smoking procedure itself or on the conditions of human smoking that should be approximated. Since these criteria seemed logical and important, a smoking procedure based on them was derived to be used in experimental work and further work that might be done in the future.

From this same article mentioned in the preceding paragraph the general plans for constructing a simple smoking machine were formed. These proved to be quite practicable.

The book The Story of Lucky Strike written by R. C. Flannagan furnished an excellent picture of the cigarette and tobacco industry, including planting, harvesting, selling, processing, and cigarette manufacturing. It supplies an excellent background for work in any phase of the tobacco industry.

One of the greatest problems in making a substitute is to attain the proper burning properties and rate. Likewise, the burning properties and rate of tobacco is undoubtedly one of the greatest problems of tobacco growers and cigarette manufacturers. Of this A. L. Chesley (2) says: "Crystals of potassium nitrate occur naturally in tobacco. As much as two per cent KNO_3 is found along the midrib. Years ago it was the custom to add KNO_3 to improve leaf of poor burning quality. Today it is made unnecessary by the use of proper fertilizers and control of the growth and curing of leaf."

III. EXPERIMENTAL

A. Purpose of Study. The purpose of this study was to investigate the properties of a good smoking mixture and to discover a cellulose base suitable for synthesizing to a smoking product. A successful smoking product would embody all the desireable characteristics and properties of a high grade smoking tobacco mixture, and yet be devoid of such undesireable properties as the nicotine content, the finger-staining effect, the habit-forming property, and the tendency of a tobacco to become stale on exposure to air. A successful smoking product would necessarily have a pleasing odor, somewhat similar to that of tobacco. It should burn continuously, particularly if made up into cigarette form, and at a rate approximating that of the tobacco, or perhaps a little slower, as the smoking public seems to demand at present.

B. Plan of Investigation.

1. To construct a smoking apparatus.
2. To establish a smoking procedure and smoking standards of tobacco so that tests made on smoking products might be interpreted in terms

of actual human smoking consumption.

3. To construct cigarettes of cellulose bases and test these in the smoking apparatus.

C. Materials.

Viscose Cellophane was used as a cellulose base. It was obtained from E. I. du Pont de Nemours and Co., Station B, Buffalo, N. Y.-CB82747.

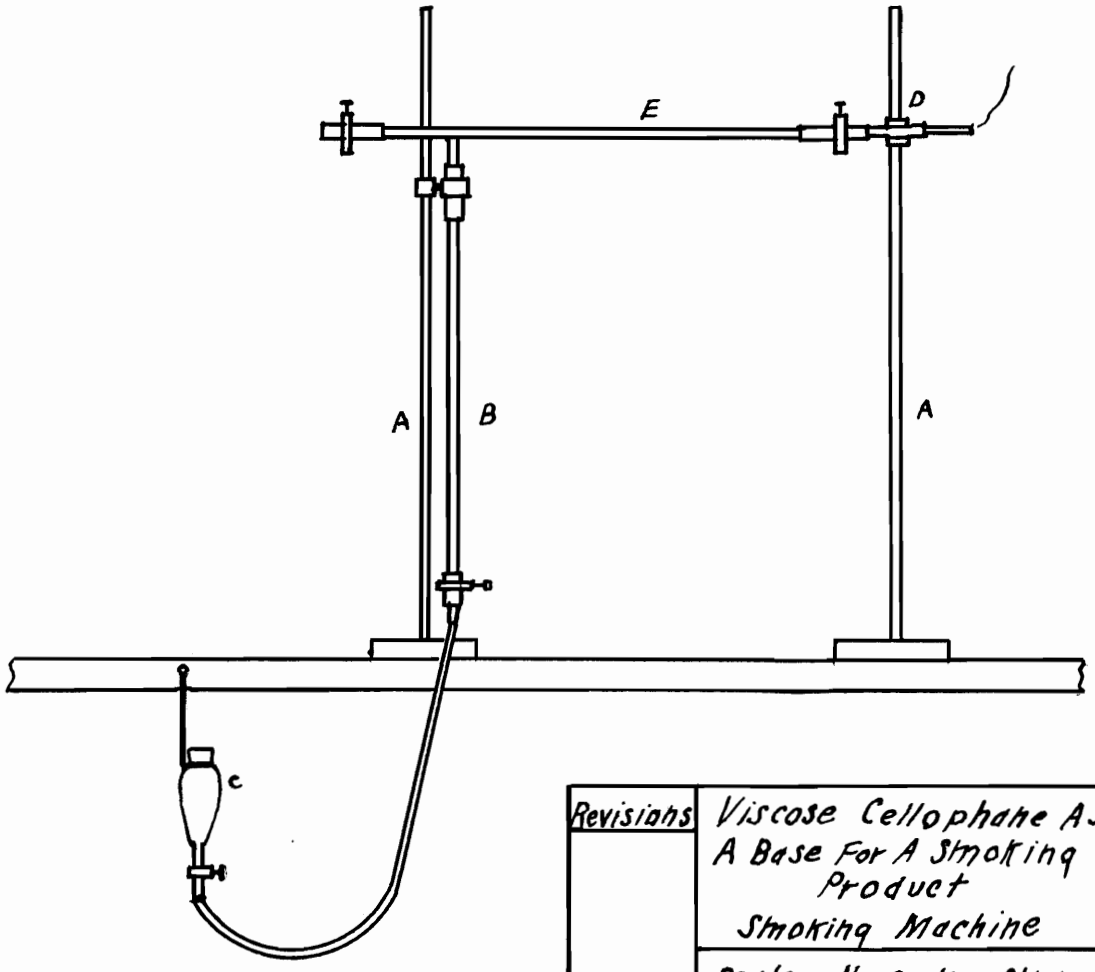
KNO_3 solution - 3% by weight was used to aid burning properties of substitute. KNO_3 was c.p. pure and was obtained from the Chemistry department stockroom

Cured but untreated tobacco leaf was used to test burning properties of untreated tobacco. It was cured by Dr. A. H. Cooper, V. P. I., dept. of Chemical Engineering

Cigarette papers were manufactured by the Brown and Williamson corporation of Louisville, Ky. Size-2.75 inches in length and 1.5 inches wide.

D. Apparatus. The smoking apparatus is shown in the accompanying drawing. It was made up with the following parts:

A - Stand
B - Burrette
C - Separatory Funnel
D - Cigarette Holder
E - Glass Tube



Revisions	Viscose Cellophane As A Base For A Smoking Product Smoking Machine
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1-50 c.c. pinch-clamp burrette.

1-3/8 inch glass T - eight inches by three inches.

1-cigarette holder.

1-3/8 inch rubber tube-48 inches long.

1-125 c.c. separation funnel.

3-3/8 inch rubber tubes - three inches long.

1-pinch clamp.

2-24 inch stands and clamps.

Target Cigarette Roller. This cigarette roller consists principally of a metal half-cylinder over the outside of which is a canvas strip 2.75 inches in width. This cloth strip is long enough to leave about .75 inches of slack when stretched over the cylindrical surface. Underneath the cloth is a metal roller bar that pivots about the center of the half cylinder and follows the surface of the cylinder closely. The machine is operated by pushing the roller bar to a horizontal position and the tobacco placed in the slack part of the cloth strip which forms a sort of trough in front of the bar. The cigarette paper is placed on the surface of the cylinder in front of the tobacco.

The roller bar is then pivoted over to the opposite horizontal position and in doing so rolls the tobacco up in the paper and drops out a completed cigarette upon reaching the opposite position. This machine may be purchased in any tobacco shop.

E. Methods of procedure.

1. To establish some standards by which results of a smoking experiment might be interpreted in terms of actual consumption, two persons, whose consumption of cigarettes seemed average, were observed while smoking a standard brand of cigarettes. The time of consumption and the number of inhales were taken, tabulated and averaged to get a standard time of consumption and number of inhales.

2. Separate tests were made with the cooperation of the same two persons to determine the standard size of puff of smoke. This was done in the following manner: The subject took a puff on a cigarette and then inserted the large end of a 50 c.c. burrette filled with water in his mouth. The stop cock was opened allowing the water to run out the bottom and creating a vacuum in the burrette which drew the smoke from the subject's mouth.

When the smoke ceased to flow from the subject's mouth the stop cock was closed and the volume of water displaced was read from the graduated burrette and taken as the volume of the puff. The cigarettes were smoked down to within, approximately, an inch of the end. Ten readings were taken from each subject, tabulated and averaged.

3. The same standard brand of cigarettes was tested on the smoking apparatus using a puff of 37 c.c. and a complete inhale and exhale cycle once every 50 seconds, timed from the beginning of each inhale. The number of puffs and the time of burning were taken for ten cigarettes and recorded and averaged. These averages were compared with the ones obtained from actual smoking to insure that the smoking apparatus could be operated under conditions similar to human smoking.

4. The smoking apparatus was operated in the following manner: First the separatory funnel was filled with water and the water then allowed to fill the burrette by raising the funnel to a higher level and opening the pinch clamp on the burrette. To accomplish the inhale, the pinch clamp was closed and

the funnel lowered to a level below the bottom of the burrette. The pinch clamp was then opened and the water running into the funnel created a vacuum in the burrette which drew smoke from the cigarette into the burrette. The exhale was accomplished by raising the funnel to a level considerably above the top of the burrette, opening the pinch clamp on the end of the horizontal tube that was closed off during the inhale. This allowed the water to run up into the burrette and drive the smoke out into the atmosphere.

5. The first batch of experimental cigarettes was made from viscose cellophane. The cellophane was cut into strips 3/8 inch long and 1/8 inch wide. These were rolled on a Target roller and tested in the smoking apparatus.

The second batch of cigarettes was made from the same cellophane cut into strips 1/4 inch long and 1/16 inch wide to obtain a higher apparent density. These were tested as before.

The third batch of cigarettes was made by soaking viscose cellophane in a 3%, by weight, solution of KNO_3 for 48 hours. The cellophane was dried in

air and cut into strips 1/4 inch long and 1/16 inch wide. The cigarettes were rolled and tested as before.

F. Data and Results.

Table I shows the time of consumption and number of puffs taken by the two subjects.

TABLE I

No.	Time of Consumption		Number of Puffs	
	Subject A	Subject B	Subject A	Subject B
1	12 min.	9 min.	14	11
2	10 "	10 "	10	10
3	12 "	9 "	11	10
4	12 "	14 "	8	9
5	7 "	12 "	13	8
6	11 "	11 "	7	10
7	9 "	11 "	12	9
8	7 "	10 "	11	12
9	10 "	10 "	9	8
10	12 "	9 "	9	11
Average	11 min.	10 min.	10	9

From Table I it can be seen that the average time of consumption is 10,5 minutes and the number

of puffs per cigarette is 9.5. The time of consumption is the burning rate of cigarettes under smoking conditions.

Table II shows the size of puffs taken by the two subjects.

TABLE II

No.	Size of Puffs	
	Subject A	Subject B
1	34 c.c.	39 c.c.
2	30 "	42 "
3	38 "	34 "
4	39 "	36 "
5	40 "	40 "
6	37 "	37 "
7	35 "	32 "
8	33 "	38 "
9	39 "	33 "
10	40 "	36 "
Average	36 c.c.	37 c.c.

Table III shows the time of consumption and the number of 37 c.c. puffs produced in the smoking apparatus in an attempt to reproduce human smoking.

TABLE III

No.	Time of Consumption	Number of Puffs	Size of Puffs
1	9	11	37 c.c.
2	10	12	"
3	9	11	"
4	9	11	"
5	10	12	"
6	9	10	"
7	10	12	"
8	8	10	"
9	9	11	"
10	10	12	"
Average	9.4	11	37 c.c.

Results of Tests on Experimental Cigarettes.

Batch No. 1. Tests on the first batch of cigarettes, made from strips of viscose cellophane 3/8 inch long and 1/8 inch wide and loosely packed in comparison with standard cigarettes, revealed

that they would burn only while there was a draft on the cigarette. After relighting the cigarette several times a glow similar to that in standard cigarettes was obtained. It would not last more than a few seconds. However, the cellophane did produce a smoke with an odor that was not too strongly pronounced to be disagreeable. This seemed to indicate that viscose cellophane had possibilities as a base for a tobacco substitute if it could be made to burn continuously and at a satisfactory rate.

Batch No. 2. The second batch of cigarettes was made from smaller pieces of viscose cellophane and packed more tightly than the first batch to keep the heat within the cigarette and hold the temperature above the burning point, if possible. These cigarettes had an average apparent density of 0.380 gr./c.c. This is fairly close to the average apparent density of the commercial cigarettes tested. These had an apparent density of 0.351 grams per c.c. These cigarettes burned longer and more evenly than the first batch indicating that

the tighter packing had a beneficial effect on the burning qualities. They did not, however, continue to burn more than a minute. Since it was impracticable to pack the cigarettes any tighter it seemed that the best method of improving the burning qualities of the cellophane was to treat it with some substance such as KNO_3.

Batch No. 3. The third batch of cigarettes was made from viscose cellophane soaked for 48 hours in a three per cent solution of KNO_3 and then dried in atmosphere. These cigarettes had an apparent density of 0.372 grams per c.c. These were found to burn more evenly and longer than the previous batches. They burned about half the distance usually smoked before extinguishing.

IV. DISCUSSION

The first batch of cigarettes, made from loosely packed viscose cellophane, did not burn at all satisfactorily in regard to continuity of combustion. However, the odor of the smoke produced was not too strong or disagreeable to be used in cigarettes. It did not, therefore, seem necessary to discard cellophane as a base for a smoking substitute.

The tighter packing of the second batch of cigarettes improved the burning considerably, and gave a continuous burning of more than a minute's duration. Since the apparent density of these experimental cigarettes in the second batch was already greater than that of standard cigarettes it did not seem advisable to pack them any tighter.

It was discovered in reviewing literature that cigarette manufacturers had formerly used KNO_3 to improve the burning properties of tobacco. (2) The author of the article, however, claimed that improved methods of cultivation had eliminated the necessity of treating tobacco with KNO_3. This statement was substantiated to some degree by making a cigarette of cured but untreated tobacco leaf and testing it. This cigarette burned continuously but with a less

agreeable odor than manufactured cigarettes.

Since KNO_3 had been used to improve the burning qualities of tobacco it seemed feasible to treat viscose cellophane with KNO_3. The KNO_3 improved greatly the burning of the cellophane and the third batch of cigarettes burned about half the length usually consumed in smoking. This indicated that perhaps with longer soaking in KNO_3 the cellophane might burn continuously. The KNO_3 did not, however, improve the odor of the smoke. It seemed to give it a rather stronger odor.

The standards of smoking consumption could, of course, have been more accurate if a greater number of subjects had been observed. In view of the fact that such observations can not be made with extreme accuracy, the averages obtained seem sufficiently accurate for most experimental work that might be undertaken. While the experimental cigarettes made did not burn continuously enough to give results that could be compared with the standards, these observations may be used with tests on any experimental smoking substance that might be developed in the future.

Dividing the average time of cigarette consumption of the persons observed, by the number of puffs taken it was observed that the subjects averaged an inhale every 50 se-

conds. This interval between inhales was used on the smoking apparatus with a standard brand of cigarettes and the average time of consumption obtained was close enough to that observed in human consumption to be practicable.

V. CONCLUSIONS

From the results of this study it was found that:

A. A smoking apparatus should be operated with a 50 second interval between successive inhales.

B. An inhale of approximately 37 c.c. volume should be used in a smoking apparatus.

C. Tight packing and raising the apparent density of cellophane cigarettes to 0.381 improves the burning properties of the cellophane.

D. Treating viscose cellophane with a three per cent solution of KNO_3 further improves the burning properties of the cellophane and makes possible continuous combustion of half the length of a cigarette.

E. Viscose cellophane might be developed into a successful smoking product by further experimentation in treating it with KNO_3.

VI. SUMMARY

Recognizing that natural tobacco has many undesireable features, such as drying, crumbling, and the nicotine content, this study investigated the properties of a good smoking tobacco and attempted to discover a cellulose base suitable for synthesizing to a smoking product. The review of available literature furnished suggestions for the construction of the smoking apparatus used in this study. A smoking apparatus was constructed and was operated under conditions similar to those found in the human consumption of cigarettes. Standards of human consumption were established and it was found that the average time of consumption was 10.5 minutes, that there was an average interval of 50 seconds between successive inhales, and that the average volume of inhale was 37 c.c. Viscose cellophane was used as a smoking product in cigarettes. Its burning properties were improved by packing it in the cigarettes to an apparent density of 0.381. The burning properties were further improved by treating the cellophane with a three per cent solution of KNO_3. This batch of cigarettes burned evenly and about half the length of cigarettes.

usually smoked, indicating that further experimentation in treating viscose cellophane with KNO_3 might produce a smoking product with ideal burning properties.

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