PLUG WRAP PAPERS

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Cigarette paper is the wrapping material surrounding the tobacco to form a cigarette rod. Cigarettes can be made from tobacco, filter cigarette paper and filter papers. Filter papers contain plug wrap papers and tipping papers. The permeability range of the highly porous plug wrap papers is one of their most important properties. In addition, other properties, such as mass (g/m^2), breaking length, opacity and texture should be considered. Most papers are naturally porous, their pores occur during paper sheet formation.
In this study, three different pulps were used to produce plug wrap papers. Permeability and other tests were performed to reach the final objective of obtaining highly porous plug wrap papers for producing cigarette filters. To do this, a correlation is established between the permeability of plug wrap papers and the pulp mixtures. Usually, the type and amount of cellulose affect permeability. In the study, a suitable mixture of sisal and eucalyptus pulps (70% sisal + 30% eucalyptus) for plug wrap papers was employed.

Keywords: cigarette paper, porous plug wrap paper, sisal pulp, eucalyptus pulp, permeability

INTRODUCTION

Today, in both Europe and the U.S.A, several studies are devoted to cigarettes and cigarette papers, aiming at increasing the permeability range and decreasing the nicotine range. In addition, other properties such as tensile strength, calcium carbonate and substance (as polymeric binder) content have been investigated. Therefore, the quality of both tobacco and cigarette papers has been highly improved.[1]

The overall permeability ranges between 250 and 25,000 Coresta units, only few suppliers providing plug wraps with a very high permeability range (from 20,000 to 25,000), since these papers are made on “tea bag” paper machines.

Most papers are naturally porous, their pores being produced during paper sheet formation.[1]

Cigarette paper is the wrapping material surrounding the tobacco to form a cigarette rod. The main component of both cigars and cigarettes is tobacco (90%), from any of the numerous species of the tobacco plant. Nicotine is present in tobacco in variable amounts, as depending on its species and variety.[2] Even if a large part of the nicotine contained in cigarettes is destroyed during burning, the remaining quantity is harmful enough to our organism.[3] The nicotine and tar present in smoke can be controlled by filter papers.

The cigarette paper wrapping the column of tobacco can be made from flax, wood or from a combination of different fibers. It may also contain additives to provide whiteness, to improve ash appearance and burn uniformity.

Cigarettes can be made from tobacco, filter cigarette paper and filter papers. Filter papers contain plug wrap papers and tipping papers. A part of a cigarette is shown[4] in Figure 1. A plug wrap is used as a filtration material (*i.e.*, filter tow and plasticizer), while a tipping paper holds the filter to the cigarette rod.

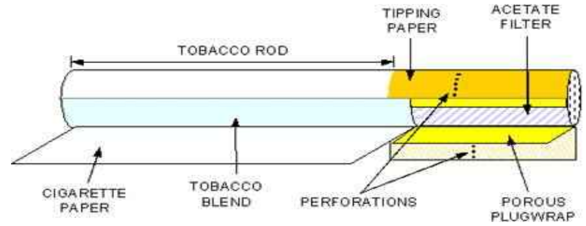

Figure 1: Diagram of a cigarette

The plug wrap paper wraps the outer layer of the cigarette filter plug and holds the filter material in cylindrical form. Highly porous plug wrap papers are used in the production of filter-ventilated cigarettes.

The tipping paper joins the filter element with the tobacco rod. Tipping papers, which are either white or buff in color, should be both printable and glueable at high speeds, for producing distinctive cigarettes. Pre-perforated tipping papers are an important design element of the filter-ventilated cigarettes.

When combined, these components (porous cigarette paper, perforated tipping paper and a dense filter with a porous plug wrap paper) increase the amount of air drawn through the cigarette, thus providing a much lighter taste.

The high-porosity plug wrap paper is used to wrap the cigarette plug, in order to ventilate it together with the perforated cigarette mouthpiece paper, thus reducing the smoke and tar content in the smoke.

It is impossible to establish the amount of tar and nicotine a smoker absorbs from any cigarette. Smokers of lower nicotine cigarettes tend to compensate the lower amount of nicotine by taking deeper and more frequent puffs than from a regular cigarette.[5]

Cigarette filters prevent the inhalation of some harmful substances, thus reducing the amount of nicotine breathed in. Accordingly, the structure and properties of filter papers are especially important.[5]

Apart from properties such as mass (g/m^2), breaking length, opacity and texture, the most important properties of highly porous plug wrap papers refer to their permeability.

In this study, a set of experiments was performed, meant at obtaining highly porous plug wrap paper for cigarette filter.

EXPERIMENTAL

The plug wrap papers used in the study were obtained from three different pulp mixtures. Permeability and other tests were performed to establish a correlation between the permeability of plug wrap papers and that of the pulp mixtures. Also, a close interrelationship has been evidenced between the pulp and paper properties *versus* the permeability ratio. The increase in the long fiber content may induce an increase in paper permeability.

As the objective of the present study was to produce highly porous plug wrap paper, three different pulps (sisal, eucalyptus and hybrid poplar M049) were used for pulping.

The experimental design involved three phases, referring to: (I) properties of the fibers used; (II) plug wrap sheet production; (III) testing of sheets.

Phase I involved the characterization of the pulp fibers. First of all, the dimensions of sisal, eucalyptus and hybrid poplar (M049) fibers were measured with a projection microscope. In the second step, the handsheets were made, dried and rewetted. Their length weighed average fiber lengths (LWAFL) were determined with a Kajaani FS 200 instrument, by the TAPPI method T271 pm-91. Pulp coarseness values were calculated from these data.[6]

Phase II involved the production of sample sheets, on a Rapid Köthen apparatus, from eucalyptus, sisal and poplar pulps. The eucalyptus and sisal pulps were provided by a commercial Pulp and Paper Mill (Mopak-Kastamonu Mill) producing cigarette papers. The pulp of poplar and of all sample sheets was prepared in the laboratories of the Forest Faculty, at Istanbul University, from different mixtures of unbeaten eucalyptus, poplar and sisal pulps, weighing 32-38 g/m^2. The experimental plan of the study is summarized in Table 1.

Phase III involved the testing of the paper samples. The sheets were characterized as to their various parameters, according to the test methods listed in Table 2.

The air permeability of the paper is expressed, in Coresta units, as the amount of air, (cm^3), passing through 1 cm^2 of paper in 1 min, at a constant pressure difference of 1.0 kiloPascal.[4]

Table 1
Experimental plan of the study

Trial no.	1	2	3	4	5	6	7	8	9	10	11
Sisal, %	-	-	100	50	70	50	70	60	60	80	70
Eucalyptus, %	-	100	-	50	30	-	-	30	10	10	30
Poplar, %	100	-	-	-	-	50	30	10	30	10	-
Latex (Acrosol A-40), %	-	-	-	-	-	-	-	-	-	-	5

Table 2
Test methods for handsheet characterization

Parameter	Test Method
Mass, g/m^2	T 410om-88[8]
Breaking length, m	T 404om-87[8]
Stretch, %	T 404om-87[8]
Coresta (Cu), cm/min.cbar	Coresta Inf. Bull. 1975
Opacity, %	T 425om-88[8]
Klemm, 10s, mm	SCANC-12[9]

RESULTS AND DISCUSSION

Table 3 lists the properties of sisal, eucalyptus and poplar fibers, the felting power ratio (L/Dx100) and the elasticity coefficient (l/Dx100). As one may see, the length and felting power ratio of the sisal fiber are much higher than those of the eucalyptus and poplar fibers.

Table 4 shows the results of Kajaani fiber analysis, according to which the fiber length values in trials 7 and 5 are much higher (1.35 mm and 1.26 mm, respectively) than those in the other trials. On the other hand, the coarseness of the fibers from trial 5 is much higher than that of the others. Pulp coarseness, representing fiber mass per unit of length, is an important property of the papermaking fibers, as it influences the response of the fibers to papermaking treatments and most of the product (structural, strength and optical) properties.

Table 5 shows the physical and optical characteristics of the plug wrap paper. As one can see, the permeability ranges (Coresta) of the fifth and eleventh samples are higher than those of the other samples. These two samples represent a mixture of eucalyptus and sisal pulps. The difference between samples 5 and 11 and the other samples lies in the presence of latex, added into the pulp suspension at 5%.

Table 3
Properties of sisal, eucalyptus and poplar fibers

	Length, mm	Diameter, µm	L/Dx100	l/Dx100
Sisal	1.32	2.94	44.98	50.74
Eucalyptus	0.65	2.45	26.53	47.62
Poplar	0.71	4.20	16.90	62.92

Table 4
Results of Kajaani fiber analysis

Trial no.	Average length, mm	Number of fibers	Fiber distribution, %	Coarseness, mg/m
1	0.77	28451	15.56	0.160
2	0.68	11839	12.52	0.310
3	0.67	17614	12.17	0.207
4	0.67	16645	11.77	0.217
5	1.26	4730	11.25	1.998
6	1.14	5229	14.53	1.448
7	1.35	7511	15.76	1.438
8	1.18	19644	13.36	0.420
9	1.24	19464	14.70	0.471
10	1.05	10279	12.89	0.664
11	1.26	11079	11.89	0.842

Table 5
Results of plug wrap paper tests

Trial no.	Mass, g/m^2	Breaking length, m	Stretch, %	Cu (Coresta), cm/min.cbar	Opacity, %	Klemm, 10s, mm
1	32	3985	3	518	92.48	12.0
2	38	836	0.5	1944	67.84	32.6
3	38	1034	0.5	2341	75.56	34.8
4	38	926	0.5	2207	73.03	36.8
5	38	1885	1.5	5445	61.78	39.6
6	37	3000	1.5	2611	83.75	28.9
7	38	2587	1.4	3524	79.75	34.6
8	36	1920	1.1	4024	70.38	34.0
9	38	2702	1.3	2928	79.23	35.6
10	35	1869	1	3371	75.16	38.4
11	38	1655	1	5520	64.14	35.0

The Klemm value is higher for the fifth sample, while opacity is higher in the first, sixth and seventh sample. On the other hand, the breaking length values are higher for the first, sixth, seventh and ninth samples, which contain poplar pulp.

Breaking length and opacity decrease with increasing Coresta value (Figs. 2 and 3), while the Klemm index increases with its increase (Fig. 4). The Coresta value increases with increasing the long/short fiber ratio (Fig. 5).

Figure 2 plots the breaking length as a function of Coresta, for different pulp contents of a plug wrap paper. Breaking length decreases slightly with increasing Coresta. Opacity decreases with increasing Coresta (Fig. 3).

Figure 4 shows the relationship between the the Klemm and Coresta indices. When Coresta increases, Klemm should be also increased.

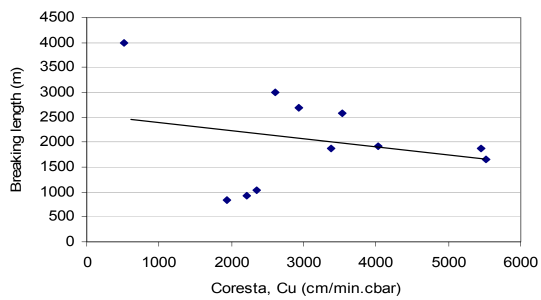

Figure 2: Breaking length and Coresta relationships

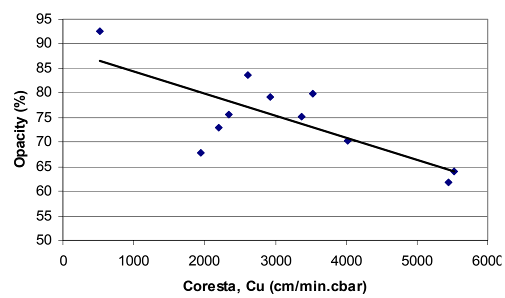

Figure 3: Opacity and Coresta relationships

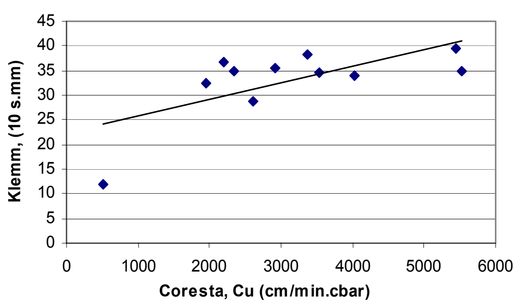

Figure 4: Klemm and Coresta relationships

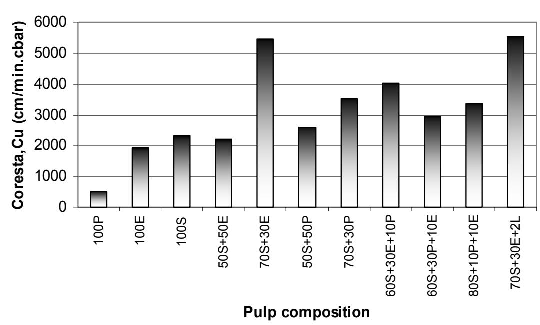

Figure 5: Pulp ratio and Coresta relationships
(E: Eucalyptus, S: Sisal, P: Poplar, L: Latex)

Figure 5 also provides a comparison between pulp composition and Coresta. Increasing the sisal ratio increases the Coresta value of the plug wrap paper.

CONCLUSIONS

The amount of air passing through the filter during smoking can be increased by making paper porous, either mechanically or by laser, or by using paper with high air-permeability. The components of cigarette smoke, such as tar or nicotine, are reduced during smoking. The amount of smoke components is controlled during the design and manufacture of cigarette products.[7]

At the same time, the amount of smoke components may be controlled if highly porous plug wrap papers are used. Long fibers have high bulk and air-permeability. If porous plug wrap papers are manufactured on a Fourdriner paper machine, some aspects should be carefully considered. The mixture of short fibers with pulp at the head-box evidences no flocculation. The air-permeability of paper has been positively affected by varying and increasing the ratio of long fibers, according to that of the short fiber, moisture increases, while the beating degree, press, mass (g/m^2) and amount of filler are negatively influenced. Consequently, only one of the seven vacuum-boxes should be used, or the last but one box should be replaced by the Uhle-box, with a lower split and high vacuum. In this way, paper with higher porosity may be obtained. The study has shown that plug wrap paper made from sisal and eucalyptus pulp has a high Coresta value, which permitted the conclusion that a 70% sisal/30% eucalyptus mixture is ideal (Fig. 5). The air-permeability of the fifth sample was of 5445 Coresta, breaking length – 1885 m, and water absorption within 10 sec (Klemm) was of 39.6 mm. Therefore, the fifth sample appears as suitable for either filter joining paper or plug wrap paper for cigarettes.

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