A Method for Measuring the Elution of Nicotine and Total Particulate Matter from a Cigarette Filter*

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INTRODUCTION

It has been shown that, during smoking, compounds with boiling points as high as 317° C are not held irreversibly by the cigarette filter. Previous work in our laboratory indicated that phenol, nicotine, isobutyric acid, 3-pentanone, ethanol, dodecane, tridecane, tetradecane, pentadecane, hexadecane, and octadecane added to a cellulose acetate filter vaporized from the fibers during smoking of the cigarette. These compounds escaped from the filter by entrapment in nonfiltered aerosol particles (2). The method used to investigate this phenomenon was to add a C¹⁴-labeled compound to a filter, smoke the cigarettes, and measure the amount of C¹⁴-labeled compounds that escaped from the filter (3). This method does not accurately simulate filtration conditions since the C¹⁴-labeled compounds were not filtered from cigarette smoke but were added to the filter before the cigarette was smoked. The purposes of this work were to develop a technique that more closely simulates conditions that occur during filtration of cigarette smoke than the previous procedure did (3) and to utilize this new technique to measure: 1. the amounts of nicotine and total particulate matter (TPM) that are captured by a filter for at least the duration of a puff, 2. the amounts of captured nicotine and TPM that are eluted from a filter by subsequent puffs of smoke, and 3. the amounts of nicotine and TPM that are trapped on the tobacco behind the burning zone. The technique developed in this work utilized filter cigarettes constructed from tobacco treated with C¹⁴-labeled nicotine or C¹⁴ randomly labeled tobacco. The smoking of these cigarettes introduced a small amount of the C¹⁴-labeled nicotine or C¹⁴-labeled TPM into the smoke stream immediately behind the burning zone; subsequently, some of the labeled components in the smoke were filtered by the cellulose acetate filter. A second filter cigarette was constructed from this filter (containing the C¹⁴-labeled TPM or nicotine) and a regular tobacco column. This filter cigarette was smoked and the quantity of

previously filtered C¹⁴-labeled nicotine or C¹⁴-labeled TPM which escaped from the filter was measured.

The escape of filtered "semi-volatile" (SV) compounds from a cigarette filter is not a simple vaporization phenomenon (4). When cigarette smoke passes through a filter, the escape of previously trapped SV compounds from the filter is appreciable. When air is passed through a filter containing SV compounds, there is only a slight loss of SV compounds from the filter. Thus, the passage of smoke aerosol particles through a filter is necessary before an appreciable amount of filtered SV smoke compounds can escape from a filter. Some of the processes which probably occur within a filter as cigarette smoke passes through it are presented schematically in Fig. 1 (not drawn to scale). An SV compound which has been filtered can vaporize to some extent from the fiber (A) or from an aerosol particle (B) and condense either on another fiber (C) or on another aerosol particle (D). The SV compound that condenses on an aerosol particle vaporizes from the particle (E), is removed by filtration as part of a filtered particle (F), or escapes filtration as part of a nonfiltered particle (G). These processes may occur a number of times before the SV compound escapes from the filter. This overall process of a filtered SV compound escaping from a fiber by entrapment in nonfiltered aerosol particles as they pass through the filter has been designated "elution".

Figure 1. Schematic diagram of the elution phenomenon.

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EXPERIMENTAL

Materials and Methods

All the experimental cigarettes were constructed with a Laredo cigarette maker using medium porosity cigarette paper (Ecusta 556). The C^{14} -labeled nicotine was purchased from Mallinkrodt/Nuclear and Tracerlab. The C^{14} randomly labeled, uncut tobacco was obtained from American Tobacco Company. Four different tobacco samples were used in the construction of the different experimental cigarettes. Sample 1 was tobacco from a popular domestic cigarette. Sample 2 consisted of tobacco sprayed with an aqueous solution (20 ml) of C^{14} -labeled nicotine (4.0 mg), regular nicotine (5.8 mg), and malic acid (11.0 mg). This solution had a specific activity of 0.01133 mC/mg nicotine. Sample 3 consisted of tobacco sprayed with an aqueous solution (20 ml) of C^{14} -labeled nicotine (1.6 mg), regular nicotine (100.9 mg), and malic acid (84.4 mg). This solution had a specific activity of 0.00261 mC/mg nicotine. Sample 4 consisted of C^{14} randomly labeled tobacco (982 mg) blended with tobacco (9003 mg) from a popular domestic cigarette. These tobacco samples were conditioned for five days at $75 \pm 5^\circ$ F and $60 \pm 5\%$ RH before being processed into experimental cigarettes. (An example of an experimental cigarette is cigarette X in Fig. 2.) Each filter cigarette consisted of a 20-mm cellulose acetate filter and a 65-mm tobacco column. The tobacco column consisted of two types of tobacco — treated tobacco and regular tobacco. The tobacco column section which was composed of treated tobacco varied in length depending upon the number of puffs to be taken on the cigarette. Type 1 cigarettes were constructed from treated tobacco (Sample 2), regular tobacco (Sample 1), and a filter constructed from 5.0 den./fil, 40,000-total-denier cellulose acetate tow bonded with 13% triacetin. The filter's pressure drop was 4.4 cm. Type 2 cigarettes were constructed from treated tobacco (Sample 3), regular tobacco (Sample 1), and a filter constructed from 1.6 den./fil, 48,000-total-denier cellulose acetate tow bonded with 10% triacetin. The filter's pressure drop was 7.7 cm. Type 3 cigarettes were constructed from treated tobacco (Sample 4), regular tobacco (Sample 1), and a filter constructed from 1.6 den./fil, 48,000-total-denier cellulose acetate tow bonded with 10% triacetin. The filter's pressure drop was 8.8 cm. The experimental smoking procedure was to smoke the cigarettes in a vertical position at

Figure 3. Apparatus used to smoke cigarettes that contain C^{14} .

the rate of one 35-ml puff of 2-sec. duration each min. by a syringe-type automatic smoking machine in a laboratory maintained at $75 \pm 5^\circ$ F and $60 \pm 10\%$ RH. Since the cigarettes contained radioactive materials, precautions were taken to insure that all radioactive products were trapped and disposed of safely. The apparatus used to trap the mainstream and sidestream smoke is shown in Fig. 3. The conical chimney is 30 cm in diameter at its base and is 40 cm in height. Air was drawn upward and around the burning cigarette to carry the sidestream smoke through a glass-fiber filter, then through a trap containing 250 g of Ascarite and 250 g of Drierite, and finally through a Mine Safety Appliance (MSA) type-N gas-mask canister that absorbs CO and organic gases. The smoking machine was vented through the same gas traps.

Determination of Radioactivity of C^{14} -Labeled Nicotine in TPM

Type-3 cigarettes were smoked, and the TPM from each cigarette was collected on a separate Cambridge filter. The TPM was extracted from the Cambridge filters and from the cellulose acetate filters with methanol. Before steam distillation of each methanol extract (20 ml), 6 mg of nicotine and a slight excess of 30% NaOH solution saturated with NaCl were added. The distillation rate was 10 ml/min. The distillate was collected in a 100-ml volumetric flask that contained 5 ml of 5% HCl. After 100 ml of distillate had

Figure 2. Smoking procedure for elution experiments.

Table 1. Determination of radioactivity of C^{14} -labeled nicotine in TPM.

Source	Disintegrations per minute*	
	Cambridge filter	Cellulose acetate filter
Extract (E)	1,168,120	307,400
Distillate (D)	1,110,880	301,040
Supernate (S)	42,400	21,200
C^{14} -Nicotine (D-S)	1,068,480	279,840

*Avg. for three runs.

been collected, 1 ml of 12% silicotungstic acid was added to the distillate to precipitate the nicotine. The resulting solution was heated on a steam bath for 15 min., cooled slowly to room temperature, and stored at 5° C for 12 hr. Aliquots of each methanol extract, each distillate, and each supernate solution were analyzed for radioactivity. The results are shown in Table 1.

Smoking Procedure for Elution Experiments

The smoking procedure for the elution experiments was conducted according to the scheme in Fig. 2. When cigarette X was smoked, the experimental cigarette was such that only C¹⁴-labeled tobacco was consumed; consequently, cigarette filter X contained C¹⁴-labeled material filtered from cigarette smoke. The C¹⁴-labeled material delivered by the experimental cigarette was contained on Cambridge filter X. Cigarette Y consisted of regular tobacco (Sample 1) and a filter identical with cigarette filter X. The same number of puffs were taken on both cigarettes X and Y with the matching puff of cigarette Y lagging approximately 30 sec. behind that of cigarette X. After the specified number of puffs (p) were taken on cigarette X, it was removed from the smoking machine, and a clearing puff of air was taken through Cambridge filter X. The cigarette filter and the tobacco column of cigarette X were separated. The tobacco column was discarded, and cigarette filter X was retained and used in the construction of cigarette Z. After the specified number of puffs (p) were taken on cigarette Y, it was removed from the smoking machine without extinguishing the burning cone, and the filter was detached and discarded. (This procedure was followed to obtain a nonlabeled tobacco column as much like that of cigarette X as possible.) During the 58-sec. rest period between puffs, cigarette Z was constructed from the lighted tobacco column Y and cigarette filter X. Cigarette Z was placed in the smoking machine in preparation for the elution puff. The elution puff was a single puff taken on cigarette Z which simulates puff (p+1) of cigarette X. After the elution puff was taken, cigarette Z was removed from the smoking machine, and a clearing puff of air was taken through Cambridge filter Z. The C¹⁴-labeled material which eluted from cigarette filter X during the elution puff was contained on Cambridge filter Z. Cigarette filter X of cigarette Z contained the C¹⁴-labeled material retained during the smoking of cigarette X minus the C¹⁴-labeled material that was eluted by the elution puff of cigarette Z. Since there was a limited supply of C¹⁴-labeled tobacco available, the tobacco column of type-3 cigarette was used to determine the concentration of C¹⁴-labeled TPM along the tobacco column behind the burning zone. After the specified number of puffs were taken on the cigarette, the burning zone was extinguished without damage to the tobacco column. The cigarette was removed from the smoking machine, and the tobacco column and filter were separated. The portion of the type-3 cigarette tobacco column that consisted of tobacco from a popular domestic cigarette was

partitioned into 5-mm sections, and each section was analyzed. In the experiment to determine the concentration of C¹⁴-labeled nicotine along the tobacco column behind the burning zone, a type-2 cigarette was smoked. Three puffs, which consumed all the tobacco treated with C¹⁴-labeled nicotine malate plus 5 mm of tobacco from a popular domestic cigarette, were taken on the cigarette. The burning zone was extinguished, and the tobacco column was removed from the filter and partitioned into 5-mm sections. Each tobacco section, Cambridge filter, and cigarette filter was analyzed. Each smoking operation was performed either three or five times.

Analysis of Radioactive Material

Acetone was used to dissolve the cigarette filters containing C¹⁴-labeled nicotine and TPM. Methanol was used to extract the C¹⁴-labeled nicotine and TPM from the Cambridge filters and tobacco sections. Each solution was analyzed with a Packard 3002 Tri-Carb liquid scintillation spectrometer. The scintillating solution was prepared by dissolving 5.5 g of Perma-blend I (purchased from Packard) per liter of toluene. When aqueous solutions were analyzed, 2 ml of Scintisol-GP (purchased from Isolab) was added to the scintillating solution (15 ml). Each solution, except the methanol extract of Cambridge filter Z, was counted until approximately 20,000 counts had been recorded.

DISCUSSION OF RESULTS

Experimental Cigarettes and Methods

A statistical analysis of the data in Table 2 showed no significant difference in puff number per cigarette and dry TPM delivered per cigarette between experimental cigarettes constructed with the Laredo cigarette maker and commercially constructed cigarettes. The commercial and experimental cigarettes consisted of the same tobacco blend, same amount of tobacco, and same type filters. The data in Table 3 show that experimental cigarettes smoked by experimental smoking procedure delivered less nicotine and TPM than those smoked by the standard smoking procedure

Table 2. Comparison of experimental and commercial cigarettes.

Cigarette	Puffs, no./cigarette	Dry TPM delivered, mg/cigarette
Commercial	10.3	24.5
	9.8	23.8
	10.0	26.2
	9.9	25.5
	avg. 10.0	avg. 25.0
Experimental	10.5	25.2
	9.9	24.0
	10.1	23.1
	10.3	24.3
	avg. 10.2	avg. 24.2

Table 3. Comparison of experimental smoking procedure (vertical position) with standard smoking procedure.

Smoking procedure	Nicotine delivered, mg/cigarette	TPM delivered, mg/cigarette
Standard	1.54	25.2
	1.46	24.0
	1.40	23.1
	1.48	24.3
	avg. 1.47	avg. 24.2
Experimental	1.38	22.8
	1.37	22.6
	1.29	21.3
	1.26	20.8
	avg. 1.32	avg. 21.9

(CORESTA specifications). This may be due to the cigarette being smoked in a vertical position with air passing around it. The 10% reduction in TPM delivery by cigarettes smoked by the experimental smoking procedure does not significantly affect the elution results, since it has been shown that a 50% change in smoke concentration does not seriously affect the elution of high-boiling smoke compounds and has only a slight effect on the highly volatile compounds (5). Nicotine is steam distillable under slightly basic conditions and reacts quantitatively with silicotungstic acid

to form nicotine silicotungstate (1). This property was used to determine the percentage of radioactivity due to C^{14} -labeled nicotine on a Cambridge filter and a cellulose acetate filter (Table 1). The disintegrations in the distillate (D) minus the disintegrations in the supernate (S) represent the disintegrations contributed by C^{14} -labeled nicotine (D-S). The disintegrations contributed by C^{14} -labeled nicotine (D-S) times 100 divided by the disintegrations in the extract (E) represents the percentage of disintegrations contributed by C^{14} -labeled nicotine on the Cambridge filter (91%) and the cellulose acetate filter (91%). The presence of C^{14} -labeled fragments obtained by pyrolysis of nicotine is minor and does not affect the conclusions since all the conclusions are based on percentage values.

Elution of Smoke Components from Filters

The data in Tables 4, 5, and 6 show the number of puffs (p) and amounts of C^{14} -labeled material available for filtration (A_p), delivered (D_p), retained (R_p), eluted (E_p), filtered ($R_p + E_{p+1}$), and the total elution (ΣE_{p+1}) after a specific number of puffs. The amount of material captured ($R_p + \Sigma E_{p+1}$) and retained by the filter for at least the duration of a puff is also shown. The percentage of C^{14} -labeled material [captured by the filter during a specific number of puffs (p)] eluted from the filter by puff (p+1) is $E_p \times 100 / (R_p + \Sigma E_{p+1})$.

Table 4. Elution of C^{14} -labeled nicotine from a 5 den./fil cellulose acetate filter.

Number of puffs (p)	C^{14} -labeled nicotine, μG^*						
	Available (A_p)	Delivered (D_p)	Retained (R_p)	Eluted (E_p)	Filtered ($R_p + E_{p+1}$)	Total elution (ΣE_{p+1})	Captured ($R_p + \Sigma E_{p+1}$)
2	9.7	7.1	2.5	—	2.6	—	2.6
3	15.0	11.2	3.6	0.1	3.8	0.1	3.9
4	14.0	10.8	3.0	0.2	3.2	0.3	3.5
5	28.8	21.8	6.6	0.2	7.0	0.5	7.5
6	35.3	26.4	8.3	0.4	8.9	0.9	9.8
7	39.9	29.5	9.6	0.6	10.4	1.5	11.9
8	52.3	38.8	12.3	0.8	13.5	2.3	15.8
9	—	—	—	1.2	—	3.5	—

* Avg. of five runs (experimental type-1 cigarettes were used).

Table 5. Elution of C^{14} -labeled nicotine from a 1.6 den./fil cellulose acetate filter.

Number of puffs (p)	C^{14} -labeled nicotine, μG^*						
	Available (A_p)	Delivered (D_p)	Retained (R_p)	Eluted (E_p)	Filtered ($R_p + E_{p+1}$)	Total elution (ΣE_{p+1})	Captured ($R_p + \Sigma E_{p+1}$)
2	76.6	45.2	27.2	—	31.4	—	31.4
3	128.7	76.3	47.0	4.2	52.4	4.2	56.6
4	172.4	102.0	63.3	5.4	70.4	9.6	80.0
5	221.1	133.4	79.9	7.1	87.7	16.7	104.4
6	259.0	155.6	95.4	7.8	103.4	24.5	127.9
7	341.4	202.1	131.9	8.0	139.3	32.5	171.8
8	399.2	227.3	164.8	7.4	171.9	39.9	221.8
9	—	—	—	7.1	—	47.0	—

* Avg. of five runs (experimental type-2 cigarettes were used).

Figure 4. Performance of a 5 den./fil cellulose acetate filter.

Elution of Nicotine

The data in Table 4 show that 9.7 μg of C^{14} -labeled nicotine was available for filtration during the first and second puffs, 7.1 μg (col. 3) was delivered during the first and second puffs, and 2.6 μg (col. 8) was captured by the filter during the first and second puffs. The third puff caused the elution of 0.1 μg (col. 5) of the C^{14} -labeled nicotine that had been captured by the filter during the first and second puffs. The percentage of C^{14} -labeled nicotine captured by the filter during the first and second puffs and eluted from the filter by the third puff was $0.1 \times 100 / 3.9$ or 3%.

The curves in Figures 4 and 5 were constructed from the data in Tables 4 and 5. The curves represent percentage values which relate the material captured, filtered, and eluted to the available material. The amount of available C^{14} -labeled nicotine from eight puffs and C^{14} -labeled TPM from seven puffs was arbitrarily designated 100%. The curve labeled "available" shows the fraction of nicotine available for filtration for each puff. The curve labeled "delivered" represents the fraction of available nicotine not removed by the filter for each puff. The curve labeled "captured" represents the fraction of available nicotine that came in contact with the filter and was captured for at least the duration of a puff. The curve labeled "filtered" represents the fraction of available nicotine that was on the filter after the specified puff. The curve labeled "elution" represents the cumulative fraction of available nicotine that was captured by and then eluted from the filter by subsequent puffs. Since the available nicotine at the eighth puff was designated 100%, the value (26%) in Fig. 4 for filtered nicotine at the eighth puff represents the actual efficiency of this filter (5 den./fil, 40,000 total denier) for removing

Figure 5. Performance of a 1.6 den./fil cellulose acetate filter.

nicotine. The value (30%) for captured nicotine at the eighth puff represents the efficiency that would have been obtained if all the nicotine that had contacted the filter had remained on the filter. The value (4%) for the elution of nicotine at the eighth puff represents the fraction of captured nicotine that was eluted from the filter by subsequent puffs. After eight puffs, 15% of the nicotine captured by the filter was eluted from it. The data in Fig. 5 show that the value (43%) for filtered nicotine at the eighth puff represents the actual efficiency of this filter (1.6 den./fil, 48,000 total denier) for removing nicotine. The value (53%) for captured nicotine at the eighth puff represents the efficiency that would have been obtained if all the nicotine that had contacted the filter had remained on the filter. The value (10%) for elution of nicotine after eight puffs represents the fraction of captured nicotine that was eluted from the filter by subsequent puffs. After eight puffs, 19% of the nicotine that was in contact with the filter was eluted from it. Therefore, a 1.6 den./fil, 48,000-total-denier filter retains less of the nicotine in contact with it than a 5 den./fil, 40,000-total-denier filter does, indicating that the size of the filament affects the elution of nicotine. This increase in elution from the finer denier-per-filament filter is probably due to the higher specific surface area of the finer fibers. The percentage of nicotine in contact with both filters, but not removed by them, is significant. It has been reported that the percentage of nicotine that elutes from a filter can be altered by treating the fibers (3).

Elution of TPM

The data in Fig. 6 show that the value (53%) for filtered TPM at the seventh puff represents the actual

Table 6. Elution of C¹⁴-labeled TPM from a 1.6 den./fil cellulose acetate filter.

Number of puffs (p)	Available (A _p)	Delivered (D _p)	Retained (R _p)	C ¹⁴ -labeled TPM, μG*			Total elution (Σ E _p + 1)	Captured (R _p + Σ E _p + 1)
				Eluted (E _p)	Filtered (R _p + E _p + 1)			
2	271	130	139	—	141	—	—	141
3	336	162	172	2	174	2	2	176
4	430	203	224	2	227	4	4	231
5	572	266	302	3	306	7	7	313
6	711	339	368	4	378	11	11	383
7	883	413	465	4	470	15	15	484
8	—	—	—	5	—	20	20	—

* Avg. of five runs (experimental type-3 cigarettes were used).

efficiency of this filter (1.6 den./fil, 48,000 total denier) for removing TPM. The value (55%) for captured TPM at the seventh puff represents the efficiency that would have been obtained if all the TPM that had contacted the filter had remained on it. The value (2%) for elution of TPM after seven puffs represents the fraction of captured TPM that was eluted from the filter by subsequent puffs. After seven puffs, 4% of the TPM that was in contact with the filter was eluted from it. Thus, the elution phenomenon is a minor factor in the filtration mechanism for TPM but is an important factor in the filtration of certain individual smoke components such as nicotine (2).

Concentration of Nicotine and TPM Behind the Burning Zone

The graph in Fig. 7 shows that the efficiency of the tobacco column for removing nicotine decreases rapidly

Figure 6. Performance of a 1.6 den./fil cellulose acetate filter.

* Average of three runs (experimental type-3 cigarettes).

in the first 20 mm behind the burning zone and remains constant for the remaining column. The graph in Fig. 8 shows that the efficiency of the tobacco column for removing TPM varies with the distance from the burning zone in the same manner as does the efficiency of the tobacco column for removing nicotine. Due to the nature of the experiment, the tobacco section 5 to 10 mm behind the burning zone may be contaminated with C¹⁴-labeled tobacco; therefore, the 22% value in Fig. 8 may be high. *Mumpower* and *Touey* (6) reported that the burning zone temperature of a filter cigarette is 850° to 900° C and that the temperature

Figure 7. Efficiency of tobacco column segments for removing nicotine.

Figure 8. Efficiency of tobacco column segments for removing TPM.

of the smoke only 8 and 22 mm from the burning zone is 80° and 67° C, respectively. This rapid reduction of smoke temperature is conducive to condensation and probably explains the increased filtration of nicotine and TPM by the 20-mm tobacco section behind the burning zone. This increased filtration causes a buildup of nicotine and TPM on the tobacco column adjacent to the burning zone and accounts for part of the increased delivery of nicotine and TPM while the last portion of the cigarette is smoked. There is a decrease in smoke temperature from 70° to 25° C as it travels through the tobacco column (20 to 40 mm from the burning zone), yet the filtration of available nicotine and TPM by this portion of the tobacco column remained constant (3%). This indicates that a 35° C reduction in smoke temperature does not affect the filtration of nicotine and TPM.

SUMMARY

A method was developed to measure the amount of an SV smoke component captured by a filter for at least the duration of a puff and eluted from the filter by subsequent puffs of cigarette smoke. It was concluded that the size of the filament affects the elution of nicotine by a cellulose acetate filter and that the elution phenomenon is an important factor in the filtration mechanism of nicotine and a minor factor in the filtration mechanism of TPM. Due to condensation, there is a buildup of nicotine and TPM within 5 mm of the burning zone. This accounts for some of the increased delivery of nicotine and TPM observed when the last portion of the cigarette is smoked.

ZUSAMMENFASSUNG

Es wurde eine Methode entwickelt, die geeignet ist, die Menge eines flüchtigen (semi-volatile) Rauchinhaltsstoffes zu messen, die in einem Filter während der Dauer mindestens eines Rauchzuges aufgefangen und aus dem Filter durch die nachfolgenden Züge „eluiert“ wird. Die Untersuchungen führen zu der Schlußfolgerung, daß die Faserstärke die Nikotinelution in einem Celluloseacetat-

filter beeinflusst und daß das Elutionsphänomen bei der Filtration des Nikotins eine große Rolle spielt, während es bei der Filtration des Gesamtkondensates von geringerer Bedeutung ist. Durch Kondensation reichern sich in dem Bereich der ersten 5 mm hinter der Glutzone Nikotin und Gesamtkondensat an, wodurch sich zum Teil die erhöhte Ausbeute an diesen Stoffen erklären läßt, die beim Verrauchen des letzten Teiles der Zigarette zu beobachten ist.

RESUME

On a développé une méthode pour mesurer la quantité d'un composant SV de fumée fixée sur le filtre pendant au moins la durée d'une bouffée, et éluée du filtre par les bouffées suivantes de fumée. On a conclu que la dimension du filament affecte l'éluion de la nicotine par un filtre en acétate de cellulose et que le phénomène d'éluion est un facteur important dans le mécanisme de filtration de la nicotine, et un facteur mineur dans le mécanisme de filtration de MPT. Par la condensation, il y a une concentration de nicotine et de MPT dans un rayon de 5 mm autour de la zone de combustion. Ceci explique en partie l'augmentation de concentration de nicotine et MPT observée quand on fume la dernière partie de cigarette.

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