INNER HOLLOW TUBE DIAMETER INFLUENCE ON CIGARETTE SMOKE

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Abstract

There has been a number of significant changes in tobacco industry over the last few years driven by various new legislations. Over the next decade regulations on packaging will almost undoubtedly evolve to outright plain packaging in mature markets and then move on to emerging ones. This will and already is driving innovation in filter industry to offer consumers more choice, unique taste experiences and visual differentiation lost through plain packaging, let alone special filters playing a key part in creation of combustable tobacco products with more favourable smoke constituent profile. Hollow filter has recently been growing in popularity on a large scale and we therefore would like to focus on this product.

In this study we analysed influence of hollow tube inner diameter on cigarette smoke parameters. We made four different hollow filter cigarettes with inner tube diameter of 2,0mm, 3,0mm, 4,0mm, 5,0mm and then compared tar, nicotine, level of triacetin and temperature of smoke in the middle of 7,5mm hollow tube. Cigarettes with different test filters were made in a standardised way and all confounding factors removed.

Cigarettes with the above described filters were made with 50% ventilation and without any. The smoke was collected on Cambridge filter pads using the ISO with some machine adjustments in order to measure smoke temperature. Analyses of smoke composites were made using Agilent 5973N GC-MS.

Experimental

Triple hollow filters with 2mm, 3mm, 4mm and 5mm hollow tube were produced as per Table 1. All parameters were constant except hollow tube diameter.

Table 1. Parameters of filters.

	Parameter	Mouth side	Middle side	Tobacco side
Filter H2	Acetate	5,0Y35000	2,1Y32000	1,9Y55000
	Hollow diameter	2	-	-
	PD, mmWG/segment	-	42	58
	Triacetin, %	15	7	7
Filter H3	Acetate	5,0Y35000	2,1Y32000	1,9Y55000
	Hollow diameter	3	-	-
	PD, mmWG/segment	-	42	58
	Triacetin, %	15	7	7
Filter H4	Acetate	5,0Y35000	2,1Y32000	1,9Y55000
	Hollow diameter	4	-	-
	PD, mmWG/segment	-	42	58
	Triacetin,%	15	7	7
Filter H5	Acetate	5,0Y35000	2,1Y32000	1,9Y55000
	Hollow diameter	5	-	-
	PD, mmWG/segment	-	42	58
	Triacetin,%	15	7	7

The cigarettes were weighted and conditioned, then smoked under ISO smoking regime (volume 35ml, puff time 2s, pause 60s) on Cambridge filter pads for TPM collection. 20 cigarettes were smoked for each type of filter on each pad for 5 times. Temperature was measured at 3,25mm from the mouth side with micro thermophore inside.

Results

All filter samples were produced with same specification base rods keeping tight deviation of pressure drop. Hollow tube effect on pressure drop is shown on **Pic.2.**

Our results showed that inner tube diameter and ventilation affects cigarettes smoke temperature **Pic.2.** The smoke temperature is related to the size of hole. Filter H5 reduces smoke temperature by 50% compered to H2 in non ventilated cigarettes. With ventilation there is no significant difference of temperature between cigarette samples.

Delivery of TPM and triacetin in H2 sample was significant different than expected. The TPM and triacetin delivery was higher than in other samples by 25% for TPM and 30% for triacetin. We believe mainstream warm smoke goes easily through the walls and takes triacetin with it because H2 filter has thick and low density walls with low pressure drop. The higher smoke temperature may fasten triacetin desorption from acetate tow **Pic. 3** and **Pic 4.** This abnormality disappears when ventilation is applied and cool air flows through the wall. This unexpected effect appears only with H2 diameter hollow tube. The wall/ hollow ratio here is 0,07 and that means H2 filter behaves more like monoacetate filter rather than hollow. In addition, tar residues were visible on wall surface after smoking H2 sample.

The pressure drop of hollow walls is shown in **Table 2**.

The hole diameter did not show any effect on nicotine delivery: it was 0,1mg in cigarettes with ventilation and 0,5mg without.

Pic. 1 Pressure drop increase depending on hollow tube size.

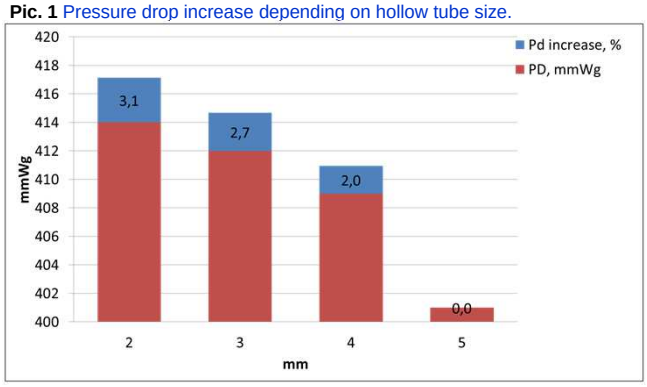
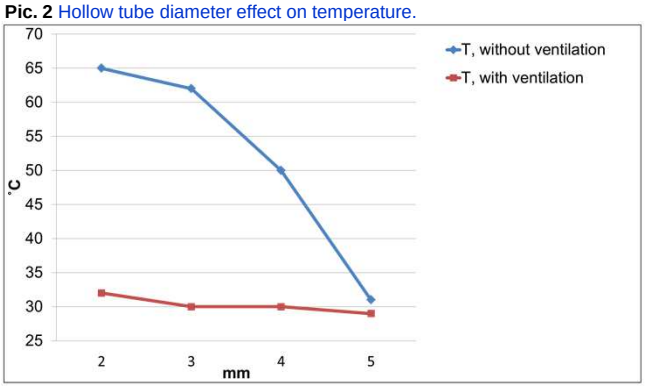


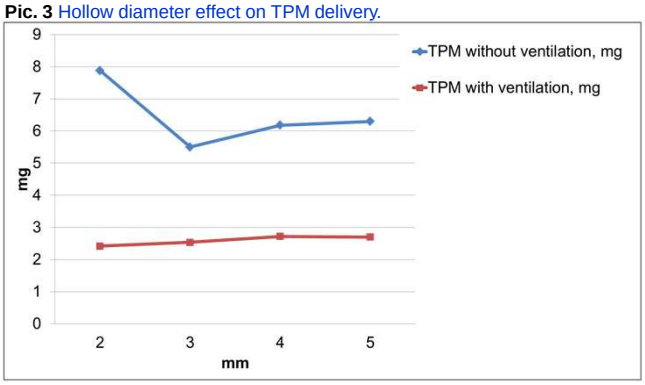
Table 2 Parameters of hollow tubes.

Hollow, mm	2	3	4	5
Pressure drop, mmWg/7,5mm	54	70	77	149
Hole area, mm²	3,14	7,07	12,57	19,64
Wall area, mm²	43,18	39,26	33,76	26,69
Hollow/ wall ratio	0,07	0,18	0,37	0,74

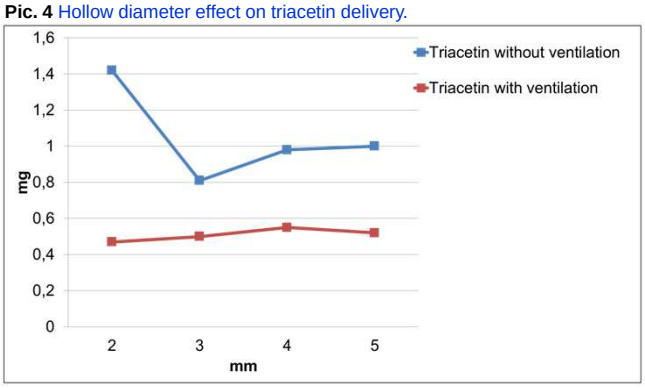
Pic. 2 Hollow tube diameter effect on temperature.



Pic. 3 Hollow diameter effect on TPM delivery.



Pic. 4 Hollow diameter effect on triacetin delivery.



Conclusions

- Hollow tube has minor effect on filter pressure drop, up to 3,0% depending on hole diameter.
- High diameter hole significantly reduces smoke temperature in non ventilated cigarettes.
- Smaller hole diameter has higher delivery of triacetin and TPM.
- Ventilation eliminates hollow tube influence on cigarette.