



Technical Report

**Chemical and physical performance of a filter for cigarette smoke
(device SMOKAT)**

PCT IB2018/052448 - 102018000000775 -102017000039687

Introduction

SMOKAT is a patented device (patents:PCT IB2018/052448 - 102018000000775 - 102017000039687) to treat and filter cigarette inhaled smoke..

This work comes from a commitment (number prot. 64/17 del 10/11/2017) aimed to determine Smokat filtering performance with respect to the main cigarette gaseous compounds CH_4 , CO , C_2H_6 e C_3H_8 .

CG measyremnte were made for different oprating conditions and for several cigarette types.

In order to determine total particulate content (TPM) and nicotine into particulate an external commitment has been assigned to ASL Analytic Service laboratory GmbH, Hamburg.

Experimental method for smoke analysis

The experimental campaign aims to measure the following compounds CH_4 , CO , C_2H_6 e C_3H_8 into exhausted (smoked) gas both with and without SMOKAT.

SMOKAT is equipped with a ferrule to regulate smoke flow rate; measurement were made in two different conditions

- A. Maximum flow rate
- B. Minimum flow rate

Measurements were made for three typologies of cigarettes: full flavour, mid flavour and light.



Fig 1: SMOKAT.

The measurement procedure resemble a common cigarette experience: a calibrated sampling system produces 6 draws (puffs): each puff volume is 25ml and is separated by 60 seconds from the next one as indicated into ISO 3308:2009 standard; the content of the sixth puff is adopted for smoke composition measurements.

The calibrated cigarette smoke sampling system is reported in fig. 2. The CG CG model CP-4900 Varian (Fig. 2) based on thermal conductivity sensor. (TCD), is used for gas composition measurement. It is shown in fig. 3.



Fig. 2: smoke sampling system



Fig. 3: CG P-4900 by VARIAN.

Experimental results

For each cigarette typology (full flavour, mid flavour and light), 6 puffs were made separated by 60 seconds each (ISO 3308:2009). The procedure was repeated for each of the following different conditions:

Without SMOKAT

With SMOKAT and max flow rate (ferrule completely opened) - condition A

With SMOKAT and min flow rate (ferrule minimum opening) - condition B

The temperature of aspirated gas (exhausted gas) is included into 25°C - 27°C range depending on drawing resistance and environmental temperature.

The gas of the 6th puff was analysed by CG, Results are expressed in terms of volumetric percentage and reported in Tab. 1.

Tab. 1: experimental results on different conditions.

		Average composition %v/v 6 th puff (25 ml/puff)				
		Methane (CH ₄)	Carbon moxide (CO)	Ethane (C ₂ H ₆)	Propane (C ₃ H ₈)	Othe
full flavour	without SMOKAT	0,16	1,53	0,74	0,04	97,53
	with SMOKAT A	0	0	0,15	0,03	99,82
	with SMOKAT B	0	1,03	0,54	0,04	98,39
mid flavour	without SMOKAT	0,07	1,20	0,49	0,05	98,19
	with SMOKAT A	0	0,23	0,65	0,05	99,07
	with SMOKAT B	0,04	0,77	0,27	0,05	98,87
light	without SMOKAT	0	0,22	1,69	0,06	98,03
	with SMOKAT A	0	0,22	0,01	0,03	99,74
	with SMOKAT B	0	0,19	0	0,06	99,75

Note: 0% indicates concentration under instrumentation sensibility.

Risultati di misurazione effettuate da laboratorio esterno

In order to determine further smoke content an external commitment has been assigned to ASL "Analytic Service laboratory GmbH, Hamburg". Measurements were made with a smoking machine RM 200 A (Borgwaldt-KC) equipped with smoke trap "Central filter 92 mm". Measurements aimed to determine:

- Total Particulate (TPM);
- Nicotine on TPM
- Dry Particulate without nicotine;

Committed measurements were made only for full flavour cigarette with minimum flow rate condition B. Measurement results are reported (Lab. Protocols n°180405/05-1 and 180405/05-2) are reported in Tab.2

Tab. 2: Committed measurements results for full flavour without and with SMOKAT at minimum flow rate

		TPM [mg/cig]	Nicotine on particulate [mg/cig]	Dry Particulate without [mg/cig]
full flavour	without SMOKAT	8	0.5	6
	With Smokat	6	0.4	5

In Annex I all CG graphs are reported for any kind of cigarette for each condition.

In Annex II complete reports of committed measurements are reported.

Conclusions

For each typology of cigarette and for each condition, SMOKAT produces the following filtering performances on inhaled smoked gases:

full flavour

SMOKAT in A condition (max flow rate) produces:

1. Total reduction (under the instrumental sensibility) of methane CH_4 ;
2. Total reduction (under the instrumental sensibility) of **Carbon Monoxide** CO ;
3. 80% reduction of ethane C_2H_6 ;
4. 25% reduction of propane C_3H_8

SMOKAT in B condition (min flow rate) produces:

1. Total reduction (under the instrumental sensibility) of methane CH_4 ;
2. 33% reduction of **Carbon Monoxide** CO ;
3. **27% reduction** of propane C_3H_8
4. **25% reduction of TPM (total particulate)**
5. **20% reduction of nicotine**
6. **17% reduction of dry particulate without nicotine.**

Mid flavour

SMOKAT in A condition (max flow rate) produces:

1. **43%** reduction of **methane** CH_4 ;
2. **36%** reduction of **Carbon Monoxide** CO ;

SMOKAT in B condition (min flow rate) produces:

3. Total reduction (under the instrumental sensibility) of methane CH_4 ;
1. **33%** reduction of **Carbon Monoxide** CO ;
2. **45%** reduction of ethane C_2H_6

light

SMOKAT in A condition (max flow rate) produces:

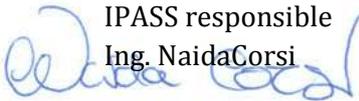
1. 99% reduction of ethane C_2H_6 ;
2. 50% reduction of propane C_3H_8

SMOKAT in B condition (max flow rate) produces:

1. **14%** reduction of **Carbon Monoxide** CO ;
2. Total reduction (under the instrumental sensibility) of ethane C_2H_6 .

Perugia 07/05/2018

IPASS responsible
Ing. Naida Corsi





Annex 1

CG graphs

full flavour

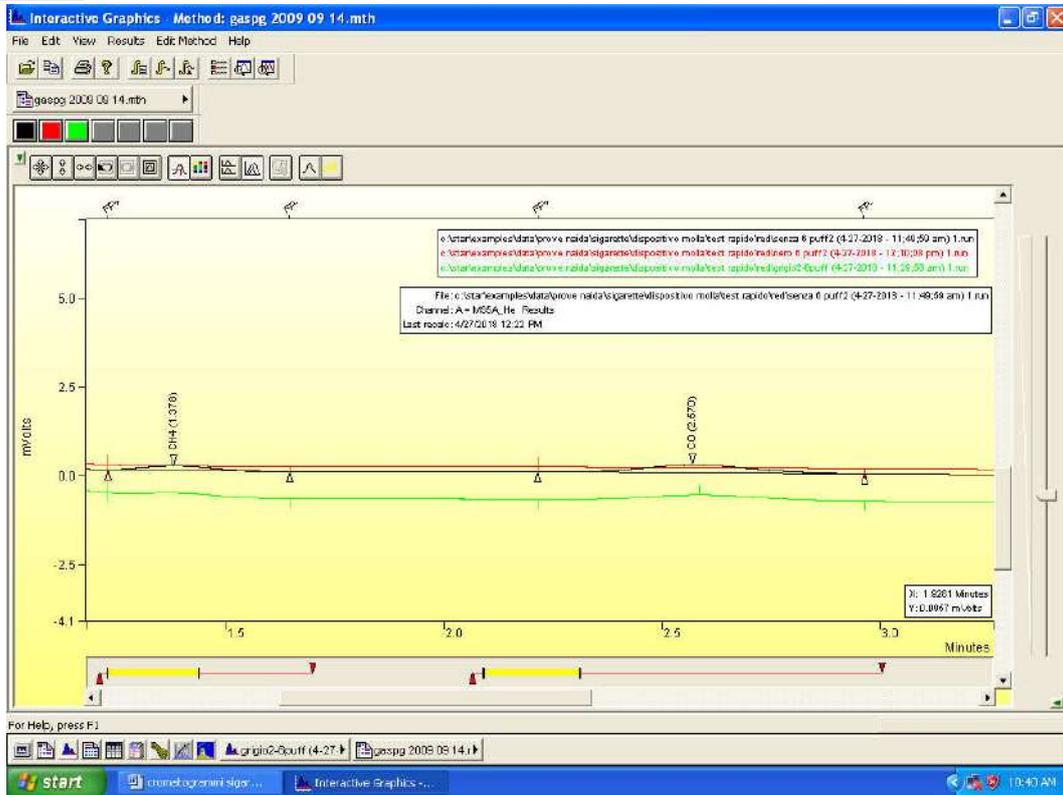


Fig. I: full flavour - (CH₄ e CO)

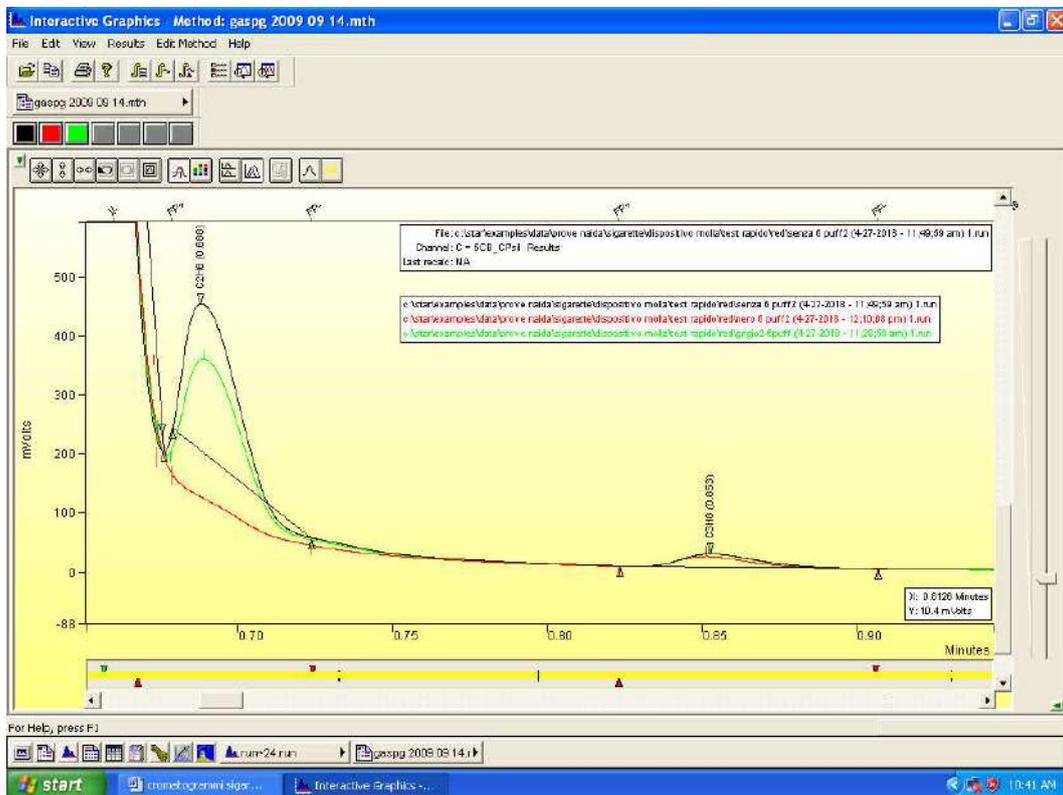


Fig. II: full flavour - (C₂H₆ e C₃H₈)

light

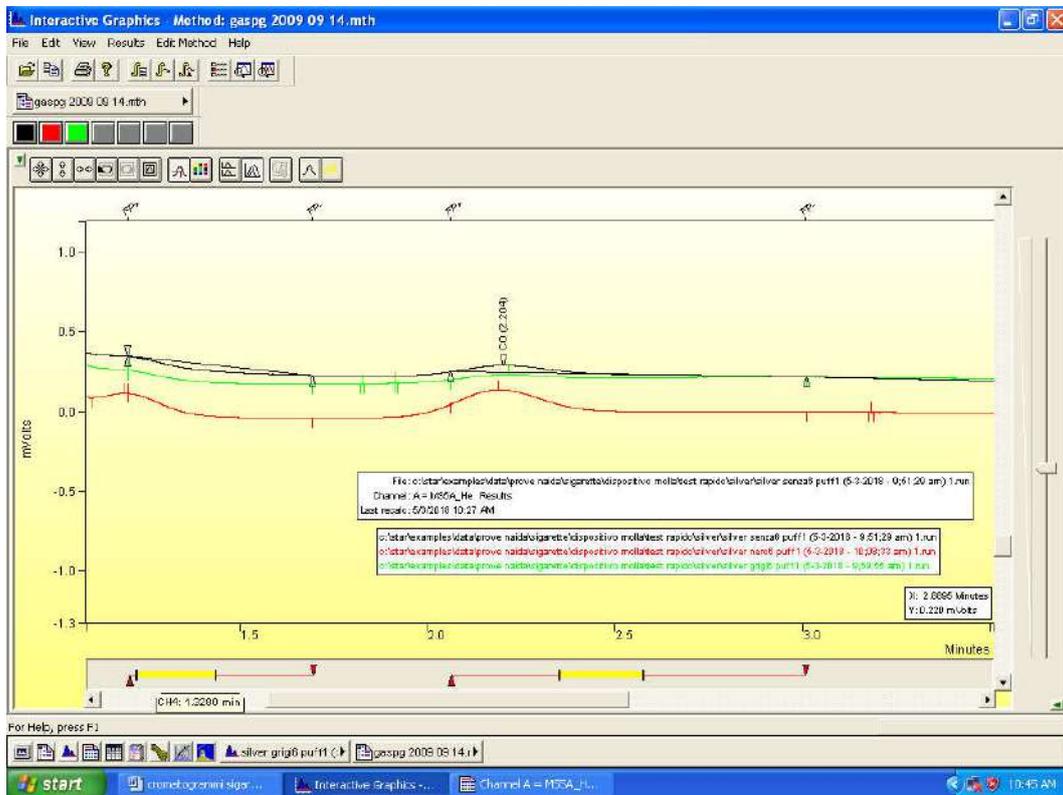


Fig. V: light- (CH_4 e CO)

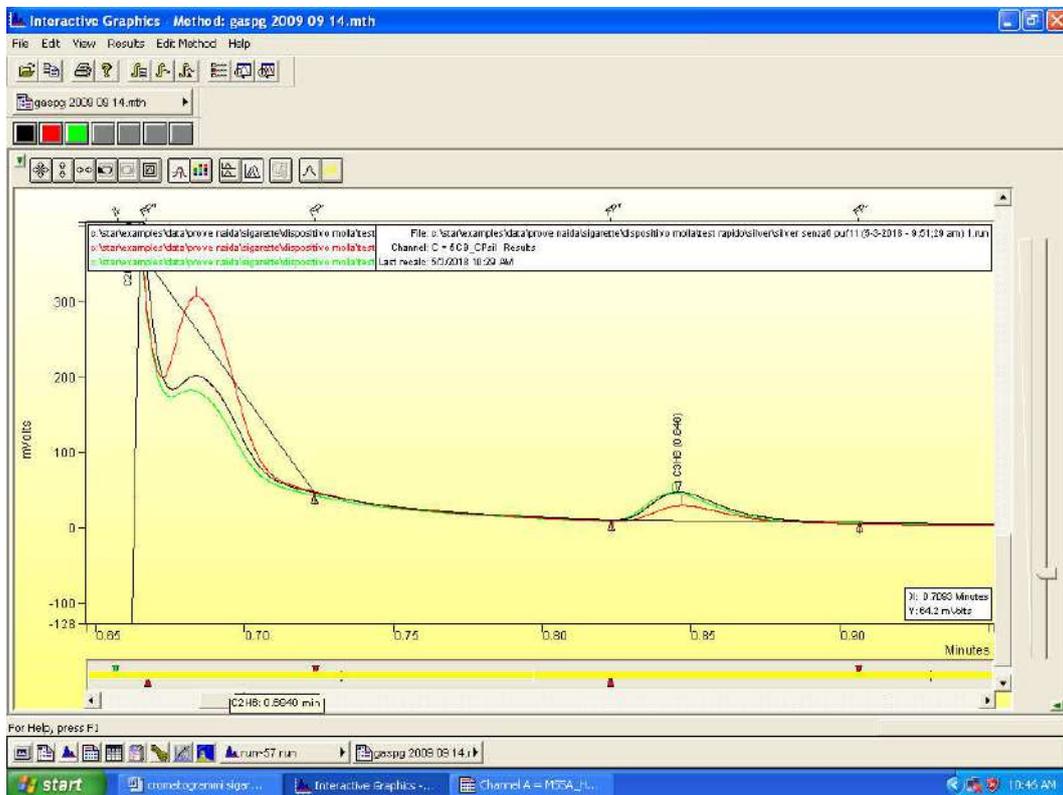


Fig. VI: light(C_2H_6 e C_3H_8)



Annex II
Measurements Report committed to ASL Analitic Service
laboratory GmbH



ASL Analytic Service Laboratory GmbH

Origin: BTS Srl
Via M. Calari 11
40011 Anzola dell'Emilia (BO)

Italy

Analysis report April 11. 2018

Name **FULL FLAVOUR(*)** with filter

Packing hardbox
Date of delivery April 04. 2018
Quantity 120 Cigarettes
Analysis-No. 180405/05-2
Date of analysis 09.04. - 10.04.2018

Order

Determination of TPM and NFDPM (based on ISO 4387)
Determination of nicotine content in smoke condensates (ISO 10315)
Determination of carbon monoxide (CO) in vapour phase of smoke (based on ISO 8454)
Based on ASL method QE-16/VA-01-PA-K01,K04

Results

Type of smoking machine Smoking machine RM200 A (Borgwaldt -KC) smoke trap " Central Filter 92 mm "

Number of cigarettes smoked 2 smoking runs 20 cigarettes
total 40 cigarettes

Cigarette weight mean: 866 mg

Puff number 6,0

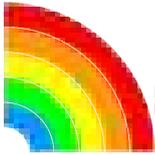
Total particulate matter (TPM) mean: 6 mg/cig.

Nicotine in TPM mean: 0,4 mg/cig.

Nicotine-free dry PM mean: 5 mg/cig.

Carbon monoxide mean: 6 mg/cig.

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ASL Analytic Service Laboratory GmbH

Origin: BTS Srl
Via M. Calari 11
40011 Anzola dell'Emilia (BO)

Analysis report Italy April 11, 2018

Name **FULL FLAVOUR(*)**

Packing hardbox
Date of delivery April 04, 2018
Quantity 120 Cigarettes
Analysis-No. 180405/05-1
Date of analysis 09.04. - 10.04.2018

Order **Determination of TPM and NFDPM (based on ISO 4387)**
Determination of nicotine content in smoke condensates (ISO 10315)
Determination of carbon monoxide (CO) in vapour phase of smoke (based on ISO 8454)
Based on ASL method QE-16/VA-01-PA-K01,K04

Results

Type of smoking machine Smoking machine RM200 A (Borgwaldt -KC) smoke trap " Central Filter 92 mm "

Number of cigarettes smoked 2 smoking runs 20 cigarettes
total 40 cigarettes

Cigarette weight mean: 872 mg

Puff number 6,0

Total particulate matter (TPM) mean: 8 mg/cig.

Nicotine in TPM mean: 0,5 mg/cig.

Nicotine-free dry PM mean: 6 mg/cig.

Carbon monoxide mean: 7 mg/cig.

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