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TECHNICAL REPORT ABOUT KILLING OF THE QUANTITIES OF POLLUTANTS PRESENT IN CIGARETTE SMOKE PRODUCT FROM THE DEVICE "SMOKAT" (PCT IB2018 / 052448 -102018000000775-102017000039687)

The undersigned Prof. Ing. Giordano Franceschini, Professor of Industrial Bioengineering (ING / IND 34) at the Department of Engineering of the University of Perugia (in defined time frame), as well as freelancer and member of the Order of Engineers Province of Perugia at number A1576, at the request of the start - up companies SMOKAT s.r.l.. San Giustino (Perugia), presents in this report the results of some surveys, conducted by the same on their own by the use of gas chromatography, about abatement of the amount of pollutants present in cigarette smoke obtained from "SMOKAT" device (hereinafter Smokat) from the same product.

PREMISE

The Smokat Society of San Giustino (PG) is a start-up founded in 2014 to develop the homonymous device, whose patent has (PCT IB2018 / 052448 - 102018000000775 -
102,017,000,039,687). As part of the development of the device, the company owner conducted numerous surveys on their own, then go through the analysis performed at the foreign institute of analysis "ASL" in Hamburg – Germany (**Attachment 1).**

The results of the above surveys, which have always proved the validity of the product
under development, have encouraged owners to lead the company, along with the writer, the here exposed protocol tests with gas chromatograph, the results of which indicate with appropriate scientific rigor the actual validity of the device for the gaseous pollutants, and also provide effective premise for a series of tests to be performed at specific institutions devoted to the study of the harmfulness of smoking to human health.

ABOUT THE DEVICE SMOKAT.

The Smokat device looks like what originally was called by smokers "mouthpiece", ie
an extension to apply the rear of the cigarette, through which passes all the aspirated smoke. The Smokat, however, presents some peculiarities such as to differentiate it compared to a traditional mouthpiece, and times to carry out actions on the aspirated

smoke, which are summarized here referring, for illustration, to the product brochure and the illustration of the test method (**Attachment 2):**
- The presence of an internal filter, cylindrical, removable, replaceable and renewable for cleaning, through which passes all the smoke aspirated; such a filter looks like in its cylindrical shape to the filter already commonly present in cigarettes;
- The passage of all the aspirated smoke inside this filter is realized by means of a pin cable, the rear end of which is inserted in the aforementioned filter, while the front end emerges into the cigarette housing, in such a way to penetrate when the same is applied.
The pin, therefore, captures all the smoke aspirated from the cigarette, conveying it in the internal filter to the device.
The forced passage of the smoke through the removable filter achieves entrapment, internally to the same, of the solid particles, tar or not, carried in suspension in the smoke itself.
- The suction pin also plays **the function of catalyst,** or device within which occur certain chemical reactions, mainly of the type oxidation / reduction, which alter the composition of the smoke aspirated and the one in transit along the same.
- The presence of an adjustable ring, downstream of the pin and the removable filter before described, which, being screwed, narrows the passage of air in suction after filtering, operating a smoke flow control aspirated useful to decrease the concentration of pollutants and modify the perception of taste by the smoker.
- The presence, in the front destined to the housing of the cigarette, radial slotted openings designed to maintain the discovered micro holes, which cigarettes present diffusely on their filter, which, realizing the intake of fresh air along the cigarette filter during the so-called "breath", enriched with oxygen in the hot smoke passage, triggering a sort of post - combustion extremely useful to break down the pollutant constituted by carbon monoxide (CO). It is not excluded that the
original purpose of those holes has been, in the cigarette manufacturers intentions, to operate a controlled alteration of taste perceived by the smoker, as the differentiated insertion of fresh air produces such an effect, but it is a given in fact, confirmed by these tests, that these holes, which differ in quantity and distribution to various cigarette models, operate an important reduction of the pollutants present in the smoke.
In summary, the Smokat device can be described as a mouthpiece with an adjustable intake section, with pin catalyst, removable filter and slot for lateral aspirations,
DESCRIPTION OF TESTS CONDUCTED.
In order to quantify correctly types and quantity of the gas components of cigarette smoke, the writer has conducted an analysis of the same by means of gas - chromatograph, analyzing in sequence the smoke produced by a conventional cigarette, and then the smoke produced by the same type of cigarette with Smokat

applied the device, adjusting the smoke flow, using the special ring, in two extremal positions, namely position "A", corresponding to the maximum flow, and "B" position,
corresponding to the minimum flow. The gas chromatograph, the only guaranteed reliable tool for the type of measure, by their measures dealing with the smoke detection with two gases:

- A carrier gas which, mixing with the smoke itself, constitutes a concentration and density of the fluid controlled, which is confined within a specific detection volume;
- A contrast gas which, placed inside a similar volume of detection, allows to observe the differences between their electrical conductivity and the gas under test consists of the mixture between the carrier gas and the smoke test. The results of the analysis by gas - chromatograph are exposed with a specific representation, called spectrum, in which each type of the gaseous components of smoke analyzed, pollutant or less, corresponds to a precise "peak" of the graph, and the peak intensity of the same It indicates the concentration in percentage of the total volume. Please refer to the specific **Attached 2** for the precise description of the instrumentation and test mode.

FINDINGS OF THE TESTS CONDUCTED BY WRITING WITH GAS CHROMATOGRAPH.

On 01/02/2019 the writer has conducted the aforementioned tests, using a gas - chromatograph VARIAN brand, model CP 4900, which has previously performed all the required calibration procedures with sample gas. Trying cigarettes belonging to three different categories, namely "full flavor", "mid Flavor" and "light"
Each cigarette was subjected, in accordance with ISO 3308: 2009, to a sequence of six aspirations 25ml each, spaced 60 seconds, and analyzing the contents of the sixth and final aspiration, captured in an appropriate ampoule. The results of the measurements, for which detailed explanation, refer to the specific attachment (**Attachment 3)** they are summarized in terms of a percentage of the volume concentration, as follows, noting that the zero concentration is indicated whenever the measurement
was lower than the sensitivity threshold of the instrument used:

- For cigarettes such as "full flavor":

	WITHOUT SMOKAT	WITH SMOKAT A	WITH SMOKAT B
METHANE (CH4)	0.16	0	0
Monoxid Carbon (CO)	1,53	0	1,03
Ethan (C2H6)	0,74	0,45	0,54
PROPANE(C3H8)	0,04	0,03	0,04
Other	97,53	99,82	98,39

- **For cigarettes type "mid flavor":**

	WITHOUT SMOKAT	WITH SMOKAT A	WITH SMOKAT B
METHANE (CH4)	0.07	0	0,04
Monoxid Carbon (CO)	1,20	0,23	0,77
Ethan (C2H6)	0,49	0,27	0,45
PROPANE(C3H8)	0,05	0,05	0,05
Other	98,19	99,45	98,65

-For Cigarettes type " light"

	WITHOUT SMOKAT	WITH SMOKAT A	WITH SMOKAT B
METHANE (CH4)	0	0	0
Monoxid Carbon (CO)	0,22	0,22	0,19
Ethan (C2H6)	1,69	0,01	0
PROPANE(C3H8)	0,06	0,03	0,06
Other	98,03	99,74	99,75

It is therefore detects a significant reduction of the gaseous pollutants in each condition of use of Smokat device.
SURVEY OF THE RESULTS OF THE TESTS ON SOLID POLLUTANTS CARRIED OUT BY THE SMOKAT AT "ASL" LABORATORY in HAMBURG (Germany).
Prior to the tests described in this report, the Company has commissioned Smokat, the 9th April 2018, a series of tests at the laboratory **ASL Analytic Service Laboratory in Hamburg (Germany)** whose
purpose was to quantify the reduction of pollutants "solid":

- Total particulate matter (TPM);
- Nicotine contained in TPM particulate;
- Dry Particulate without nicotine.

The tests were conducted using the equipment "Smoking Machine RM 100 A" Borgwaldt - KC and a "trap" for solid pollutants "Central filter 92 mm", and were conducted on only one type of cigarette "full flavor", or the one with the higher content of nicotine, and adjusting the Smokat in configuration "B", or with the minimum suction flow. The results of these tests, which the writer acquires postponing, for their complete description, the specific attachment (**Attachment n.1)** can be summarized as follows:

	WITHOUT SMOKAT	WITH SMOKAT “B”
TPM (mg/ cigarette)	8	6
NICOTINE(mg/cigarette)	0,5	0,4
Dry Particulatewithout nicotine	6	5

CHARACTERIZATION OF INLET HOLES

The day 01st February 2019, the writer wanted to test a sample by means of gas chromatograph of cigarettes type "Marlboro red" in order to quantify the impact on the amount of pollutants of the aspirated smoke, of suction holes present on the same filter, by performing the following sequence of
tests:
- Aspiration of Cigarette Smoke WITHOUT the device Smokat Applied and CLOSING of the radial holes of air inlet present on the cigarette itself.
-Aspiration of Cigarette Smoke WITHOUT the device Smokat Applied with OPENING of radial holes for air inlet present on the cigarette itself (normal condition);
- Aspiration of cigarette smoke WITH the device Smokat Applied, with OPENING of radial

holes for air inlet present on the cigarette.

The spectra processed by the gas - chromatograph showed the following results:

	WITHOUT SMOKAT HOLES CLOSED	WITHOUTH SMOKAT HOLES OPEN	WITH SMOKAT HOLES OPEN
METHANE(CH4)	0,75	0,18	0
MONOXIDE CARBON (CO)	0,0072	0,0059	0,0037
ETHANE (C2H6)	1,36	0,2	0
PROPANE (C3H8)	0,044	0,036	0,030
OTHER	98,03	99,74	99,75

Which demonstrate the validity of the presumption abatement of pollutants operated by air suction through the micro holes on the cigarette filters. The variety of the distribution of these holes, different from a cigarette model to model, suggested to the Smokat manufacturers to modify the first prototypes of such a device in order to equip them with slots that do not obstruct in any way the micro holes, whatever their layout was.

CONCLUSIONS

On the basis of all the tests conducted and acquired, relatively to the gaseous smoke pollutants, the writer concludes that the Smokat device:
employed on cigarettes "Full Flavor" in configuration "A" (maximum flow) produces:

- Total reduction of pollutant Methane;
- Reduction of the total carbon monoxide;
- Reduction of approximately 80% ethane;
- Reduction of approximately 25% of propane.

employed on cigarettes "Full Flavor" in configuration "B" (minimum flow) produces:

- Total reduction of pollutant Methane;
- Reduction of approximately 33% of the carbon monoxide;
- Reduction of approximately 80% ethane;
- Reduction of approximately 27% of propane;
- Reduction of 25% of the total particulate TPM;
- Reduction of 20% of the nicotine;
- Reduction of 17% of the dry particulates without nicotine.

Employed on cigarettes "Mid Flavor" in configuration "A" (maximum flow) produces:

- Reduction of 43% of the pollutant Methane;
- Reduction of 36% carbon monoxide;
- Reduction of approximately 80% ethane;
- Reduction of approximately 25% of propane.

employed on cigarettes "Mid Flavor" in configuration "B" (minimum flow) produces:

- Total reduction of pollutant Methane;
- Reduction of approximately 33% of carbon monoxide
- Reduction of approximately 45% ethane;

employed on cigarettes "Light" in configuration "A" (maximum flow) produces:

- Reduction of approximately 99% ethane;
- Reduction of approximately 50% of propane.

employed on cigarettes "Light" in configuration "B" (minimum flow) produces:

- Reduction of approximately 14% of carbon monoxide;
- Total reduction of ethane;

On the basis of these results, the writer detects the efficient dejection of gaseous and solid pollutants from the operation of Smokat.

Perugia, 4 March 2019

Prof. Ing. Giordano Franceschini
Attached to this report:
- Annex 1: Test results on solid pollutants.
- Attachment 2: Test Method with gas - chromatograph.
- Appendix 3: Gas test results - chromatograph.

Attachment n. 2
Gas trial methododology- chromatograph

Introduction

The SMOKAT device is the subject of patentPCTIB2018/052448 – 102018000000775 - 102017000039687 and constitutes a system to physically and chemically process the combustion gas (smoke) of cigarettes.
The aim of this activity, (in reference to Our Offer protocol 64/17 of the 10th of November 2017) is to measure the effect of the SMOKAT device on the main gaseous compounds of the products deriving from cigarette combustion (smoke):
CH_4, CO, C_2H_6e C_3H_8.
In order to do so, gas chromatographic measurements have been carried out in different operating conditions and with different types of cigarettes.
Furthermore, in order to determine the total particle matter (TPM) ,the nicotine contained in the TPM and the particulate matter without nicotine, a measurement campaign by the ASLAnalytic Service Laboratory GmbH of Hamburg has been commissioned, of which we report the findings.

Experimental method for cigarette smoke compounds analysis

The experimentation has been carried out to evaluate the content of the following compoundsCH_4, CO, C_2H_6e, C_3H_8C in the cigarette's combustion gas with and without SMOKAT.
SMOKAT has a regulatory system of the inhaled smoke flow rate; the evaluations mentioned above have been carried out using two different settings of the controller:

A. Maximum inhalation rate
B. Minimum inhalation rate

The testing has been carried out on three types of commercial cigarettes: full flavour, mid flavour and light.

Figure 1: SMOKAT device

The methods of measurement used replicate cigarette consumption: 6 puffs of 25 ml each are made with 60 second intervals as indicated in regulationISO 3308:2009; the content of the 6th puff will be used to determine the combustion gas composition.

Instrumentation used

Picture 2 shows a photo of the experimental apparatus used for cigarette smoke sampling.

Figure 2: cigarette smoke sampling system

The sampling system is made up of a 25ml gas proof Hamilton syringe connected to a spherical valve which is connected to the cigarette with or without applying the filter.

Instrumentation used for analysis

For the analysis, a VARIAN CP-4900 micro GC gas chromatograph has been used (figure 2) which has a thermal conductibility detector (TCD).

Figure 3: VARIAN CP-4900 micro GC gas chromatograph

This type of instrument allows usto analyse the compound concentration levels in a gas mixture.

The sample, which is suctioned by the instrument via a pump, is introducedduring the mobile phase to a carrier gas, through chromatographic columns into the stationary phase, which can eitherbe a porous granular solid or a liquid. Each chemical specimen deposited in the stationary phase and inserted in the current of the mobile phase will dynamically distribute itself between the two phases, in proportion to the different affinities they possess. The TCD detector reacts to the thermal conductibility differences between the carrier gas and the components of the sample. In a TCD the signal generatedby the passage of the carrier gas is compared to thatof an (equivalent)comparable gas. The passage of the sample components inside the detector will cause a signal imbalance in proportion to its concentration. Therefore every substance coming out of the column will generate a signal. When measuring the concentration of the substances exiting the column we will obtain a chromatogram which will report the exiting substance concentration levels versus retention time, that is the time takenfor every single component to go through the whole stationary phase. Chromatograms show the separation process, with the distribution of every substance according to concentration peaks of Gaussian form.4 different channels have been installed in the used instrument:

Canale A · Molsieve MS5A column,Ar carrier

Canale B · Poraplot PPU column, Hecarrier

Canale C · CPSil 5CB column, Hecarrier

Canale D· Molsieve MS5A column, Hecarrier

The instrument is equipped with a dedicated software (SW STAR version 6.41), which allows us to capture, manage and analyse data. The quantitative analysis carried out through the software is based on the comparison of the chromatogram's peak areas, using, for the

calibration of the instrument, the method of external standardization with which it is possible to determine the concentration levels just in the compounds of interest.Such a method allows the building of a calibration curve using known concentration standard mixtures for the component of interest; of which mixtures we inject in a rigorously quantitative, equal way. Automatically the software will display in a graph the peak areas in operation of the concentration of the corresponding standard. A fraction of the sample is then analysed, strictly identical to the previous ones, measuring the component areas of interest and, through an automatic comparison, its concentration can be determined.

SMOKAT device- February 2019

Attachment n.3
Gas trial results-chromatograph
Chromatograms

Fullflavour

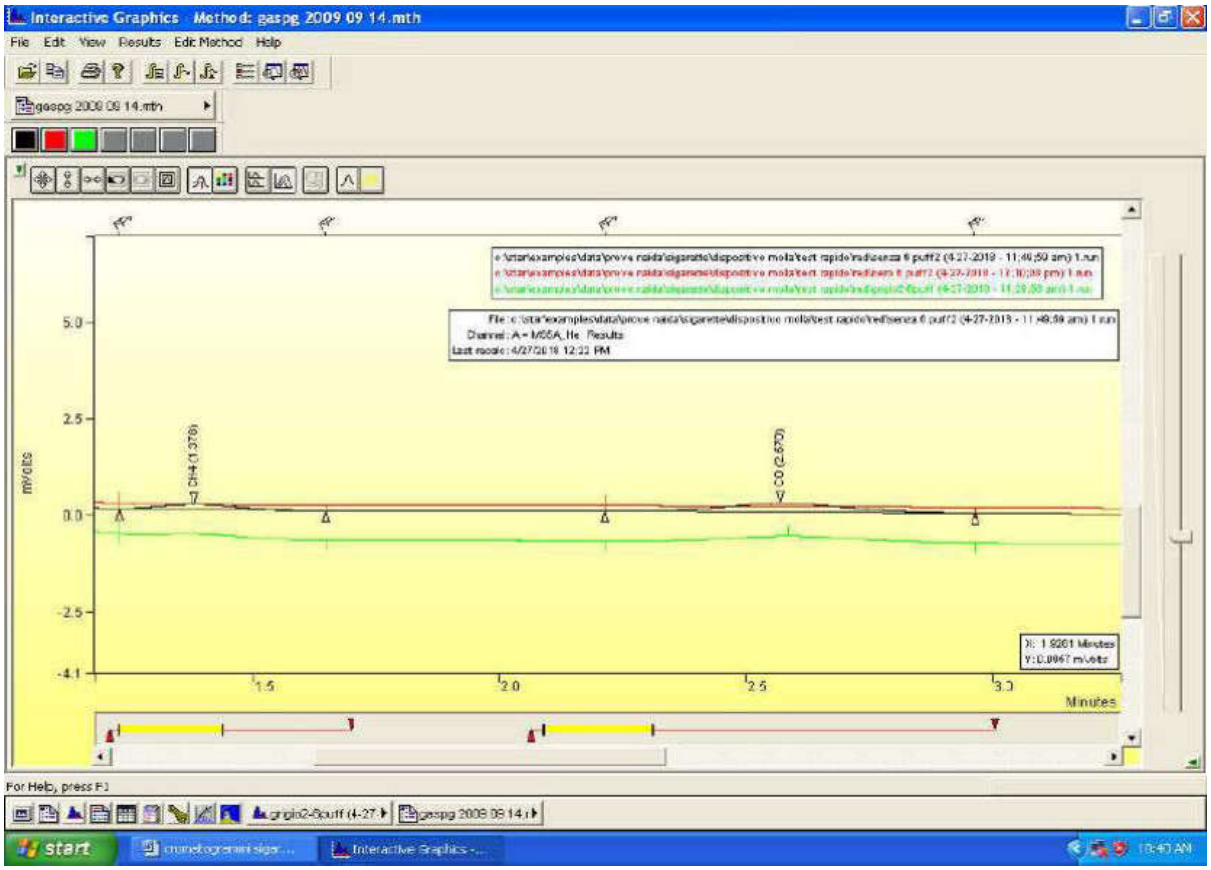

Figure I: full flavour- chromatogram channel A (CH4 and CO)

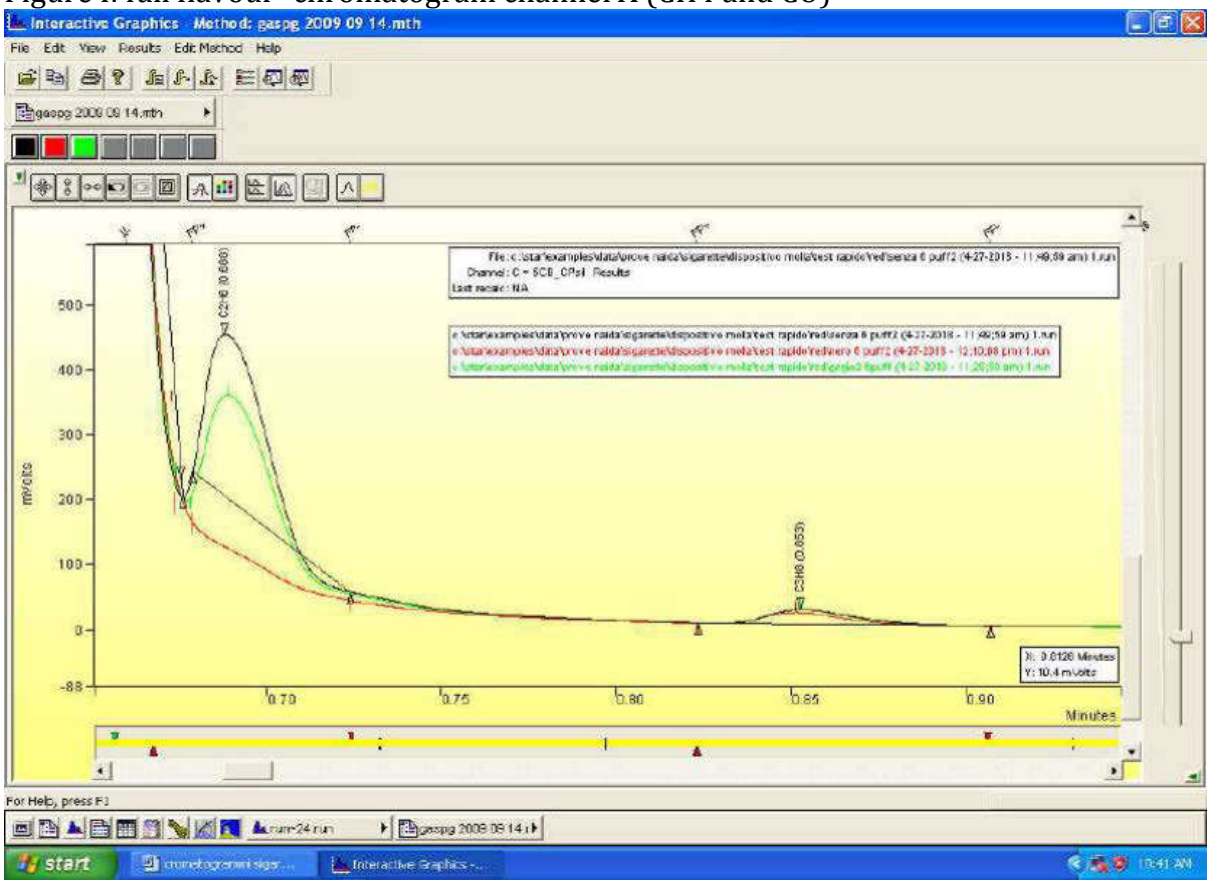

Figure II: full flavour- chromatogram channel C (C2H6 and C3H)

Mid flavour

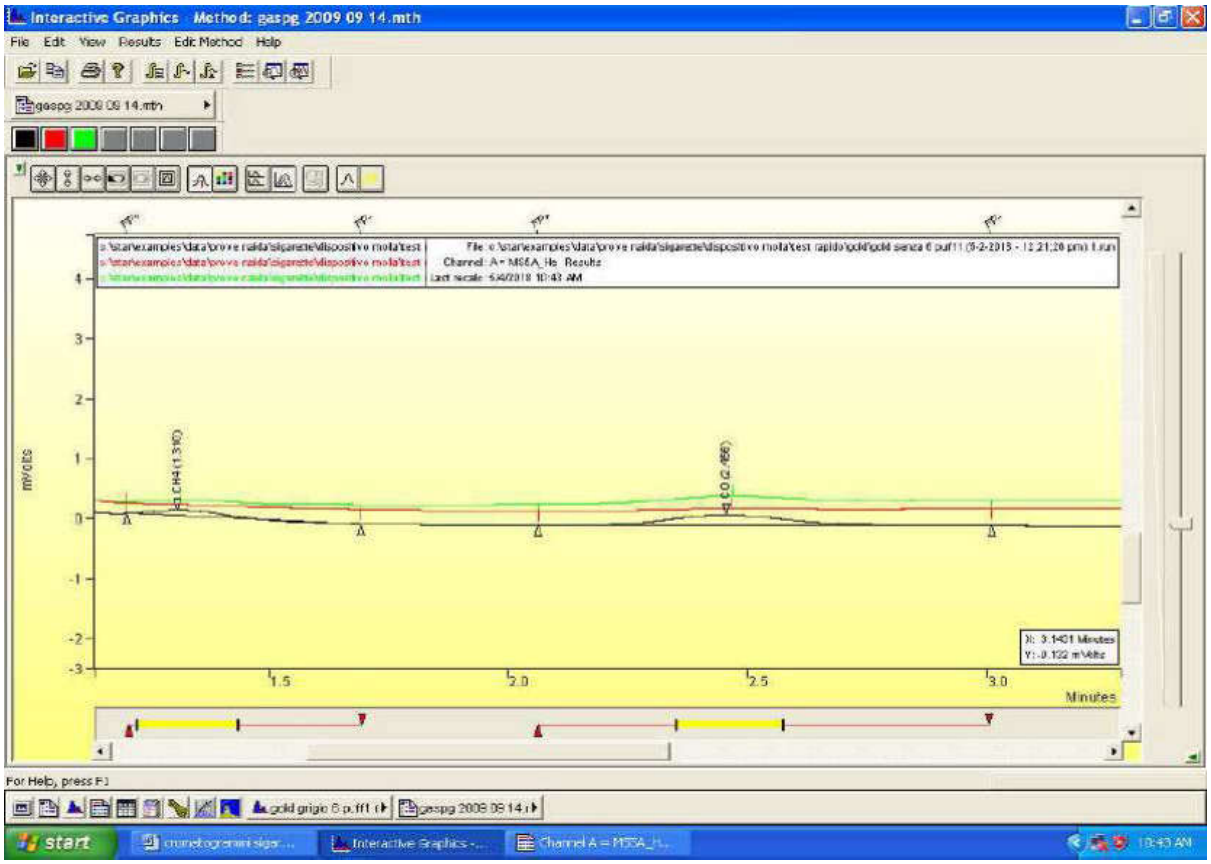

Figure III: Mid flavour- chromatogram Channel A (CH4 and CO)

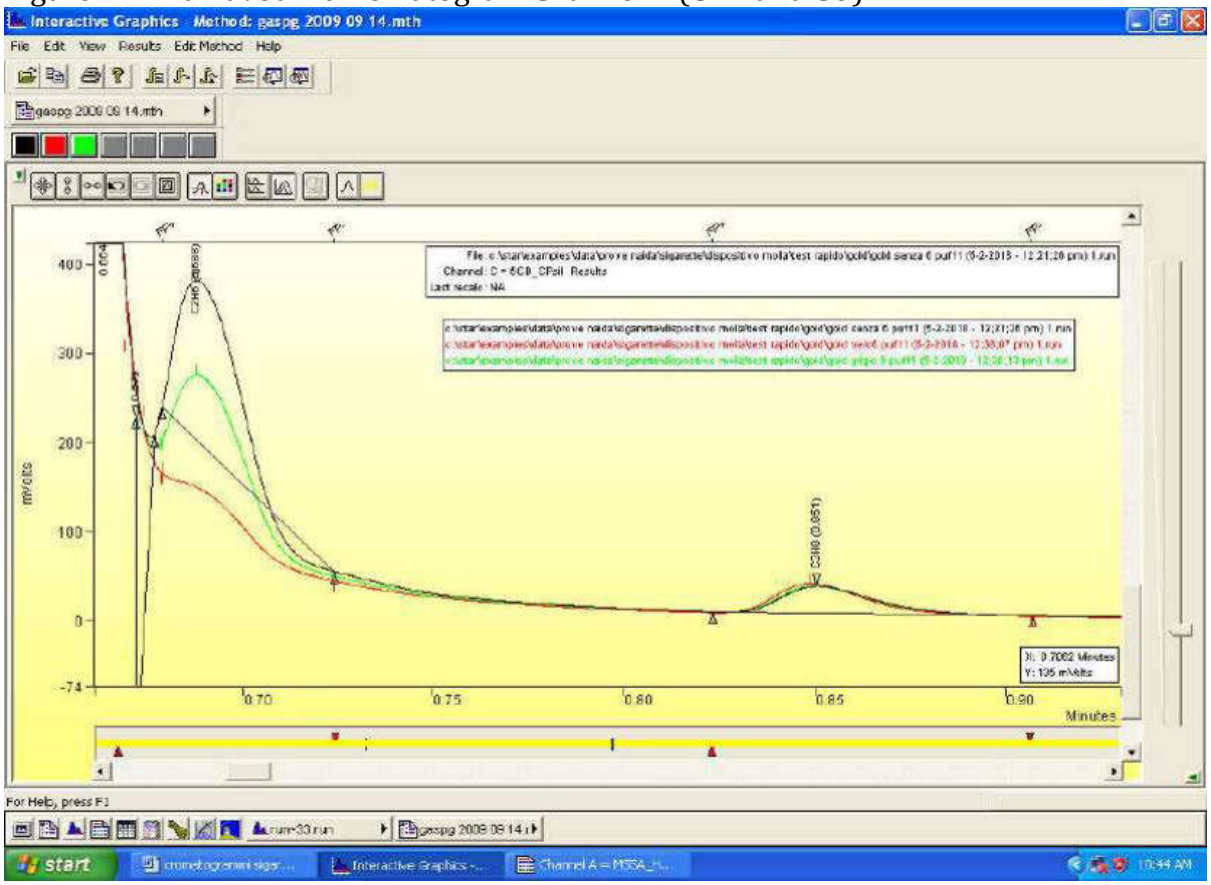

Figure IV: Mid flavour- chromatogram Channel C (C2H6 and C3H8)

Light

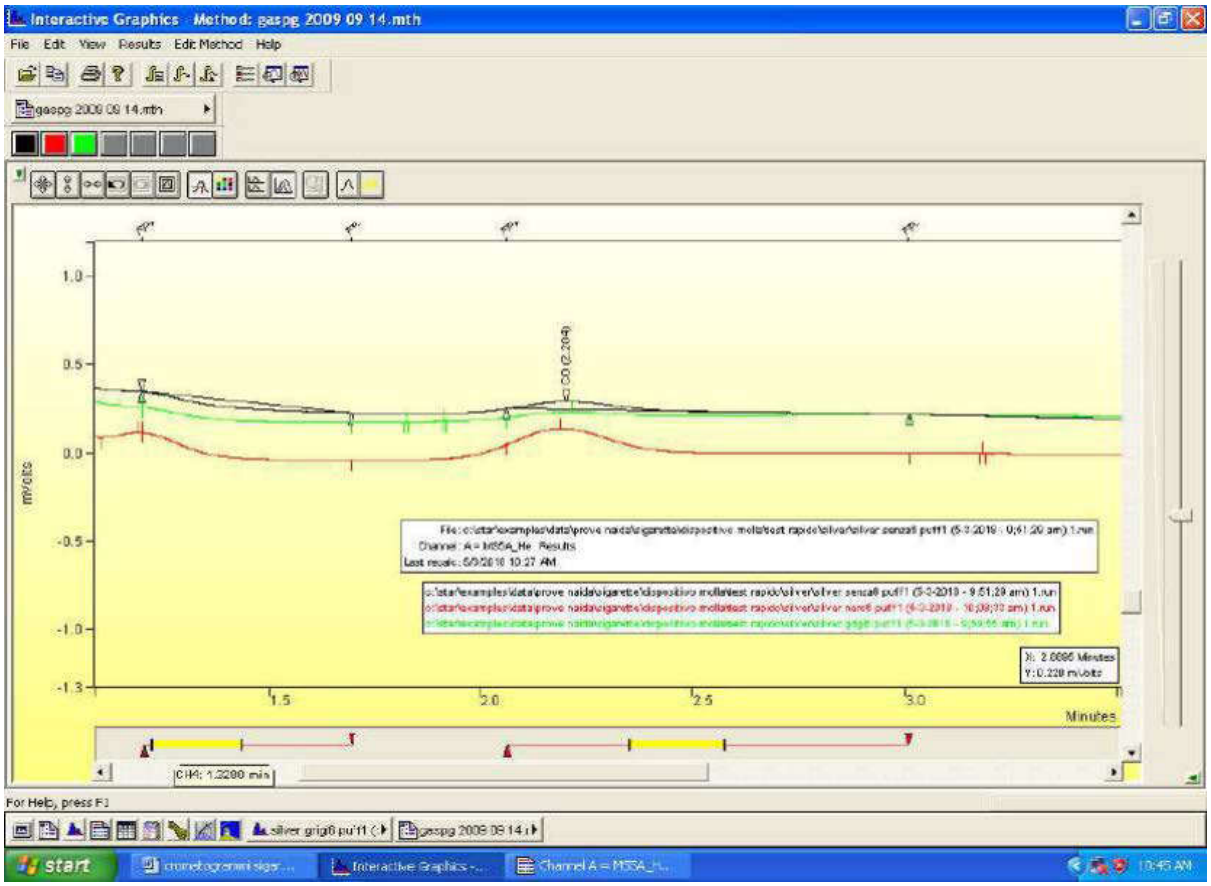

Figure V: light-chromatogram channel A (CH4 and CO)

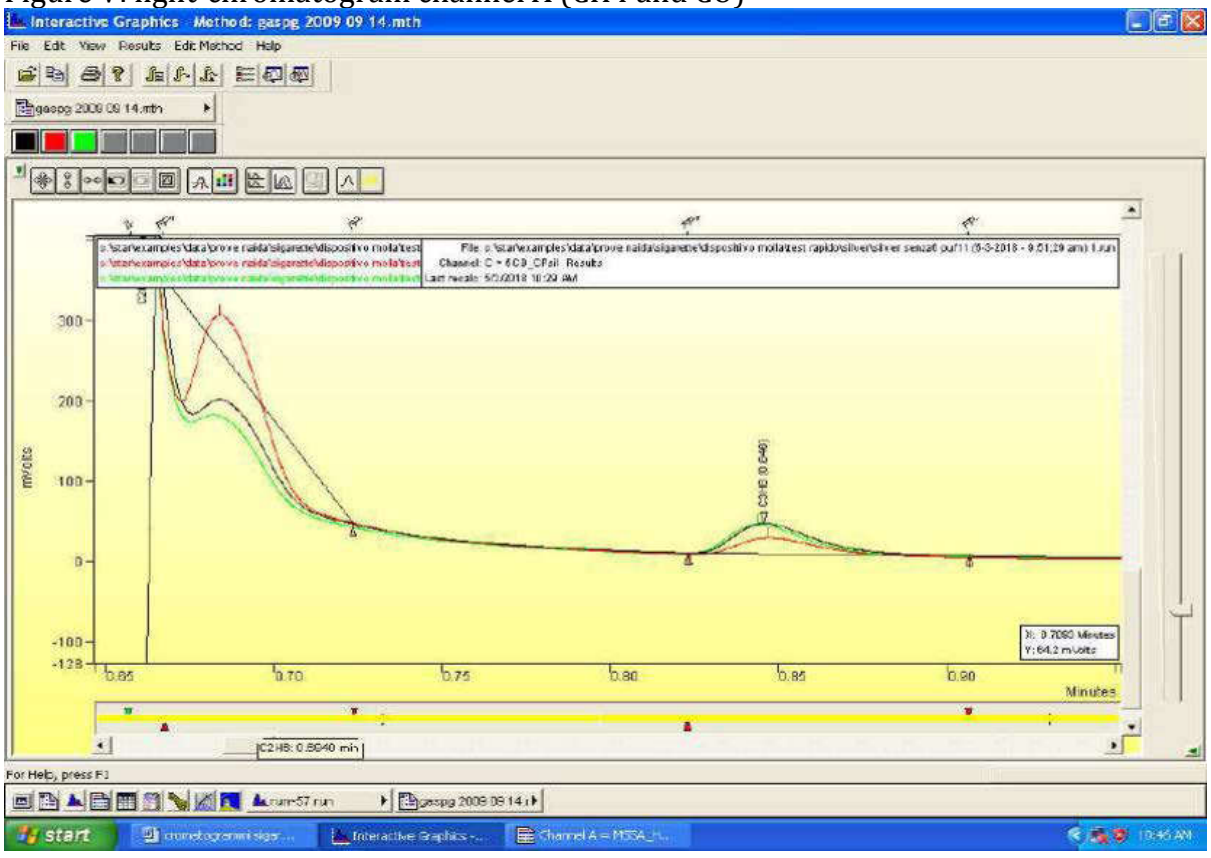

Figure VI: light-chromatogram channel C (C2H6 and C3H8)