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(54) **NANOPOROUS ACTIVATED CARBONS AS ADDITIVES IN TOBACCO FOR REDUCING THE EMISSION OF TOXIC PRODUCTS**

(57) The invention relates to the use of nanoporous activated carbons as additives for reducing the amount of toxic and carcinogenic compounds present in tobacco smoke, and to the mixture of tobacco with nanoporous activated carbons.

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**Description****Technical field**

5 **[0001]** The present invention relates to the use of nanoporous activated carbons as additives for reducing the toxic and carcinogenic compounds present in tobacco smoke.

**State of the art**

10 **[0002]** The smoke generated during combustion of tobacco contains a number of toxic and carcinogenic compounds, which are inhaled by both active and passive smokers, and which make tobacco a major cause of mortality worldwide. The habit of smoking tobacco is a global problem with very negative consequences on the health of human beings, with a very significant impact on the departments or ministries of health.

15 **[0003]** More than 4,000 different compounds have been identified in the smoke that is generated from the combustion of tobacco [R.R. Baker y L. J. Bishop, J. Anal. Appl. [Pyrol., 74 (2005), 145], at least 60 of them are recognised as toxic and carcinogenic. The most abundant are tars, carbon monoxide and dioxide, acetaldehyde, phenols, acetone, formaldehyde, benzene, toluene, and nicotine. Nicotine is the main addictive component present in the tobacco smoke.

20 **[0004]** The process of smoking a cigarette generates the emergence of two types of smoke streams, the so-called "mainstream", consisting of smoke that the smoker inhales and exhales directly from the cigarette and the sidestream, consisting of smoke eliminated through the burning cigarette, which is diluted in the surrounding air and is inhaled by passive smokers. To reduce the concentration of toxic compounds in both streams would be of the utmost importance from all points of view.

25 **[0005]** There are numerous patents on the use of activated carbons with different characteristics and in different forms, such as granular in cloth form, in fibre form, mixed with other types of compounds and for various purposes, from the adsorption of heavy organic compounds, including nicotine and tars, to the reduction of carbon monoxide. In fact, several brands including these types of filters have been marketed. The following patents are examples of such applications.

**[0006]** Patent US75552735 describes a filter formed by bundles of activated carbon fibres distributed in a conventional filter. It also describes the helical arrangement of such bundles, as well as the addition of other adsorbent particles.

30 **[0007]** Patent US7784471 describes the use of spherical particles of activated carbon to fill cavities in conventional filters and retain certain compounds.

**[0008]** Patent US7484511 describes the use of activated carbons in filters to release aromas when smoke passes therethrough.

**[0009]** The patent application US20110088704 describes a concentric activated carbon filter in a conventional cellulose acetate filter.

35 **[0010]** However, the documents described above refer to the use of activated carbon in filters

**[0011]** Mesoporous activated carbons can be obtained by processes of physical activation with CO<sub>2</sub> using catalysts such as iron or calcium salts, or by chemical activation with different precursors, such as petroleum tars or coal, anthracites, certain types of petroleum coke or polymers, using high proportions of activating agent, typically phosphoric acid, sodium or potassium hydroxide or potassium carbonate. Thus, such materials are described, for example, in the bibliography, and can achieve characteristics such as BET surface areas ranging between 0-3500 m<sup>2</sup>/g, total pore volume between 0 and 2.5 cm<sup>3</sup>/g and micropore volume between 0 and 1.5 cm<sup>3</sup>/g (Carbon, 47 (2009) 195-200; Chemistry and Physics of Carbon (2008), 30, 1-62; Energy & Fuels 2002, 16, 1321-1328; Journal of Porous Materials 5, 43-58 (1998); Carbon 48 (2010) 636-644; Fuel Processing Technology (2013), 106, 501-510.

45 **[0012]** There are patents describing procedures for their obtaining (Preparation of super active carbon, SONGLIN ZUO; XUAN CAI, Application number: CN20081243618 20081210; Preparation of super active carbon material: WEN-DONG XU; HAIJUN BIAN, Application number: CN20071302283 20071224; Method for preparing pressed active carbon; KAXI LI; GUOHUA SUN; JIAN WANG; Application number: CN20101166141 20100505; CN101439857; Mesoporous activated carbon and preparation process thereof; SHITANG TONG: Application number: CN20081186027 20081211).

50 **[0013]** No document, which relates to the use of carbon directly mixed with tobacco so that it is present in the combustion process, has been found.

**[0014]** The present invention describes a new application of these materials which consists of the use of this type of activated carbons and super activated mesoporous mixed directly with tobacco, so they are present in the process of combustion of tobacco and have a particle size and morphology that do not cross the conventional filter and with the aim of reducing the toxic and carcinogenic substances in the tobacco smoke.

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**Summary of the invention**

**[0015]** Thus, in a first aspect, the present invention relates to the use of mesoporous activated carbons with a particle

size comprised between 1-100  $\mu\text{m}$ , of high degree of activation, with a surface  $S_{\text{BET}}$  comprised between 1200-4200  $\text{m}^2/\text{g}$ , a volume  $V_{\text{MIC}}$  comprised between 0.4-1.2  $\text{cm}^3/\text{g}$  and a volume  $V_{\text{MESO}}$  comprised between 0.6-2.8  $\text{cm}^3/\text{g}$  as an additive to reduce toxic and carcinogenic substances in the tobacco smoke.

[0016] In a more particular embodiment, the mesoporous activated carbons have a particle size between 2-20  $\mu\text{m}$ . More particularly, the particle size of the mesoporous activated carbons is between 5-15  $\mu\text{m}$ .

[0017] In a particular embodiment, the mesoporous activated carbons are impregnated with materials of the type of carbonates or hydroxides of metals, such as Na, Ca, Fe, Ce or Zr, or mixed with zeolite or aluminosilicates, or mixed with acid or sodium forms, or exchanged with oxides of Fe, Ce, or Zr or mixtures thereof, of zeolites or aluminosilicates.

[0018] In a second aspect, the present invention relates to a mixture comprising dry tobacco and mesoporous activated carbons, with a particle size comprised between 1-100  $\mu\text{m}$ , with a surface  $S_{\text{BET}}$  comprised between 1200-4200  $\text{m}^2/\text{g}$ , a volume  $V_{\text{MIC}}$  comprised between 0.4-1.2  $\text{cm}^3/\text{g}$  and a volume  $V_{\text{MESO}}$  comprised between 0.6-2.8  $\text{cm}^3/\text{g}$  as an additive. In a more particular embodiment, the mesoporous activated carbons have a particle size between 2-20  $\mu\text{m}$ . More particularly, the particle size of the mesoporous activated carbons is between 5-15  $\mu\text{m}$ .

[0019] In a more particular embodiment, the mesoporous activated carbons of the mixture are in a concentration comprised between 0.5-15% by weight with respect to dry tobacco. More particularly, the mesoporous activated carbons of the mixture are in a concentration comprised between 2-7% by weight with respect to dry tobacco.

[0020] In a particular embodiment of the present invention, the mesoporous activated carbons of the mixture have a particle size comprised between 5 and 15  $\mu\text{m}$ , a surface  $S_{\text{BET}}$  greater than 3000  $\text{m}^2/\text{g}$ , a volume  $V_{\text{MIC}}$  greater than 1.1  $\text{cm}^3/\text{g}$  and a volume  $V_{\text{MESO}}$  greater than 2.0  $\text{cm}^3/\text{g}$ .

## Description of the figures

### [0021]

Figure 1. Isotherms of  $\text{N}_2$  adsorption at 77 K of the activated carbons used, where  $V_{\text{ads}}$  STP ( $\text{cm}^3/\text{g}$ ) represents the volume of gas adsorbed under normal conditions at relative pressure  $P/P_0$ .

Figure 2. Typical SEM image of the carbons used.

Figure 3. Detail, between the retention times of 15 and 21 min, from the chromatogram of the liquids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

Figure 4. Detail, between the retention times of 21 and 25 min, from the chromatogram of the fluids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

Figure 5. Detail, between the retention times of 25 and 55 min, from the chromatogram of the fluids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

Figure 6. Detail, between the retention times of 15 and 21 min, from the chromatogram of the fluids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

Figure 7. Detail, between the retention times of 21 and 25 min, from the chromatogram of the fluids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

Figure 8. Detail, between the retention times of 25 and 55 min, from the chromatogram of the fluids generated when smoking tobacco 3R4F and 3R4F mixed with the carbon AML-414.

## Detailed description of the invention

[0022] The present invention relates to the use of activated carbons mixed with tobacco so that they are present in the process of combustion of tobacco. The mechanism by which these materials are more or less active in the reduction of emissions of certain substances in the process of pyrolysis and combustion of tobacco can be of a different nature. First, it should be noted that the presence of this type of materials, due to their composition, essentially carbon, can contribute to the rise in temperature of the cigarette ember by its own burning, substantially changing the process of pyrolysis of the tobacco in areas close to the ember, as well as the burning of the tobacco. In addition, their combustion mainly generates carbon dioxide and water, so they do not contribute to the generation of nicotine and tar. In addition, and depending on their structure and form of arrangement, they may not undergo combustion processes. They can also retain, through adsorption, the compounds generated in pyrolysis and combustion in the heat areas of the ember and next to it, so that these compounds can undergo pyrolysis or oxidation reactions in a significantly different way to that which would take place if they were not confined to the porous structure of these materials, or they can also be simply desorbed without undergoing any further modification. However, not all activated carbons are equally active in this process. The precursor of the activated carbon, the degree of activation and porous texture developed, as well as the presence of an activating agent or other compounds, play a fundamental role in the processes of oxygen diffusion and combustion of the carbon itself, as well as the possible adsorption-desorption and reaction of the products generated in the pyrolysis and combustion of tobacco. Its particle size and form of arrangement, which can modify its own combustion

and the permeability of the tobacco and carbon bed, are aspects that may also have a significant influence on the processes that take place in smoking, for example, a cigarette. The type of tobacco and additives contained are also variables to be taken into account. In this way, very activated but essentially microporous carbons are able to reduce the generation of tars and nicotine, but in a much smaller proportion than other activated carbons of a high degree of activation and with a highly developed mesoporosity. These materials are able to drastically reduce the generation of tars, nicotine and even carbon monoxide. It is evident, therefore, that the porous texture plays an important role in this process and makes these materials excellent candidates to be used in order to reduce the emission of toxic compounds in tobacco.

**[0023]** In order to demonstrate the role of the additives proposed in this patent, cigarettes of reference 3R4F from the University of Kentucky and tobacco cigarettes from two trademarks in which different activated carbons were incorporated, were smoked using a smoking machine that functioned in accordance with the following operation variables:

#### Conditions of cigarettes smoking and analysis of the generated products

- 10 cigarettes are simultaneously smoked according to the specifications of the standard ISO 3308 (puffs of 2 s of duration, 35 mL inhaled volume, frequency of puffs 60 s and pressure loss in the puff less than 300 Pa).
- Cigarettes are conditioned at 23 °C and 60% relative humidity, by keeping them in a desiccator provided with a solution saturated with sodium nitrite, at least 48 h before being smoked.
- During the smoking process, smoke, including CO, CO<sub>2</sub> and other non-condensable products, pass through the cigarette filter as well as through a trap (glass fibre filter) located before the gas collection bag. Non-condensable products are collected in a Tedlar bag for gases, which is kept for further analysis by gas chromatography (GC), while condensable products are collected in the cigarette filter and the subsequent trap. Condensable products which would be directly inhaled by smokers are retained therein.
- The smoking machine suction pressure is in the order of 150 cm H<sub>2</sub>O.
- The condensable products retained in the trap are extracted with 2-propanol, ensuring that all the compounds retained in the trap are recovered. Then the extract is dried with sodium sulphate and is kept for later analysis by GC/MS.
- The determination of the content of CO and CO<sub>2</sub> in the non-condensable fraction is carried out by GC, using a detector of thermal conductivity (GC-TCD) and a concentric column CTRI used for the analysis of O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub> and CO, in a SHIMADZU GC-14A instrument, using a calibration through external patterns. Quantification has been made calculating the response factor (grams of compound/peak area) of these compounds by injection of different volumes (between 0.5 and 2.5 mL) of the corresponding pattern (carbon monoxide, carbon dioxide, hydrogen, methane and oxygen). The conditions of the analysis are:
  - Carrier gas: He
  - Injector temperature: 28 °C
  - Detector temperature: 110 °C
  - Injected volume: 2.5 mL
  - Constant column flow: 40 mL/min
  - Oven temperature program: isothermal at 110 °C
  - Analysis time 20 min
- The remaining non-condensable components are analysed by GC with flame ionisation detector (GC-FID), using a GAS-PRO column and the following conditions:
  - Injector temperature: 150 °C
  - Detector temperature: 210 °C
  - Carrier gas: Helium
  - Volume of sample injected: 150 µL
  - Constant column flow: 2 mL/min
  - Oven temperature program:
    - Column initial temperature 35 °C for 10 min
    - Heating to 100 °C with a ramp of 5 °C/min
    - Heating to 200 °C with a ramp of 15 °C/min
  - End time: 10 min
- Condensable compounds (extracted with 2-propanol) are analysed by GC with mass spectrometry (GC-MS) detector, using a HP-5MS column and the following conditions:

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- Injector temperature: 250 °C
- Carrier gas: Helium
- Volume of sample injected: 1 µL
- Constant column flow: 2 mL/min
- Oven temperature program:
- Column initial temperature 40 °C for 5 min
- Heating to 320 °C with a ramp of 12°C/min
- End time: 25 min

- For the determination of the quantities obtained for each compound, the integration of the area under the chromatographic peaks is carried out and the corresponding response factors are used.

### Cigarette preparation conditions

**[0024]** To carry out all tests, cigarettes in which the chopped tobacco has been mixed by hand with the corresponding activated carbon were prepared.

**[0025]** In all cases a nominal percentage of 5% by weight of additive is used. Cigarettes were prepared using the procedure described in "Cigarette preparation conditions" and using the activated carbons, the textural characteristics of which are shown in Table 1 (textural characteristics of used activated carbons). Figure 1 shows the corresponding isotherms of N<sub>2</sub> adsorption at 77 K. It can be seen that carbons of high degree of activation and different percentage of mesoporosity have been used.

Table 1

SAMPLE	BET S (m <sup>2</sup> /g)	V <sub>MIC</sub> (cm <sup>3</sup> /g)	V <sub>MESO</sub> (cm <sup>3</sup> /g)
LMA-285	1715	0.56	0.67
LMA-285-Ca	1237	0.43	0.56
LMA-41	2767	0.95	0.32
LMA-47	3263	1.07	0.98
LMA-414	3052	1.02	1.09

**[0026]** All carbons, except LMA-41, have a distinctly mesoporous nature, especially marked in AML-47 and AML-414. It is precisely these carbons which exhibit greater activity, as will be seen in the examples presented. The appearance of the materials used can be seen in Figure 2, where it can be seen that most of the particles are greater than 10 µm, as well as the presence of particles with a size close to 200 µm.

**[0027]** Examples corresponding to different tobacco-activated carbon mixtures.

**[0028]** Table 2 shows the mixtures tested as an example of the effect of different activated carbons on the tobaccos of reference 3R4F and two commercial tobaccos (TOBACCO 1 and TOBACCO 2).

Table 2

<i>Mixtures studied</i>
3R4F+LMA-414
3R4F+LMA-285
3R4F+LMA-285-Ca
TOBACCO 1 + LMA-41
TOBACCO 1 + LMA-414
TOBACCO 1 + LMA-47
TOBACCO 2 + LMA-47

**[0029]** In Tables 3, 4, 5 and 6 the results obtained by smoking the cigarettes using the preparation conditions of the cigarettes, the smoking and analysis conditions of the product generated corresponding to different tobacco-additive

mixtures are presented. The obtained values are shown for:

- CO and CO<sub>2</sub> in mg of compound/cigarette
- amount of some toxic products, in mg of compound/cigarette
- total particulate matter (TPM) in mg/cigarette, calculated as:

$$m_{TPM} = \frac{m_1 - m_0}{q}$$

where:

- $m_0$  is the mass of the trap subsequent to the filter, in mg, before smoking
- $m_1$  is the mass of the trap subsequent to the filter, in mg, after smoking  $q$  cigarettes
- $q$  is the number of cigarettes smoked

**[0030]** Table 3 shows the content of CO and CO<sub>2</sub> in the tobacco smoke generated under controlled conditions.

Table 3

<b>Sample</b>	<b>CO<sub>2</sub> (mg/cigarette)</b>	<b>CO (mg/cigarette)</b>
3R4F	40.9	6.92
3R4F+LMA-414	36.9	5.55
3R4F+LMA-285	44.9	7.24
3R4F+LMA-285-Ca	38.7	7.21
TOBBACO 1	35.4	6.82
TOBACCO 1 + LMA-41	32.8	6.23
TOBACCO 1 + LMA-414	36.4	6.51
TOBACCO 1 + LMA-47	30.0	5.75
TOBACCO 2	38.3	6.31
TOBACCO 2 + LMA-47	26.2	3.25

**[0031]** Table 4 shows the percentage of carbon, number of puffs, tobacco amount per cigarette, and TPM obtained by smoking tobacco under controlled conditions.

Table 4

<b>Sample</b>	<b>% carbon</b>	<b>puffs</b>	<b>mg tobacco/cigarette</b>	<b>TPM (mg/cigarette)</b>
3R4F	0.00	8	0.797	6.03
3R4F+LMA-414	3.97	8	0.796	1.08
3R4F+LMA-285	4.18	9	0.841	5.45
3R4F+LMA-285-Ca	4.13	8	0.836	4.18
TOBACCO 1	0.00	8	0.817	6.23
TOBACCO 1 + LMA-41	4.44	8	0.823	3.10
TOBACCO 1 + LMA-414	3.93	8	0.770	2.60
TOBACCO 1 + LMA-47	3.96	8	0.806	3.73
TOBACCO 2	0.00	8	0.838	5.63

(continued)

<b>Sample</b>	<b>% carbon</b>	<b>puffs</b>	<b>mg tobacco/cigarette</b>	<b>TPM (mg/cigarette)</b>
TOBACCO 2 + LMA-47	3.71	8.5	0.854	0.87

**[0032]** Table 5 shows the generation (mg compound/cigarette) of different toxic compounds present in the gases collected in the Tedlar bag after smoking tobacco under controlled conditions.

<b>Sample</b>	<b>Propionaldehyde</b>	<b>Toluene</b>	<b>Benzene</b>	<b>Acetaldehyde</b>
3R4F	1.55E-02	2.11E-02	9.71E-02	4.25E-01
3R4F+LMA-414	1.00E-02	1.14E-02	7.51E-02	2.59E-01
3R4F+LMA-285-Ca	1.67E-02	1.55E-02	8.78E-02	3.63E-01
TOBACCO 1	1.26E-02	2.13E-02	8.03 E-02	4.47E-01
TOBACCO 1 + LMA-414	1.19E-02	1.74E-02	9.93 E-02	4.77E-01
TOBACCO 2	1.29E-02	1.68E-02	7.02 E-02	3.29E-01
TOBACCO 2 + LMA-47	5.40E-03	4.10E-03	3.41 E-02	1.03E-01

Table 5

<b>Sample</b>	<b>HEN</b>	<b>Crotonaldehyde</b>
3R4F	7.80E-03	7.00E-03
3R4F+LMA-414	7.85E-03	4.10E-03
3R4F+LMA-285-Ca	8.10E-03	5.10E-03
TOBACCO 1	4.60E-03	4.80E-03
TOBACCO 1 + LMA-414	9.70E-03	4.00E-03
TOBACCO 2	7.90E-03	5.20E-03
TOBACCO 2 + LMA-47	6.10E-03	2.80E-03

Table 5 continued.

**[0033]** Table 6 shows the generation (mg compound/cigarette) of different toxic compounds present in the condensable products retained in the trap subsequent to the filter when smoking tobacco under controlled conditions.

Table 6

<b>Sample</b>	<b>Nicotine</b>	<b>Phenol</b>	<b>p-Cresol</b>	<b>Hydroquinone</b>	<b>Miosmine</b>	<b>Cotinine</b>
3R4F	4.77E-01	1.80E-04	--	2.23E-03	2.46E-03	2.41 E-03
3R4F+LMA-414	1.94E-01	--	--	--	--	6.60E-04
3R4F+LMA-285-Ca	3.06E-01	--	--	3.06E-03	8.20E-04	1.35E-03
TOBACCO 1	4.67E-01	5.50E-04	--	3.94E-03	1.24E-03	2.83E-03
TOBACCO 1 + LMA-414	1.91E-01	--	--	1.52E-03	5.40E-04	4.70E-04
TOBACCO 2	4.56E-01	1.25E-03	1.15E-03	1.75E-02	2.74E-03	4.01 E-03
TOBACCO 2 + LMA-47	5.22E-02	--	--	--	--	4.50E-04

**[0034]** Tables 3 to 6 evidence that some of the activated carbons considered in the examples, especially those of higher mesoporous character, provide a significant reduction in the amount of toxic compounds found in tobacco smoke, being especially appreciable in the compounds analysed in the condensed liquid fraction. A total of up to 33 compounds in gases and 84 in liquids retained in the trap and corresponding to the peaks of larger area have been analysed. As can be seen in the chromatograms presented, all peaks experience a noticeable reduction, as shown for some selected exemplary compounds in the tables above. Many of the compounds are virtually eliminated in the presence of the catalyst. This reduction in turn means a reduction in the potential negative effects caused by tobacco smoke in active and passive smokers, without causing appreciable changes in tobacco organoleptic properties, flavour and consistency, and without the apparent generation of other undesirable compounds. Furthermore, not only toxic compounds are reduced, but, in general, it also appreciably reduces the total amount of gases and liquids that are formed when smoking the cigarette (total particulate matter, TPM, plus liquids retained in the filter), while increasing the solid residue together with the ashes. Moreover, no presence of the catalyst in the filters has been detected.

**[0035]** As previously evidenced, the use of some of these additives causes a significant reduction of the toxic substances that are present in the tobacco smoke, such as CO, nicotine, etc., as well as the total amount of liquid and gaseous products. For example, in Table 3, the results obtained for the production of CO and CO<sub>2</sub> are shown expressed in mg of compound/cigarette for a reference cigarette and for mixtures with some of the activated carbons, which may be considered representative of the rest. As can be seen, the amount of CO obtained when some of the activated carbons were used is reduced from 20 to 50%, depending on the tobacco used, while that of CO<sub>2</sub> is reduced in the order of 10-30%. In some cases, carbons do not produce reductions in these compounds. Furthermore, according to the data presented in Table 4, and as already evidenced, the studied materials also reduce the amount of condensed liquid products reaching a reduction of TPM between 20-80% the value obtained in the reference cigarette. Table 5 shows, by way of example, the results for the production of some of the toxic and carcinogenic compounds present in tobacco smoke. As can be seen, in most cases, the use of the proposed additives provides a reduction of more than 20% for many compounds, although, as discussed above, the reductions achieved in the gaseous fraction are less than those achieved in the condensed liquid fraction. For example, when LMA-414 is used as additive with reference tobacco 3R4F, the following reductions were observed with respect to the reference cigarette (% reduction = 100 (1-m/r) where m = amount obtained when using the additive, r = amount obtained in the reference cigarette):

9.9% CO<sub>2</sub>; 19.9% CO; 82% TPM; 59.4% nicotine; 72.6% cotinine, 38.9% acetaldehyde; 46.0% toluene, and 22.7% benzene.

**[0036]** Figures 3 to 5 and 6 to 8 show two chromatograms corresponding to the liquid contained in the Cambridge filters (subject to identical processes for the extraction and corresponding to smoking 10 cigarettes) when the tobacco 3R4F and TOBACCO 1 were smoked and mixed with the carbon AML-414, respectively. The chromatograms have been divided into three to clearly observe the various compounds, for this, the central area thereof, corresponding to retention times where nicotine appears (major component) are displayed enlarged in the y-axis.

**[0037]** It can be seen that all detected peaks have significantly reduced their area; some of them have even totally disappeared.

**[0038]** Furthermore, all mixtures described may also be prepared by using speed mixers, fluidised or driven beds and any other equipment that promotes the mixture between the tobacco fibre and the additive. Sieves can also be used to separate and recirculate the additive that has not been fixed onto the tobacco fibres. Furthermore, for other different preparations of conventional cigarettes, where the preparation of the tobacco-additive mixtures are to be performed manually by the smoker him/herself, a dispenser can be used that provides the proper amount of catalyst for the preparation of blond, black, leaf bite, rolling, pipe tobacco, and any other capable of being smoked. This dispenser may be a blister, where each cavity contains the selected amount (between 5 and 70 mg, so as to obtain between 0.5 and 10% with respect to tobacco, which will be usually consumed in portions of about 1 g tobacco), individual capsules containing such quantities, a container including a calibrated or graduated spoon or any other calibrated dispenser or packaging form allowing the proper dosage. To prepare the product ready to smoke (MYO, RYO, pipe or other forms), the content of the calibrated dispenser or selected container is poured onto the tobacco fibre and thoroughly mixed by hand. This procedure guarantees excellent results, which are as good as those presented in Tables 3 to 6.

**[0039]** These activated carbons can also be used mixed with other additives or impregnated with non-toxic materials of the type of compounds of potassium, calcium, sodium, iron, which can modify their performance and the evolution of CO type compounds.

## Claims

1. A use of mesoporous activated carbons with a particle size comprised between 1-100  $\mu\text{m}$ , with a surface  $S_{\text{BET}}$



comprised between 1200-4200 m<sup>2</sup>/g, a volume V<sub>MIC</sub> comprised between 0.4-1.2 cm<sup>3</sup>/g and a volume V<sub>MESO</sub> comprised between 0.6-2.8 cm<sup>3</sup>/g as an additive to reduce toxic and carcinogenic substances in the tobacco smoke.

2. The use according to Claim 1, wherein the particle size is comprised between 2-20 μm.
3. The use according to any of the preceding claims, wherein the particle size is comprised between 5-15 μm.
4. The use according to any of the preceding claims, wherein the mesoporous activated carbons are impregnated with materials of the type of carbonates or hydroxides of metals, such as Na, Ca, Fe, Ce or Zr, or mixed with zeolite or aluminosilicates, or mixed with acid or sodium forms, or exchanged with oxides of Fe, Ce, or Zr or mixtures thereof of zeolites or aluminosilicates.
5. A mixture comprising dry tobacco and mesoporous activated carbons, with a particle size comprised between 1-100 μm, with a surface S<sub>BET</sub> comprised between 1200-4200 m<sup>2</sup>/g, a volume V<sub>MIC</sub> comprised between 0.4-1.2 cm<sup>3</sup>/g and a volume V<sub>MESO</sub> comprised between 0.6-2.8 cm<sup>3</sup>/g as an additive.
6. The mixture according to Claim 5, wherein the particle size of the mesoporous activated carbons is comprised between 2-20 μm.
7. The mixture according to Claim 6, wherein the particle size of the mesoporous activated carbons is comprised between 5-15 μm.
8. The mixture according to Claim 5, **characterised in that** the mesoporous activated carbons are in a concentration comprised between 0.5-15% by weight with respect to dry tobacco.
9. The mixture according to Claim 8, **characterised in that** the mesoporous activated carbons are in a concentration comprised between 2-7% by weight with respect to dry tobacco.
10. The mixture according to any of Claims 5-9, **characterised in that** the mesoporous activated carbons of the mixture have a particle size comprised between 5 and 15 μm, with a surface S<sub>BET</sub> greater than 3000 m<sup>2</sup>/g, a volume V<sub>MIC</sub> greater than 1.1 cm<sup>3</sup>/g and a volume V<sub>MESO</sub> greater than 2.0 cm<sup>3</sup>/g.

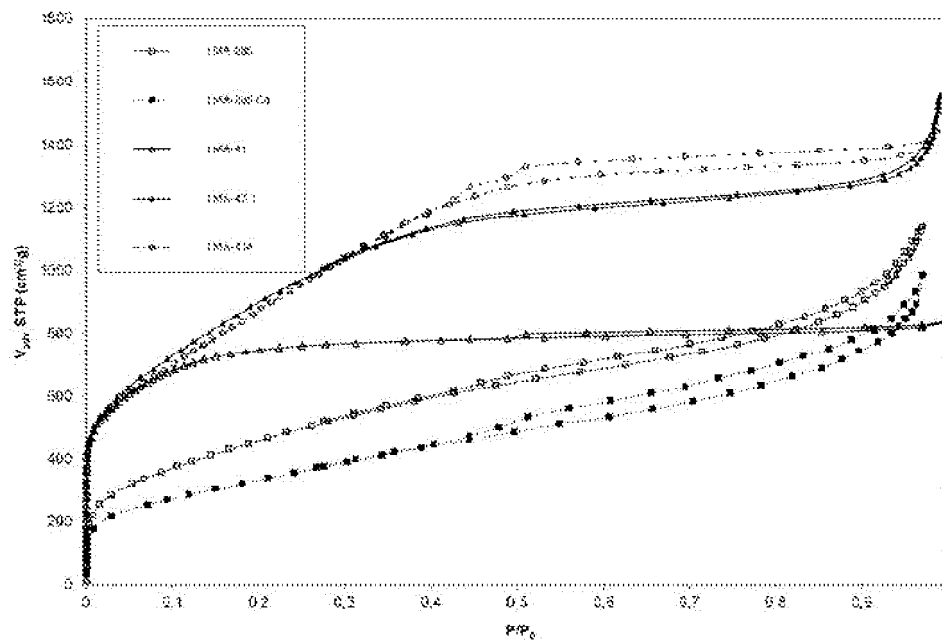


FIGURE 1

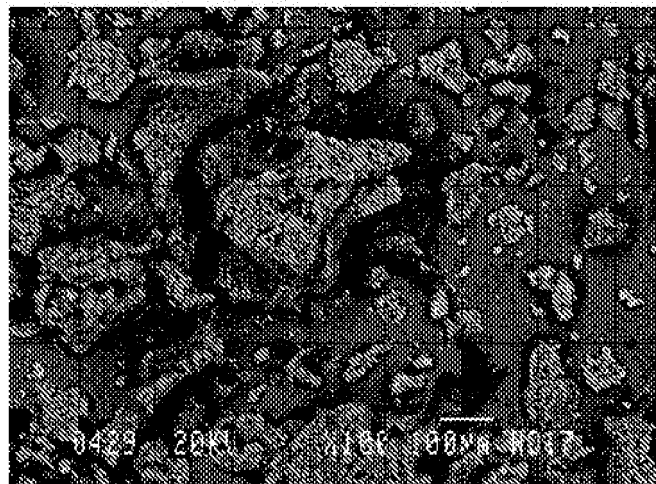
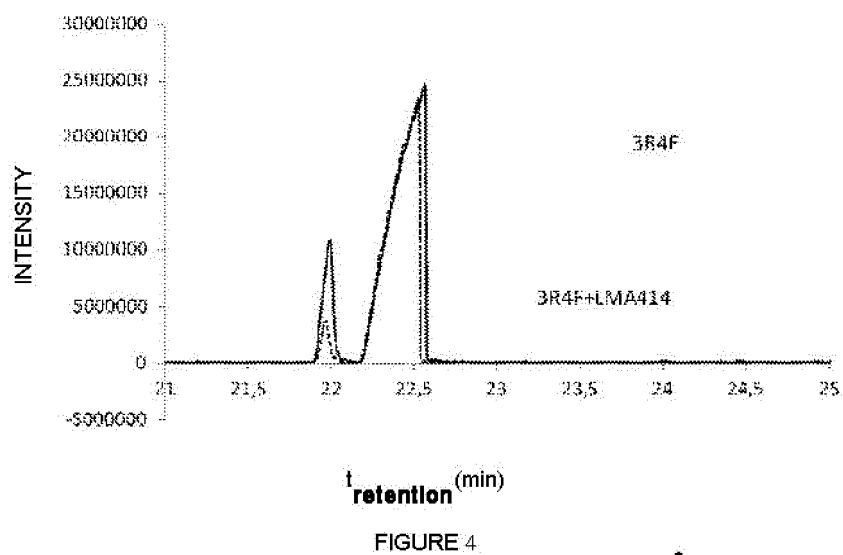
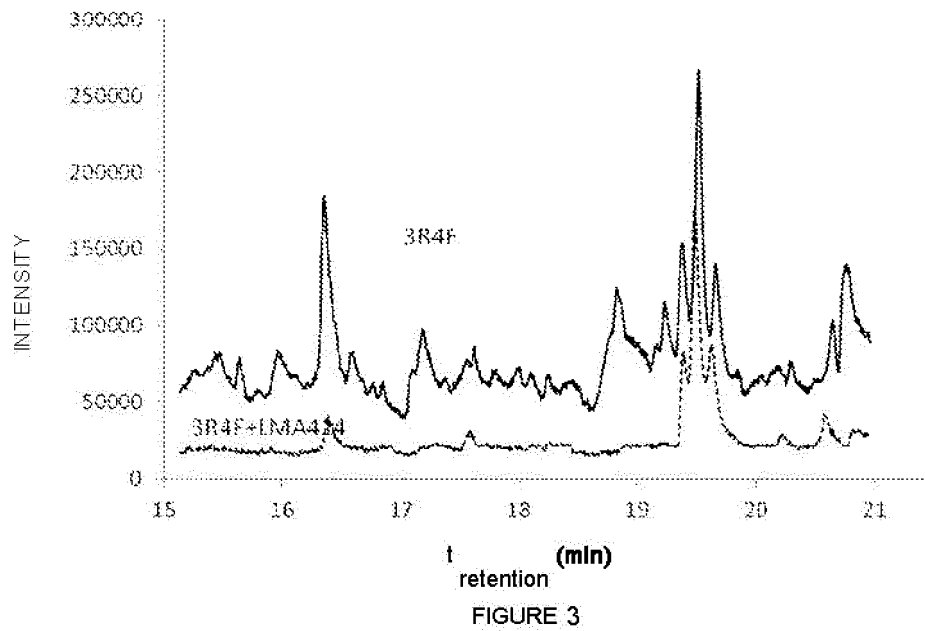


FIGURE 2



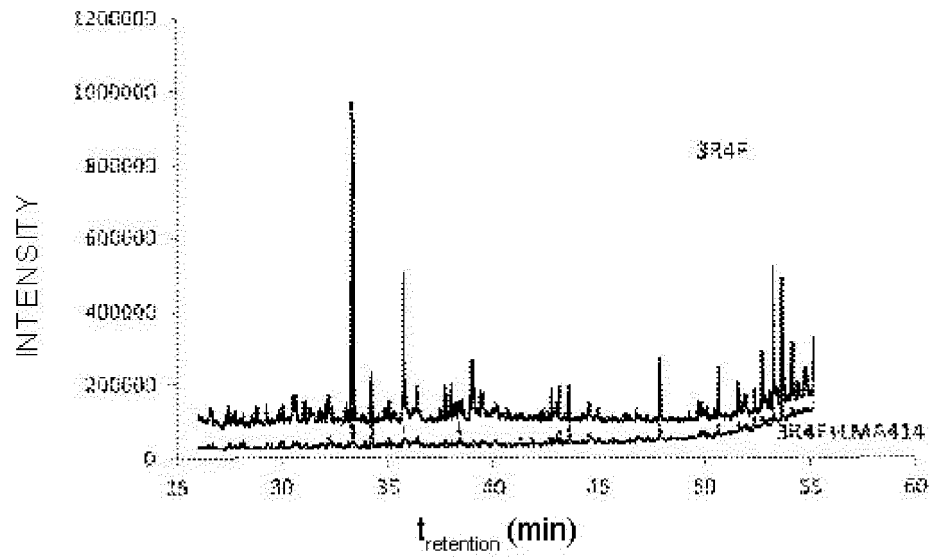


FIGURE 5

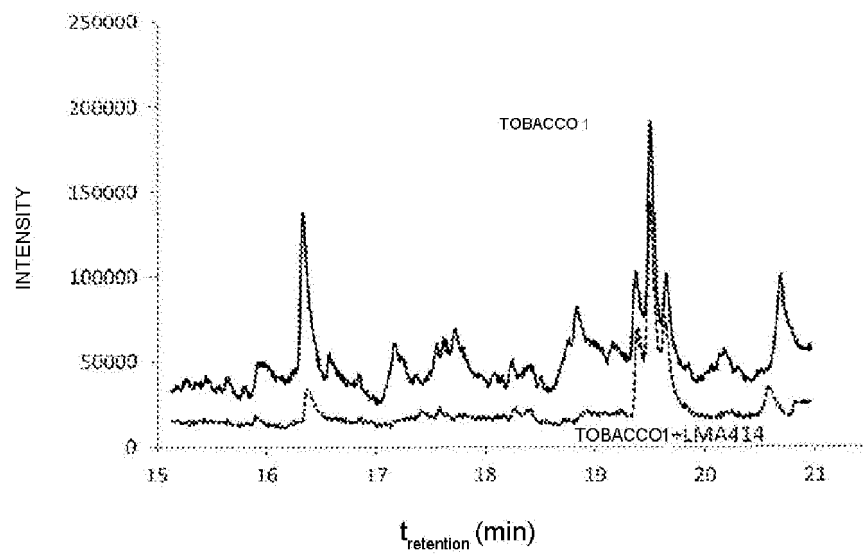


FIGURE 6

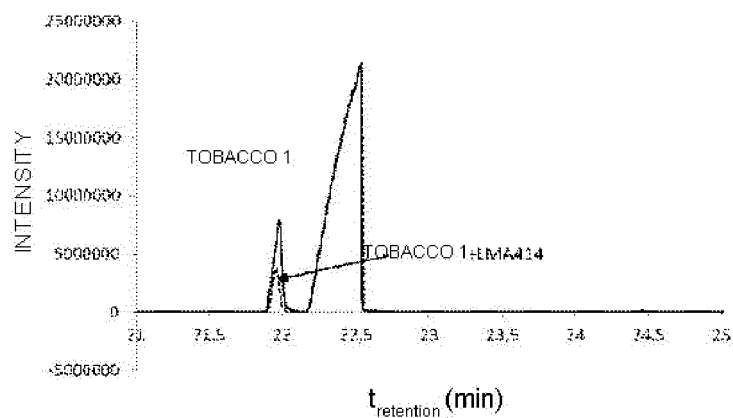


FIGURE 7

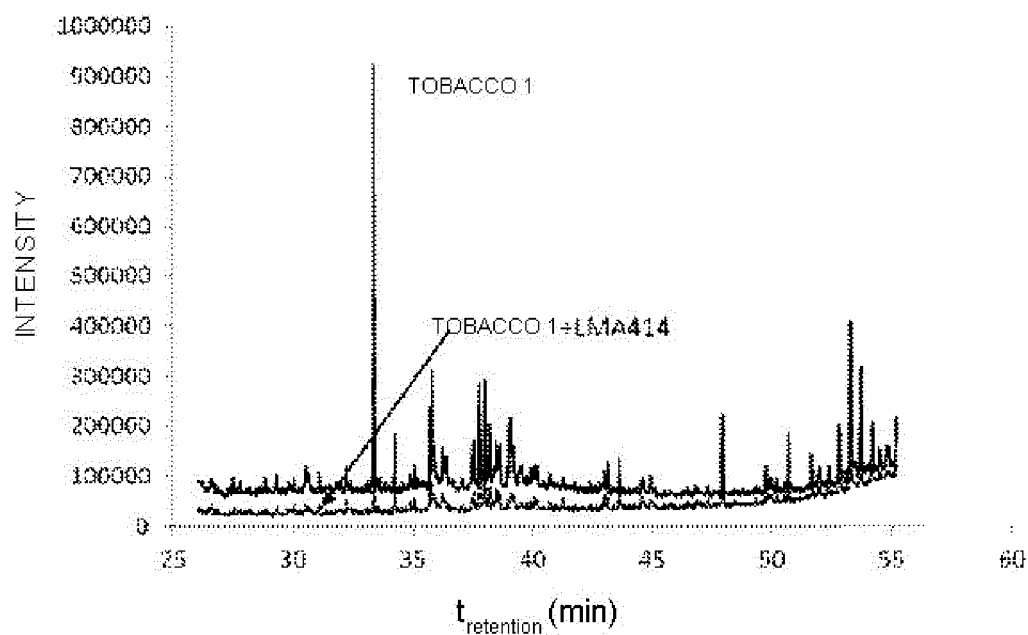


FIGURE 8

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/ES2014/070204

## A. CLASSIFICATION OF SUBJECT MATTER

**A24B15/28** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**A24B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPODOC, INVENES, WPI, CAS**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2012032349 A1 (BRITISH AMERICAN TOBACCO CO ET AL.) 15/03/2012, description	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

**28/04/2014**

Date of mailing of the international search report

**(05/05/2014)**

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International application No.

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