



(51) International Patent Classification:

A24D 3/12 (2006.01) A24F 47/00 (2006.01)
A24D 3/16 (2006.01)

(21) International Application Number:

PCT/GB2015/051995

(22) International Filing Date:

9 July 2015 (09.07.2015)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1412752.6 17 July 2014 (17.07.2014) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: ELECTRONIC VAPOUR PROVISION SYSTEM

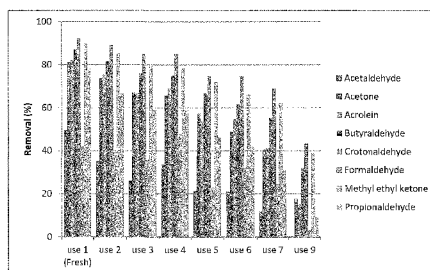


Figure 1(i) - 60mg AC (HPLC).

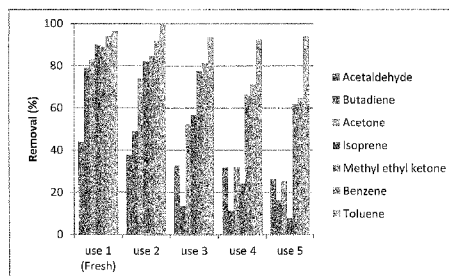


Figure 1(ii) - 60mg AC (TOF-MS).

(57) Abstract: There is provided an electronic vapour provision system comprising: a vaporiser for vaporising liquid for inhalation by a user of the electronic vapour provision system; a power supply comprising a cell or battery for supplying power to the vaporiser; and a filter for filtering vaporised liquid prior to inhalation by the user of the electronic vapour provision system, wherein the filter can partially or completely remove from the vapour one or more aldehydes present in the vapour.

ELECTRONIC VAPOUR PROVISION SYSTEM

FIELD OF THE INVENTION

- 5 The present disclosure relates to electronic vapour provision systems such as electronic nicotine delivery systems (e.g. e-cigarettes).

BACKGROUND TO THE INVENTION

- 10 Electronic vapour provision systems such as e-cigarettes generally contain a reservoir of liquid which is to be vaporised, typically nicotine. When a user inhales on the device, a heater is activated to vaporise a small amount of liquid, which is therefore inhaled by the user.
- 15 The use of e-cigarettes in the UK has grown rapidly, and it has been estimated that there are now over a million people using them in the UK.

During the operation of electronic vapour provision systems, the heater may heat the liquid to be vaporised to an extent that some undesirable impurities are formed by the heating. For
20 example, the liquid may be heated to the extent that undesirable aldehyde compounds may be formed. Such compounds may impact on the taste of the inhaled vapour.

SUMMARY OF THE INVENTION

- 25 In one aspect, there is provided an electronic vapour provision system comprising:
 a vaporiser for vaporising liquid for inhalation by a user of the electronic vapour provision system;
 a power supply comprising a cell or battery for supplying power to the vaporiser; and
 a filter for filtering vaporised liquid prior to inhalation by the user of the electronic
30 vapour provision system,
 wherein the filter can partially or completely remove from the vapour one or more aldehydes present in the vapour.

We have found that aldehydes, which are undesirable at least because of the taste which
35 they may impart to the vapour, may be produced by the heating of the liquid to be vaporised. We have found that the aldehydes have a particular tendency to form in vapour provision systems, such as e-cigarettes, and this is especially the case towards the end of the use of

the vapour provision system. Towards the end of the use of the system when the amount of liquid present in the device is low, the heater may contact a relatively small amount of liquid and heat the liquid to a temperature which is higher than the typical temperature during the majority of the operation of the device. This is a problem unique to electronic vapour provision systems containing a heating element. The provision of a filter that can partially or completely remove from the vapour one or more aldehydes present in the vapour addresses this problem.

That filters can be provided which remove aldehydes from the vapour of electronic vapour provision systems was surprising at least because the airflow observed in such vapour provision systems is very different to that seen in systems where similar filters have previously been used, such as in combustible tobacco products. Furthermore, the number of puffs taken on a single electronic vapour provision system, such as an e-cigarette, can be as high as 250 or 300. In contrast the number of puffs taken on a single combustible cigarette is typically less than 10.

For ease of reference, these and further aspects of the present invention are now discussed under appropriate section headings. However, the teachings under each section are not necessarily limited to each particular section.

DETAILED DESCRIPTION

As described above, the present disclosure relates to an electronic vapour provision system, such as an e-cigarette. Throughout the following description the term "e-cigarette" is used; however, this term may be used interchangeably with electronic vapour provision system.

As discussed herein, the filter used in the present invention can partially or completely remove from the vapour one or more aldehydes present in the vapour. In one aspect, the filter partially or completely removes at least one aldehyde present in the vapour. In one aspect, the filter partially or completely removes at least two aldehydes present in the vapour. In one aspect, the filter partially or completely removes at least three aldehydes present in the vapour. In one aspect, the filter partially or completely removes each aldehyde present in the vapour.

As will be understood by one skilled in the art when aldehydes are formed in an electronic vapour provision system, some of the aldehydes are present in the particulate phase and some of the aldehydes are present in the vapour phase. The filter of the present invention

acts to selectively remove aldehydes from the vapour phase and the purpose of the filter is not to remove aldehydes from the particulate phase. In the present specification (unless otherwise stated) all references to removal of aldehydes from the vapour phase refer only to the removal of aldehydes within that vapour phase and not the removal of any aldehydes within the particulate phase. It will be understood by one skilled in the art that the particulate phase may be carried by the vapour phase. References in the present specification to the removal of particular amounts of aldehyde from the vapour phase are based (unless otherwise stated) on the amount of aldehyde in the vapour phase and do not refer to or include the amount of aldehyde present in the particulate phase, irrespective of whether that particulate phase is carried by the vapour phase.

By the term "partially removes" it is meant that during an inhalation of vapour through the filter at least a portion of aldehyde is removed. In one aspect the term "partially removes" means at least 10 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 20 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 30 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 40 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 50 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 60 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 70 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 80 wt.% of aldehyde present in the vapour is removed from the vapour by the filter. In one aspect the term "partially removes" means at least 90 wt.% of aldehyde present in the vapour is removed from the vapour by the filter.

It is desirable that the filter of the present invention remains active over a significant number of uses. In particular it is desirable that the filter of the present invention remains active over the large number of inhalations which an e-cigarette is designed to provide. In one aspect after 30 inhalations of vapour have passed through the filter at least 30 wt.% of the one or more aldehydes present in the vapour are removed from the vapour by the filter. In one aspect after 30 inhalations of vapour have passed through the filter at least 40 wt.% of the one or more aldehydes present in the vapour are removed from the vapour by the filter. In one aspect after 30 inhalations of vapour have passed through the filter at least 50 wt.% of the one or more aldehydes present in the vapour are removed from the vapour by the filter.

In one aspect after 30 inhalations of vapour have passed through the filter at least 60 wt.% of the one or more aldehydes present in the vapour are removed from the vapour by the filter.

- 5 In one aspect after 30 inhalations of vapour have passed through the filter at least 30 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 30 inhalations of vapour have passed through the filter at least 40 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 30 inhalations of vapour have passed through the filter at least 50 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 30 inhalations of vapour have passed through the filter at least 60 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter.

- 15 In one aspect after 100 inhalations of vapour have passed through the filter at least 20 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 100 inhalations of vapour have passed through the filter at least 30 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 100 inhalations of vapour have passed through the filter at least 40 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 100 inhalations of vapour have passed through the filter at least 50 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 100 inhalations of vapour have passed through the filter at least 60 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter.

- 25 In one aspect after 250 inhalations of vapour have passed through the filter at least 20 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 250 inhalations of vapour have passed through the filter at least 30 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 250 inhalations of vapour have passed through the filter at least 40 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 250 inhalations of vapour have passed through the filter at least 50 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 250 inhalations of vapour have passed through the filter at least 60 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter.

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In one aspect after 300 inhalations of vapour have passed through the filter at least 20 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect

after 300 inhalations of vapour have passed through the filter at least 30 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 300 inhalations of vapour have passed through the filter at least 40 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect
5 after 300 inhalations of vapour have passed through the filter at least 50 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter. In one aspect after 300 inhalations of vapour have passed through the filter at least 60 wt.% of formaldehyde present in the vapour is removed from the vapour by the filter.

- 10 The nature of the aldehydes to be removed from the vapour may depend on the liquid being vaporised. In one aspect the vapour contains and the filter can partially or completely remove from the vapour one or more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour two or
15 more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour three or more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the
20 vapour four or more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour five or more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde. In one aspect the vapour contains and the filter can partially or completely
25 remove from the vapour each of acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde.

In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least one or more aldehydes selected from acetaldehyde, acrolein and
30 formaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour two or more aldehydes selected from acetaldehyde, acrolein and formaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour each of acetaldehyde, acrolein and formaldehyde.

- 35 In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least formaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least acetaldehyde. In one aspect the vapour contains

and the filter can partially or completely remove from the vapour at least acrolein. In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least acetaldehyde and formaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least acrolein and formaldehyde.

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A "key" aldehyde to be removed from vapour is formaldehyde. In one aspect the vapour contains and the filter can partially or completely remove from the vapour at least formaldehyde. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least 10 wt.% of the formaldehyde present in the vapour. In one aspect
10 the vapour contains formaldehyde and the filter can remove from the vapour at least at least 20 wt.% of the formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 30 wt.% of the formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 40 wt.% of the formaldehyde present in
15 the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 50 wt.% of the formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 60 wt.% of the formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 70 wt.% of the
20 formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 80 wt.% of the formaldehyde present in the vapour. In one aspect the vapour contains formaldehyde and the filter can remove from the vapour at least at least 90 wt.% of the formaldehyde present in the vapour.

25 The filter can partially or completely remove from the vapour one or more aldehydes present in the vapour. As will be understood by one skilled in the art the effectiveness of the filter will depend on the extent to which it has already filtered aldehyde from the vapour. The removal may be achieved by any known mechanism by which a filter material may remove a constituent from a vapour. Typically the filter adsorbs the one or more aldehydes or the filter
30 reacts with one or more aldehydes. In one aspect, the filter adsorbs the one or more aldehydes. As will be understood by one skilled in the art, in this context, adsorption is the adhesion to a surface of the filter material aldehyde present in the vapour. In one aspect, the filter reacts with one or more aldehydes. In the process known as chemisorption, a bond will be formed between aldehyde and the material of the filter. In a typical and preferred aspect,
35 the filter is provided with an amine functional group. When an amine functional group reacts with an aldehyde it forms an imine.

In one aspect, the filter physically adsorbs the one or more aldehydes. In this aspect, the filter may be selected from any suitable adsorbent materials. In this aspect, preferably the filter comprises or is activated carbon (AC).

- 5 In one aspect, the filter reacts with aldehydes. In this aspect, the filter may be selected from any suitable materials which may react with the one or more aldehydes. As discussed above, preferably this is achieved by selection of a filter containing or carrying an amine functional group which reacts with an aldehyde. In one aspect, the filter is a resin having polyamine groups bonded to a cross-linked polystyrene matrix. Preferably the reactive filter material is an ion exchange resin.

10 Ion exchange resins are highly ionic, covalently cross-linked, insoluble polyelectrolytes. They are often supplied as porous beads or granules, their high surface area:volume ratio maximising the rate of ion exchange and the total ion exchange capacity. They can be precisely engineered to have a particular porosity and surface chemistry (i.e. surface functional groups for ion exchange), these features facilitating selective and effective ion exchange. They can be fabricated by cross-linking polymer molecules. In some cases, they can be made by cross-linking polystyrene using the cross-linking agent, divinylbenzene.

- 20 The composition of the present invention may comprise any ion exchange resin as long as it is suitable for incorporating into an e-cigarette. In some embodiments, the ion exchange resin may comprise ion exchange resin beads. In these embodiments, the beads may have any suitable size (i.e. diameter) and any suitable size distribution. In some embodiments, the beads may have a mean diameter of from about 20 to about 1200 μm , from about 100 to about 1100 μm , from about 200 to about 1000 μm , from about 300 to about 900 μm , from about 400 to about 800 μm , from about 500 to about 700 μm , or about 600 μm .

30 In some embodiments, the ion exchange resin may comprise porous ion exchange resin beads. In these embodiments, the beads may have any suitable porosity. The porosity of the beads may be precisely engineered by controlling the conditions used in resin synthesis, such as the concentration of the cross-linking agent. The porosity of the beads can affect the surface area:volume ratio of the resin. The ion exchange resin may have any suitable surface area:volume ratio, although in some embodiments it may be beneficial to maximise the surface area:volume ratio in order to maximise the rate of, and capacity for, ion exchange.

In some embodiments, the ion exchange resin may have a BET surface area of about 10 –

300 m²/g. In some embodiments, the ion exchange resin may have a BET surface area of from about 15 to about 250 m²/g, from about 20 to about 200 m²/g, from about 25 to about 150 m²/g, from about 30 to about 100 m²/g, from about 35 to about 80 m²/g, from about 40 to about 60 m²/g, from about 45 to about 55 m²/g, or about 50 m²/g.

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In some embodiments, the ion exchange resin may have a mass density of from about 0.1 to about 1 g/cm. In some embodiments, the ion exchange resin may have a mass density of from about 0.1 to about 0.9 g/cm, from about 0.2 to about 0.8 g/cm, from about 0.3 to about 0.7 g/cm, from about 0.4 to about 0.6 g/cm, or about 0.5 g/cm.

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In some embodiments, the ion exchange resin may have a total exchange capacity of from about 0.5 to about 20 meq/cm³. In some embodiments, it may be beneficial to maximise the total exchange capacity to maximise the number of ions that can be adsorbed from vapour. In some embodiments, the resin may have a total exchange capacity of from about 0.1 to about 18 meq/cm³, from about 0.5 to about 15 meq/cm³, or from about 0.7 to about 10 meq/cm³. In some embodiments, the total exchange capacity of the resin is from about 0.5 to about 2 meq/cm³.

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The filter may be present in any suitable amount to provide the required extent of filtration. In some embodiments, the filter is present in an amount of from 10 to 100 mg, such as in an amount of from 20 to 80 mg, such as in an amount of from 30 to 70 mg, such as in an amount of from 30 to 50 mg, such as in an amount of from 40 to 70 mg, such as in an amount of from 50 to 70 mg. In some embodiments, the ion exchange resin is present in an amount of from 10 to 100 mg, such as in an amount of from 20 to 80 mg, such as in an amount of from 30 to 70 mg, such as in an amount of from 30 to 50 mg, such as in an amount of from 40 to 70 mg, such as in an amount of from 50 to 70 mg.

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In some embodiments, the ion exchange resin may comprise one type of functional group. In other embodiments, it may comprise two or more types of functional group. Having one type of functional group may make the resin more selective in ion exchange, and result in a smaller range of ionic species being adsorbed. Having two or more functional groups may make the resin less selective in ion exchange, and result in a greater range of ionic species being adsorbed.

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The functional groups of the resin may be anionic, cationic, and/or neutral. In some embodiments, they may be suitable for removing one or more compounds from vapour. In some embodiments, they may be suitable for removing one or more compounds from vapour

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which are undesirable for human inhalation. They are of course suitable for removing aldehydes, such as formaldehyde, acrolein and acetaldehyde from vapour.

In some embodiments, the composition of the invention comprises a Diaion® CR20 ion exchange resin. In some embodiments, the composition of the invention comprises a XORBEX ion exchange resin. The surface chemistries and porosities of these resins make them highly effective for the selective adsorption of compounds from vapour.

It may be beneficial for the composition of the invention to comprise a Diaion® CR20 resin. Diaion® CR20 resin is a resin having polyamine groups bonded to a cross-linked polystyrene matrix. Diaion® CR20 resins have previously been used in combustible tobacco products, such as cigarettes, because they can selectively and effectively remove compounds by ion exchange. They have amine functional groups with a high affinity for aldehydes and cyanides. They can thus selectively remove constituents that are undesirable for human inhalation, such as formaldehyde, acrolein and acetaldehyde.

We have found that the use of filter formed from a resin having polyamine groups bonded to a cross-linked polystyrene matrix, such as Diaion® CR20 resin, is particularly advantageous because of the large number of uses over which aldehydes are adsorbed and in particular the large number of uses over which formaldehyde is adsorbed. The longevity of such resins particularly in respect of formaldehyde is extremely useful in the field of e-cigarettes and no suggestion of such advantages can be found in the prior art.

In embodiments wherein the composition of the invention comprises a Diaion® CR20 resin, the Diaion® CR20 resin may have any suitable properties. In some embodiments, the Diaion® CR20 resin may comprise beads with a mean diameter of from about 500 to about 700 μm , a density of from about 0.4 to about 0.6 g/cm^3 , and a total exchange capacity of from about 0.5 to about 2 meq/cm^3 . In some embodiments, the Diaion® CR20 resin may comprise beads with a mean diameter of about 600 μm , a density of about 0.5 g/cm^3 , and a total exchange capacity of about 1 meq/cm^3 .

In some embodiments the filter is or comprises an ion exchange resin has one or more of the following properties: a mean bead diameter of from about 20 to about 1200 μm ; a BET surface area of from about 10 to about 300 m^2/g ; a mass density of from about 0.1 to about 1 g/cm^3 ; and a total exchange capacity of from about 0.5 to about 2 meq/cm^3 .

The invention will now be described with reference to the following non-limiting example.

Example

The aim of the current study was to investigate a filter material that could still exhibit some filtration efficiency when used for multiple inhalations. Synthetic AC beads (Blücher GmbH) which have been found to be an exceptionally efficient filter and CR20 (Mitsubishi Chemical Company) which is selective and highly efficient for aldehydes (and especially formaldehyde), were chosen as the adsorbents of choice [Branton et al., Adsorption Sci. & Technology, 29, 117-138 (2011), Branton et al., Chem.Central. 5:15 (2011)].

EXPERIMENTAL

Activated Carbon was supplied by Blücher GmbH. CR20 was supplied by Mitsubishi Chemical Company. Material characteristics are shown in Table 1.

Table 1 – Filter Additive Characteristics

Adsorbent	AC	CR20
Particle shape	Spherical	Spherical
Mean Particle size (mm)	0.40	0.60
Apparent density (g/cm ³)	0.37	0.64
*Surface area (m ² /g)	1660 (micro/meso/macroporous)	44 (macroporous)
*Total pore volume (cm ³ g ⁻¹)	0.94	0.08
Surface chemistry	-	Amine functionality

*From nitrogen adsorption at 77 K

A predetermined weight of additive (60-150 mg) was weighed into a filter. Each use was six puffs, equivalent to smoking one tobacco cigarette.

Selected aldehydes were measured using real time Time of Flight Mass Spectrometry (TOF-MS) (acetaldehyde, 1,3-butadiene, acetone, isoprene, MEK, benzene, toluene) and HPLC (acetaldehyde, acetone, acrolein, butyraldehyde, crotonaldehyde, formaldehyde, MEK, propionaldehyde). Aldehyde yields were measured from the whole aerosol (vapour+particulate phases). It is known that 70% of formaldehyde is present in the vapour phase, selective filtration of formaldehyde (or any compound) in the particulate phase is extremely unlikely and thus a selective reduction of 70% is the maximum likely. By contrast,

other aldehydes such as acetaldehyde are essentially exclusively in the vapour phase and thus a 100% selective removal is theoretically possible.

AC samples were also evaluated using a Rubotherm InfraSorp (Fraunhofer Institute, Dresden, Germany) which enables material (both fresh and previously contacted with aldehydes) to be screened for their adsorption characteristics.

n-Butane was used as the test adsorbate gas. The sample size required was only 200mg and 20 samples could be screened in 2 hours.

RESULTS AND DISCUSSION

Figures 1(i) to (v) shows the effect on filtration efficiency as a function of usage using 60mg and 150mg of Activated Carbon beads in the filter by TOF-MS and HPLC analytical procedures and 60mg CR20 by HPLC.

Despite the different analytical methods used for the measurement of aldehydes, it is clear from the figures that there was good agreement between the two techniques. Filtration efficiencies differ for different aldehydes, i.e. each aldehydes has a different breakthrough profile. For example, re-using AC 8 times results in the filtration efficiency falling :
80→20% for acetone & 90→40% for crotonaldehyde using 60mg of AC and
90→60% for acetone & 90→70% for crotonaldehyde using 150mg of AC.

CR20 is an excellent filter for formaldehyde. Even using only 60 mg in the filter, the filtration efficiency does not significantly fall over 5 uses (30 puffs).

By measuring the heat of adsorption (using n-butane) it was found that there was a trend with the filtration performance of a filter material .

Figure 2 shows the thermal response of AC that was used 5 times (using 150 mg in the filter) and 'fresh' AC upon exposure to n-butane gas.

The greater the peak area above the y-axis, the stronger the adsorption (greater heat loss). This implies a greater available surface area and thus greater filtration efficiency. The greater the peak area below the y-axis, the stronger the desorption (greater heat rise) and thus the pores are partially filled suggesting a lower available surface area and lower filtration efficiency (and also higher odour from desorption of volatile species).

The peak areas (weight normalised) for adsorption and desorption and the ratio of desorption to adsorption are shown in Table 2 for AC.

5 Table 2 - Adsorption-Desorption Peak Areas for AC

AC	Adsorption peak area (arb units)	Desorption peak area (arb units)	Desorption:Adsorption ratio
Fresh	13.6	0	0
Used once	6.4	-1.2	-0.2
Used twice	3.8	-2.4	-0.6
Used 3 times	2.3	-5.6	-2.4
Used 5 times	1.5	-9.4	-6.5

As can be seen from Table 2, the adsorption peak area falls with increasing number of uses, whilst the desorption peak increases.

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Purging with dry air at room temperature was investigated to see if the AC surface area could be regenerated.

There is a significant loss in the AC adsorption capacity (for butane) of ca 90% after 5 reuses.

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The percentage of adsorption sites for butane on AC before and after purging are summarised below.

<u>Fresh</u>	<u>used once</u>	<u>used 2 times</u>	<u>used 3 times</u>	<u>used 5 times</u>
100%	46→83%	27→55%	16→48%	11→35%

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The above shows that after one use, the number of available adsorption sites fell to 46%. By purging with dry air at room temperature, the number of available adsorption sites could be increased to 83% (it is extremely difficult to desorb the volatile species from the smallest of pores without using heat and a vacuum and so a 100% regeneration in practice would be unlikely).

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After two uses, the number of available adsorption sites fell to 27%. By purging with dry air at room temperature, the number of available adsorption sites could be increased to 55% and so on.

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CONCLUSIONS

Activated Carbon (60-150mg) can be reused at least 5 times whilst maintaining some enhanced filtration.

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CR20 (60mg) can be reused at least 5 times without a significant drop in formaldehyde filtration efficiency.

The AC activity can be (partially) regenerated via purging with dry air.

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Various modifications and variations of the present invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in chemistry or related fields are intended to be within the scope of the following claims.

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CLAIMS

1. An electronic vapour provision system comprising:
a vaporiser for vaporising liquid for inhalation by a user of the electronic vapour
5 provision system;
a power supply comprising a cell or battery for supplying power to the vaporiser; and
a filter for filtering vaporised liquid prior to inhalation by the user of the electronic
vapour provision system,
wherein the filter can partially or completely remove from the vapour one or more
10 aldehydes present in the vapour.
2. An electronic vapour provision system according to claim 1 wherein the filter is
selected from filters which adsorb aldehydes and filters which react with aldehydes.
- 15 3. An electronic vapour provision system according to claim 1 or 2 wherein the filter is
selected from filters which adsorb aldehydes or which have an amine functional group with
reacts with aldehydes
4. An electronic vapour provision system according to any one of claims 1 to 3 wherein
20 the filter is selected from filters which adsorb aldehydes.
5. An electronic vapour provision system according to claim 4 wherein the filter is
activated carbon.
- 25 6. An electronic vapour provision system according to any one of claims 1 to 3 wherein
the filter reacts with aldehydes.
7. An electronic vapour provision system according to any one of claims 1 to 3 wherein
the filter has an amine functional group which reacts with aldehydes.
30
8. An electronic vapour provision system according to any one of claims 1 to 3 wherein
the filter is an ion exchange resin.
9. An electronic vapour provision system according to claim 7 or 8 wherein the filter is a
35 resin having polyamine groups bonded to a cross-linked polystyrene matrix.
10. An electronic vapour provision system according to claim 9 wherein the filter is

11. An electronic vapour provision system according to any one of claims 1 to 10 wherein the filter can partially or completely remove from the vapour each aldehyde present in the vapour.

12. An electronic vapour provision system according to any one of claims 1 to 11 wherein the filter can partially or completely remove from the vapour one or more aldehydes selected from acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde.

13. An electronic vapour provision system according to any one of claims 1 to 12 wherein the filter can partially or completely remove from the vapour at least formaldehyde.

14. An electronic vapour provision system according to any one of claims 1 to 13 wherein the filter can partially or completely remove from the vapour each of acetaldehyde, acrolein, butyraldehyde, crotonaldehyde, formaldehyde and propionaldehyde.

15. An electronic vapour provision system according to any one of claims 1 to 14 wherein at least 30% of the one or more aldehydes present in the vapour are removed from the vapour by the filter.

16. An electronic vapour provision system according to any one of claims 1 to 14 wherein at least 50% of the one or more aldehydes present in the vapour are removed from the vapour by the filter.

17. An electronic vapour provision system according to any one of claims 1 to 14 wherein after 30 inhalations of vapour have passed through the filter at least 40% of the one or more aldehydes present in the vapour are removed from the vapour by the filter.

18. An electronic vapour provision system according to any one of claims 1 to 14 wherein after 30 inhalations of vapour have passed through the filter at least 40% of formaldehyde present in the vapour is removed from the vapour by the filter.

19. An electronic vapour provision system according to any one of claims 1 to 14 wherein after 100 inhalations of vapour have passed through the filter at least 40% of formaldehyde present in the vapour is removed from the vapour by the filter.

20. An electronic vapour provision system according to any one of claims 1 to 14 wherein after 250 inhalations of vapour have passed through the filter at least 40% of formaldehyde present in the vapour is removed from the vapour by the filter.

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21. An electronic vapour provision system as substantially defined herein.

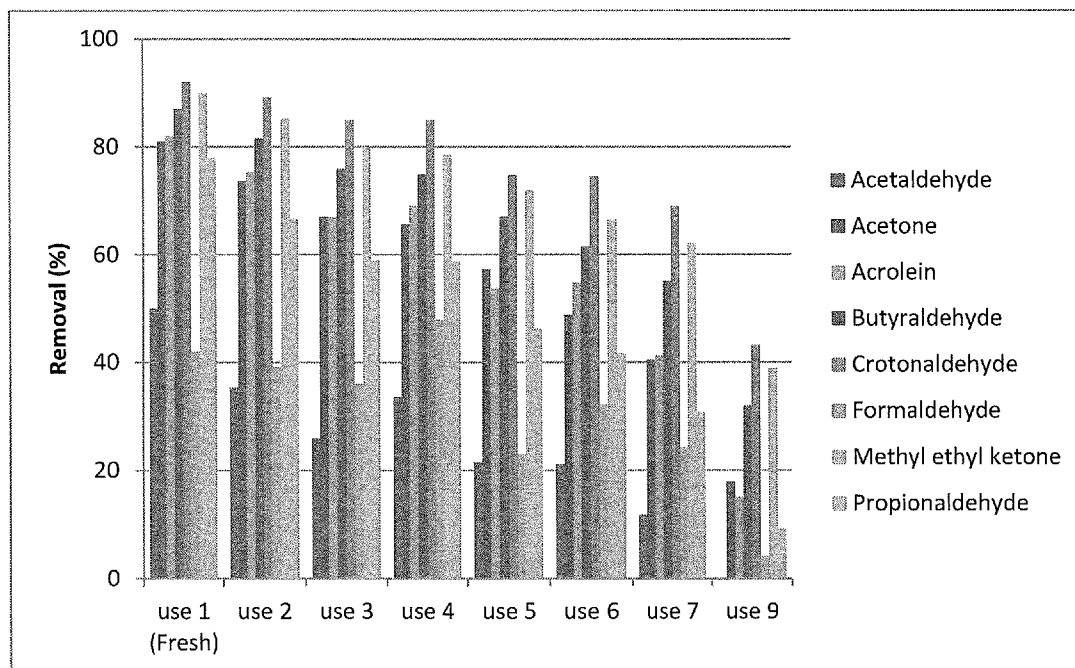


Figure 1(i) - 60mg AC (HPLC),

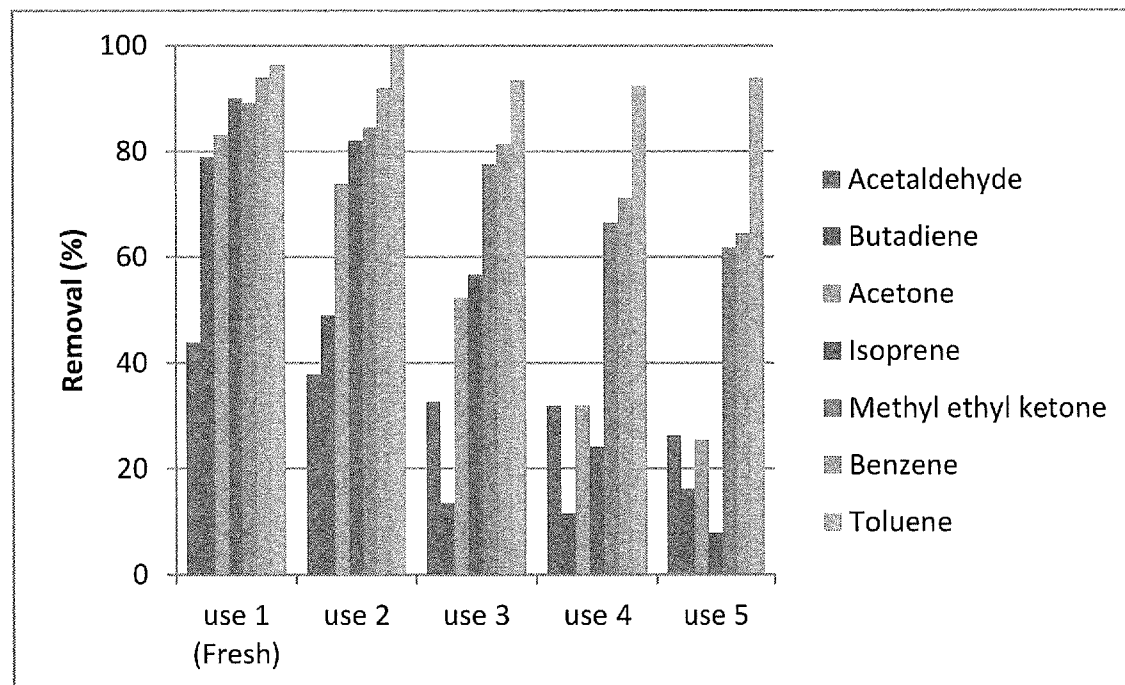


Figure 1(ii) - 60mg AC (TOF-MS),

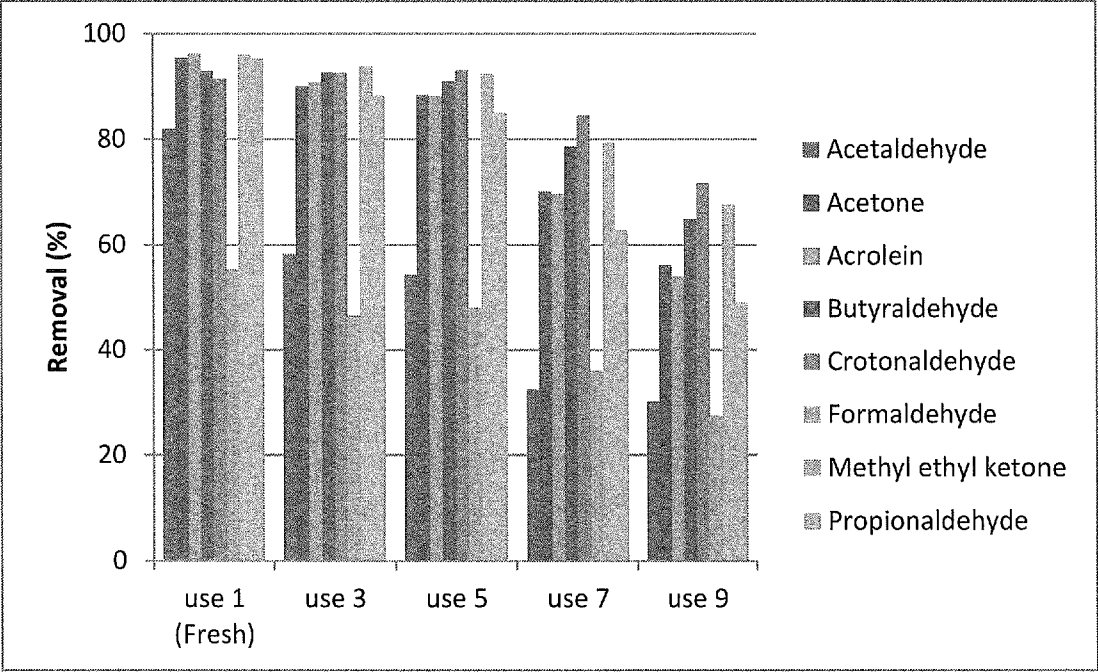


Figure 1(iii) - 150mg AC (HPLC)

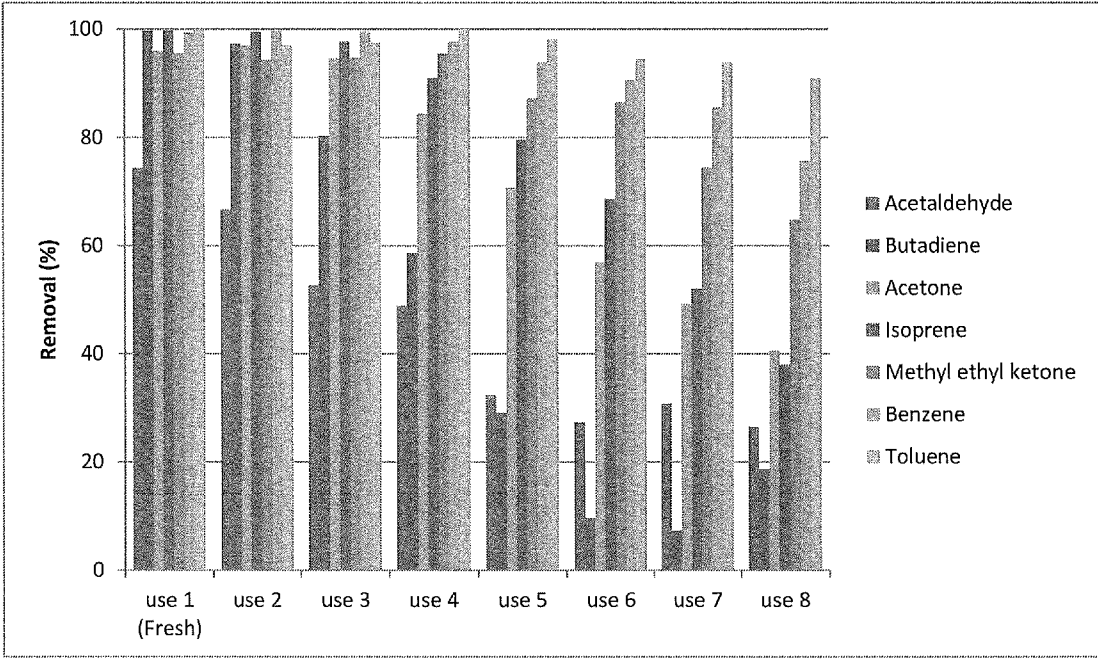


Figure 1(iv) - 150mg AC (TOF-MS),

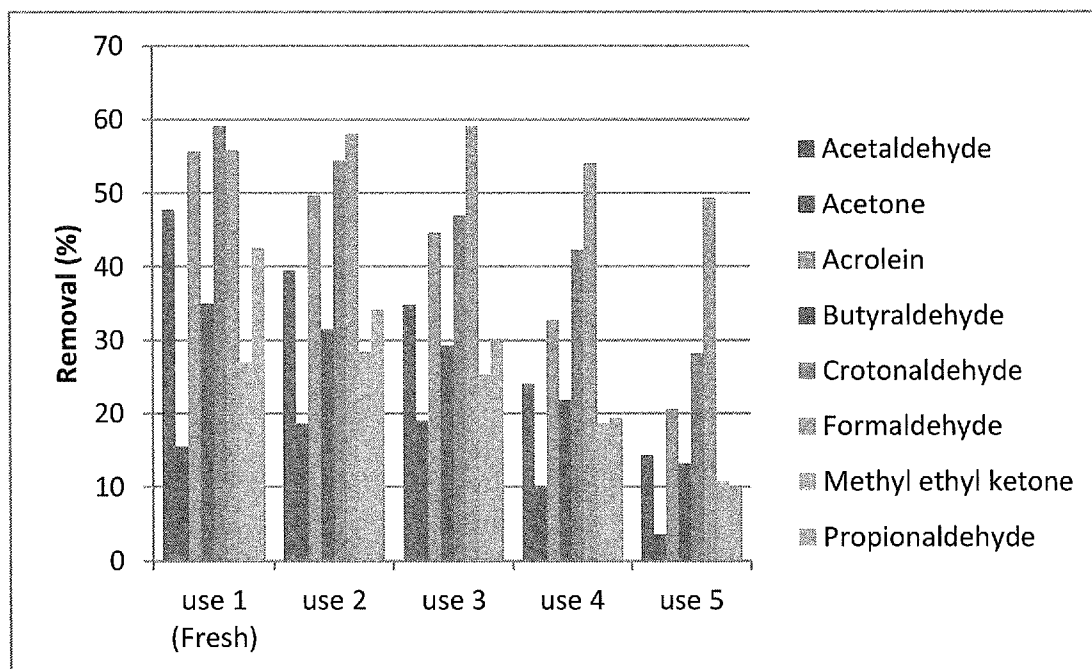


Figure 1(v) - 60mg CR20 (HPLC)

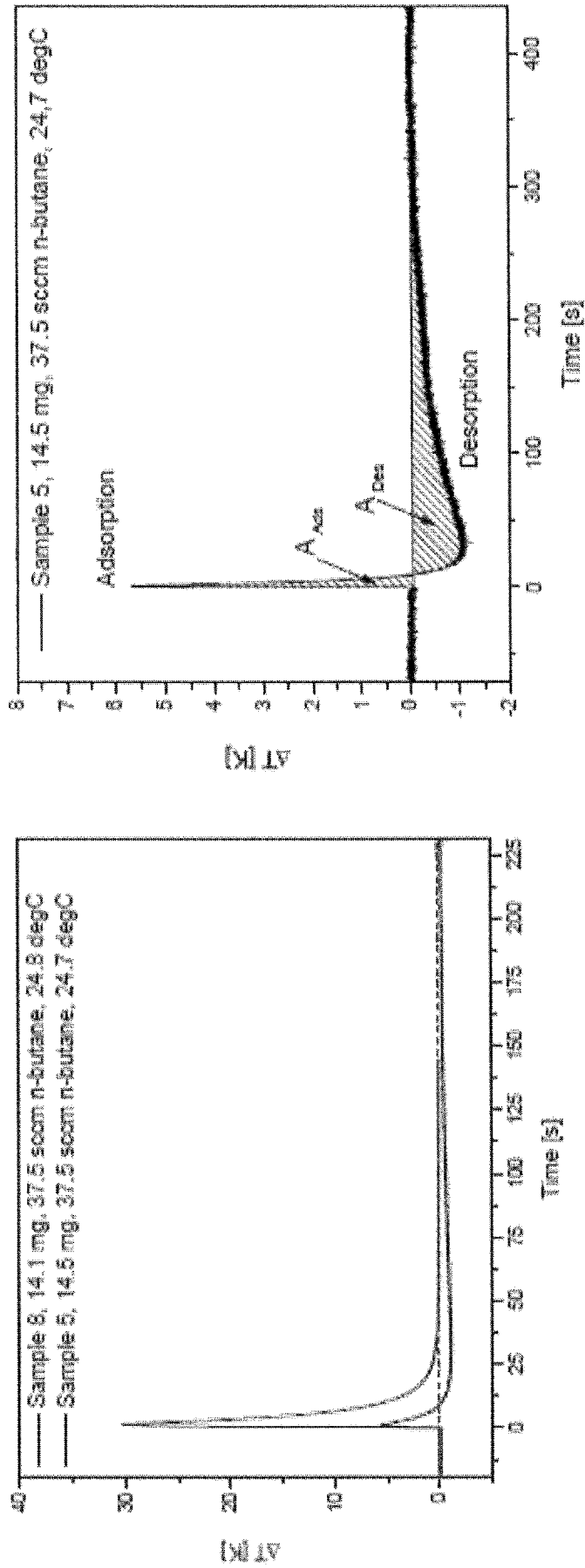


Figure 2 - Sample 8 Fresh AC, sample 5 AC exposed to 5 uses

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/051995

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24D3/12 A24D3/16 A24F47/00
ADD.

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)
A24D A24F

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/084907 A1 (CELANESE ACETATE LLC [US]) 14 July 2011 (2011-07-14) page 1, paragraph 1 - paragraph 2 page 2, paragraph 1 page 5, paragraph 1 - paragraph 2 page 8, paragraph 2 page 11, paragraph 4 - page 12, paragraph 1	1-21
X	----- CN 202 233 005 U (SHENZHEN AHK TECHNOLOGY CO LTD) 30 May 2012 (2012-05-30) claims 1, 2, 3 ----- -/-	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

25 September 2015

Date of mailing of the international search report

06/10/2015

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Authorized officer

Dimoula, Kerasina

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/051995

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	CA 2 813 575 A1 (CELANESE ACETATE LLC [US]) 26 April 2012 (2012-04-26) claims 1, 14, 15, 21, 22, 42, 43, 44, 60 -----	1-21

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Information on patent family members

International application No

PCT/GB2015/051995

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