

Device for evaporating a liquid active substance

5

The invention concerns a device for evaporating a liquid active substance as set forth in the classifying portion of claim 1 and a process for producing such a device.

10 A device of that kind is known from DE 37 37 272 A1. In that device a liquid chemical - in particular an insecticide - is drawn up by the capillary action of a porous wick which dips into the chemical, and is evaporated by a heating effect which acts on the upper end of the wick.

15 In that device from the state of the art, the problem solved is that of improving evaporation of the chemical from a wick comprising an inorganic powder body. In accordance with that solution the inventor proposes adding an oxidation-preventing agent to the mixture for the production of the wick, whereby the aim is advantageously to provide that clogging of the wick is avoided.

20 However - besides the expenditure that is additionally required by virtue of the oxidation-preventing agent and besides the problem, which frequently occurs due to the porous wick, of leakage if the arrangement is not stored in an upright position - such a device suffers from the disadvantage that the conveyor or evaporation rate of the insecticide (that is to say the amount per unit of time) varies to a very considerable degree
25 depending on the filling condition of the active substance container: it has been found by experiment that the evaporation rate when the active substance container is completely filled differs considerably from that of a container which is almost emptied.

30 That inevitably gives rise to the problem of irregular and thus defective administerability of the insecticide. Furthermore, this confronts the designer of a suitable wick with the problem of so dimensioning the wick that, over the entire filling height of the insecticide container, the evaporation rate provided is one which on the

one hand achieves the desired purpose of destroying insects, while on the other hand limiting the dosage administration of the insecticide to a level such that there is no possibility of danger to the health of people who spend time in the proximity of the device: that problem weighs all the heavier insofar as the usual insecticides such as for example those from the group of pyrethroids are highly effective nerve poisons which basically can be dangerous to all living beings and in regard to which the threat is determined exclusively by the degree of dosage administration. Precise dosage administration is therefore a fundamental requirement for effectively avoiding any threat to health.

Not least due to the attitude of the public, which has become increasingly critical in recent times, in relation to insecticides based on the evaporation of chemical active substances, it is therefore necessary, in terms of future market success, to provide evaporation devices with which it is possible effectively to combat doubts and misgivings of that kind.

Therefore the object of the present invention is to provide a device for evaporating a liquid active substance, as set forth in the classifying portion of claim 1, which permits more uniform evaporation of the active substance and which permits a substantially constant evaporation rate in particular over the entire effective filling height - from the lowest point on the immersed wick up to the maximum level of the liquid.

That object is attained by the device for evaporating a liquid active substance as set forth in the classifying portion of claim 1, by means of the features of the characterising portion of claim 1.

Thus the configuration of the wick in accordance with the invention prevents liquid from penetrating into the wick at its peripheral surface which is immersed into the liquid active substance, and being transported with the capillary flow in the direction towards the heating device. On the other hand, at any possible depth of immersion of the wick, liquid can pass into the lowermost end of the wick in the region of the end face which is disposed at that point, and can provide for a uniform flow in the wick.

Advantageous developments and configurations of the invention are set forth in the appendant claims and described hereinafter.

Thus, advantageously, the wick may be formed from strong, porous material - for example from a ceramic material - whereby it is particularly
5 well suited to series production as a mass-produced article and it has properties which can be satisfactorily reproduced. A similar consideration applies in regard to the use of a lacquer or paint, a plastic material (for example a plastic case or cover) or a glaze (for example by means of powder coating) to achieve the desired property of the peripheral surface.
10 Preferably the wick is substantially cylindrical.

Advantageously the wick is also provided with a coating in the region of the heating device. That provides in particular the advantage that, even when the device is not stored in a perpendicular position or if the device falls over with the wick immersed, no insecticide can unwantedly
15 issue through the projecting portion of the wick. That is important in particular in terms of storage and transportation of the device, up to the time that it is first brought into operation.

Moreover, advantageously the coating - either only in the region of the heating device or along the entire peripheral surface - may be such
20 that the coating becomes permeable for the evaporating active substance in the region of the heating device, only when the wick portion is heated to operating temperature at that location: when heating is effected, either the coating permanently melts away in that region (one-time dissolution) or however the coating is of such a nature that, upon being heated, it becomes
25 permeable and then closes again when the wick portion subsequently cools down (reversible dissolution). That can also prevent liquid active substance from undesirably escaping from the wick portion to be heated.

In accordance with a preferred development of the invention therefore the coating can be such that, when the operating temperature of
30 the wick is reached, in the region of the heating device, the coating melts or is destroyed in some other manner and makes the wick permeable for the evaporating active substance, in that region. In this development which

corresponds to the one-time dissolution (see above), in accordance with a further preferred configuration the coating can be provided by sealing lacquer, wax or a material with comparable melting properties. On the other hand, in accordance with a development of the invention, in the manner of reversible dissolution (see above), the coating can be such that, when the operating temperature of the wick is reached, in the region of the heating device, the coating becomes porous and thereby permeable for the evaporating active substance, whereas it becomes impermeable at lower temperatures. It would further be preferred for such a coating to be in the form of a layer of rubber, caoutchouc or comparable material.

Finally this coating can advantageously also be in the form of a membrane which is impermeable for the liquid active substance and permeable for the evaporating active substance. In an elegant fashion, that on the one hand prevents liquid from undesirably passing into the peripheral surface, while on the other hand providing for unimpeded discharge of the evaporating (evaporated) active substance out of the heated wick portion without liquid also being able to escape as a result. Preferably the liquid active substance is an insecticide or a perfume; other comparable substances are however also suitable for evaporation.

Preferably the heating device is embodied using a PTC. That arrangement not only provides for making flexible and inexpensive use of electrical energy for evaporation purposes, but at the same time the PTC, by virtue of its temperature-dependent resistance characteristic, also acts as a regulating element which always keeps the temperature of the heating device at a constant working point.

Mechanically, the device according to the invention is preferably disposed in a housing to which a container for the active substance is fixed removably - for example for the purposes of replacement. In accordance with a preferred development of the invention the fixing between the container and the housing is particularly suitably embodied by a screw connection.

In a further preferred configuration the housing can be easily fitted with a plug formed thereon into a plug socket in order there to be supplied with electric current and at the same time mechanically held in position.

5 In accordance with a further aspect of the invention for which protection is claimed independently, the wick which also but not exclusively is suitable for use in the device according to the invention is produced by drawing or pressing (in particular extrusion) and subsequent calcining or firing of a starting material which is prepared on the basis
10 of a ceramic base material. In accordance with the invention firing of the wick is effected at a firing temperature which is so set that it is below the sintering temperature which is given for the drawing material. In this context the term sintering temperature is used to denote the temperature at which the drawing material, by virtue of firing, assumes a dense,
15 substantially pore-free form in which it is completely impermeable for the liquid active substance. More specifically, in accordance with the invention it was found that the permeability of the drawing material (as the starting material for the wick) for liquid is determined solely by the firing temperature: the higher the firing temperature, the correspondingly
20 lower becomes the wick evaporation rate which is to be achieved with the wick, wherein practically no further liquid at all is evaporated through the wick when the sintering temperature is reached. In addition the firing time is immaterial in this connection; the only important consideration is the maximum temperature reached - that is to say the temperature which is
25 suitably set in the process according to the invention and thus controls the porosity of the wick.

Further advantages, features and details of the invention are apparent from the following description of embodiments by way of example with reference to the Figures in which:

30 Figure 1 is a diagrammatic view in section of the evaporation device in accordance with a first embodiment.

Figure 2 is a view in section of a wick with a coating in accordance with a further embodiment.

Figure 3 is a diagrammatic detail view of the heating device and the upper wick portion in accordance with yet a further embodiment, and

5 Figure 4 is a view in section of a wick in accordance with the state of the art.

Figure 1 shows a first embodiment of the device for the evaporation of a liquid active substance. This first embodiment is to be interpreted in that respect as the best mode of carrying the invention into effect. A
10 bottle-shaped container 1 of plastic material which is substantially cylindrical and which tapers towards the opening and which is filled with liquid insecticide is fixed in the region of its opening to a plastic housing 2 in such a way that it can be unscrewed therefrom.

A diagrammatically illustrated heating device 3 is provided in the
15 housing 2. For the generation of heat the heating device 3 has a PTC-resistance element 4 which is supplied with current by way of the mains plug 5 which is fitted on the housing. The mains plug serves at the same time for mechanically holding the entire device in a plug socket and is mounted rotatably in the housing 2 for adaptation to vertically or
20 horizontally arranged pairs of contacts of such a plug socket so that the device can always be held in a vertical position.

Provided on the PTC-element, for the transmission of heat, are plates 6 which are made from stamped portions and which are arranged to enclose a wick 7. On the one hand, that arrangement provides that heat is
25 transferred from the PTC to the wick over as short a distance as possible and with the minimum level of losses, while on the other hand the suitably shaped plates 6 which practically play-free touch the wick form a mechanical means for holding the wick 7 in the housing 2. As moreover the ceramic wick 7 is not burnable, a device with a high level of operational
30 safety can be achieved in that way, in contrast to for example a wick comprising cardboard or comparable burnable material. As moreover the ceramic wick 7 acts as an electrical insulator, the described arrangement

is also operationally sound and secure from the electrical point of view and can be produced without involving further electrical insulation expenditure.

5 The wick 7 which is substantially cylindrical in cross-section comprises a porous clay body 8 which was produced by drawing or extrusion and firing of a mixture which substantially comprises clay and wood dust and mixed with water.

10 In accordance with the first embodiment the wick 7 has, along its peripheral surface, a coating 9 which extends from the lowermost end of the wick as shown in Figure 1 to the attachment of the heating device 3. The peripheral surface in the region of the heating device 3 as well as the lower and upper end faces 10 and 11 of the wick remain free of the coating.

The coating 9 comprises a layer of acrylic lacquer or varnish (for example commercially available nail varnish is also suitable).

15 The wick 7 extends into the container 1 which is filled with a liquid insecticide 12, composed of a pyrethroid insecticide in a paraffin carrier liquid. It is guaranteed in this respect that the wick is covered as far as the maximum filling level of the liquid in the container 1, at the peripheral surface of the wick, with the coating 9 which is impermeable for the liquid 12 and which is also insoluble in the liquid 12. In
20 addition, a seal which is not shown in the Figure is provided between the wick 7 and the container 1, at the neck thereof.

In operation the PTC-heating element 4 is supplied with voltage by way of the mains plug 5 and heats up. The upper portion of the wick 7
25 which is disposed in the region of the heating device 3 is heated by way of the plates 6 which act as heat-transfer means.

Liquid insecticide which, by virtue of capillary action within the wick 7, passes into the wick 7 by way of the lower end face or surface 10 and passes upwardly in the clay body 8 is evaporated or vaporised (these
30 terms are used synonymously in the present application) by virtue of the heating effect in the region of the heating device 3 and issues from the wick in gas form. In that case the PTC-heating element, in dependence on

the requirements of the selected liquid insecticide, provides for a substantially constant temperature in the usual range of between 100° and 140°C. The particular property of a PTC-resistor, namely reacting to fluctuations in temperature with changes in resistance and thereby
5 producing a rise or fall in current with corresponding temperature movements, is utilised here in order in a simple fashion to keep the temperature at the upper wick portion constant at a working point.

By virtue of the coating 9 along the entire peripheral surface which dips into the liquid insecticide, the subsequent ongoing flow of
10 insecticide can pass into the clay body 8 which provides the transportation effect, only in the region of the lower end face 10. That ensures that - irrespective of the filling height of the liquid active substance 12 in the container 1 - there is always an equal effective surface area for the ongoing flow of insecticide to pass therethrough, thereby satisfying a
15 prerequisite for affording an evaporation rate which is constant over all filling heights.

Reference will be made hereinafter to Figure 4 showing a non-coated porous wick which is known from the state of the art, to explain why the wick configuration according to the invention, in contrast to the known
20 wick, permits a through-flow of liquid insecticide, which is substantially constant in all regions of the filling height.

As shown in Figure 4 by means of arrows, liquid active substance penetrates into the porous wick through all immersed surfaces. Accordingly, turbulence phenomena 14 occur in the interior of the wick, in
25 the main conveyor path (arrow 13) which extends vertically from below upwardly. The turbulence phenomena 14 are in particular the result of secondary flows which pass into the wick in a transverse direction. The turbulence effects 14 impede the directed flow of the main conveyor flow and adversely influence the through-flow speed and therewith the
30 evaporation rate. As moreover less turbulence occurs with a falling level of liquid (due to consumption of the liquid), the influences on the main

conveyor flow due to the turbulence effects are also different, depending on the level of liquid.

In comparison, preventing liquid from penetrating into the wick in the transverse direction, in accordance with the present invention, eliminates the above-described disadvantageous effects and makes it possible to have a properly directed liquid conveyor flow which is independent of the filling height. In that respect, experiments have shown that the influence on the delivery amount, due to the pressure which is dependent on the level of liquid, is insignificant.

While, in the illustrated embodiment, a plastic lacquer or varnish was selected as the material for the coating 9, it can also be formed from any other material, for example a glaze or a plastic case or cover. The only important consideration is that the coating 9 is impermeable in relation to the liquid insecticide 12 and also cannot dissolve therein so that the coating 9 does not suffer from any detachment or dissolution, even in the event of storage over a prolonged period of time. Preferably the material adopted for the coating or the lacquering or varnish is a material which does not itself penetrate deeply into the porous clay body 8 in order not to clog the pores thereof and thus reduce the effective capillary-action cross-sectional area.

Figure 2 is a view in longitudinal section through the wick 7 in accordance with a further embodiment of the invention.

In this embodiment the coating 9 is so disposed on the clay body 8 that it covers the entire peripheral surface of the clay body 8 and the upper end face 11. Figure 2 shows a wick in the condition as supplied and delivered, which can be fitted in that way into the arrangement shown in Figure 1 and which can be transported and stored together with the entire arrangement, without liquid being able to escape from the upper end, even when the arrangement is in an inclined position. In this embodiment the coating 9 is made from a material which, upon being heated, locally melts and thus, upon being used for the first time in the evaporation device, at

the working temperature, clears and opens the upper portion of the wick for the gaseous insecticide to issue therefrom.

Experiments have shown that, in accordance with this embodiment, a material which has proved its worth for the coating 9 is a sealing lacquer or varnish which is applied thinly and whose melting temperature is somewhat below the working point of the PTC or the evaporation temperature at the upper wick portion. It should be possible however also to achieve a comparable result with other coatings which locally melt or are destroyed in some other fashion, at the temperature in question, and thus expose the clay body of the wick in the region of the heating device.

To act as a cap for the wick, which cap can be melted away, it would also be possible to contemplate using a prestressed rubber cover which could approximately correspond to an air balloon envelope, in terms of the material and thickness involved. The prestressed rubber changes its strength with increasing temperature. With suitable dimensioning, it can then be possible to provide that such a covering tears at operating temperature and then the entire upper evaporation region is immediately exposed, due to the prestressing effect.

It will be appreciated that it is alternatively possible for that region to be provided with a simple cap which can be suitably manually removed (or re-fitted again).

Having regard to the temperatures involved, it is for example possible to use an active substance which, for evaporation purposes, requires a temperature in the region of the upper end face of about 120°, in which case then preferably the melting or destruction temperature of the local coating in that region could be adjusted to about 100°C.

Figure 3 is a view in cross-section of an upper wick portion in accordance with yet a further embodiment of the present invention.

In this embodiment the entire peripheral surface of the wick 7 and the upper end face 11 are also covered with the coating 9. It will be noted that, in contrast to the second embodiment shown in Figure 2, the

coating is maintained at all locations even during operation and is not partially destroyed when the wick is heated for the first time.

So that gaseous insecticide can nonetheless issue when heating occurs, the material adopted for the coating in accordance with this
5 embodiment must be a material which is permeable for the gaseous insecticide, at least in the heated condition.

Rubber or caoutchouc materials which have the property of stretching very greatly and, when in the form of correspondingly thin layers, forming more or less thick pores, are suitable materials for a coating of this
10 kind: upon being heated by the heating device, the material shrinks in point fashion, and pores are formed in the coating, as shown in Figure 3, through which the gaseous insecticide can escape. The pores close up again when the wick subsequently cools down.

Advantageously, such a coating which closes again permits leak-proof
15 transportation of a device with fitted wick and filled insecticide container which has already been in operation.

As an alternative, for the purposes of forming a coating which is permeable when heating occurs, it is possible to use a plastic material which is used for - known - shrinkage tubes. As is known, shrinkage tubes
20 of that kind have the property of contracting upon being heated and, as soon as the heating exceeds a given period of time and/or temperature, pores or cracks or tears are formed in the material so that the intended effect can also be achieved thereby. It will be appreciated however that the described shrinkage operation for shrinkage-tube material is generally
25 irreversible, that is to say, the material does not close up again when the wick is subsequently cooled.

Alternatively, it is also possible to envisage the use of membranes as the coating 9, which (also independently of temperature) have openings through which gaseous insecticide can admittedly pass, but in contrast
30 liquid insecticide cannot. Membranes of that kind, for example on a TEFLON basis, are generally known and would need to be suitably adapted to the molecule sizes and conditions which occur here.

The described embodiments are set forth purely by way of example and the present invention is not limited thereto. Thus it is possible to envisage in particular any desired wick form and manner of manufacture and any desired cross-section, as long as the described inventive principle is carried into effect. In particular the term "periphery" in the present application is used to denote the peripheral surface of a wick of any shape and cross-sectional area.

Thus the concept of the present invention in particular also embraces the feature that the coating on the peripheral surface, which is described by reference numeral 9 for example in Figure 1, does not extend completely down to the lower end face 10; on the contrary, the principle of the invention is to be interpreted such that the coating 9 extends only over a large part of the peripheral surface which dips into the active substance so that for example a predetermined portion of the peripheral surface, which is small in relation to the surface of the coating, can still remain uncovered in the region of the end face 10.

The use of the present invention is also not limited to the evaporation of liquid insecticides. Thus the device is also suitable in particular for the evaporation of liquid disinfectants, perfumes or comparable chemicals. Containers of a correspondingly suitable configuration are then to be provided, in which respect the wick is advantageously carried with its lower end face (indicated at 10 in the Figure) at a lowest possible location in such a container, in order to permit complete emptying thereof.

Thus, in accordance with an advantageous development of the invention, it is possible in particular to promote the described delivery flow which is directed in the longitudinal direction of the wick, by virtue of the fact that manufacture of the wick involves using elongate wood fibres, cotton threads or the like which are already suitably oriented in the wick production material and which then, in the finished wick, provide for a suitably elongate pore arrangement.

As the present invention also involves a product which is suitable as a mass-produced article and which must be manufacturable inexpensively in large numbers, further configurations which are suitable for such mass production are also deemed to be particularly preferred. They include in particular coatings on the wick which are produced by powder coating, baking lacquering or enamel, rolling, with brushes or paint brushes and/or by being dipped in suitable lacquer or varnish.

Described hereinafter is a process for the production of a wick which is preferably suitable for use in an evaporation device of the kind described with reference to Figures 1 through 4.

A cylindrical ceramic wick of this kind is produced on the basis of a cordierite material as is usually employed as a carrier material for electrical heating devices or the like. Materials of that kind are standardised for example by DIN VDE 0335.

The described embodiment involves more accurately a cordierite drawing material which, as substantial components, contains Al_2O_3 (about 34%), SiO_2 (about 49%) and MgO (about 2%). A drawing material of that kind has a prescribed firing temperature (sintering temperature) of about 1300°C and after firing at that temperature forms a substantially water-impermeable, fully sintered body, as is required as a highly heat-resistant, electrical insulator in its original area of use. Alternatively, it is possible to use a barium-steatite drawing material which contains BaO . The other manufacturing parameters which are to be described hereinafter are the same.

In accordance with the invention, for use as a wick in the present case, the drawing material is admittedly mixed in the usual manner with water (a proportion of about 10 to 20%) or drawing oil, and then the basic shape of the wick is determined by drawing and cutting to length; the firing operation however is effected at a temperature which is markedly below the sintering temperature of 1300°C . For the use according to the invention, it has been proven advantageous for the firing temperature to be set to a range of between 1000 and 1200°C , further preferably between 1050

and 1100°C, in which respect it was found that the porosity of the wick is dependent only on that set firing temperature. The higher the firing temperature is set, the correspondingly smaller become the individual pores and the correspondingly lower becomes the transmission or evaporation rate
5 of the active substance through the wick. In that respect therefore the firing temperature controls the evaporation properties of the wick.

It has further been found that the actual firing period - which is usually about 12 hours - is without any influence on the porosity; the essential parameter, as mentioned, is the set firing temperature.

10 It is to be noted in this connection that the wick in accordance with this embodiment - with the exception of the drawing oil or water added to prepare the drawing material - must not contain any further filling substances at all (for example organic materials or the like); the desired porosity is already afforded by virtue of setting the firing temperature in
15 accordance with the present invention.



CLAIMS

1. A device for evaporating a liquid active substance comprising a wick (7) which can dip into the liquid active substance (12) for conveying the active substance,

wherein one end of the wick in the immersed condition projects out of the liquid active substance, and

a heating device (3) provided on the wick in the region of the projecting end,

characterised in that

the wick is of such a configuration that

at its peripheral surface it is substantially impermeable for the liquid active substance (12) at least over the large part of its length which dips into the liquid active substance,

it is substantially permeable for the liquid active substance (12) in the region of its end face (10) which is opposite to the projecting end, and

it is permeable for evaporating active substance (12) in the region of the heating device (3) at least in the heated condition.

2. A device as set forth in claim 1 characterised in that the wick comprises firm porous material.

3. A device as set forth in claim 1 or claim 2 characterised in that at its entire peripheral surface with the exception of the region of the heating device the wick is provided with a coating (9) which is impermeable for the liquid active substance and which is insoluble in the liquid active substance.

4. A device as set forth in claim 3 characterised in that the coating is produced by lacquering, powder coating or by a glaze.



5. A device as set forth in one of claims 1 through 4 characterised in that in the region of the heating device the wick is provided with a coating which is of such a nature that it becomes permeable for the evaporating active substance at an operating temperature of the wick, which is produced by the heating device.

6. A device as set forth in claim 1 or claim 2 characterised in that at its entire peripheral surface the wick is provided with a coating which is impermeable for the liquid active substance and which is insoluble in the liquid active substance and which is such that it is permeable for the evaporating active substance at a wick operating temperature which is produced by the heating device.

7. A device as set forth in one of claims 1 through 6 characterised in that the heating device (3) is in the form of an electrical heating device with at least one PTC-element (4), wherein transfer of heat from the PTC-element (4) to the wick (7) occurs by way of an electrode (6) of the PTC-element, said electrode enclosing the wick in the region of the projecting end.

8. A device as set forth in one of claims 1 through 7 characterised in that

the wick (7) and the heating device (3) are held in a housing (2),
a container (1) is provided for the liquid active substance (12),
and

the container (1) is removably fixed to the housing (2).

9. A device as set forth in claim 8 characterised in that provided on the housing (2) is a plug (5) for insertion into a plug socket and for holding the device therein.



10. A process for producing a device for evaporation of a liquid active substance as set forth in one of claims 1 through 9 characterised by the following steps:

- preparing a drawing or pressing material from ceramic starting material,
- forming the wick from the drawing or pressing material,
- setting a firing temperature for the wick at a temperature value which is below the sintering temperature of the drawing material, and
- firing the wick at the set firing temperature.

11. A process as set forth in claim 10 characterised in that the drawing material is a cordierite or a barium-steatite drawing material and the firing temperature is set to a value of between 1000 and 1200°C.

12. A process as set forth in claim 10 or claim 11 characterised by the following step:

- providing the wick at its peripheral surface with a coating.