TECHNIQUES FOR THERAPEUTIC SMOKE TREATMENT OF BEE COLONIES

L. DE WAEL
O. VAN LAERE
BELGIUM

The use of smoke as a carrier of pesticides in bee colonies has become of great importance since the application of the specific acaricides di-p-chlorophenyl-ethanol ("dimite") and chlorobenzilate ("Folbex") for the control of acarine disease, caused by *Acarapis woodi.*

A therapeutical smoke treatment of a bee colony implicates that all the bees of the colony are exposed in a given space of time to a given smoke concentration. The technology of fumigation of bee colonies involves therefore several aspects. Special attention should be paid to :

— The homogeneity of smoke distribution in the hive.
— The concentration of the smoke.
— The resistance of the bees to the treatment with special consideration to the temperature, the available space for the bees and an eventual need of water.
— The treatment of the colony in its entirety.

I. General considerations

For smoke treatments in general a few basic principles should be taken into account :

1. *The surrounding temperature*

Smoke treatments in practice with the acaricides "dimite" and "kelthane" repeatedly demonstrated that treatments at temperatures under 15°C may cause queen mortality.

Observations in hives with transparent front and back walls have demonstrated that in weak colonies which do not cover all the combs, the distribution of the smoke within the hive can be totally insufficient in free combustion fumigations under 15°C. Very often a dense layer of smoke remains immovable for a long time in the lower part of the hive. So, the smoke does not penetrate sufficiently between the frames.

2. *Available space in the hive*

A hive fumigation often causes some movement amongst the bees, through which the space occupied by the bees is liable to increase. This increased activity may result in a dangerous increase of temperature and relative humidity. It is therefore necessary to give a supplementary hive space, for instance by placing an additional empty super.

3. *The need for water*

A prolonged confinement of a bee colony (one hour or more) may result in bee mortality, especially in strong colonies.

Studies of Lindauer (1955) and Vuillaume (1957) concerning the need for water absorption by bees during a prolonged confinement have shown an important decrease of mortallity after consumption of a least one liter of water in 24 hours by strong colonies.

From preliminary experiments in colonies, which are confined for smoke treatments, it can be supposed that a supply of water during and one or two hours after the fumigation, results in an increased resistance of the bees. Further research is necessary to confirm this.

4. *Smoke concentration and duration of treatment*

It is clear that for each product and method the amount of active substance per unit of volume and the duration of treatment should be determined in order to get an optimal result without injury for the bees.

II. Different fumigation techniques

1. *Free combustion*

Smoke treatment by free combustion means the suspension of a smoke strip by means of a metallic wire, either between two frames which are somewhat removed from each other or in an empty frame which is placed in a super (Fig. 1 and 2).

This fumigation method gives an accurate dosage, while the smoke can be concentrated at most.

One important disadvantage is the necessity to open the hives for each treatment. There could also be a certain fire danger and the smoke distribution is not optimal in all circumstances.

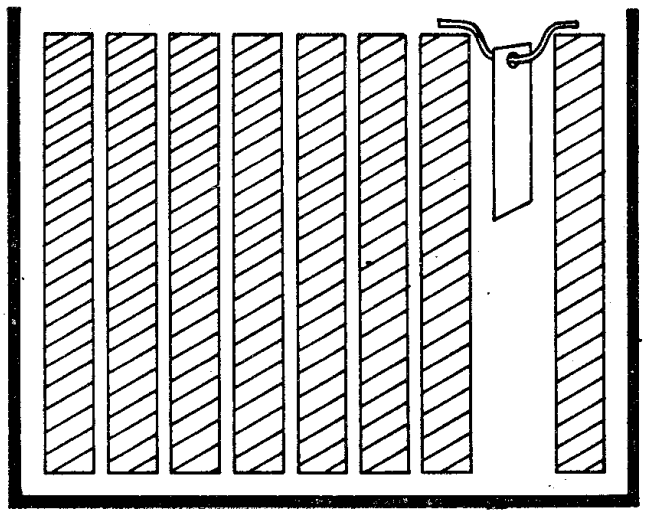

Fig. 1 — *Fumigation strip placed in brood chamber*

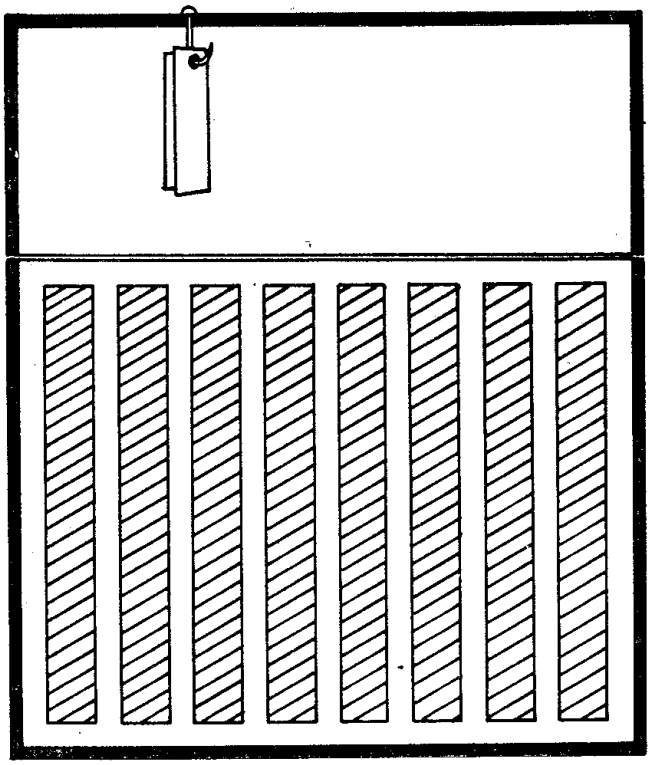

Fig. 2 — *Fumigation strip placed in empty super*

2. *The ordinary smoker*

Several fumigation tickets can be used at the same time in a common bee smoker and the smoke can be introduced in the hive through the entrance and divided among several colonies.

This method can by no means guarantee an accurate dosage, mainly because of a considerable and irregular mixture with exterior air.

3. *The smoke injector*

Fig. 3 represents schematically a small smoke injector, developed by Koch (1956).

The apparatus consists of a cylindric combustion chamber (C) in brass with a diameter of 20 mm and a wall gauge of 0.6 mm. The combustion chamber is surrounded by an isolating spacing of 5 mm, limited by two rings (A and B) and a cylinder in brass (M). The smoke-strip is fixed in the combustion chamber by means of a metallic wire (F).

The strip is folded longitudinally, through which the combustion is accelerated. At the top there is a smoke outfall-pipe on one side (b) and an air supply pipe on the other side (a). The position of these two pipes is in such a way that the injection of exterior air causes the aspiration of smoke from the combustion chamber.

The smoke is injected in the hives, for example through a hole in the upper half of the back wall of the hive.

With this apparatus an ideal homogeneous distribution of the produced smoke is obtained, while the hives are treated without having to open them.

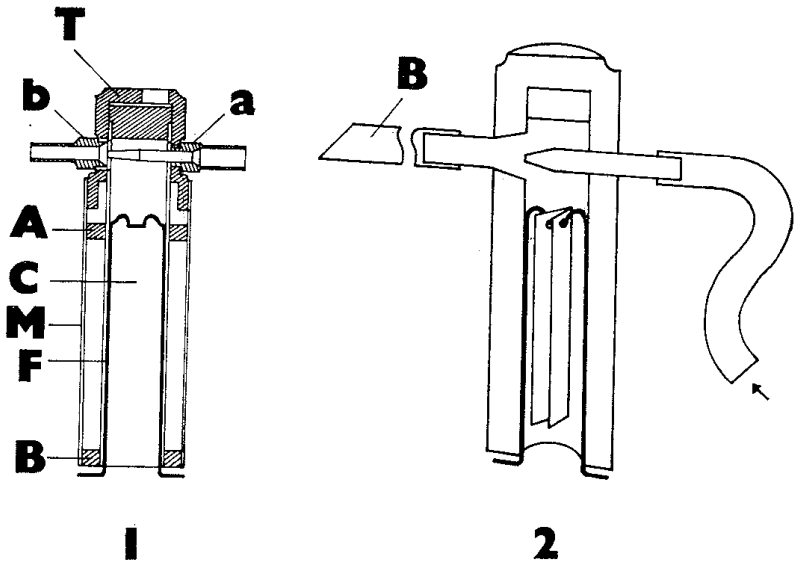

Fig. 3 — *Koch smoke injector (explanation in text)*

The combustion of one smoke-strip necessitates the injection of some 10 to 12 liters of exterior air. This has two disadvantages : the produced smoke is considerably diluted and the blowing of air through the mouth should better be replaced by a technical air supply system.

A convenient system for this is the "Bell-bucket", represented in fig. 4. It consists of two plastic buckets, one which is filled with water.

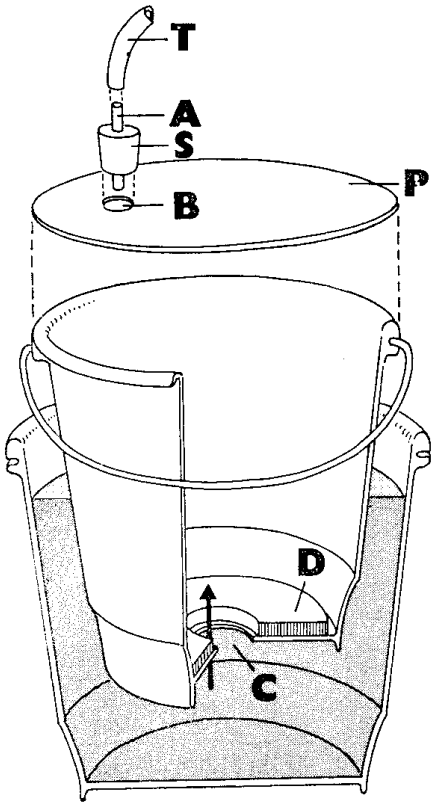

Fig. 4 — *"Bell-bucket" for blowing air into fumigation devices*

The second one has an opening (C) in the bottom, a metallic ballast of about 2,5 kg (D). It is closed at the top with a plate (P), provided with a hole (B), a stopper (S), an outfall-pipe (A) and a plastic tubing (T).

A simple air injection system can be constructed by fitting a supplementary outfall tubing on an inner tube.

4. *Passive smoke circulation*

A system for fumigation with passive smoke circulation has been developed. It is based on the principle of a simple device, proposed by the Belgian beekeeper Seret, taking into account advantages and disadvantages of several other systems.

Based on the recirculation of the interior hive air through the smoker, the appartus (fig. 5) is composed of a combustion-chamber (A), in which the smoke-strip is fixed on the cover by means of a clamp.

During the operation, the warm smoke rises and enters the supply pipe, where it becomes heavier because of falling temperature. The smoke enters the hive while new air from the inner space of the hive is introduced into the combustion chamber by self aspiration.

The apparatus has an outfall-pipe in plastic with a length of some 7 cm, which can be introduced into the hive between two combs through a hole of ± 2.5 cm in the crown board of the hive. The same hole gives access to the combustion chamber, the air passing along the passage B.

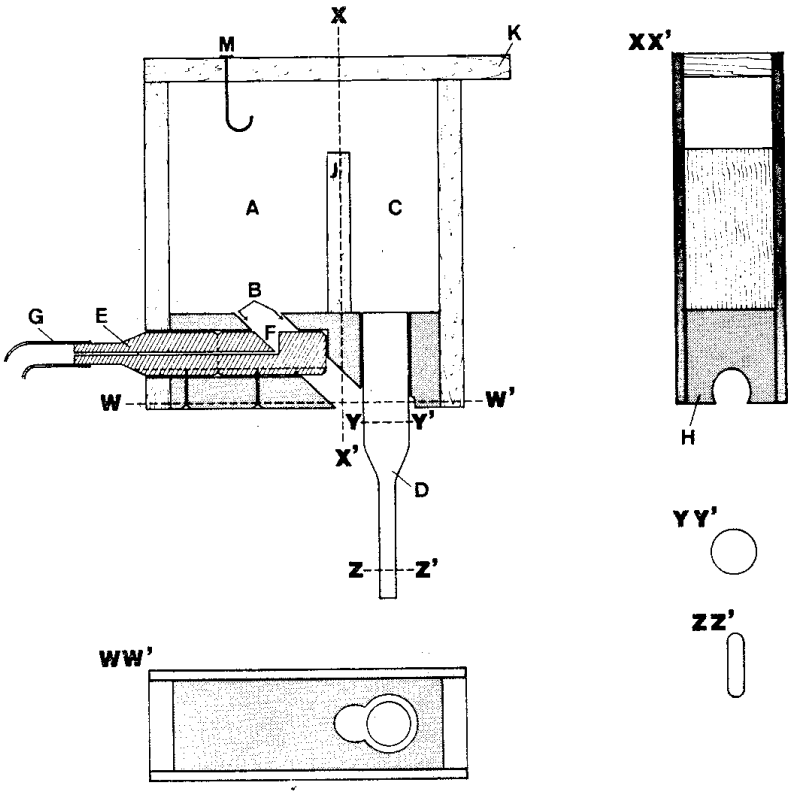

Fig. 5 — *Passive smoke circulation device*

The air supply may be interrupted by means of the sliderod E, which brings the external air supply gap F into the passagge B. This combustion air supply can be used for a few seconds, when the bees prevent the air from flowing normally into the smoker by active directed ventillation.

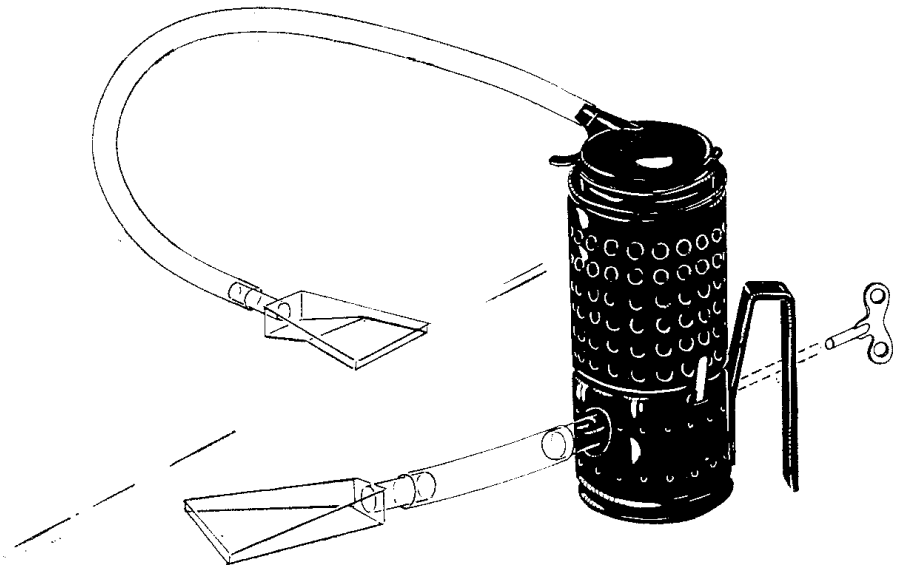

Fig. 6 — *Fumigation apparatus with active smoke circulation*

5. *Active smoke circulation.*

Using the in bee practice commonly used automatic "Vulcain"-smoker, a fumigation apparatus with continuous active smoke circulation was constructed (fig. 6).

The combustion chamber may contain one or several smoke strips. The outlet of the smoker is extended with a plastic tubing, which fits in the entrance of the hive with a flattened adapor. The smoker has an incorporated fan, with which a continuous air and smoke circulation is obtained. The internal hive air is aspirated into the smoker with a tubing, analogous to that of the outlet, either from the entrance or from another opening in the hive wall or cover.

The dosage can be regulated with this apparatus in a optimum way and the smoke distribution in all parts of the hive is ideal in all circumstances. For a given quantity of active substance per smoke strip the smoke concentration is maximal with this system.

6. *Smoke injection under pressure*

In order to get an optimal smoke distribution and a high smoke concentration in the hive, several systems of smoke injection under pressure were developed.

The principle of this system is that the smoke from one or more strips is produced in a separate container and introduced into the hive

under pressure. The smoke injection takes only a few seconds, so that the loss of active substance by condensation is reduced to a minimum.

However, these fumigation techniques appeared to be too complicated for being currently applied in beekeeping practice.

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