

Methods for reliable measurement of pheromone dispenser performance

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Abstract: The standard methods for measuring dispenser release rate – weighing the dispensers between periods of field exposure or measuring the pheromone load remaining in the dispensers - suffer from a variety of systematical errors. We have developed a standardized method to measure the bulk release rate of dispensers within a few days with high resolution and reproducibility. For dispensers releasing more than one pheromone, we have substantially improved existing gas chromatographic methods to measure the release rates of the individual components. Since our methods are non destructive, they can be applied repeatedly over the lifetime of individual dispensers.

Key words: mating disruption, pheromone, pheromone dispenser, release rate, dispenser standard, precision weighing, GC analysis

Introduction

Up to now, the bulk release rate of pheromone dispensers was usually determined in the following way: Individual dispensers were taken from the field, weighed and then put back in the field in the same position, and this procedure was repeated in e.g. 7 day intervals. This procedure is subject to several systematical errors: 1) Since the release rate depends on wind and temperature, this type of procedure inseparably measures both the weather effects and the ability of the dispensers to release pheromones; 2) differences in weight may result from changes in the water content of the dispenser material as caused by changes in relative humidity and rainfall; 3) differences in weight may also occur when dust particles stick to the dispenser surface. We have developed a method for measuring dispenser release rate which avoids the above mentioned systematical errors.

Methods and results

The dispensers are held in a specially developed wind tunnel in which wind speed, temperature and relative humidity are kept constant (Fig. 1). The dispensers are

weighed every 12 hours using a scale with a resolution of 0.01 mg. Usually, a period of 4 days is sufficient to determine the release rate with an error of less than 0.1 mg/day (Fig. 3, 4). Depending on the type of dispenser, an accommodation period of 1 to 3 days is necessary to obtain a straight line in the weight decay curve, indicating a stable release rate (Fig. 2).

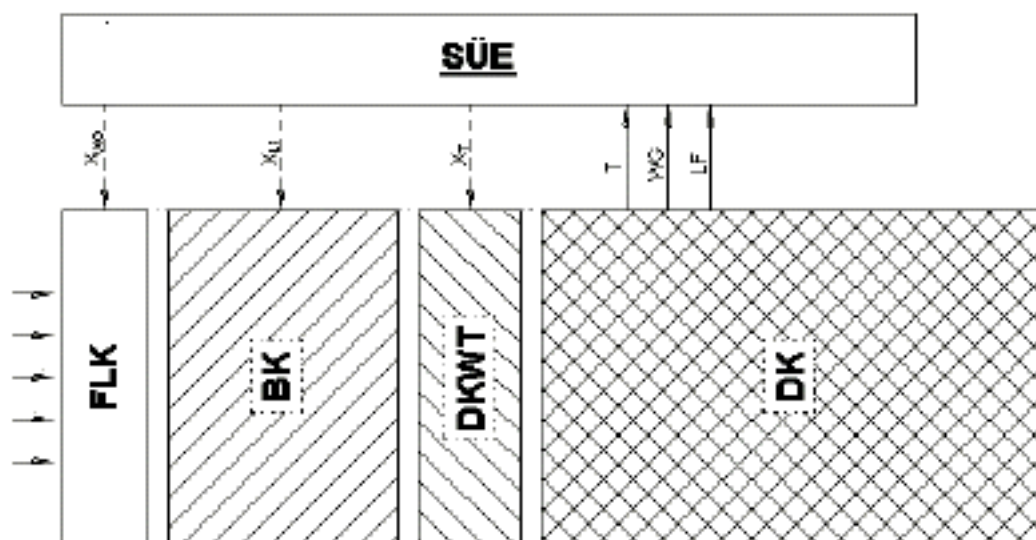


Figure 1. Schematic diagram of wind tunnel for measurements of dispenser bulk release rate. Wind speed (WG), temperature (T), and humidity (LF) are measured at the dispenser chamber (DK) and transferred to the central control unit (SÜE) which in turn varies ventilators (FLK), humidity unit (BK) and heat exchanger (DKWT) to keep these variables constant with high precision. Weight is measured by a precision scale (resolution 0.01 mg) connected to a computer for fast and reliable evaluation.

When dispensers contain several active ingredients, the measurement of bulk release rate as described above cannot yield information about the relative contribution of each ingredient to the bulk release rate. Up to now, the usual method for measuring the release rate in this case was to retrieve dispensers from the field, extract all ingredients remaining in the dispenser, measure their quantity by gas chromatography and repeat this procedure in 2-4 week intervals. Beside the interference of weather effects as discussed above, this method suffers from the fact that for the determination of release rates, a difference between two measurements of active ingredient content from different samples is needed. The relative error of such a difference measurement is quite high, unless a large number of specimen is tested. This, however, is prohibited by the relatively high costs of GC-analysis.

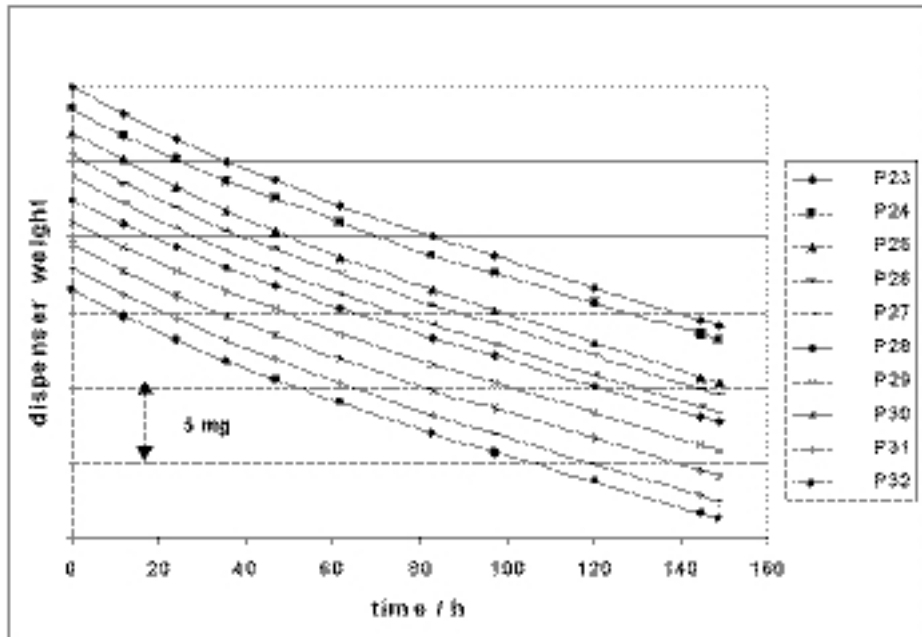


Figure 2. Weight of dispensers as determined with high precision scale plotted versus time (the individual weight of each dispenser at $t = 0$ was subtracted to yield equally spaced starting points). Note the initial curvature of the graphs which indicates that the dispensers had not yet reached equilibrium values of release rate.

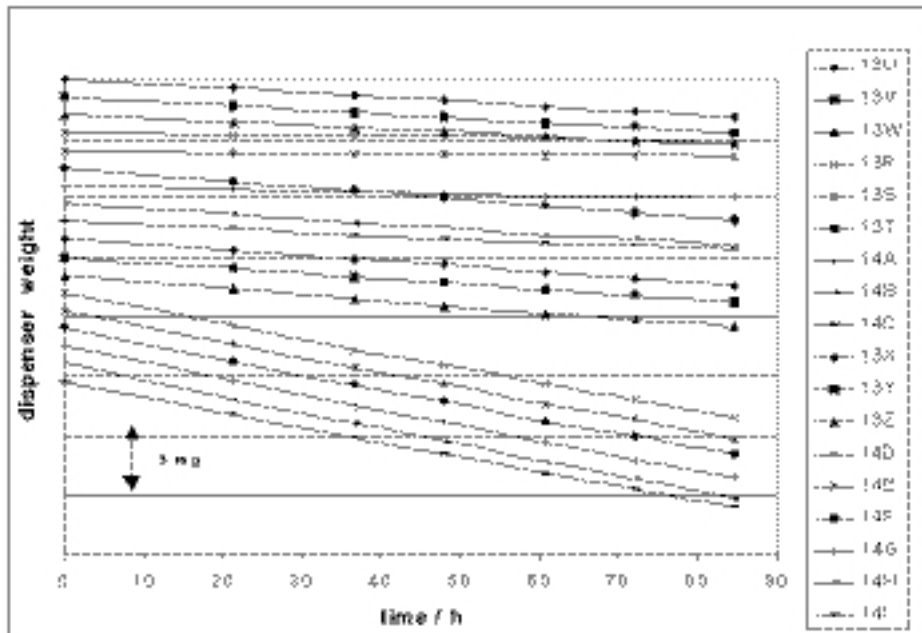


Figure 3. Weight changes of different dispenser types in a routine wind tunnel measurement. Note that dispensers 13R and 13S show extremely small but measurable weight changes.

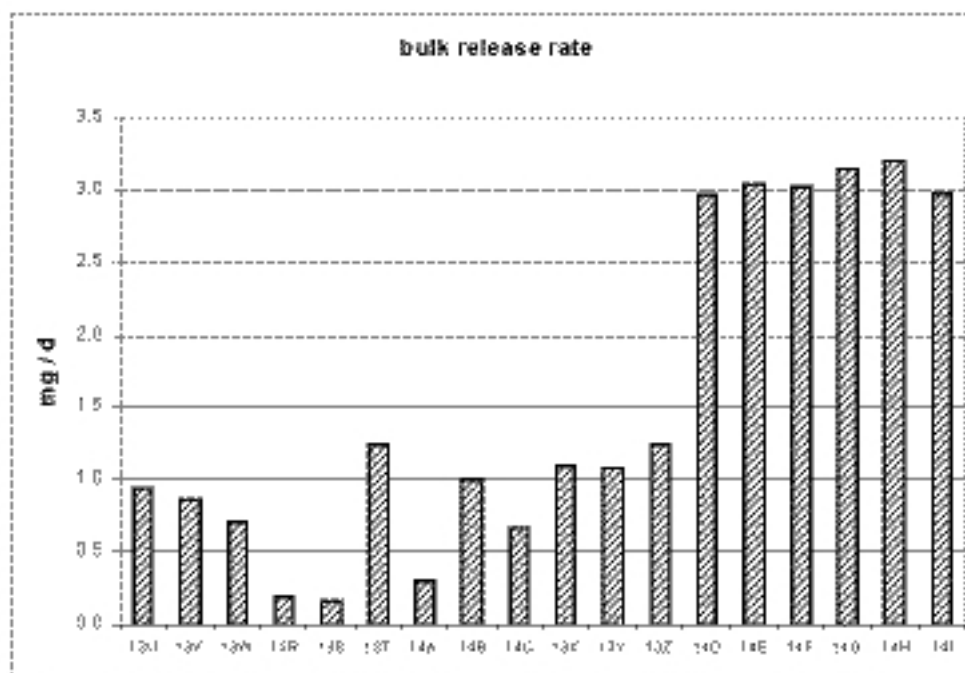


Figure 4. Bulk release rates of dispensers displayed in Figure 3, as calculated from straight line fits to the data of Figure 3. Note that the smallest release rate measured here was 0.2 mg/d (13R & 13S).

Based on a method published by Arn *et al.*(1997), we have developed a procedure to measure release rates of individual active ingredients in a short time without affecting the dispenser and its properties. The dispenser is mounted in a tube inside a temperature controlled air space (Fig. 5). A stream of air with constant velocity is drawn through the tube by means of a suction pump. After passing the tube containing the dispenser, the whole air stream is drawn through a filter cartridge containing an adsorbent material (Fig. 5). After 1-4 hours of sampling, the cartridge is washed with a solvent which in turn is analyzed for its content of active ingredients by GC analysis.

This type of measurement can yield useful data only if the dispenser is at an equilibrium state, i.e. a condition in which the release rate has become constant under wind tunnel conditions as stated above. Thus, several dispensers are first observed in a standard bulk release rate measurement. Then, a typical and an extreme specimen are chosen and their release rate of individual active ingredients is measured in the adsorption device. Under normal conditions, the bulk release rate and the sum of the release rates for the individual components match within a 20% error margin.

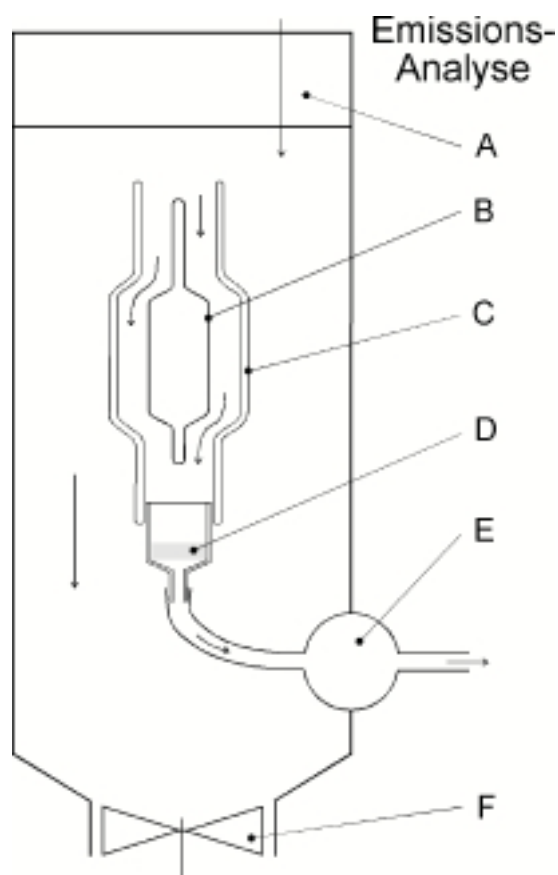


Figure 5. Schematic drawing of method for measurement of release rate of individual components. A fan (F) moves air through the chamber, entering through a heat exchanger (A) driven by a water thermostate. The dispenser under test (B) is mounted in an airflow chamber (C) modelled to maintain constant air speed around the dispenser. A suction pump (E) moves air through the adsorption cartridge (D) which retains all active substances to be later analyzed by GC.

Discussion

We have presented an improved method for the measurement of dispenser bulk release rate. This method measures the release rate independent of weather effects and therefore can be used to compare dispenser performance over different periods of use, climate conditions or production batches.

Together with a specification of appropriate temperature, wind speed and relative humidity in the wind tunnel, it can be used to specify dispenser release rate and its persistence over time as the decisive criterion for comparing dispenser performance between different products.

The use of the method for measurements of release rates of individual components is essential whenever information about the function of multi-component dis-

dispensers is needed. Our method offers the possibility to measure the behavior of one individual dispenser repeatedly over time and enables developers and users of dispensers to gain information fast and reliably.

In several cases, we found dispensers which, after a certain time of use, released one main active ingredient normally but were unable to release the other ingredient. In these cases, the bulk release rate measurement yielded „normal“ results, and the analysis of dispenser content showed that „enough“ of the critical ingredient was still inside the dispenser. Only the individual component analysis showed that it did not come out any more.

We would like to mention that the facilities at the University of Kaiserslautern are available for measurements of dispenser properties such as bulk release rate, release rate of individual components and contents of remaining active ingredients. We welcome inquiries about measurements in small or large quantities for individuals or commercial enterprises.

Acknowledgements

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Reference

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