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Standard Practice for Assessing the Efficacy of Air Freshener Products in Reducing Sensorily Perceived Indoor Air Malodor Intensity¹

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1. Scope

1.1 This practice covers standardized procedures for the quantitative sensory assessment of the reduction of perceived olfactory intensity of indoor malodors, for the purpose of assessing the deodorant efficacy of air freshener products. This practice is confined to static conditions only.

1.2 The determination of this efficacy can be useful for establishing performance claims for a given formulation, and for substantiation of those claims in product advertising. However, one must be aware that certain types of claims exist that this type of testing will not support.

1.3 This practice is limited to the assessment of a specific malodor intensity by trained judges under controlled laboratory conditions. Methods that reflect actual consumer environmental conditions are valid for selected sensory tasks, but they may be less sensitive. Methods that include highly controlled environmental conditions will increase the chances of detecting small differences among treatments. The degree of control of extraneous experimental factors in an experiment is variable and is governed by the purpose of the test, amount of resources available to provide that degree of control, and desired level of statistical sensitivity (see Appendix X3).

1.4 Selection of representative malodor sources is of critical importance. The malodor source must be readily available and of a consistent odor quality. A reasonable malodor source should be chemically and aesthetically correct. The experimenter and client must agree upon the appropriateness of a malodor source before further details of the test design are worked out. Experimental variation will be reduced by using uniform malodor sources. Information collected on malodor reduction will thus be more comparable from experiment to experiment and from laboratory to laboratory.

1.5 It is recognized that, while sometimes desirable, the use of actual “live” malodors is often impractical due to the inherent variability of the malodor sources. A true malodor source may be used when practical. However, the use of a formulated odor source has several advantages, including consistency and availability.

1.6 Air freshener products are sold commercially with the intent of providing a means of improving the odor quality of a volume of air, relative to some existing environmental condition. This typically involves the application of an odorous substance into the air space by means of some mechanical or physical mechanism. When the existing environment includes some undesirable odor source, or malodor, reduction of the perception of the malodor is usually accomplished with other odorous substances by masking. This procedure is also applicable to other mechanisms of odor reduction.

1.7 The purpose of this practice is to assess the ability of air freshener products to reduce indoor air malodor intensity from a control state. Several experimental hypotheses are possible, depending on the objective of the test. Possible objectives with respective hypotheses are given in Appendix X1.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 6 and X3.6.3.7.

2. Referenced Documents

- 2.1 *ASTM Special Technical Publications.*²
STP 434, Manual on Sensory Testing Methods
STP 758, Guidelines for the Selection and Training of Sensory Panel Members
STP 913, Physical Requirement Guidelines for Sensory Evaluation Laboratories

3. Terminology

3.1 Definitions:

3.1.1 *activation time*—the length of time that a product is permitted to be exposed in a chamber prior to evaluation by panelists.

3.1.2 *malodor*—an olfactory stimulant that, when detected, is considered unpleasant or undesirable by the target population.

3.1.3 *malodor control*—a treatment consisting of a chamber containing a malodor without any additional treatment.

¹ This practice is under the jurisdiction of ASTM Committee E18 on Sensory Evaluation of Materials and Products and is the direct responsibility of Subcommittee E 18.07 on Personal Care and Household Evaluation.

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² Available from ASTM, 100 Barr Harbor Drive, Conshohocken, PA 19428.

3.1.4 *malodor reduction efficacy*—the degree to which a product treatment or process reduces perceived malodor intensity.

3.1.5 *masking*—the reduction or elimination of olfactory perception of a defined odor stimulus by means of another odorous substance without the physical removal or chemical alteration of the defined stimulus from the environment.

3.1.6 *product control*—a treatment consisting of a chamber containing product only.

3.1.7 *spray time*—the length of time in seconds for which an aerosol air freshener is sprayed with the actuator depressed fully.

3.1.8 *synthetic model*—a mixture of components used to represent an odor.

4. Summary of Practice

4.1 The procedures described herein provide for the selection of individuals and their training to perform the functions of judges, and for the presentation of treated or untreated samples, or both, to these judges, in order to evoke an assessment of perceived malodor intensity. These assessments are performed under controlled laboratory conditions in order to determine the effect of a given product in reducing the intensity of a standard malodor intensity.

4.2 Air freshener products should be tested in a manner that maximizes test sensitivity while remaining consistent with normal product usage.

5. Significance and Use

5.1 The procedure recommended can be used for assessment of the malodor efficacy of an air freshener product on either an absolute or relative basis.

5.2 These procedures are applicable in the assessment of any products that reduce the perception of any malodor, regardless of the mode of action.

5.3 The determination of product efficacy can be useful in several situations, including product development, substantiation of performance claims in product advertising to consumers, and facilitation of communication of efficacy among product manufacturers and suppliers.

5.4 These procedures are applicable to aerosol/spray and continuous/solid air freshener products. It should be noted that while aerosol/spray and continuous/solid product evaluations are fundamentally the same, differences in technique are necessary due to the difference in the product delivery system.

5.5 These procedures can be used to assess efficacy against any standard malodor.

6. Precautions

6.1 Extreme care should be taken when handling and preparing samples under conditions that will maintain the odorless state of the laboratory area.

6.2 Appropriate safety precautions should be taken when handling all chemical compounds.

7. Selection of Panelists

7.1 *Purpose*—The purpose of this series of tests is to screen potential panelists for a malodor efficacy panel. The screening is for olfactory acuity, specific anosmia to malodorants, inter-

est, and availability for testing. This screening of potential panelists should be divided into two phases (interview and testing). The two phases should be conducted as separate sessions (see *STP 758* for panelist selection considerations).

7.2 *Panelist Recruitment*—In order to ensure an adequate number of panelists for testing, a larger number should be recruited. This is to offset the attrition experienced in interviewing, testing, and training based on the assumption that roughly half the number of recruits will fail. A final number of panelists should be selected in advance. A panel size of 20 is typically recommended for a scaling experiment. Refer to *STP 434* or Kraemer and Thieman (1),³ or both, for other considerations affecting sample size.

7.3 *Interview* (15 min)—During the interview, it is important that the judge fully understand the nature of the testing for which she/he is volunteering, including the types of malodors to be used in malodor testing. In addition, she/he should be made aware of and agree to the time commitment expected, scheduling of testing, and “good testing practices” such as the following: refraining from smoking for at least 1 h before testing, refraining from wearing perfume or after-shave on the day of testing, etc. A short questionnaire regarding the person’s physical health should be administered to determine whether the candidate has nasal or upper respiratory allergies, asthma, or is prone to frequent colds. These conditions may result in a decrease in judge sensitivity.

7.4 *Testing*—The key concept in this phase of screening is to ensure that the panelists are able to (1) discriminate and (2) detect the malodorant(s) being studied. One example of how this can be accomplished is by using a sequential analysis technique (2).

7.4.1 Recruits should be tested to determine their ability to detect and discriminate the malodors of interest. Appropriate testing methods for assessing ability include discrimination, ranking, or intensity scaling, or combination thereof.

7.4.2 The malodorant(s) in question should be the focus of the screening. Several concentrations of each of the malodorant(s) should be chosen for this testing. The concentrations should be representative of intensities experienced during regular malodor efficacy testing. Different levels of difficulty should be included in the test set. Each level of difficulty is established by pretesting.

7.4.3 Selected concentrations of each of the malodorants should be presented to recruits in a manner consistent with the difference testing procedure described in *STP 434*.

7.4.4 The selection of panelists should first rest on the results of the acuity testing. Additional tests for selected panelists may be necessary to accept or reject them. (That is, their performance may indicate the need for more testing.) If the number of recruits is greater than required, the additional information gained from the interview process should be applied.

³ The boldface numbers in parentheses refer to the list of references at the end of this standard.

8. Training of Panelists

8.1 *Purpose*—The purpose of the experimental procedures discussed here is to recommend a program of training for a group of qualified people to act as malodor efficacy panelists.

8.2 Panelist training is accomplished in three phases: (1) orientation, (2) mock deodorancy studies, and (3) regular monitoring of panelist performance (see *STP 758* for panelist training considerations).

8.2.1 *Orientation*—A brief orientation session may be held for the trainees. The objective of the orientation is to familiarize the panelists with the task of evaluating malodor efficacy as fully as possible in order to reduce the experimental error. The objective can be achieved by doing such things as introducing the panelists to each other and to test personnel involved in conducting malodor efficacy, explaining the purpose of malodor efficacy testing in the company, orienting and training judges to the selected rating scale, discussing typical testing procedures, describing panelist's responsibilities, and providing a tour of the facilities used to conduct malodor efficacy testing.

8.2.2 *Mock Efficacy Study*—One or more mock studies may be arranged to give the panelists the opportunity to practice making efficacy evaluations. Products for testing should have known differences and may include all types of air care products. The study may be similar to an actual efficacy test in order to smooth the transition from training to regular testing. Panelists should be given the opportunity to practice and demonstrate the ability to make odor intensity judgments. In addition, through discussion and feedback, panelists should be trained to “smell through” any extraneous odor(s), such as the fragrance of the product, to evaluate malodor intensity. Individual panelist performance can be monitored during the training phase by analyzing for variance due to panelists. Individuals who exhibit errant results should undergo additional training and monitoring. However, repeated underperformers should be dropped from the panel.

9. Selection and Qualification of Malodor Models

9.1 Synthetic models of malodors are used widely in odor testing involving the determination of air freshener efficacy. Synthetics have several advantages, most of which center on avoiding logistical and safety difficulties associated with using the actual malodor source (for instance, fecal odors). In general, laboratory efficacy testing involves the screening of various materials for their efficacy in reducing the perceived level of malodor intensity. The synthetic malodor is used to represent the actual odor. The validity of results from these types of tests is maximized when the actual malodor source is used under conditions representative of the consumer environment.

9.1.1 When synthetic models are used, they must be developed to be as similar as possible to the odor experienced by the consumer, in both the chemical and perceptual sense. Thus, any synthetic malodor model used should have been tested previously for its validity as a model of the actual odor.

9.1.2 There are many potential techniques for accomplishing validation. The application of each technique, be it descriptive, discrimination, or consumer testing, must be evaluated on

its own merit. It is not within the scope of this practice to enumerate the details of all techniques. However, it is imperative that the results should indicate clearly that the synthetic mixture is reasonably similar to the actual malodor as experienced by the consumer.

9.2 The following criteria may be used to validate the choice of malodorant(s). One or all of these criteria may be appropriate, depending on the specific mode of action of the products.

9.2.1 *Chemical Composition*—If the product is meant to function by some physical method (other than masking), the chemical composition of the malodor model is critical. The chemical compositions of the malodor model and samples of the actual malodor source should be determined by appropriate analytical methods. Similarities and differences should be noted and evaluated for relative importance.

9.2.2 *Multiple Choice Data*—The data generated from a multiple choice descriptor panel can be used to support a potential malodor model. Malodor samples should be presented at appropriate intensities. The number of panelists, malodor samples, and possible descriptors should be considered before beginning any such test. Other factors to consider include the sample presentation, descriptor terms, and acceptance criteria. For an example ballot and profiles, see Appendix X2.

9.2.3 *Odor Profile Data*—The data generated from an odor profile panel can also be used to support a potential malodor model. Although this procedure is more time- and resource-intensive, it will provide more detailed information on major and minor odor descriptors that are detected in a potential malodor model. The considerations discussed relative to the multiple choice tests should also be considered for odor profile tests. For information concerning odor profiling, see Dravnieks (3) or Jeltema and Southwick (4), or both.

9.3 *Toxicological Review*—The synthetic model should be subjected to a safety review by the appropriate health and safety professionals to ensure that human health is not endangered and that panelists are not being exposed to regulated substances at levels exceeding those allowed by law.

10. Procedure

10.1 Sample Preparation:

10.1.1 Sample preparation is dependent on the type of air care product and nature of the individual malodor standard.

10.1.2 Measurement of product efficacy requires a minimum of two treatments: (1) an untreated malodor control and (2) a combination of malodor and product. If desired, the test can include a treatment consisting of a product alone, that is, without malodor. Several different treatments may be evaluated in the same panel session.

10.1.3 The number of treatments that can be evaluated in a single session will depend on the number of chambers available, nature of the malodor, and skill of the panel. The experimenter will need to determine empirically the limitations imposed by the malodor and by the panelists. It is critical that the independence of judgments for any given treatment be maintained. The main factor influencing independence of

judgments is sensory adaptation/fatigue in detecting the malodor. Therefore, plan adequate time to prevent adaptation between evaluations of different treatments.

10.1.4 The application of malodor and product to the chambers usually occurs chronologically. The application order will depend on the specific product use. Typical approaches are as follows: (1) malodor is applied first, and product is applied second; or (2) product is applied first, and malodor is applied second.

10.1.5 After the appropriate exposure time for the malodorant or product, or both, has elapsed, both the malodorant and the product may or may not be removed from the chamber(s). This decision must be made considering the goal of the specific test. While removing the odorants, take care to preserve the odorless state of the surrounding laboratory.

10.2 *Malodor Treatments:*

10.2.1 The selection of a representative malodor source is of critical importance. No agreed-upon standards exist. Review 1.4, 1.5, 9, and Appendix X2.

10.2.2 Tests are typically set up to evaluate a single malodor at a time. Tests in which panelists are exposed to different malodors in different chambers can be confusing and may reduce test sensitivity.

10.3 *Product Treatments:*

10.3.1 The appropriateness of controlled air flow or static air conditions must be determined based on the specific test objectives. A mixer must be used if static conditions are selected.

10.3.2 *Aerosol Spray and Trigger Pump-Type Delivery Systems:*

10.3.2.1 Prior to applying product to the malodor in the chamber, spray the products for 1 to 2 s into a fume hood to clear the dip tubes.

10.3.2.2 There are two generally used methods of application: equal spray time and equal weights. Note the weights when using equal spray time. Adjust the spray time or weight amount according to the volume of the chamber. Regardless of brand, valve type, actuator type, etc. equal spray time will provide an estimate of product efficacy that will be representative of the total product being evaluated (not including appearance attributes).

10.3.2.3 Apply the product to the chamber atmosphere using a broad, sweeping motion and by directing the spray toward the ceiling. This should be completed at least 5 min prior to evaluation by the judges.

10.3.3 *Continuous/Solid-Type Delivery Systems*—Prior to conducting a test for effectiveness, determine a proper activation time. It is difficult to give a specific value for this time interval since it will vary from a few minutes to several hours, depending on the mode of action and the volume of the test room.

11. Sample Presentation

11.1 Samples are presented to panelists in odor evaluation chambers. The chambers should be labeled with randomly generated, three digit codes. Temperature and relative humidity conditions should be controlled as much as possible. Typical conditions are 22°C and 50 %, respectively. Conditions should be recorded and equivalent for all chambers. Each panelist evaluates the chambers in random order. It should be noted that in order to maintain independence of judgments between samples, judges should be required to rest in between each sample as described in 11.2. Chambers should be evaluated in a manner that minimizes dilution of the chamber contents. This is usually accomplished by having panelists smell the contents of the chamber through a small port.

11.2 The smelling procedure is as follows:

11.2.1 An initial malodor-only booth, which all panelists smell first, is recommended. This booth is identified as containing the malodor of interest. Panelists then smell each test booth for that particular odor. The data from the initial, malodor-only booth is usually not used in any analyses. In addition to acquainting the panelists with the malodor in question, this approach may reduce the order of presentation effect between samples as well as the effect of fatigue.

11.2.2 Smell the chamber contents and evaluate the intensity of the malodor using an appropriate sensory method (see *STP 434*). Other attributes such as overall intensity, hedonics, and qualitative change may also be assessed at this time.

11.2.3 The amount of waiting time between each evaluation depends on the time it takes to overcome sensory adaptation/fatigue. The amount of time depends on many factors and should be determined through experience using good experimental techniques. A 10-s minimum is recommended.

11.2.4 Repeat 11.2.1 and 11.2.2 until all of the samples are evaluated. Samples may consist of positive and negative controls (product without malodor and malodor without product), other controls (such as blank chamber), and market targets, as well as test products.

11.3 Whenever possible, the test should be scheduled in such a way that only one panelist is in the chamber area at a time.

12. Data Collection and Analyses and Interpretation of Results

12.1 Sensory malodor intensity evaluations are obtained by using any acceptable sensory method (paired comparisons, ranking, or scaling).

12.2 The statistical analyses to be conducted depend on the objective of the test and the procedure used (see Appendix X1).

12.3 The interpretation of test results after statistical analysis of the data are given in Appendix X1.

13. Keywords

13.1 air fresheners; indoor air; malodor counteraction; sensory facilities; sensory test chamber construction