Designation: F 2130 – 09

Standard Test Method for Measuring Repellency, Retention, and Penetration of Liquid Pesticide Formulation Through Protective Clothing Materials[1]

This standard is issued under the fixed designation F 2130; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The health and safety of agricultural workers involved in the mixing, loading and application of liquid pesticides can be affected by dermal exposure to liquid pesticide formulations. Use of protective clothing can assist in minimizing the danger of contact with potentially harmful pesticides. Nonporous materials that provide excellent protection to the user are usually not suitable for many agricultural environments in which there is a potential for heat stress. Therefore, garments made of porous materials that can provide a balance between risk from pesticide exposure and user comfort can also be used as personal protective equipment (PPE) for agricultural workers. The movement of liquid pesticides through these materials is primarily a result of penetration through spaces between fibers and interstices between yarns. As these materials provide protection either by repelling or retaining liquid pesticide, the measurement of these properties is also important. This test method is used to measure repellency, retention, and penetration of liquid pesticides through protective clothing materials.

The degree of contamination depends on numerous factors such as type of exposure, application technique, and pesticide formulation. Worker exposure to liquid pesticides can range from low exposure caused by spray drift to high exposure as in the case of an accidental spill while mixing or handling of concentrates. As the level of exposure can vary considerably, this test method is designed to rate relative performance of PPE materials at two levels of contamination.

1. Scope

1.1 This test method measures repellency, retention and penetration of a known volume of liquid pesticide when applied to protective clothing material. No external hydrostatic or mechanical pressure is applied to the test specimen during or after the application of the liquid pesticide.

1.2 This test method is designed to measure performance of protective clothing materials at two levels of contamination. Low level of contamination is achieved by applying 0.1-mL liquid formulation and high level by applying 0.2 mL.

1.3 This test method does not measure resistance to permeation or degradation.

1.4 This test method is suitable for field strength pesticide formulations. This test method may not be suitable for testing protective clothing materials against volatile pesticides.

1.5 The values stated in SI units are to be regarded as the standard.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 123 Terminology Relating to Textiles

E 105 Practice for Probability Sampling Of Materials

F 1494 Terminology Relating to Protective Clothing

3. Terminology

3.1 *Definitions:*

[1] This test method is under the jurisdiction of ASTM Committee F23 on Personal Protective Clothing and Equipment and is the direct responsibility of Subcommittee F23.30 on Chemicals.

Current edition approved Feb. 1, 2009. Published February 2009. Originally approved in 2001. Last previous edition approved in 2001 as F 2130 - 01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.1 *analytical technique*, *n*—a procedure whereby the concentration of the challenge chemical in a collection medium is quantitatively determined.

3.1.1.1 *Discussion*—These techniques are often specific to individual chemical and collection medium combinations. Applicable techniques include, but are not limited to, flame ionization, photo ionization, electro-chemical, ultraviolet and infrared spectrophotometry, gas and liquid chromatography, colorimetry, length-of-stain detector tubes, and radionuclide tagging/detection counting.

3.1.2 *coated fabric*, *n*—flexible material composed of a textile fabric and an adherent polymeric or other material applied to one or both surfaces.

3.1.3 *degradation*, *n*—deleterious change in one or more properties of a material.

3.1.4 *penetration*, *n*—for chemical protective clothing, the movement of substances through voids in protective clothing materials or items on a non-molecular level.

3.1.4.1 *Discussion*—Voids include gaps, pores, holes, and imperfections in closures, seams, interfaces and protective clothing materials. Penetration does not require a change of state; solid chemicals move through voids in the materials as solids, liquids as liquids and gases as gases. Penetration is a distinctly different mechanism from permeation.

3.1.5 *permeation*, *n*—for chemical protective clothing, the movement of chemicals, as molecules, through protective clothing materials by the processes of (*1*) absorption of the chemical into the contact surface of the material, (*2*) diffusion of the absorbed molecules throughout the material, and (*3*) desorption of the chemical from the opposite surface of the material.

3.1.5.1 *Discussion*—Permeation is a distinctly different mechanism from penetration.

3.1.6 *pesticide retention*, *n*—amount of pesticide active ingredient retained in the protective clothing material.

3.1.7 *protective clothing*, *n*—an item of clothing that is specifically designed and constructed for the intended purpose of isolating all or part of the body from a potential hazard; or, isolating the external environment from contamination by the wearer of the clothing.

3.1.8 *repellency*, *n*—characteristic to resist wetting and penetration by a liquid.

3.1.9 *test chemical*, *n*—solid, liquid, gas, or mixture thereof, used to evaluate the performance of a protective clothing material.

3.1.9.1 *Discussion*—For the purpose of this test method, test chemical is limited to liquid chemicals that are a mixture of raw materials, including, but not limited to, active ingredients, inert ingredients, and a base solvent used in pesticide formulation. Additional ingredients could include emulsifiers and surfactants. Solvents used in the formulation could be water, isopropyl alcohol, or petroleum distillate. Solid materials (powders, granules, and so forth) may be dissolved or emulsified to form a liquid or suspension. These formulations may be ready to use or concentrates that require dilution to field strength. In some ultra-low volume applications, concentrated oil-based formulations are used without dilution; testing for this application is beyond the scope of this test method.

3.1.10 For other textile terminology see Terminology D 123.

3.1.11 For other protective clothing terminology see Terminology F 1494.

4. Summary of Test Method

4.1 A pipettor is used to apply liquid pesticide to the surface of the test assembly. The test assembly consists of single- or multiple-layer protective clothing material (test specimen) and an absorbent paper backed by polyethylene film (collector layer).

4.1.1 Another absorbent paper backed by polyethylene film is placed on the surface test specimen after a specified time to remove the remaining liquid.

4.1.2 The contaminated test specimen, collector layer, and paper used to remove liquid from the surface of the material are separated and extracted.

4.1.3 The extracts are analyzed quantitatively.

4.1.4 Data are used to calculate percent repellency, pesticide retention, and penetration.

5. Significance and Use

5.1 This test method can be used for laboratory screening of protective clothing material used to manufacture garments and accessories worn by pesticide workers.

5.2 This test method can be used for the development and evaluation of new protective clothing materials.

5.3 This test method can be used for the evaluation of protective clothing materials against new pesticide formulations.

6. Apparatus and Materials

6.1 Apparatus and materials for contamination of test specimen:

6.1.1 *Test Chemical*, to contaminate the test specimen.

NOTE 1—Diluted and concentrated formulations can be used with this test method.

6.1.2 *Pipettor*, with disposable pipet tip, mounted on a support stand, for pipetting 0.1 ± 0.002 mL of liquid for low contamination level and 0.2 ± 0.004 mL for high contamination level.

6.1.3 *Specimen Holder*, that consists of a base plate (100 by 100 mm) and a cover plate (100 by 100 mm with a 60 by 60 mm opening in the center). The specimen holder is made of polymethyl methacrylate (PMMA) (4-mm thickness).

6.1.4 *Timer*, accurate to 1 s.

6.1.5 *Absorbent Paper*, two 80 by 80-mm squares of Whatman Benchkote Plus[3] Paper (absorbent paper backed by polyethylene film) per test specimen. One square is used to measure penetration, and the second to measure repellency.

NOTE 2—Substitutions are not recommended, as due to differences in sorptive properties, use of absorbent papers other than Benchkote Plus may affect the test results.

[3] Whatman Benchkote Plus absorbent paper is available through scientific products suppliers or from Whatman Company. Information on the paper and suppliers can be obtained from www.whatman.com