



Designation: E641 – 01(Reapproved 2006)

## Standard Methods for Testing Hydraulic Spray Nozzles Used in Agriculture<sup>1</sup>

This standard is issued under the fixed designation E641; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 These methods cover procedures for testing hydraulic spray nozzles used in agriculture. The methods herein cover the following performance parameters: nozzle flow rate, nozzle spray angle, liquid distribution, spray droplet size, and nozzle wearability.

1.2 These methods are applicable to hydraulic spray nozzles which produce the following spray patterns: flat-fan, hollow cone, and full cone.

1.3 *This standard does not purport to address the safety concerns 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. Terminology

#### 2.1 Definitions of Terms Specific to This Standard:

2.1.1 The types of hydraulic spray nozzles considered are categorized according to spray characteristics, as follows:

2.1.1.1 *flat-fan “tapered edge” type spray nozzle*—this nozzle provides a range of atomization sizes throughout the pattern area. Its edges are tapered to permit the overlapping of spray patterns from adjacent nozzles, thereby providing relatively uniform overall distribution. These nozzles are popular on field-type crop sprayers where uniform coverage is desired across the swath.

2.1.1.2 *flat fan “even edge” type spray nozzle*—this nozzle provides relatively uniform atomization size as compared to the “tapered edge” type nozzle and uniform distribution throughout the spray pattern. There is no requirement for overlap of adjacent spray patterns when using this nozzle. It is used primarily to spray uniform strips or bands in fields.

2.1.1.3 *flooding or deflector-fan type spray nozzle*—this nozzle produces a low impact spray with a wide-angle flat pattern having uniform distribution when low pressures are

used. It is used primarily on field-type sprayers when broad coverage at lower pressures is desired.

2.1.1.4 *hollow cone and full cone nozzle*—the hollow cone nozzle normally provides uniform distribution throughout a hollow cone pattern area. The full cone nozzle, provides uniform distribution throughout its full cone pattern. Both types are used extensively for spraying of fruits and vegetables, some row crops with pesticides, and aerial applications.

### 3. Significance and Use

3.1 The purpose of these methods is to provide uniform testing procedures for evaluating the performance criteria of hydraulic spray nozzles used for agricultural purposes.

3.2 The procedures set forth in these methods are for spray nozzles of the hydraulic energy type in which the spray material is forced through an orifice under pressure, providing fluid break-up into droplets.

3.3 Droplet producing nozzles that operate by means other than hydraulic energy are not applicable to these methods.

### 4. Apparatus

4.1 This section covers equipment used in testing hydraulic spray nozzles. The equipment and apparatus listed are sufficient for use in all methods described herein.

4.2 Fundamental equipment common to all of the test methods are as follows:

4.2.1 *Water Reservoir or Retaining Vessel*—A water reservoir or vessel sufficiently large to provide smooth continuous flow to the nozzle(s) throughout the duration of a particular test.

4.2.2 *Pump or Source of Water Pressure*—A pump or source of water pressure sufficient to maintain the required test pressure with less than  $\pm 2\%$  deviation from the nominal pressure.

#### 4.2.3 Pressure Gage:

4.2.3.1 A pressure gage with an accuracy of  $\pm 2\%$  at the actual working pressure. It should have a maximum pressure reading on the dial face such that the test pressure can be as near the midrange of the gage as possible.

4.2.3.2 The pressure gage should be calibrated prior to use at each of the required test pressures by using a Certified Dead Weight Gage calibrator or a suitable manometer capable of gage calibration.

<sup>1</sup> These methods are under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents and are the direct responsibility of Subcommittee E35.22 on Pesticide Formulations and Delivery Systems.

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- 4.2.4 Pressure Regulator,
- 4.2.5 Control Valves,
- 4.2.6 Inline Strainer,
- 4.2.7 Piping,
- 4.2.8 Union Tees,
- 4.2.9 Union Elbows.

4.3 General equipment and arrangement schematics used in testing each of the performance criteria are as follows.

4.3.1 Discharge Rate:

4.3.1.1 Apparatus Schematic—See Fig. 1.

4.3.1.2 Cylinders, Graduated, sized to meet specific test requirement.

4.3.1.3 Stop Watch, having 0.2-s resolution or better.

4.3.1.4 Collecting Vessel, glass, metal or plastic, sized to meet test requirements.

4.3.1.5 Laboratory Beakers,

4.3.1.6 Flowmeter, Electronic or manual with accuracy of  $\pm 3\%$  of scale

4.3.1.7 Balance, top loading with sensitivity of  $\pm 0.01\text{g}$  or better accuracy of 0.1g or better.

4.3.2 Spray angle:

4.3.2.1 Apparatus Schematic—See Fig. 2.

4.3.2.2 Spray Pattern Distribution Testing Table.

4.3.2.3 Spray Protractor, having a minimum arm length of 300-mm (12-in.).

4.3.3 Distribution:

4.3.3.1 Apparatus Schematic—See Fig. 3 and Fig. 4.

4.3.3.2 Spray Pattern Distribution Testing Table.

4.3.3.3 Spray Pattern Distribution Testing Racks, Troughs, and Beakers.

4.3.3.4 Balance, as in 4.3.1.7.

4.3.3.5 Stop Watch, as in 4.3.1.3.

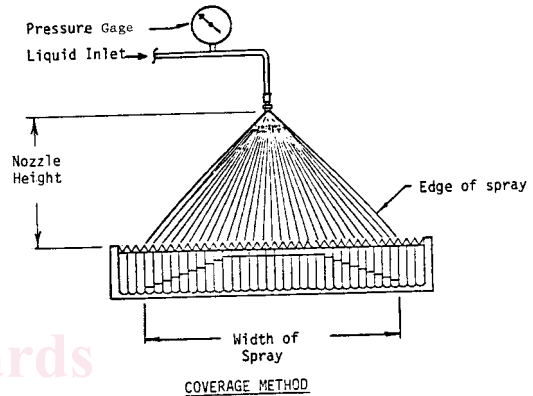
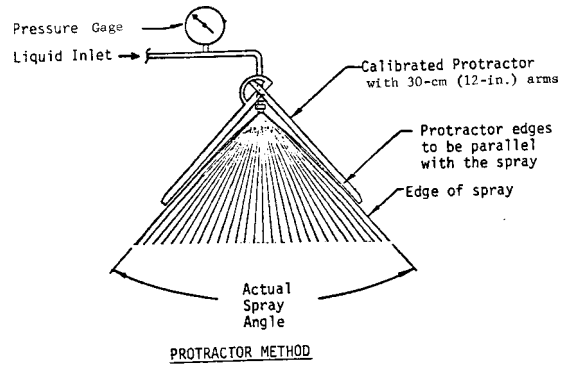


FIG. 2 Spray Angle Test Equipment

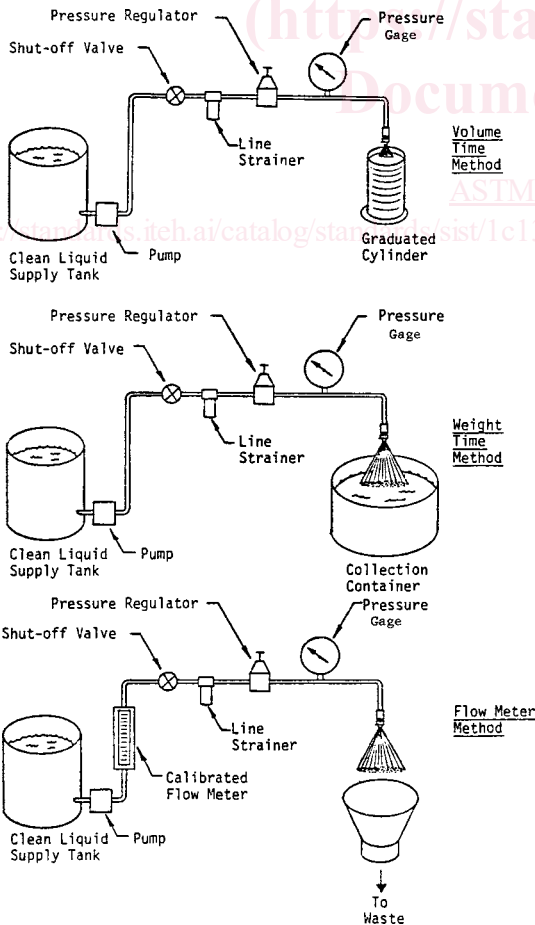


FIG. 1 Discharge Rate Test Equipment

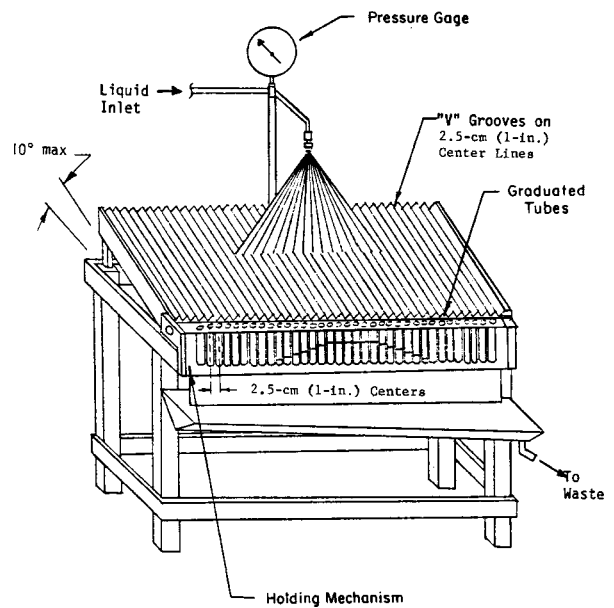


FIG. 3 Distribution Table

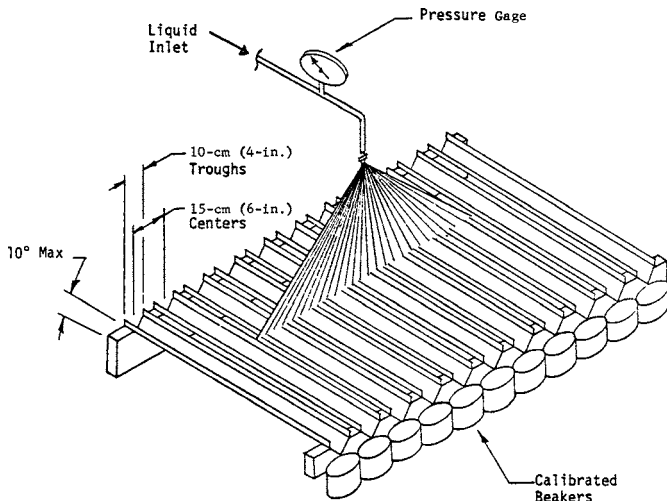


FIG. 4 Distribution Rack

4.3.4 *Particle Size*—Since there is no agreement on methods of sampling and measurement, this section is omitted at this time. (Note the section on reporting of measurements, 6.5.)

4.3.5 *Wearability*:

4.3.5.1 *Apparatus Schematic*—See Fig. 5.

4.3.5.2 *Pressure Tank*, with agitator and air regulator.

4.3.5.3 *Wear Media*.

4.3.5.4 *Imhoff Settling Cone*, 1000-ml.

4.3.5.5 *Spray Pattern Distribution Testing Table*.

4.3.5.6 *Spray Pattern Distribution Testing Racks, Troughs, and Beakers*.

4.3.5.7 *Collection Vessel*, as in 4.3.1.4.

4.3.5.8 *Balance*, as in 4.3.1.7.

4.3.5.9 *Stop Watch*, as in 4.3.1.3.

4.3.5.10 *Cylinder*, as in 4.3.1.2.

4.3.5.11 *Flowmeter*, as in 4.3.1.6.

## 5. Spray Medium

5.1 It has been accepted practice to use clean, clear water as a standard. However, testing procedures do not preclude using these methods for other liquids.

5.2 Unless otherwise indicated, references to water shall be understood to mean clean, clear, filtered water at a temperature of 20 to 25°C (68 to 70°F).

## 6. Procedure

6.1 *Pressure Adjustment*:

6.1.1 *Pump Method*:

6.1.1.1 Add the spray media to the system.

6.1.1.2 With the recirculation valve open and the spray valve closed, turn on the spray pump.

6.1.1.3 Open the spray valve and slowly close the recirculation valve until the desired spray pressure is reached.

6.1.2 *Air Pressure Method*:

6.1.2.1 Add the spray media to the system.

6.1.2.2 With both the spray valve and pressure regulator closed, apply air pressure to the system.

6.1.2.3 Open the spray valve and slowly open the pressure regulator until the desired spray pressure is obtained.

6.2 *Discharge Rate*:

6.2.1 The discharge rate of a nozzle is normally denoted in volume-time units such as litres per minute, litres per second, or gallons per minute.

6.2.2 The discharge rate can be determined by a method such as an actual volume-time measurement, an actual weight-time measurement, or a volume-time measurement observed directly from an accurately calibrated flow meter. The discharge rate of the nozzle may determine what method of measurement is practical. (See Fig. 1.)

6.2.3 *Volume-Time Measurement Method*:

6.2.3.1 Adjust spray pressure to desired setting.

6.2.3.2 Pass water through the nozzle and collect it in a clean, dry, graduated cylinder for an interval of at least 1 min, as measured by a stop watch. The nozzle discharge during the time interval should fill at least 75 % of the cylinder graduated volume.

6.2.3.3 Read the amount of water collected directly from the graduated cylinder to the nearest units denoted, thereby providing the volume-time discharge rate.

6.2.3.4 Repeat this procedure three separate times and use an average of the three observations as the measured discharge rate.

6.2.3.5 *Report*—Nozzle type and size, test pressure, spray time, average discharge rate, graduated cylinder capacity and lowest unit of measure, and spray media.

6.2.4 *Weight-Time Method*:

6.2.4.1 Establish the tare weight of a collection vessel.

6.2.4.2 Adjust spray pressure to desired setting.

6.2.4.3 Spray water into the collection vessel for an interval of at least 1 min, as timed by a stop watch.

6.2.4.4 Establish the net weight of the discharged water by reweighing the collection vessel to the nearest 0.1 g. The result

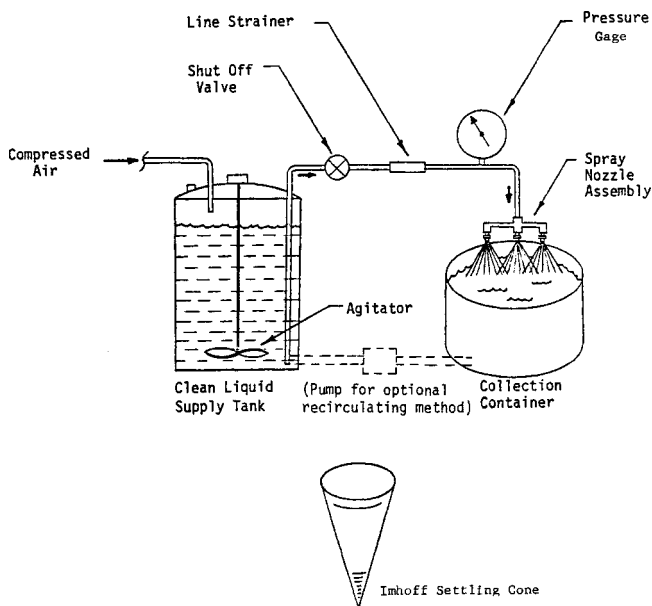


FIG. 5 Wearability Test Equipment