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Crop protection equipment — Droplet-size spectra from atomizers — Measurement and classification

Équipement de protection des cultures — Spectres de taille des gouttes des systèmes d'atomisation — Mesurage et classification

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Foreword

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Introduction

The measurement and classification of droplet size spectra for applications of pesticides and other chemicals facilitate the description of sprays and therefore enhance efficacy and spray drift management.

Most atomizers produce a spectrum of droplet sizes, giving different droplet size spectra in different operating conditions.

Measurement systems and laboratories can produce different absolute values for a given droplet spectrum. Differences are usually due primarily to sampling effects, dynamic size range capabilities, data processing and reporting. Some of these differences can be minimized through the use of appropriate sampling techniques. However, discrete differences in absolute values of droplet size spectra can still remain between measurement systems, especially where spatial size distribution (size distribution of particles in a given volume of space where there is no significant variation in the distribution during the sampling interval) and flux size distribution (size distribution of particles passing through a sampling zone during a given interval of time where individual particles are counted and sized)lead to sampling differences.

An approach that has been successfully used for describing spray droplet size spectra using standardized terminology involves the use of reference sprays to define reference categories for increased uniformity in the relative measures and classification of spray droplet spectra among different measurement systems and laboratories[1][2]. This is the approach taken by this document.

Each measurement facility should determine its own "in-house" reference categories using this document (with one set for each measurement system and sampling method), and then classify sprays being measured using the same measurement and sampling procedures as those for the respective reference sprays. For example, reference curves from one source (laboratory, measuring instrument and sampling technique) cannot be used to classify sprays from a different measurement source.

Using the classification of droplet size spectra, it is also possible to provide appropriate information to the user.

Crop protection equipment — Droplet-size spectra from atomizers — Measurement and classification

1 Scope

This document specifies procedures for classifying droplet size spectra from atomizers used in spraying for crop protection. It provides a reference system for defining classes of droplet size spectra.

Depending on their function principle and individual setup, measuring systems for droplet sizing can give different results. This document provides a means of comparing measured droplet size spectra to reference spectra and enables relative comparisons of droplet size spectra obtained from different measuring systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5681, *Equipment for crop protection — Vocabulary*

ISO 5682-1, *Equipment for crop protection — Spraying equipment — Part 1: Test methods for sprayer nozzles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
droplet size class
range between two reference droplet size spectra

3.2
reference droplet size spectrum
droplet size spectrum that defines the border between two *droplet size classes* (3.1) obtained by reference nozzle/spray pressure combinations using filtered water as the liquid

3.3
droplet volume fraction
$D_{v0,x}$
droplet diameter where the fraction 0,x of the spray volume is in smaller droplet sizes

3.4
volume median diameter
$D_{v0,5}$
droplet size where half the volume of the spray is in larger droplet sizes and half in smaller droplet sizes

4 Droplet size measurement

Measurements are carried out using at least three candidate single atomizers out of a batch of at least 10 atomizers of the same type, with a maximum deviation of flow rate of ± 3 % from the value specified by the manufacturer at the reference rating recommended spray pressure, or parameters measuring the flow rate in accordance with ISO 5682-1. It is important to ensure that a representative sample of an atomizer's spray pattern is used that covers the entire droplet size spectra and accounts for all emitted droplets in a given sample time interval. During the measurement of all sprays, the spraying liquid shall have a temperature within 5 °C of the ambient air temperature, and temperature differences between measurements made with the reference nozzle and the candidate atomizer should be less than 5 °C. The air and liquid temperatures shall be recorded at the time of measurement.

For comparisons between laboratories, it is recommended to perform the drop size measurements with a spray liquid having a temperature of (20 ± 2) °C, in a controlled environment with an air temperature of (20 ± 2) °C and a relative humidity of 40 % to 80 %.

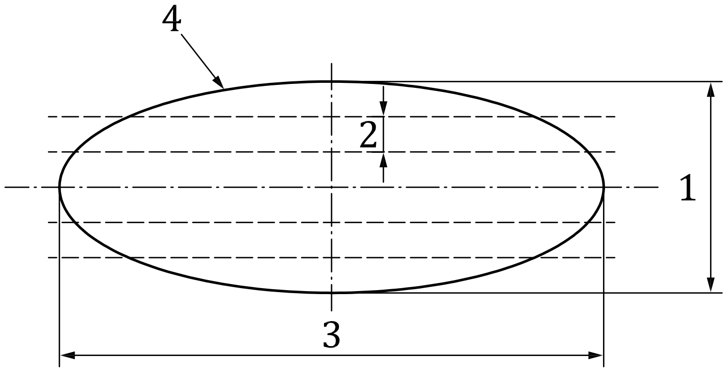
The droplet size spectrum can be measured with any non-intrusive measuring system (sampling instrument does not contact the spray or disturb the carrier air) that is appropriate for the range of droplet size and velocity within the spray and the properties of the spraying liquid. Examples for those systems are phase Doppler[4][6] light scatter, laser diffraction, or imaging principles. The instrument and measurement system shall enable repeatable measurements for the reference sprays with maximum $D_{v0,5}$ deviations between replicate (minimum three) measurements of ± 10 %, for the same setting and measuring situation.

For laser diffraction measurement systems, a minimum of three separate measurements per nozzle shall be averaged to establish the cumulative volume-versus-droplet size spectra relationship, including values of $D_{v0,1}$, $D_{v0,5}$ and $D_{v0,9}$, and with $D_{v0,1}$ and $D_{v0,5}$ replicates less than ± 5 %. With single particle counter systems, the forward speed or measuring time shall be adjusted to obtain maximum $D_{v0,1}$ and $D_{v0,5}$ deviations between replicate measurements of less than 10 %.

A representative cross-section average sample shall be obtained across the entire spray plume, with droplet size measurement being conducted at a distance of 30 cm to 50 cm from the reference nozzle outlet or at an appropriate distance for measuring a fully atomized spray, noting the manufacturer's recommendations. The sample distance shall enable representative sampling without intrusion into the spray spectrum formation process. The sampling time shall be uniform for all positions in the spray jet.

For measuring systems with a point wise measuring principle, as in phase Doppler devices, continuous or stepwise movement of the point of measurement relative to the spray fan is required in order to obtain a representative sample of droplets. These relative movements shall follow straight lines along one of the central axes immediately below the atomizer. At least two additional movement lines shall be used at each side of one of the main axis, as shown in Figure 1.

In case of continuous movement, the forward speed shall be constant for all movement lines. For stepwise movement, the measuring time shall be the same at each measuring position. Forward speed, measuring time and/or number of discrete movement lines shall be adjusted to obtain a maximum $D_{v0,5}$ deviation between replicate measurements of ± 10 %, and where possible and appropriate, to sample at least 10 000 droplets per individual nozzle.



Key

1 depth of spray fan

2 minimum 5 equally spaced lines

3 width of spray fan

4 spray fan footprint

NOTE More lines of measurement may reduce variability of results.

Figure 1 — Line measurement positions

Determine the depth and width (see Figure 1) of the spray fan using water-sensitive paper, horizontal patternator, or a similar means, and document in the test report.

For double-orifice nozzles, each single spray fan should preferably be measured and reported separately. Turn the nozzle in such a way that the single spray to be measured is directed vertically downwards and proceed as described above. Sample at least 5 000 droplets for each spray fan and merge the data with a volume weighted technique after measuring both spray fans and report the results. If spray geometry or design dictates, measure both spray patterns simultaneously in one scan to account for any interactions.

Liquid flow rate shall be measured using an appropriate technique such as a Coriolis-type[5] mass flow sensor, a calibrated flow turbine, a positive gear displacement meter or a mass loss system with an accuracy of at least ± 1 % of the measuring value.

Atomizer output shall remain constant during the measurement process with a maximum deviation of ± 2,5 % of the rated value as given in ISO 5682-1. Consistency of output rate can be monitored by flow rate or pressure or other appropriate parameters. For hydraulic nozzles, the recommended point for pressure measurements is at the nozzle body, near the nozzle tip, using a capillary tube connected to a calibrated pressure gauge. A similar location is recommended for other atomizers.

Verification or calibration to known standards of any measurement method is essential. Instrument particulars, such as size range configuration, obscuration, multiple scattering, verification, droplet path angle, calibration and repeatability shall be addressed such that accurate and repeatable (not more than 5 % deviation for $D_{\mathrm{v}0,5}$) day-to-day measurements are obtained.

Many other factors shall be considered when sampling the spray, including sampling distance (recommended to be 30 cm to 50 cm from hydraulic nozzles, or as appropriate for sampling a fully-atomized spray). The same procedures shall be followed as those used for the reference spray as appropriate, including sample size, at least ensuring a steady-state operating procedure of atomizers for data collection, instrument configuration and use, and data processing software settings. However, most of these are instrument-specific, so rather than providing detailed guidelines for measurement considerations in this document, the user is referred to appropriate standards and user manuals for their measuring instrument.