
Fine bubble technology — Agricultural applications —

Part 1:
**Test method for evaluating the
growth promotion of hydroponically
grown lettuce**



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 281, *Fine bubble technology*.

A list of all parts in the ISO 23016 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html

Introduction

The recent progress in the application of fine bubble technology exhibits successes in the various technical fields such as environmental technology in water and washing and cleaning technology for mechanical engineering. The applications for agro- and aqua- farming and food industrial field also draw high interests of markets in view of fine bubble enabled performance in enhancing growth of agro- and aqua- products, improving their quality, saving resources for farming and ensuring safety of the food products. Various industries engaged in such products are introducing the fine bubbles to their farming field by applying fine bubble generating systems, eventually creating new market for the generating systems.

However, since technology transfer from fine bubble technology to technology fields of agro- and aqua-farming and food industries is not well supported by common understanding of the fine bubbles or their generating technology, results of evaluation on fine bubble enhanced performance cannot be accepted commonly by both generating system suppliers and its users at the transaction scene. Furthermore, a variety of agro- and aqua- farming products makes it difficult to adopt a systematic approach for selection and application of generating systems.

The performance evaluation based on objective evidence resulting from standardized procedures is intended to bridge the two technologies and facilitate diverse fields of applications for fine bubble technology in the global market. In order to accelerate sound global market formation, development of test procedures is urgently demanded by both technology stakeholders.

This document is intended to meet these needs by specifying the test procedure to be applied to the generating system for agro- and aqua- farming and food industries uses. The evaluation is made by applying fine bubble water generated by the object system to lettuce and by measuring its growth. The product, lettuce, is globally accepted and the yielded test data represents the performance of the tested system over other products in such major product family as, for example, leaf vegetable. The growth process of lettuce is much simpler than other vegetables making the measuring process much easier in the test procedure. The specified test conditions, namely the environment for growth, are also easy to be controlled allowing many testing plants globally available. The parameter measured is the change in the harvested mass of lettuces with application of fine bubbles compared to that without application in a specified period of growth.

Since the performance in terms of parameters is improving rapidly as the technology evolves, the quantitative criteria for the testing are not specified in this document.

Fine bubble technology — Agricultural applications —

Part 1:

Test method for evaluating the growth promotion of hydroponically grown lettuce

1 Scope

This document specifies a test method for evaluating the effect of fine bubble water on the growth promotion of hydroponically grown lettuce by estimating the incremental gain in mass of the stems and leaves over a specified growth period.

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 20480-1, *Fine bubble technology — General principles for usage and measurement of fine bubbles — Part 1: Terminology*

ISO 20480-2, *Fine bubble technology — General principles for usage and measurement of fine bubbles — Part 2: Categorization of the attributes of fine bubbles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20480-1 and ISO 20480-2 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

plant factory

facilities which allow systematic growth and production of plants where the internal environment conditions, e.g. temperature, carbon dioxide, and liquid fertilizer are controlled

3.2

fine bubble generating system

system which mechanically generates fine bubbles (bubbles less than 100 µm in diameter) using water and air

3.3

fine bubble water

water including fine bubbles and used in *plant factories* (3.1)

3.4

raw water

tap water or water with equivalent quality level provided to produce *fine bubble water* (3.3) and used as the control water for the reference