INTERNATIONAL STANDARD

ISO 24261-1

First edition
2020-11

Fine bubble technology — Elimination method for sample characterization —

Part 1: Evaluation procedure

Technologie des fines bulles — Méthode d'élimination pour la caractérisation de l'échantillon —

Partie 1: Mode opératoire d'évaluation

Reference number
ISO 24261-1:2020(E)

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Published in Switzerland

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Foreword

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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 24261 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

Fine bubble technology has recently seen growth in its application to markets in cleaning, water treatment, agriculture, and aquaculture as well as biomedical fields. Now, methods are required to evaluate the generation systems. Especially characteristics like the number concentration index and the size index of fine bubbles are indispensable for those evaluations.

Furthermore, fine bubble dispersion water may contain other solid and liquid particles. Clearly due to this is a concern, as it may be impossible to evaluate the characteristics of fine bubbles. Therefore, it is an urgent task to address this concern.

There are several measurement methods widely used to evaluate the number concentration index and the size index of particles. However, there are few methods to distinguish bubbles in fine bubble dispersions from other particles.

This issue can be resolved, using the phenomenon by which the bubbles can be eliminated without any residues after dissolution and flotation. If a method that eliminates fine bubbles in specific size range is known, it is possible to distinguish fine bubbles from other solid and liquid particles. The eliminated particles can be fine bubbles. If most of fine bubbles decreased, a solution that doesn't have them can be used as a blank solution for measurements as background. Because it is expected that fine bubbles elimination techniques will develop further, standardizing elimination techniques and evaluation method is required.

This document is intended to specify the evaluation method for elimination efficiency of fine bubbles from fine bubble dispersions in water.

Standardization for evaluating elimination efficiency of fine bubbles enables easy and clear comparison among the several elimination techniques and realizes the optimization of conditions for respective elimination techniques.

Fine bubble technology — Elimination method for sample characterization —

Part 1: Evaluation procedure

1 Scope

This document specifies the evaluation procedure of fine bubble elimination for fine bubble dispersion in water. This document is applicable only to fine bubbles without shell.

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20480-1 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
elimination of fine bubbles
process for decrease of the concentration index of fine bubbles

3.2
fine bubble dispersion
FBD
liquid which contains fine bubbles

[SOURCE: ISO 20298-1:2018, 3.1]

4 Requirements

4.1 Sample

The fine bubble dispersion to be evaluated shall be generated by cleaned fine bubble generating systems using pure water and pure gas such as air, nitrogen and oxygen.

The purity level of water and gas depends on the sample whose size and concentration indices of fine bubbles should be evaluated because fine bubble elimination is one of the evaluating process for specified samples. So, the purity level cannot be generally determined as measurement condition for evaluations of the elimination efficiency.

The fine bubble dispersion shall not contain stabilizing agents.

If the measurement accuracy of size and concentration indices is very important (e.g. for accreditation purposes), a water purity level of Grade 1 according to ISO 3696 is recommended for the water used for generation of FBD.

4.2 Measuring instruments

When the measuring instruments are selected for evaluating fine bubble elimination for FBD in water the following parameters about concentration and size range shall be confirmed, which depends on the characteristics of the sample to be evaluated.

a) Total number concentration and/or total volume concentration including fine bubbles and contaminants such as solid particles and liquid particles can be measured. Water diluent can be used for diluting the FBD in water when the concentration is over the measuring range.

b) Total size range including fine bubbles, contaminants and aggregates of contaminants can be measured. Another measuring instrument can be used to confirm the larger aggregates.

EXAMPLE Particle tracking analysis method can be used for evaluation of number concentration, and laser diffraction method can be used for evaluation of volume concentration. ISO/TR 23015 can be referred to for details of measurement techniques which can be used for FBD in water.

5 Environment

The classification of air cleanliness should be applied for the measurements to prevent any contamination by impurities. Ambient temperature and atmospheric pressure should be stable to keep the stability of ultrafine bubbles.

Air cleanliness, ambient temperature and atmospheric pressure depend on the environment to evaluating size and concentration indices of specified samples because fine bubble elimination is one of the evaluating process for specified samples. Therefore, the environment cannot be generally determined for evaluations of the elimination efficiency.

If the measurement accuracy of size and concentration indices is very important (e.g. for accreditation purposes), the air cleanliness of ISO Class 7 as defined in ISO 14644-1 is recommended as the environment of generation and measurement of FBD in water.

6 Evaluation of fine bubble elimination efficiency

6.1 General

Fine bubbles can be eliminated from fine bubble dispersion in water using some techniques such as ultrasonication method, ultracentrifugal fractionation and freezing method. If most of the fine bubbles can be eliminated from fine bubble dispersion in water, this water can be used for blank water.

6.2 Reduction rate

The elimination efficiency should be evaluated using the number reduction rate and volume reduction rate, which are defined respectively by Formula (1) and Formula (2).

$$r_0 = (q_{0,b} - q_{0,a}) / q_{0,b} \times 100 \quad (1)$$

where

r_0 is the number reduction rate (%);

$q_{0,a}$ is the number concentration index in the specified size range after elimination process;

$q_{0,b}$ is the number concentration index in the specified size range before elimination process.

$$r_3 = (q_{3,b} - q_{3,a}) / q_{3,b} \times 100 \quad (2)$$

where

r_3 is the volume reduction rate (%);

$q_{3,a}$ is the volume concentration index in the specified size range after elimination process;

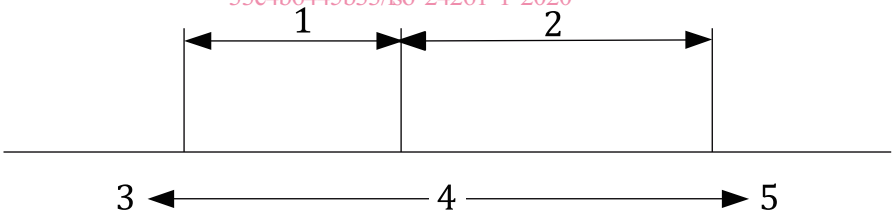
$q_{3,b}$ is the volume concentration index in the specified size range before elimination process.

6.3 Confirmation of contaminants aggregation

The number concentration index of small contaminants may be decreased because of aggregation of these particles by the elimination process. In this case, the concentration index in the larger size range may increase because of aggregation. It is very difficult to confirm the changes of particles amount in the larger size range using the number concentration index, so volume concentration index should be used to confirm the aggregation (see Annex A and Annex B).

Therefore, the decrease in number concentration index of small particles cannot be related directly to the elimination of fine bubbles, and both the number concentration index and volume concentration index should be analysed to confirm actual elimination efficiency of fine bubbles.

Change in volume concentration index of particles in the larger size range should be confirmed even in the evaluation of elimination efficiency in the specified narrow size range. See Figure 1.



Key

1 specified size range to calculate the number reduction rate
2 specified larger size range to calculate volume reduction index
3 small
4 particle size/bubble size
5 large

Figure 1 — Size range to calculate reduction rates

6.4 Evaluation procedure of fine bubble elimination

The evaluation procedure of fine bubble elimination shall be as follows.

a) Disperse uniformly the fine bubble dispersion in water.

b) Measure the number concentration index in the specified size range.

c) Measure the volume concentration index in the specified larger size range.