INTERNATIONAL STANDARD

ISO 21255

First edition
2018-11

Fine bubble technology — Storage and transportation of ultrafine bubble dispersion in water

Technologie des fines bulles — Conservation et transport d'ultrafines bulles en dispersion dans l'eau

Reference number
ISO 21255:2018(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*.

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 applications have grown steadily in recent years. They now embrace a diverse range of industrial activities from enhancing the growth rates of plants in agriculture to the separation peel-off of solar panel silicon wafers in semiconductor manufacturing process.

Improved advanced cleaning purification of waste water and enhanced high throughput removal of lubricant oil on machined works and of salt stains from a surface of traffic infrastructures, have also been demonstrated.

Most of these applications are currently limited to the site where the generating system of fine bubble water is installed close to the application objects and operated simultaneously to the application. Expansion for applications where the site of bubble application is different from that of generation is being implemented by some innovative industries, but there are currently no concrete guidelines for storage and transportation of fine bubble water, as typical ultrafine bubbles (UFB) are known to have high stability once generated. The purpose of this document is to expand the scope of application of initial measurements of fine bubble quality downstream in the supply chain.

This document specifies the requirements related to the planning, equipment and operation process necessary to store and transport ultrafine bubble dispersions without significant deterioration in terms of number concentration index. This document is intended to help assessing the acceptable conditions and periods for storage and transportation that guarantee integrity of ultrafine bubble quality.

Fine bubble technology — Storage and transportation of ultrafine bubble dispersion in water

1 Scope

This document describes the procedures and equipment for storage and transportation of ultrafine bubble dispersions in water and specifies the related requirements in order to maintain such bubble characteristics as size and number concentration.

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
water diluent
homogeneous water which is used for the dilution without causing any deleterious effects and whose number concentration of ultrafine bubbles is known

Note 1 to entry: Water diluent is used to decrease the number concentration of ultrafine bubbles in a dispersion without changing their total number, state of aggregation with particles, size or surface chemistry.

Note 2 to entry: Water diluent is called blank water when its number concentration of ultrafine bubbles is known to be zero and when it is used for the evaluation of ultrafine bubbles.

3.2
ultrafine bubble dispersion
UFBD
liquid which contains ultrafine bubbles

4 Substance for storage and transportation

The liquid to be stored and transported shall be UFBD in water with long intrinsic bubble number concentration stability sufficient for storage and transportation. The water shall not contain any chemically active compound that could damage containers under specified conditions nor any bacterial objects that would change the chemical or physical characteristics of UFBD. The water is recommended to be Grade 1, 2 or 3 defined by ISO 3696. The gas shall not be any chemically and physically active medium that could damage containers under specified conditions.

5 Container and filling

A rigid container shall be used for storage or transportation of UFBD.

Since exposure of UFBD to macroscopic air changes its characteristics over the long term and under mechanically extreme conditions such as strong vibrations, any macroscopic air interface should be reduced as much as possible. (See Figure 1.)

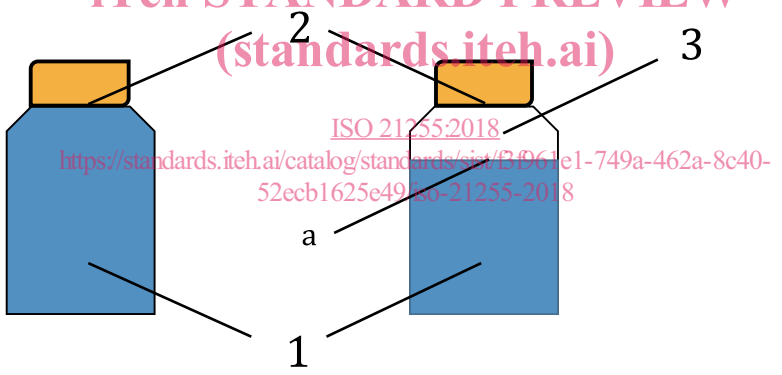
The major part of the interface between UFBD and the container shall be the surface of glassware, whose material is recommended to be borosilicate 3,3 glass defined by ISO 3585.

NOTE 1 The use of the material is intended to maintain long term stability in the characteristics of UFBD.

Any other part of the interface shall be the surface of other flexible, but less gas permeable material. The interface of the flexible material and glassware shall be kept air tight. The flexibility of the material allows the pressure of UFBD to accommodate the ambient atmosphere for storage and transportation. A recommended material is poly(isobutylene-isoprene) (IIR) (see ISO 4796-1), which has a low gas permeability, or equivalent materials.

NOTE 2 If the whole interface is covered by glassware, a temperature change of 10 °C in the environment will cause a 5 MPa pressure change and the glass will break.

Before determining the container which should be used for storage and transportation, changes in the characteristics of UFBD by elution of the container material should be evaluated quantitatively by performing test storage and transportation.



a) Correct **b) Wrong**

Key

1 UFBD
2 separator
3 air
a Surface interface.

Figure 1 — Filling of UFBD in a container

A container should be sterilized by heat or ultraviolet radiation before filling of the UFBD to prevent biological contamination such as bacterial growth. Care should be taken to avoid biological contamination of the ultrafine bubbles (UFB) and water diluent during the operations for storage and transport.

In order to remove contaminants before filling of UFBD in a container, the container shall be rinsed out adequately with water diluent or a separate portion of UFBD.

6 Storage

After the generation of UFBD and successful filling of the container following the process described in Clause 5, environmental conditions such as temperature and pressure should be kept unchanged during storage to prevent changes in characteristics and to maintain stability.

To prevent bubble extinction, UFBD shall not be kept below a temperature of 0 °C and should be kept in the range from 5 °C to 35 °C. UFBD should be stored so as to avoid exposure to direct sunlight and vibration.

Before planning the storage procedure, the long-term stability during storage under specified conditions should be evaluated quantitatively by regular testing which may enable to establish good laboratory practice.

Prior to establishing the shelf life of the specified UFBD, stability of the characteristics should be evaluated. Long-term stability of UFBD may depend on intrinsic characteristics such as size and number concentration as well as gas and generation technology.

7 Transportation

Prior to transportation, the choice of container and filling process shall be conducted as described in Clause 5. To prevent bubble extinction, UFBD shall not be kept below a temperature of 0 °C and should be kept in the range from 5 °C to 35 °C. The atmospheric pressure should be in the range of 750 hPa to 1 050 hPa. UFBD should be transported so as to avoid exposure to direct sunlight.

The acceleration should be less than 100 m/s^2 throughout the transportation, except when a few impacts are inevitable. A few impacts as high as 300 m/s^2, can be allowed, for example when loading at airports[5].

The nature of transportation shall be planned carefully to minimize the effects caused by pressure, temperature and vibration and their changes because UFBD may be more sensitive than solid and liquid particle dispersion and liquid particle dispersion. Surface transportation and air transportation may be used as far as the above conditions are met.

Courier delivery service including air cargo and surface transportation with special care for “fragile” goods is recommended. Otherwise, careful hand carrying is strongly recommended.

Before planning the transportation procedure, the stability of UFBD during transportation under specified conditions should be evaluated quantitatively by test transportation, which may enable to establish good laboratory practice.

8 Records

In order to establish a good laboratory practice for storage and transportation, record the following items.

a) Storage:

   1) start date;

   2) completion date;

   3) container (dimension, material);

   4) environment conditions during storage;

b) transportation:

   1) start date;

   2) completion date;