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Fine bubble technology — Industrial and consumer device applications —

Part 1: Assessment of water pressure driven nozzles by evaluating size and concentration indices of generated fine bubbles

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Foreword

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

A list of all parts in the ISO 7429 series can be found on the ISO website.

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Introduction

Fine bubble (FB) technology has been used in a wide range of fields, including cleaning, water treatment, agro- and aqua-culture, liquid crystal, semiconductor and solar cell manufacturing, new functional material manufacturing, chemistry, cosmetics, medicine and pharmaceuticals, and food and drinking water. The market has been expanding from B to B market to B to C market, and the market has started up rapidly and is in the process of further growth.

In particular, nozzles as consumer devices are growing rapidly in the consumer market as FB generation technology has improved. Nozzles are devices that are divided into various types, such as insertion type, submerged type, and open type, and each type has its own characteristics. The insertion type, in which the nozzle is installed in the middle of the pipe and FB is mixed into the water used, is the most widely available in the market and is widely used in industrial applications such as cleaning, water treatment, agriculture and aquaculture, as well as for home use. The submerged type is installed in a water tank to generate FB in the cleaning tank, and is widely used for hot water nozzles in baths and water supply in tanks in fisheries and agriculture. The open type, which functions by passing through the air and coming into contact with the object (FB generation), is used for hand washing and kitchen faucets. Nozzles have a wide variety of applications and are one of the most widespread key devices for fine bubble generation in various industrial and household applications.

However, in some cases, the characteristics of FBs cannot be fully confirmed, and the devices are not functioning as well as they should. Therefore, in order for microbubble technology to maintain its reliability as a technology used in industrial and consumer applications around the world, there is a need for a method to evaluate the effectiveness and efficiency of the generating system, and standardization of the nozzle evaluation is needed. The most important characteristic is the number concentration and size index of the generated fine bubbles.

Thus, devices that are versatile in terms of application, small, portable anywhere in the world, and affordable are also important as they can contribute to the sustainable development goals (SDGs).

This document provides a method for evaluating the size and concentration index of microbubbles generated by nozzles, which will serve as a basis for fair and appropriate trade of FB nozzle devices leading to widespread use of the products. The users of this document are, directly, nozzle manufacturers, manufacturers of FB generators and systems, manufacturers and builders of FB application systems and facilities, and nozzle evaluation companies. Users of industrial cleaning equipment and water utilities can also use this document.

Fine bubble technology — Industrial and consumer device applications —

Part 1:
Assessment of water pressure driven nozzles by evaluating size and concentration indices of generated fine bubbles

1 Scope

This document specifies the evaluation methods for size and concentration indices of fine bubbles (FBs) generated through a nozzle. It only applies to FB dispersions (FBDs) in water generated through the nozzle. It describes the sampling method for a FBD from the nozzle into the retention container and the measurements of size and concentration indices.

Major applications of the equipment include components of various industrial water systems and consumer baths and kitchens.

2 Normative references

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

ISO 20298-1, *Fine bubble technology — Sampling and sample preparation for measurement — Part 1: Ultrafine bubble dispersion in water*

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

ISO 21910-1, *Fine bubble technology — Characterization of microbubbles — Part 1: Off-line evaluation of size index*

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 terminology databases for use in standardization at the following addresses:

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

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

3.1
nozzle
device driven by water pressure applied from outside that discharges fine bubble water into the air or water through a single columnar pass

Note 1 to entry: Various types of fine bubble generating technologies such as venturi tube type and ejector type are used as fine bubble nozzles.

4 Types of nozzles

There are a lot of types on nozzles in the commercial market, which are categorized into three types, composed of insertion, submerged and open terminal types.

Detailed examples used in the market are included in Annex A.

5 Requirements

5.1 Samples

FB dispersions in water used to test nozzles shall be generated using clean test systems with clean water and clean gasses such as air, nitrogen or oxygen.

The degrees of purity of water and gasses depend on the purpose of the test.

The FBD shall not contain stabilizing agents such as surfactants.

If the accuracies of the measurements of size and concentration indices are critically important (for example, application to the accreditation of a FB business), ISO Grade 1 (see ISO 3696) water purity is recommended for the water used to generate a FBD.

5.2 Measuring instruments

When the measuring instruments are selected for evaluating size and concentration indices of FBs generated from the nozzle, the following requirements for the concentration and the size range shall be considered. These requirements depend on the characteristics of the test sampled.

a) The total number concentrations and the total volume concentration of the entire sample including FBs and contaminants (solid and liquid particles) shall be measured. Water can be used to dilute the FBD when its concentration exceeds the limits of the measurement technique.

b) The size range of the entire sample including FBs, contaminants, and aggregates of contaminants shall be measured. Different instruments can be used to identify larger aggregates.

NOTE The particle-tracking analysis method can be used for evaluating the number of concentrations, and the laser diffraction method can be used to evaluate the volume concentration. ISO/TR 23015 can be referred to for details of techniques, which can be used to evaluate a FBD in water.

6 Environment

Air cleanliness should be considered for measurements to prevent the introduction of impurities. Ambient temperature and atmospheric pressure should be constant to maintain the stability of FBs.

Air cleanliness, ambient temperature and atmospheric pressure depend on the local environment and can vary. However, these important settings can influence the evaluation process and should be recorded before performing evaluations.

If the accuracies of measurements of sizes and concentration indices are critically important, for example, the application to the accreditation of a FB business, air cleanliness according to ISO Class 7 (see ISO 14644-1) is recommended as the environment standard for the generation and measurement of a FBD in water.

7 Evaluation

7.1 General

When evaluating the size and concentration indices of FBs generated from the nozzle, one-way flow and circulation flow are used for microbubbles (MBs) and ultrafine bubbles (UFBs). These relations are given in Table 1 as an evaluation matrix. The variables to be evaluated depend on the purpose of the applications.

Table 1 — Evaluation matrix

	One-way flow	Circulation flow	Reference for evaluation
Microbubbles (MBs)	To be evaluated	To be evaluated [a]	ISO 21910-1
Ultrafine bubbles (UFBs)	To be evaluated	To be evaluated [b]	ISO 20298-1

[a] For applications such as baths and water treatment, the equilibrium state of microbubble dispersions (MBDs) is produced.

[b] The circulation flow is indispensable when the signal from UFBs is below the limit of detection.

7.2 Placement of the nozzle on the retention container

The nozzle shall be placed on the discharge port of the fitted nozzle submerged below the water surface. The water surface level can be maintained by overflow from the retention container.

Sufficient distance is required between the discharge port and wall or bottom of the retention container to prevent the destruction of FBs through collision.

When evaluating a nozzle that is used by submerging it deeply, it is necessary to adapt the test conditions such as submerging depth and water pressure to the actual operating environment.

For the generation of fine bubbles in the nozzle type, the differential pressure before and after the nozzle is important, and it is affected by the discharge pressure and water depth. An example is shown in Annex B.

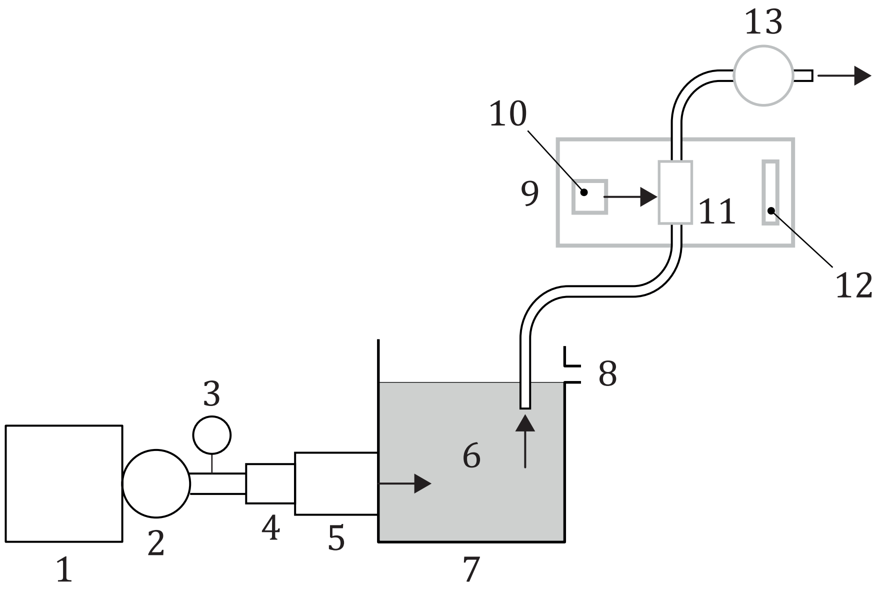
7.3 One-way flow

7.3.1 General

The evaluation of size and concentration indices of MBs shall use the one-way flow configuration. If the signal from UFBs is sufficient for measurements, the one-way flow configuration shall be used for UFBs as well.

7.3.2 Test system configuration

The test system configurations of one-way flow are shown in Figures 1 and 2.



Key

1 raw water storage tank
2 pump
3 water pressure meter
4 nozzle
5 piping
6 fine bubble water
7 retention container
8 over flow
9 measuring instrument
10 light source
11 flow cell
12 sensor
13 drain pump

Figure 1 — Typical insertion-type nozzle configuration of a one-way flow test system