



International
Standard

ISO 7428-1

Fine bubble technology — Domestic applications —

Part 1:

Assessment of showerhead devices by evaluating size and concentration indices of generated fine bubbles

Technologie des fines bulles — Applications domestiques —

Partie 1: Évaluation des dispositifs avec pommes de douche par évaluation des indices de concentration et de la taille des fines bulles générées

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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 7428 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 such as cleaning, water treatment, agriculture, aquaculture and biomedical fields. To clarify the efficacy and the efficiency of fine bubbles, the characteristics of fine bubbles should be evaluated accurately. The most important characteristics of fine bubbles are the number or volume concentration and size indices of the fine bubbles produced by the fine bubble generating systems.

Above all, fine bubble showerhead devices have been extensively used as most popular fine bubble generating devices at home. Therefore, standardization of evaluation for fine bubble showerhead device should be accelerated to maintain the reputation of fine bubble technology as an advanced technology used for consumer products all over the world.

The evaluation method for size and concentration indices of fine bubbles is the basis for fair and appropriate business of fine bubble showerhead devices, which can introduce the dissemination of fine bubble products.

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Fine bubble technology — Domestic applications —

Part 1:

Assessment of showerhead devices by evaluating size and concentration indices of generated fine bubbles

1 Scope

This document specifies the evaluation method for size and concentration indices of fine bubbles generated from the fine bubble showerhead device. It is only applicable to fine bubble dispersion in water generated from fine bubble showerhead devices using air. It describes the sampling method for fine bubble dispersion in water from the fine bubble showerhead devices into the retention container and the measurement procedure of size and concentration indices.

NOTE The discharging drive force for fine bubble showerhead devices is applied using a pump or water pressure. Therefore, the test of the subject device is performed under environmental conditions including such a practical environment.

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

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

fine bubble showerhead device

device driven by the outer water pressure and applied to discharge fine bubble dispersion in water into the air or water in the form of a spray or shower of water droplets

4 Requirements

4.1 Sample

To reduce the influence of particulate contaminants and to keep the accuracy of measurement, the fine bubble dispersions in water used to test fine bubble showerhead devices shall be generated using cleaned test systems with clean water and clean air.

The purity level of water and air depends on the purpose of the test.

The fine bubble dispersion shall not contain stabilizing agents such as surfactants.

If the measurement accuracy of size and concentration indices is very important (for example, in the case of application to the accreditation of fine bubble business), the water purity level of ISO Grade 1 (see ISO 3696) and the air cleanliness of ISO Class 5 (see ISO 14644-1) are recommended for the water and the air used for generating the fine bubble dispersion (FBD).

4.2 Measuring instruments

When the measuring instruments are selected for evaluating the size and concentration indices of fine bubbles generated from showerhead device, the following requirements for the concentration and the size range shall be considered. These requirements depend on the characteristics of the sample to be evaluated.

- a) The total number concentration and total volume concentration of the entire sample generated from the fine bubble showerhead devices including fine bubbles and contaminants (solid and liquid particles) shall be measured. Raw water can be used for diluting the FBD when the concentration is too high for the measurement technique in question.
- b) The size range of the entire sample including fine bubbles, contaminants and aggregates of contaminants shall be measured. Different measuring instruments can be used to confirm the larger aggregates.

NOTE The particle tracking analysis method can be used for evaluation of number concentration, and the laser diffraction method can be used for the 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 air cleanliness should be considered for the measurement to prevent the introduction of impurities. Ambient temperature and atmospheric pressure should be stable to maintain the stability of the size and concentration of fine bubbles.

Air cleanliness, ambient temperature and atmospheric pressure depend on the local environment and can vary. However, as they are important settings and can influence the evaluation process, they should be recorded prior to any evaluation occurring.

If the measurement accuracy of size and concentration indices is very important, (for example, in the case of application to the accreditation of fine bubble business), the air cleanliness of ISO Class 7 (see ISO 14644-1) is recommended as the environment for generation and measurement of a FBD in water.

6 Evaluation

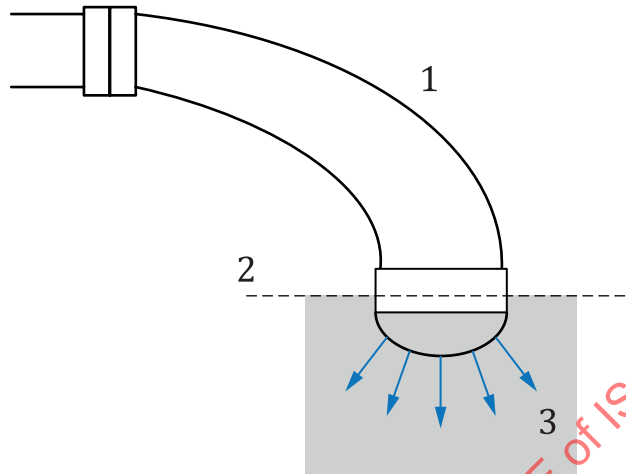
6.1 General

When evaluating the size and concentration indices of fine bubbles generated from the fine bubble showerhead device, the one-way flow configuration shall be used. However, the circulation flow configuration shall be used in the case that signal from UFB is too low to measure because of the low concentration of UFB.

6.2 Setting of fine bubble showerhead device to retention container

As shown in [Figure 1](#), the fine bubble showerhead device shall be set to fix all the discharge holes of the fitted showerhead device so that they are submerged below the water surface. The water surface level can be maintained by overflow from retention container.

To prevent the destruction of fine bubbles by collision, sufficient distance is necessary between the discharge holes and the wall or bottom of retention container.

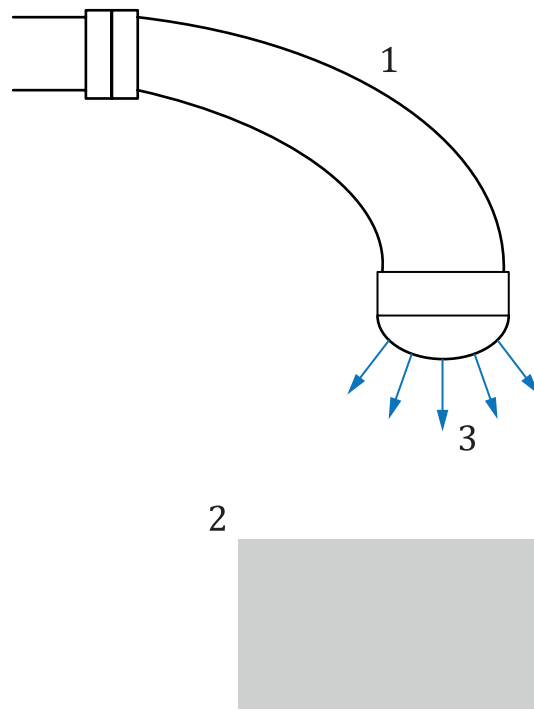


Key

- 1 fine bubble showerhead device
- 2 water surface
- 3 fine bubble dispersion in water

Figure 1 — Correct setting

In the case of incorrect setting of the fine bubble showerhead device as shown in [Figure 2](#), measurement results are unstable because contaminants in the air are mixed, and turbulent bubbles are generated by collision with the water surface, other than fine bubbles generated from the showerhead device.



Key

- 1 fine bubble showerhead device
- 2 water surface
- 3 fine bubble dispersion in water

Figure 2 — Incorrect setting

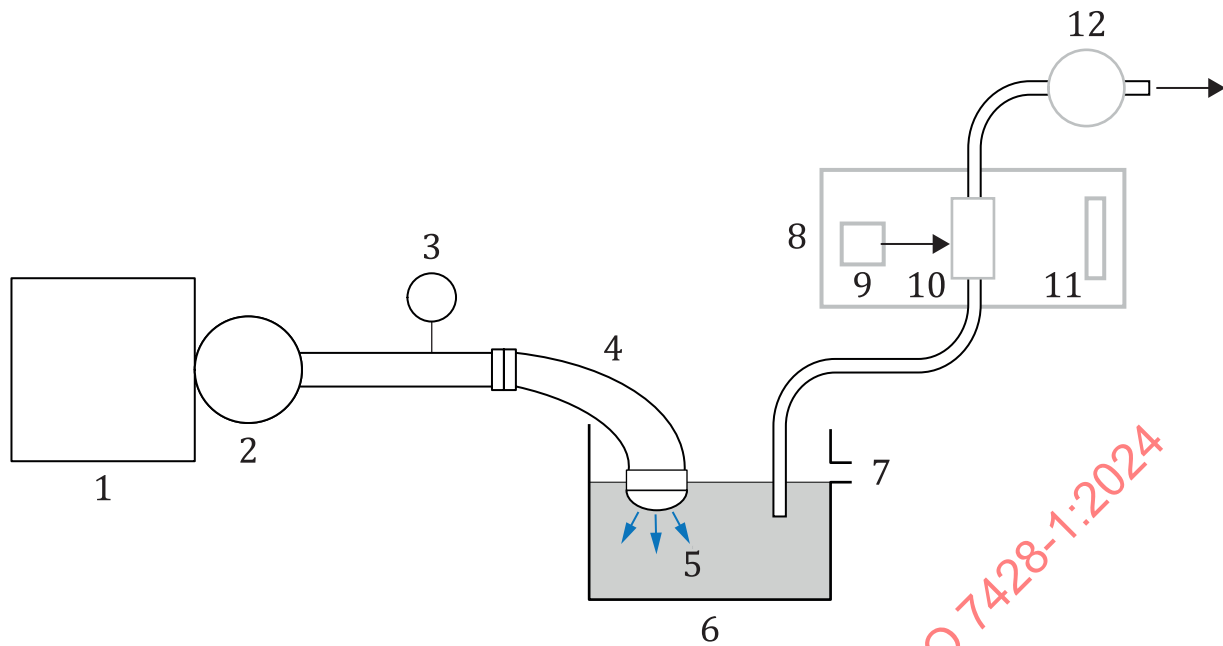
6.3 One-way flow

6.3.1 General

When evaluating the size and concentration indices of microbubbles, the one-way flow configuration shall be used. When the signal from ultrafine bubble (UFB) is sufficient for measurement, the one-way flow configuration shall also be used for UFB.

6.3.2 System configuration

The system configuration of one-way flow is shown in [Figure 3](#).



Key

- 1 raw water storage tank
- 2 pump
- 3 water pressure meter
- 4 fine bubble showerhead device
- 5 fine bubble dispersion in water
- 6 retention container
- 7 overflow
- 8 measuring instrument
- 9 light source
- 10 flow cell
- 11 sensor
- 12 drain pump

Figure 3 — One-way flow test system

The water pressure meter is used to keep the predetermined water pressure for test within the minimum fluctuation. [Annex C](#) provides information to determine the water pressure for the test.

ISO 21910-1 shall be referred to for the measurement of microbubbles. Measuring instruments based on dynamic image analysis methods, the laser diffraction method and light extinction liquid-borne particle counter can be used.

In the case of ultrafine bubbles, the sample shall be sampled in accordance with ISO 20298-1 from the retention container.

An example of the one-way flow test system is shown in [Annex D](#), see [Figure D.1](#).

6.3.3 Evaluation procedure for the one-way flow

Evaluation procedure for the one-way flow is as follows.

- a) Rinse the wetting part of the test system including the retention container, the pump and the fine bubble showerhead device using raw water to prevent contamination of solid and liquid particles.
- b) Fill the raw water storage tank and retention container with raw water.

- c) Set the fine bubble showerhead device with the appropriate position of retention container and flow raw water into showerhead device under the water pressure predetermined for the test, which should be monitored by water pressure meter to keep the minimum fluctuation.
- d) Wait a sufficient interval for stable measurement results to be obtained. This interval shall be predetermined to be appropriate for the test system to be used by trial and error. Generally, the sufficient interval should be more than the time required for discharging of fine bubble water from the showerhead with twice volume of the retention container.
- e) Measure the size and concentration indices of the fine bubble dispersion in water discharged from the fine bubble showerhead device (see [Annex A](#)).

The microbubbles shall be transferred into the measuring instrument and measured in accordance with ISO 21910-1, and the ultrafine bubbles shall be sampled and measured in accordance with ISO 20298-1.

6.4 Circulation flow

6.4.1 General

A circulation flow configuration shall be used for the evaluation of fine bubble showerhead device when the concentration is too low to measure size and concentration indices for ultrafine bubble (UFB).

A circulation flow configuration shall not be used for microbubble generated from the fine bubble showerhead device because the size and concentration become unstable.

6.4.2 System configuration

The system configuration for the circulation flow is shown in [Figure 4](#).

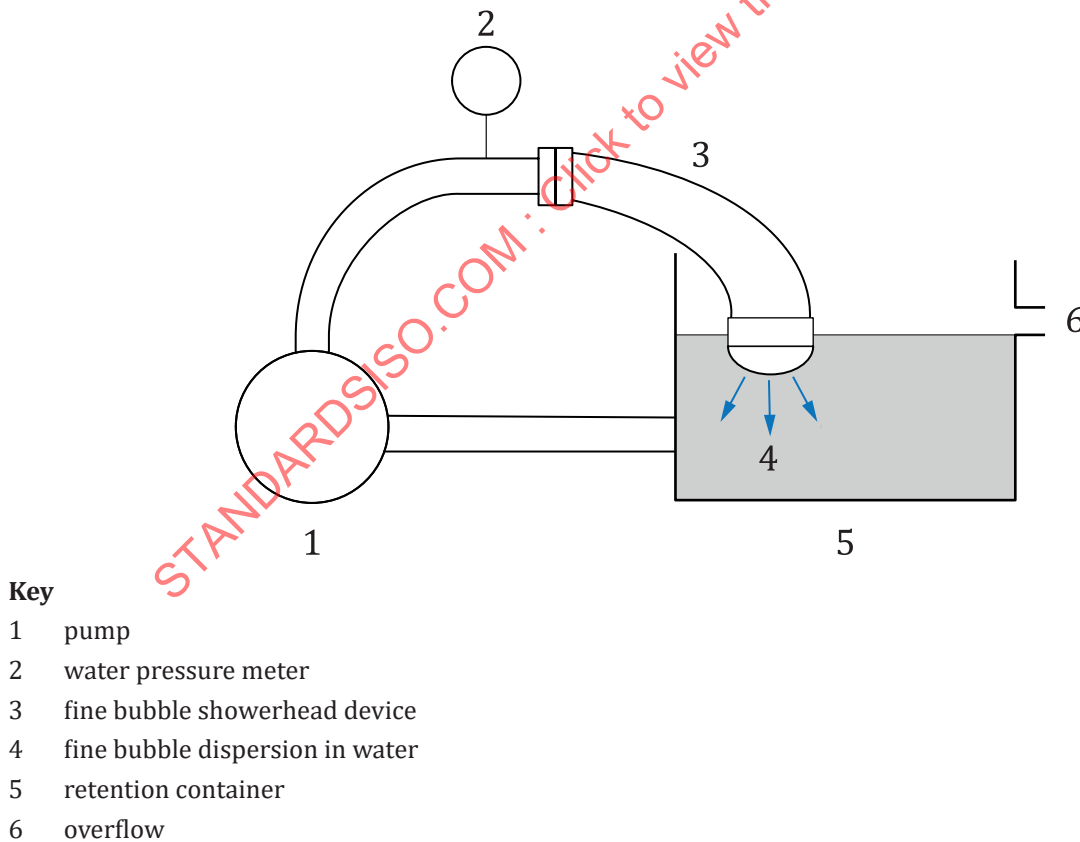


Figure 4 — Circulation flow test system

In this case, water is circulated between the fine bubble showerhead device and the retention container.

As well as the one-way flow test system, the water pressure meter is used to keep the predetermined water pressure for test within the minimum fluctuation. [Annex C](#) provides information to determine the water pressure for the test.

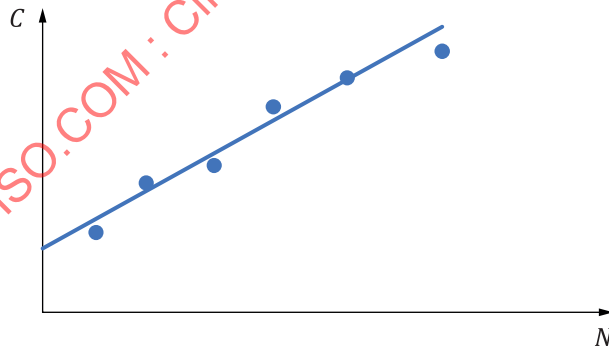
The ultrafine bubbles sample shall be sampled in accordance with ISO 20298-1 from the retention container.

An example of the circulation flow test system is shown in [Annex D](#), see [Figure D.2](#).

6.4.3 Evaluation procedure for the circulation flow

The evaluation procedure for the circulation flow is as follows.

- Rinse the wetting part of the test system including the retention container, the pump and the fine bubble showerhead device using raw water to prevent contamination of solid and liquid particles.
- Fill the retention container with raw water.
- Set the fine bubble showerhead device with the appropriate position of retention container and start the circulation between the retention container and fine bubble showerhead device under the water pressure predetermined for the test, which should be monitored by water pressure meter to keep the minimum fluctuation.
- Repeat the sampling of ultrafine bubble dispersion in water at regular intervals in accordance with ISO 20298-1. When the circulation cycle number exceeds a certain level, the concentration becomes saturated and does not increase. Therefore, stop the measurement when the concentration exceeds 100 million counts/ml.
- Measure the size and concentration indices of all samples sampled at step d).
- Draw the graph of the relationship between the concentration index and cycle number of circulations as shown in [Figure 5](#).
- Determine intercept and gradient from the data plotted as shown in [Figure 5](#), assuming linear function such as $y = ax + b$. The gradient “a” means the concentration index per 1 circulation cycle and intercept “b” means baseline (see [Annex B](#)).



Key

- N circulation cycle number
 C concentration

Figure 5 — Relationship between circulation cycle number and concentration indices

7 Test report

The measurement and measurement results of the microbubbles and ultrafine bubbles shall be in accordance with ISO 21910-1 and ISO 20298-1, respectively.

The information regarding the fine bubble showerhead device shall be reported as follows:

- a) the type name of the fine bubble showerhead device;
- b) the lot number;
- c) the part composition to generate fine bubbles;
- d) the material of wetted part.

The test system and test results shall include the following information:

- a) the configuration of one-way flow or circulation flow;
- b) a reference to this document, i.e. ISO 7428-1:2024;
- c) the specifications of the pump;
- d) the size and volume of retention container;
- e) the size and length of tubes;
- f) the information regarding the setting of the fine bubble showerhead device to the retention container;
- g) the pressure, flow rate and temperature of water introduced into the fine bubble showerhead device;
- h) the properties and purities of air and water to be used for generating fine bubbles;
- i) the measurement technique;
- j) the measuring instrument type and serial number;
- k) the software version;
- l) the volume-based and number-based size distribution;
- m) the data of the relationship between the circulation cycle number and the concentration index, in the case of a circulation flow configuration;
- n) interval for single circulation cycle, in the case of a circulation flow configuration;
- o) the names of the operator and laboratory;
- p) the date and time of the test.

The users of this document reviewing the test results using the test report specifically for conformity assessment activities (including accreditation), shall report the detailed items as shown in [Annex E](#) in addition to the above items.

Annex A
(informative)

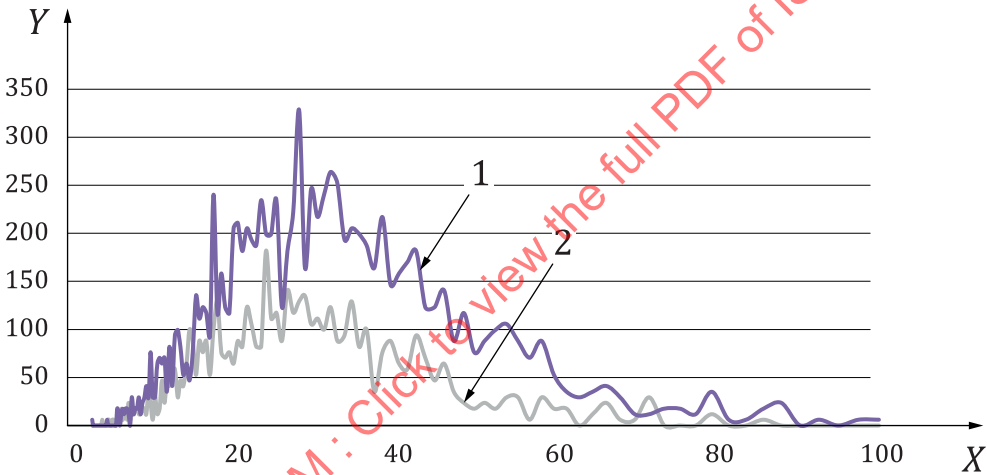
Example of results for microbubbles using the one-way flow

Table A.1 shows the relationship between water pressure and number concentration index of microbubbles as an example of measurement results for microbubble using the one-way flow.

Table A.1 — Example of results for microbubbles using the one-way flow

	50 kpa	100 kpa	150 kpa	200 kpa
Number concentration index (counts/ml)	510	5 358	10 856	10 505
Mean diameter (µm)	36,0	27,2	29,9	30,2
Modal diameter (µm)	42,4	24,8	27,4	28,9

Figure A.1 shows the size distributions in the case of two different water pressures.



Key

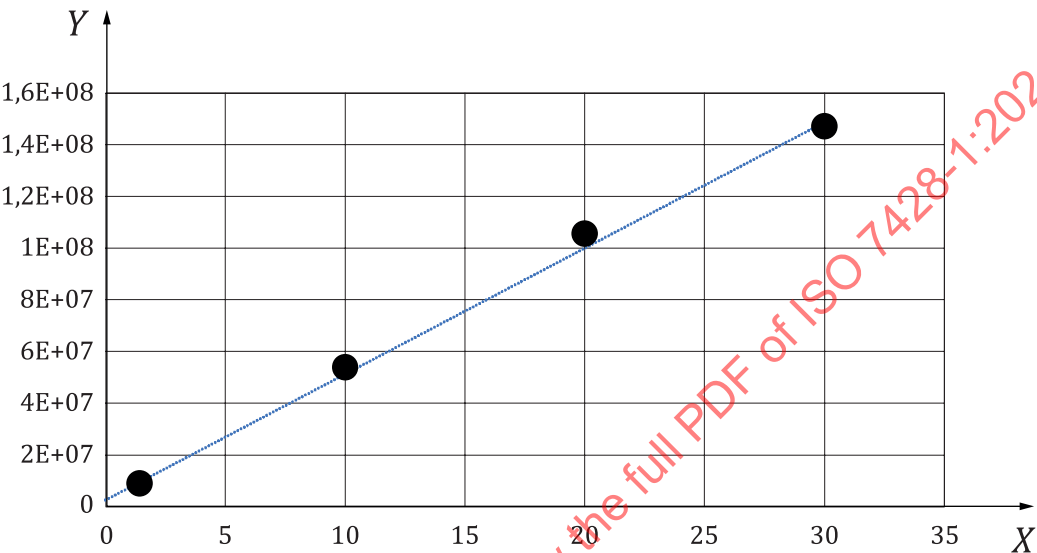
- X bubble size index (µm)
- Y number concentration index (counts/ml)
- 1 200 kpa
- 2 100 kpa

Figure A.1 — Example of results for microbubbles using the one-way flow

Annex B
(informative)

Example of results for ultrafine bubbles using the circulation flow

Figure B.1 shows the example of measurement results for ultrafine bubble concentration index using the circulation flow.



Key

- X circulation cycle number
- Y number concentration index (counts/ml)

Figure B.1 — Example of results for ultrafine bubble using the circulation flow

Formula (1) can be obtained from the relationship between circulation cycle number and number concentration plotted in Figure B.1.

$$Y = 4 \times 10^6 X + 8 \times 10^6 \tag{1}$$

Therefore, the gradient of 4×10^6 (4 millions) means the number concentration index per 1 circulation cycle, which is the fine bubble characteristic of the showerhead in regard to the concentration of ultrafine bubbles.

Annex C

(informative)

Water service standards for water pressure in different countries

Water service standards for water pressure in different countries are as shown in [Table C.1](#).

Table C.1 — Water service standards for water pressure

Country	Description of water pressure values, etc.		
	Maximum	Minimum	Others
Australia ^a	900 kpa	200 kpa	
China ^b	350 kpa (0,35 MPa)	100-200 kpa (0,1-0,2 MPa)	Figures can differ significantly in rural areas
Japan ^c	740 kpa (hydrostatic pressure)	150 kpa (hydrodynamic pressure)	Does not apply if there is no interference with water supply
Russian Federation ^d	Cold water Hot water	30-600 kpa 30-450 kpa	
Singapore ^e	No direct figure of water pressure is provided, typical range of water flow rate is between 8 l to 12 l per min		
United Kingdom ^f	100 kpa (1 bar)		
United States ^g	552 kpa (80 psi)	103 kpa (15 psi)	

^a Water Service Association of Australia WSA03-2011. <https://www.wsaa.asn.au/shop/product/27046>

^b GB 50015-2019 Standard for design of building water supply and drainage, the working pressure of washbasin is 0,100 MPa, showerhead device 0,100-0,200 MPa. The household inlet pressure is not more than 0,35 MPa. <https://www.chinesestandard.net/PDF/English.aspx/GB50015-2019>

^c Article 7 of Ministerial Ordinance to Provide for Technical Standards for Water Supply Facilities from Ministry of Health, Labour and Welfare. <https://www.mhlw.go.jp/topics/bukyoku/kenkou/suido/hourei/suidouhou/syourei/dl/08.pdf>

^d Water pressure in accordance with the legislation (Decree of the Government of the Russian Federation of 05/06/2011, No. 354, Appendix No. 1) and SNiP No. 2.04.2 of 1984. and amended SNiP from 1985.

^e Public Utilities Board, "Handbook on Application for Water Supply" 2.2 "Water pressure and availability of water supply". https://www.pub.gov.sg/Documents/Handbook_onApplication_WaterSupply.pdf

^f UK Legal requirement is 1 bar pressure (at this pressure typically a 4,5 l bucket will fill in 30 s). https://www.watersafe.org.uk/advice/common_plumbing_questions1/pressure/what_is_the_minimum_water_pressure_that_a_water_supplier_must_supply/#:~:text=As%20a%20guide%2C%20if%20you,taps%20and%20appliances%20turned%20off

^g Uniform Plumbing Code (2021): <https://epubs.iapmo.org/2021/UPC/>