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Fine bubble technology — General principles for usage and measurement of fine bubbles —

Part 3: Methods for generating fine bubbles

Technologie des fines bulles — Principes généraux pour l'utilisation et la mesure des fines bulles —

Partie 3: Méthodes pour générer des fines bulles

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Foreword

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

Any feedback or questions on this document should be directed to the user's national standards body. The complete list of these bodies is available at www.iso.org/members.html.

A list of all the parts in ISO 20480 series can be found on the ISO website.

Introduction

Until now the terminology, method and corresponding technology for the generation of fine bubbles have not been standardized. The new project to standardize the terminology of fine bubble generating systems and the corresponding technology is thought to have significant influences on the market as follows:

— convenience of customers when purchasing or using fine bubble generating system and its techniques will be improved, and owing to the improvement of their convenience, it can be expected to boost fine bubble industries;

— standardization of terminology will enhance commonality in the field of generating system performance. Improvement in performances in hardware and software will also prospectively lead to market growth of the manufacturing industries of fine bubble generating system;

— standardization of terminology will enable the application markets to be boosted in creating new markets, as well as unifying existing markets.

In addition to existing fine bubble technology standards, by specifying "common terms" of generation principles, it will allow best practices to use common terms for fine bubble generating systems as well as the market expansion is expected.

Fine bubble technology — General principles for usage and measurement of fine bubbles —

Part 3:
Methods for generating fine bubbles

1 Scope

This document describes methods for generating fine bubbles.

2 Normative references

The following documents are referred to in the text in the sense 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 the 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
flow path
passage that conveys fluid

[SOURCE: ISO 5598:2020, 3.2.302]

3.2
cavitation
formation and collapse of bubbles in a liquid when the pressure falls to or below the liquid vapour pressure, the collapse releases energy, sometimes with an audible sound and vibration

[SOURCE: ISO 16904:2016, 3.7]

3.3
Venturi tube
device which consists of a convergent inlet which is conically connected to the cylindrical part called the “throat” and an expanding section called “divergent” with a conical shape

[SOURCE: ISO 5167-1:—[1)], 3.2.5]

1) Under preparation. Stage at the time of publication ISO/DIS 5167-1:2021.

3.5
impeller
spinning disc in a centrifugal pump with protruding vanes, which is used to accelerate the fluid in the pump casing

[SOURCE: ISO 13501:2011, 3.1.51]

3.6
solubility
maximum mass of a solute that can be dissolved in a unit volume of solution measured under equilibrium conditions

[SOURCE: ISO 17327-1:2018, 3.16]

3.7
surfactant
surface active substance that reduces the surface tension of the solution

[SOURCE: ISO 8124-7:2015, 3.7]

3.8
critical micelle
state of maximum concentration of dispersing agent before micelles form

[SOURCE: ISO 14887:2000, 3.4]

3.9
ultrasound
high frequency (over 20 kHz) sound waves which propagate through fluids and solids

[SOURCE: ISO 20998-1:2006, 2.22]

3.10
self-priming
suction of fluid into flow path without using a mechanism for feeding pressure

3.11
nozzle
structure that accelerates and releases fluid

3.12
porous membrane
membrane containing pores (voids)

3.13
non-condensable gas
air and/or other gases which is not liquefied under the conditions of a saturated steam

[SOURCE: ISO 11139:2018, 3.183]

3.14
electrolysis
process in which electric current is used to promote a chemical reaction

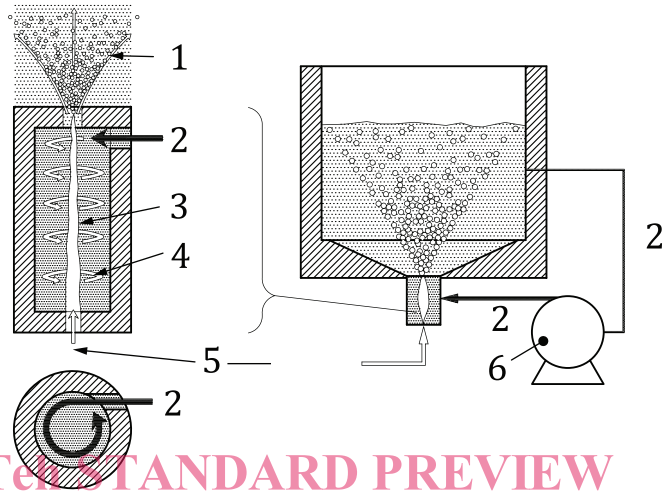
Note 1 to entry: In the case of water, the separation of hydrogen from oxygen is taken as an example.

[SOURCE: ISO/TR 15916:2015, 3.34]

4 Examples of methods for generating fine bubbles

4.1 Swirling flow system (for microbubble generation)

Liquid is made to swirl around the interior of a cylinder at a high speed, reducing the pressure near the central axis of the cylinder and thereby causing gas to be sucked in from the outside. Within the cylinder, centrifugal separation occurs where low-density gas is located at the centre and high-density liquid is located at the cylinder wall. The gas column is pulverized by the fierce shear flow to produce fine bubbles, see Figure 1.



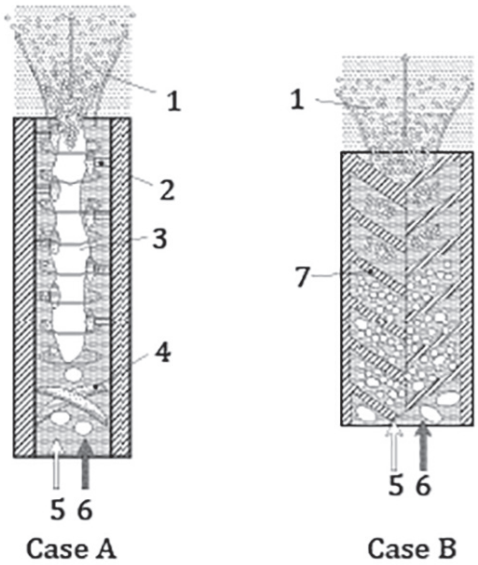
Key

1 fine bubbles
2 liquid
3 gas column
4 swirling flow
5 gas
6 pump

Figure 1 — Schematic diagram of fine bubble generation using swirling flow system

4.2 Static mixer system (for microbubble generation)

This system does not use mechanical pulverization. The flow path has a complex structure, and the circulatory drive force of the liquid produces a vortex flow which is primarily responsible for creating a large viscous shear force that pulverizes the gas. Protrusions on the inner wall of the cylinder produce vortex in the liquid flow, and the large bubbles carried along with the liquid are pulverized by the shear force to produce fine bubbles, see Figure 2.



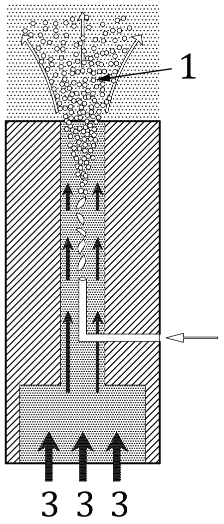
Key

1 fine bubbles
2 blade
3 gas column
4 guide vanes
5 gas
6 liquid
7 obstructions

Figure 2 — Schematic diagram of fine bubble generation using static mixer system

4.3 Ejector system

This system uses sudden narrowing and widening of the flow path, produces negative pressure and sucks air passively. The negative pressure produced when a fluid is passed through a narrow flow path at a high speed is used to suck in gas. The gas that is sucked in is pulverized thoroughly by cavitation caused by the widening of the downstream path, resulting in forming bubbles, see Figure 3.



Key

1 fine bubbles

2 suction gas

3 liquid

Figure 3 — Schematic diagram of fine bubble generation using ejector system

4.4 Venturi system

When a liquid that contains large bubbles passes through a Venturi tube with a narrowed cross-sectional area and a widened one, a sudden drop in pressure occurs when the liquid passes the throat section causes a temporal expansion of bubbles, and the subsequent sudden restoration of pressure and the shock wave cause a forceful breakup of the large bubbles. This method does not necessarily require the self-priming using reduction section, see Figure 4.

