Glossary

Fine Bubbles

Refer to Application of Ultrafine Bubbles to Grinding Processes (page 21)

HATAYAMA Yousuke, R&D Sect. No.1, Production Technology R&D Center, Engineering Div.

1 What Are Fine Bubbles?

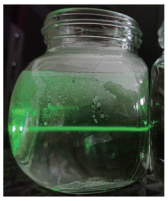
The term “fine bubbles” (FBs) is a general term for bubbles less than 100 ㎛ in diameter. Bubbles with diameters greater than 1㎛ are called microbubbles (MBs) and those with diameters less than 1 ㎛ are called ultrafine bubbles (UFBs). This terminology is defined by the International Organization for Standardization (ISO) [1]. Their properties are shown in Table 1. Large-diameter MBs appear cloudy and are visible to the naked eye. They rise slowly and eventually disappear. On the other hand, UFBs with small diameters are colorless, transparent, and cannot be visually identified. When water containing UFBs is irradiated with the light from a laser pointer, the laser light is scattered, allowing the trace to be followed. UFBs remain in the liquid without rising. They can remain there for a long time, from several weeks to even several months under certain conditions [2].

The use of FB technology is being promoted in a wide range of fields, including the environment, agriculture, food, fisheries processing, cleaning, general industry, and beauty [3]. Its major applications include wastewater treatment, food freshness preservation, semiconductor parts cleaning, and machining. The effect of MBs began to be reported in the 1990s and that of UFBs in the mid-2000s. One of the leading countries in FB technology is Japan [4].

It is said that the practical effects in the above-mentioned fields are due to the physical effects of FBs including gas dissolution effects [3], gas encapsulation effects [3], physiological activity effects [5] [6], friction reduction and lubrication effects [6] [7], and adsorption and purification effects [5] [6].

Today, there are various types of FB generators. The main types include pressurized dissolution type, high-speed vortex flow type, static mixer type, microporous type, ultrasonic type, and ejector type [3] [5]. FB generators are superior or inferior in price, structure simplicity (easy maintenance), and FB concentration depending on the type, with their own advantages and disadvantages.

Table 1 Definition and properties of FBs

Designation	UFB	MB
Bubble diameter	Several tens of nm to 1㎛	1 ㎛～100㎛
Visual detection	Invisible (colorless, transparent) 	Visible (cloudy) 
Dynamics	Remain in water for long time.	Rise very slowly and disappear.

References

1) ISO 20480-1: 2017. Fine bubble technology - General principles for usage and measurement of fine bubbles - Part 1: Terminology.
2) SERIZAWA Akimi: “Some Characteristics and Application of Micro/Nano Bubbles,” Journal of the Japan Institute of Marine Engineering, Vol.46, No.6, pp.56-61 (2011).
3) Kyushu Bureau of Economy, Trade and Industry: “Fine Bubble Application Examples: Fine Bubbles are Transforming Japanese Industry” (2017).
4) Fine Bubble Industries Association (FBIA) website: https://fbia.or.jp/en/about/ (accessed on February 4, 2025).
5) ARAI Yoshihiro: “Accelerated Industrialization of Fine Bubble Technology,” ARC Report (2016).
6) YABE Akira: “Fine Bubble Technology and its Current Stage of Development—Semiconductor Cleaning, Wafer Transfer, Plant Factory and Others—,” The Journal of The Institute of Electrical Engineers of Japan, Vol.138, No.7, pp.430-434 (2018).
7) KODAMA Yoshiaki: “Skin Friction Reduction of Ships by Microbubbles,” Journal of Japan Society of Fluid Mechanics, Vol.20, No.4, pp.278-284 (2001).