Technology

Ultrafine Bubble Generating Nozzle

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1. Introduction

Fine bubbles refer to extremely small bubbles of less than 100 µm. Among fine bubbles, those having a diameter of 1 to less than 100 µm are defined as microbubbles, and less than 1 µm as ultrafine bubbles. The main effects of fine bubbles include cleaning, growth promotion, and water purification and sterilization.

The use of fine bubbles has been expanding in various fields in the past decade or so, and their applications are diverse and closely related to the SDGs, as shown in Table 1. In particular, ultrafine bubbles are used in many application fields where their characteristics are taken advantage of, and it is expected that new applications will emerge.

This paper presents the ultrafine bubble (UFB) generating nozzle UG01 (tentative name), which was developed based on our mixing technology for various types of fluids.

Table 1. Examples of fine bubble application

Field	Application
Wastewater treatment	Efficiency improvement by activating microorganisms
Agriculture	Crop growth acceleration
Aquaculture	Making shipment earlier by accelerating growth
Food	Maintaining freshness of fresh fish
Cleaning	Cleaning of restrooms at rest areas on expressways
Industry	Improvement of grinding efficiency

2. Our mixing technology

2.1 Gas-gas mixing

We have long manufactured blowpipes used for gas welding, heating, and cutting as shown in Figure 1. Many of these blowpipes function as gas-gas mixers, which mix fuel gases such as acetylene and LPG with oxygen.

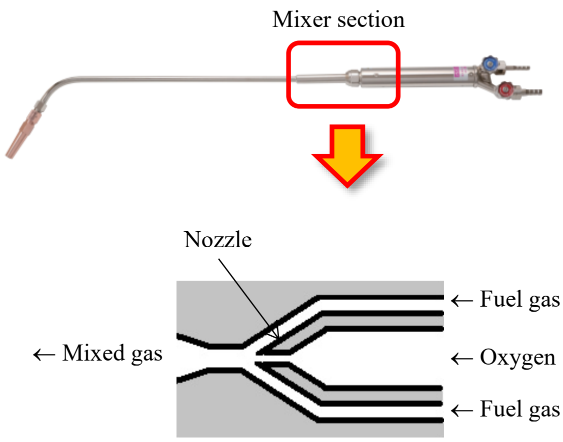

Figure 1. Manual gas heating blowpipe and mixer section

2.2 Gas-liquid mixing

We have also developed the TM01 carbonated spring mixer, which is a liquid-gas mixer that mixes hot water with carbon dioxide gas, as shown in Figure 2. The carbonated water produced by the carbonated spring mixer is used for a shower, or it is stored in a bathtub or other container once and then used.

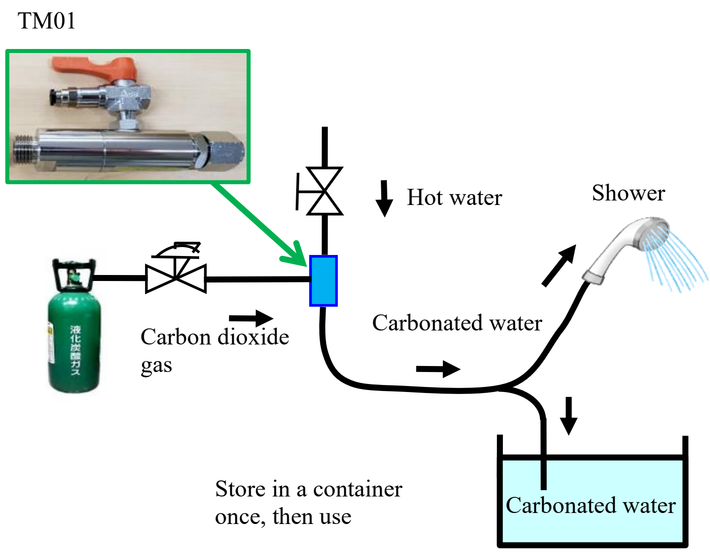

Figure 2. Carbonated spring mixer

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Figure 3 shows the carbonic acid concentration data when carbonated water (38°C) was produced using the TM01. When carbonated water released into the atmosphere from a shower was measured, the result greatly exceeded a carbonic acid concentration of 250 mg/L, which is the carbonated spring standard. When carbonated water stored in a container was directly measured, the result exceeded a carbonic acid concentration of 1000 mg/L. This indicates that the TM01 has an ability to produce carbonated water equivalent to a medical spring (high-concentration carbonated spring).

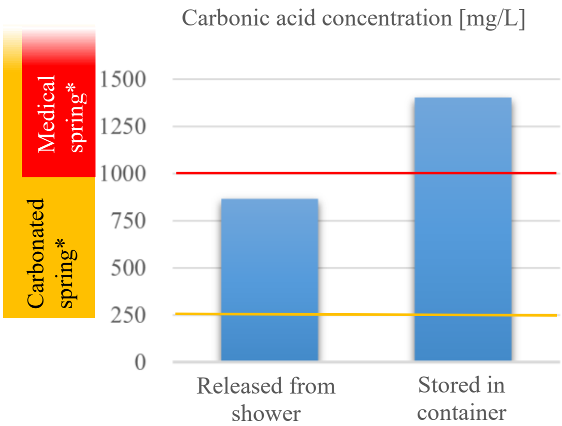

Figure 3. Carbonated water production ability of TM01

* A carbonated spring shall have a carbonic acid concentration of 250 mg/L or higher (Hot Spring Law). A medical spring shall have a carbonic acid concentration of 1000 mg/L or higher (Ministry of the Environment).

3. Ultrafine bubble (UFB) generating nozzle

The following paragraphs report the evaluation results of the UG01 ultrafine bubble (UFB) generating nozzle, which we have developed based on our mixing technology described in the previous section.

We generated ultrafine bubble (UFB) water by adding dry air to the raw water, using pure water as the raw water, by the ultrafine bubble generating nozzle while circulating the raw water using a pump, as shown in the flow in Figure 4.

We measured the ultrafine bubble number concentration of the generated ultrafine bubble water using Malvern Nano Sight NS300. Figure 5 compares the number concentrations of ultrafine bubbles generated by the developed UG01 ultrafine bubble generating nozzle and those generated by commercially available fine bubble generators under the same conditions. All the measurement data were obtained one day after water sampling. As a result of the comparison of bubble number concentrations, it was confirmed that the developed UG01 ultrafine bubble generating nozzle has a superior ultrafine bubble generation efficiency to the commercially available products.

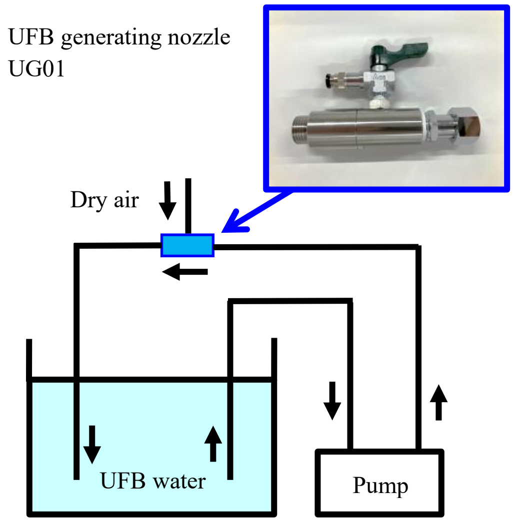

Figure 4. UFB water generation flow

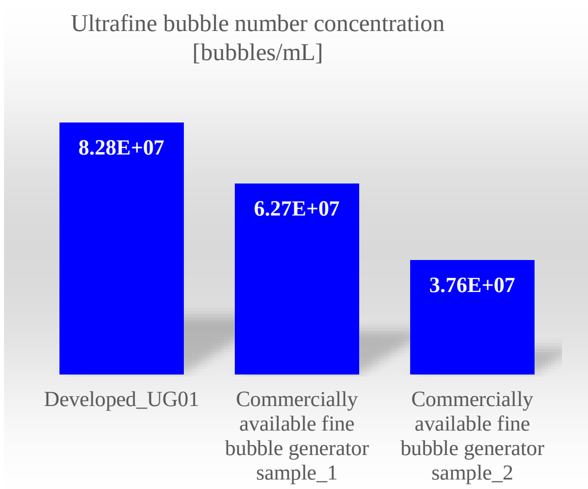

Figure 5. Comparison of fine bubble generating amounts

* Commercially available fine bubble generator sample_1 General-purpose fine bubble generator with gas adding functionality

* Commercially available fine bubble generator sample_2 Fine bubble generator for washing machines without gas adding functionality

4. Conclusion

We succeeded in developing a ultrafine bubble (UFB) generating nozzle with high generation efficiency based on our fluid mixing technology. We will apply the developed product to various fields in future and, based on the resulting feedback, we would like to make improvements and use this technology to develop new equipment.