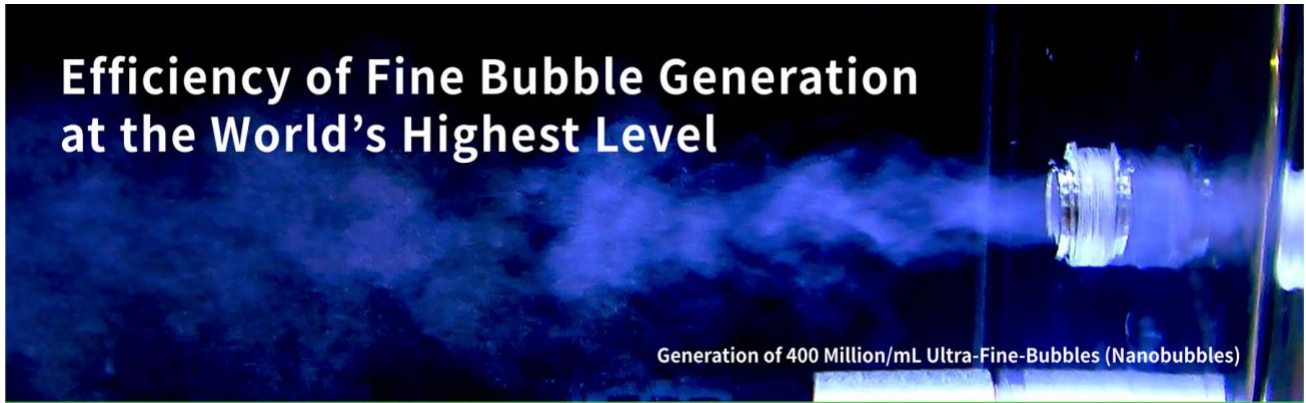


OK Engineering Co., Ltd



Loop flow OK Nozzle and its applicability

- Our company has a wide range of business development in fine bubble technology within residential use, agriculture, aquacultural, waste-water treatment, medical care, and industrial fields. However, fine bubble technology is still not well-known despite being eco-friendly. Many cases have still not been scientifically investigated, but we recognize that the spread of fine bubble use is progressing because the technology is meeting the needs of customers and exerting incredible effects.
- Currently, the efficiency of generating the fine bubbles of OK Nozzles is one of the highest in the world. We are aiming to develop OK Nozzles to generate more fine bubbles, with the aim to custom-make diameters to generate bubbles according to requirements within specific industrial areas and enable higher functionality.



EXPO 2023 @INTEX OSAKA

- Our loop flow OK Nozzle structure is highly durable, and it has a great fine bubble generation efficiency. Also, it can be produced within wide capacity range (60 mL/min to 1,200 L/min. and beyond).

Cleaning and Sterilization



Water Purification



Agricultural



Aquacultural



Floating Separation



Gas Dissolution



Resistant Reduction



Machine Tools



For Bath and Shower



Currently, our loop flow OK Nozzles are spreading in the fields as follows:

A) Bioactivation

B) Cleaning related:

Silicon wafer cleaning/super-clear mirror polishing/peeling separation; machine tool cleaning; dishwashing equipment and fish egg/potato cleaning; cleaning experiments etc.

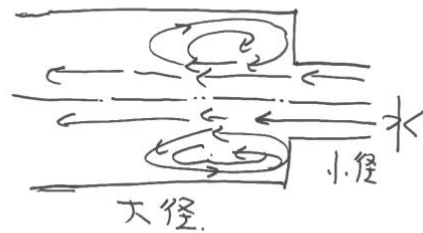
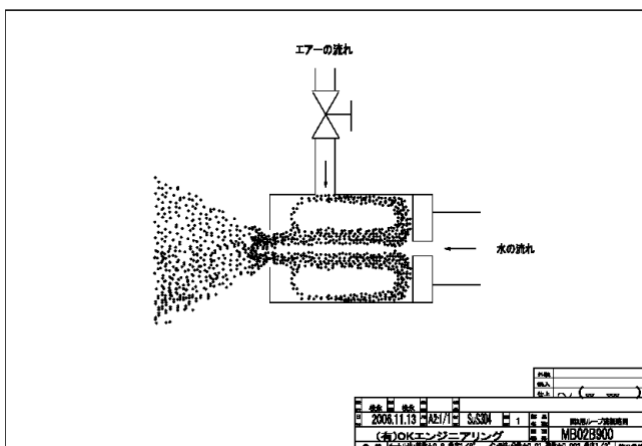
C) Others:

Ultrafine bubble water production, purification of coolant for machine tools and improvement of machinability, oil-water floating separation –crude oil/palm oil–, fuel improvement, decolorization of the pool water of hippopotamus in a zoo, sterilization of sprout shrimp, etc.

The use of fine bubbles is widely spreading. For details, please refer to our website.

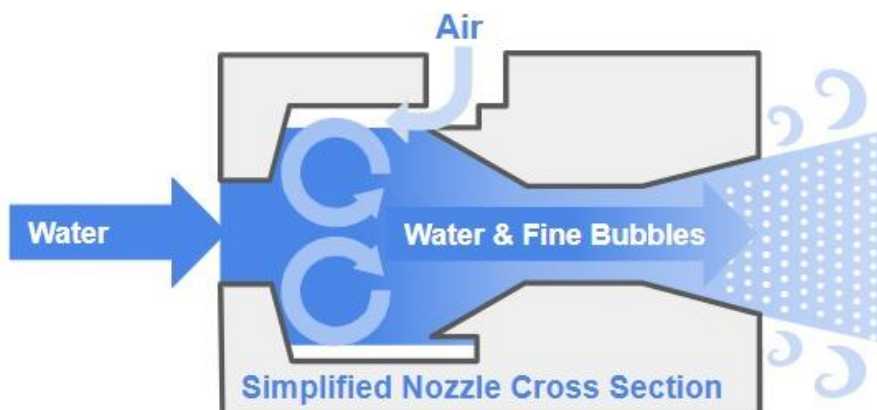
Structure of the original loop flow OK Nozzle

- When water streams down a big pipe from a small pipe, whirlpools occur in the corners of the big pipe.
- The OK Nozzle uses this whirlpool, namely, loop flow.



Structure of the current loop flow OK Nozzle

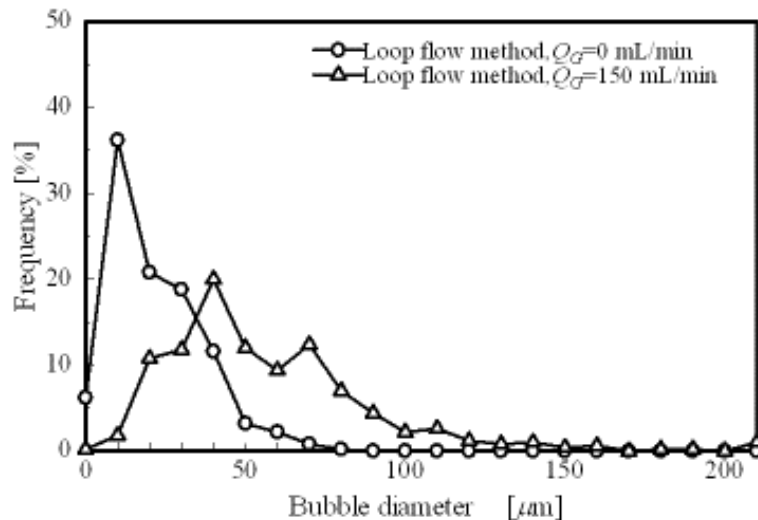
- The loop flow causes intense turbulence in several places inside the nozzle.
- This intense turbulence miniaturizes the bubbles into fine bubbles.



● Micro-bubble Diameter

by OK-Nozzle with loop flow

Peak of bubble Diameter : 10 μ m



● Nano Bubble No.3-1

water-pressure 0.1MPa

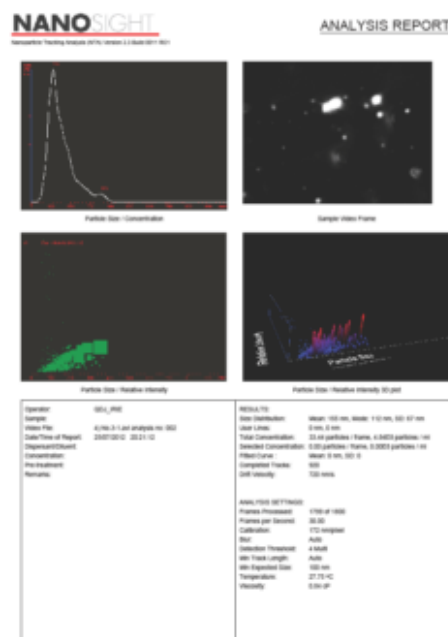
Size Distribution:

- Mean: 155 nm
- **Mode: 112 nm**
- 4.645E6 particles/ml
- SD: 67 nm

Total Concentration:

- 33.44 particles / frame
- 4.84E8 particles / ml

OK-nozzle makes many Nano-bubbles.



- Taking advantage of our engineer/CEO, Mr. Matsunaga's 40-year experience dedicating to exclusive machine tools, loop flow OK Nozzles as in the photo below were developed after considerable research. Especially, we are good at custom-made nozzles according to each customer's need. Currently the types of nozzles exceed 100.



The future and market of fine bubbles

I. The future of fine bubbles—a new technology for the next-generation

A) Various effects and the spread of fine bubbles

Fine bubbles have various effects as follows.

1. Biological activation
2. High cleaning and sterilization effect
3. Built-up edge peeling effect during aluminum processing
4. Improvement of the surface roughness of silicon wafers
5. High gas dissolution effect
6. Bactericidal effect
7. Freshness-preserving effect of fish, etc.
8. Decolorization effect
9. Floatation separation
10. Biofilm generation suppression
11. Resistance reduction
12. Water viscosity lowering effect

13. Charging and solution concentration
14. Miniaturization effect in nanoparticle manufacturing process
15. Liquid flow visualization
16. Relaxing effect
17. Unknown effects
18. Energy saving

In the future, fine bubbles will be used in many fields dealing with liquid as most of these effects lead to energy saving effects.

Especially, in "1. Biological activation", microorganisms are activated which enhances the sewage and wastewater treatment capability. There is no doubt that it will become the most advanced sewage and wastewater treatment technology in the near future.

We are hoping that Boracay will build the state-of-the-art sewage treatment plant. If Boracay takes the lead, this treatment system using fine bubbles will spread over polluted countries and regions around the world.

The market for fine bubbles is wide likewise the example of "1. Biological activation". Therefore, possibly the market aiming at the above effects is inexhaustible.

Fine bubble technology is a promising new technology. The Ministry of Economy, Trade and Industry of Japan is working on international standardization as a new technology originated in Japan.

B) Energy saving effect with fine bubbles

Most of the fine bubble effects lead to energy saving effects.

Speaking of sewage and wastewater treatment, if fine bubbles are used instead of normal aeration, only about half of the aeration power in the tank will be needed.

Sludge disappears when oxygen fine bubbles are used, and thus the sludge treatment cost can be significantly reduced. Also, the sludge-layer may not be needed, and the construction cost of the sewage treatment facility can be reduced.

2. Fine bubble market overseas

FBIA conducted market research on fine bubbles in 2014. According to the survey, the market size was presumed to become of three trillion yen in five years. This survey is the result of underestimating the industrial field. Fine bubbles will be widespread in the machine tool field in the future, and this field alone is a large market. Thus, ten years from now, the market size of the fine bubble industry is expected to reach several tens of trillion yen.

The spread of OK Nozzles overseas will be shown below.

a. February 21, 2014- September 30, 2015 –A year and seven months total

–Overseas sales: ¥480,000 + ¥2,000,000

(1) Vietnam (2) South Korea (3) Taiwan (4) Hong Kong (5) Thailand (6) UK
(7) Malaysia (8) China

b. October 1, 2015-September 30, 2016

–Overseas sales: ¥2,740,000

(1) Brazil (13) Canada (2) USA (14) Australia (3) India (15) Singapore
(4) South Korea (16) New Zealand (5) Taiwan (17) Netherlands (6) Malaysia
(7) Germany (8) Israel (9) Arab Emirates (10) China (11) UK (12) Vietnam

c. October 1, 2016-September 30, 2017

–Overseas sales: ¥4,450,000

(1) Philippines (13) Thailand (2) USA (14) Vietnam (3) Germany (15) UK
(4) Chile (16) Italy (5) China (6) Taiwan (7) South Korea (8) India (9) Hong Kong
(10) Singapore (11) Croatia (12) Peru

d. October 1, 2020-September 30, 2021

–Overseas sales: ¥18,710,000

e. October 1, 2021-September 30, 2022

–Overseas sales: ¥25,270,000

Company establishment and the progress of R&D

I. Establishment of the company

After graduating from the Department of Mechanical Engineering, Faculty of Science and Technology, Ritsumeikan University in 1972, Mr. Matsunaga had worked at machine tool manufacturer affiliated with ITOCHU Corporation, engaging in the design of special machine tools for processing automobile parts.

In 1988, he founded OK Engineering. Until working on the fine bubble business, he designed special machine tools by himself. Since 2013, the company has been specialized in the fine bubble business and is currently operated with five people. In few years, we are planning a seven-people organization.

II. Research and development of fine bubbles

Starting R&D of fine bubbles in 2000, in July 2006, Mr. Matsunaga had his eureka moment seeing invisible stealth bubbles during an experiment on the emergence of water-bloom in a rice field, which became a trigger of developing of the OK Nozzle. Then he improved the idea using existing nozzles of the experiments before.



In September 2006, we applied for a patent for the basic nozzle concept. After that, to develop a practical type of fine bubble generation OK Nozzle, 50 nozzles were prototyped and experimented for a year.



III. OK Nozzle manufacturing results –Flow rate: 60mL-1200L /min

After the patent application for the practical type of OK Nozzle in 2008, we started selling them. Since OK Nozzles has been developed according to each user's request, there are currently more than 100 types of them.





IV. Development of nozzle for draft beer server

–Within the national subsidy program

In 2015, "development of draft beer server self-help cleaning system" was started under the national manufacturing subsidy program, and by the end of 2017, OK nozzle was optimized for draft beer server. The summarized documents are attached below.

Cleaning with fine bubbles

Draft beer using loop flow OK Nozzle

Self-help cleaning system of the server & mellower beer!

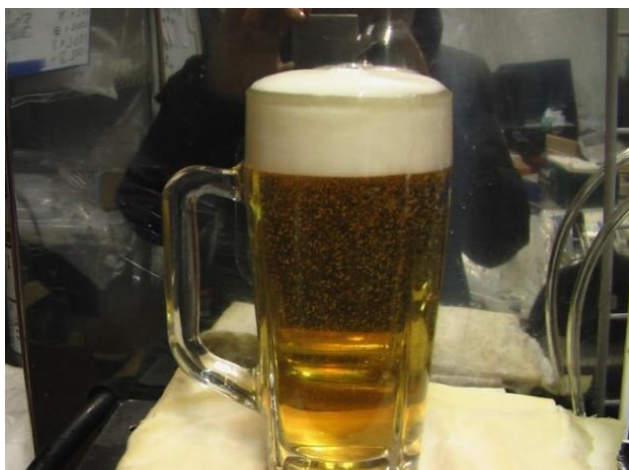


Photo of fine-bubble-infused beer taken one hour after pouring. Fine bubbles rise even after an hour!



OK Nozzle for draft beer

The purpose of this OK Nozzle for draft beer was to let the fine bubbles self-clean the draft beer server. Also, it turned out that draft beer became "mellow" as a by-product. I presume that the cause of the mellowness is the ultra-fine bubbles (nano bubbles). Please also check our website for details. In June 2018, we published the interesting experimental results at AIST. <http://ok-nozzle.com/> The OK Nozzle for draft beer servers went on sale in April 2019.

Impression of draft beer with fine bubbles

Below is what we heard from many people who tasted draft beer during this experiment.

"Mellow" "No so stingy" "Delicious!"

"Similar to the taste of kuradashi (sake fresh from the brewery)"

"This beer I can drink a lot even I don't drink much beer normally."

"Fizz will not come off forever."



1)



2)



3)

1) CO2 measuring instrument for Beer by Anton Paar

2) Tube cleaning experiment

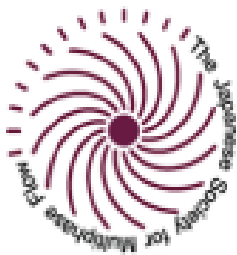
3) Experimental apparatus

The Japan Society for Multiphase Flow and FBIA

1) Encounter and enrollment with The Japan Society for Multiphase Flow

Starting participation in the lecture of The Japan Society for Multiphase Flow in 2009, we joined it in May 2011 and became a regular member with the recommendation of Professor Uemura in Kansai University. We have learned so much by participating in its annual lectures held at The University of Aizu, Kumamoto University, Kyoto Institute of Technology and so forth. In July 2012, at a lecture at the University of Tokyo's Kashiwa Campus, we lectured about the performance of the OK nozzle and the number of ultrafine bubbles being 480 million/mL, and also about the clarification of fine bubbles existing stably in ultrapure water.

http://www.jsmf.gr.jp/index_e.shtml



日本混相流学会

The Japanese Society for Multiphase Flow

2) Joining FBIA at the time of its establishment

In August 2012, joined FBIA when it was established. FBIA is entrusted by the Ministry of Economy, Trade and Industry and is working on the international standardization of fine bubbles. We are also the Japan member for the international standardization.

<https://fbia.or.jp/en/>



About us

Introducing the developer

President Takeshi Matsunaga

He developed a Loop-flow mode Nozzle and founded Nozzle company



Greetings

I am Takeshi Matsunaga from OK Engineering Co., Ltd. I have been involved in research and development of fine bubbles since 2000, focusing on the development of fine bubble generation nozzles: loop flow OK Nozzles. There have been many application examples, and the power of fine bubbles has kept surprising and impressing me. Fine bubbles apply to wide range of fields such as: home, agriculture, fisheries, industry, and medical fields, and will be used in all fields dealing with liquids in the future.

Loop flow OK Nozzle was developed taking advantage of my 40 years of experience in designing exclusive machine tools, and nearly 100 types are designed and manufactured so far. As the fields of application are so wide, we are currently focusing on manufacturing "custom-made OK nozzles" to support each purpose.

We believe that generating and using fine bubbles will lead to the protection of the natural environment, and with the conscious and extensive use of fine bubbles, we will be able to protect nature more efficiently. In the near future, it will be used in many houses, in rivers, in the sea, on the coast, in sewage treatment plants, for factory waste liquid treatment, for mechanical breakdowns and so forth.

In the fields of agriculture and aquaculture, the power of fine bubble bioactivation has made it possible to increase food production at lower cost. In cherry tomato irrigation culture, production increased by 46% using the existing house; also in flounder farming, weight gain of 20% was achieved, mortality rate was significantly reduced, and oxygen usage was halved.

Hopefully this business will be an opportunity to create new industries, and I will be very happy to work with you.



Lecture at the University of Tokyo



June 2012, Lecture of the Japanese Society for Multiphase Flow at Kashiwa Campus, the University of Tokyo,

The experiment result was presented at a lecture by the Japanese Society for Multiphase Flow held at the University of Tokyo: the highest educational institution in Japan. Here, we lectured about the experiment examining the number of ultrafine bubbles (UFB/nanobubbles) generated by OK Nozzle as a six-year compilation.

*The experiment was conducted using ultrapure water and oxygen gas with a purity of 99.999%, and as a result, 480 million UFB/mL were generated.

Personal History

1949	Born in Ikitsuki Town, Hirado City, Nagasaki
1972	Graduated from Ritsumeikan University –Faculty of Science and Technology, Department of Mechanical Engineering
1972	Employed at ITOCHU affiliated machine tool manufacturer and engaged in designing exclusive machine tools for processing automobile parts, etc.

1988	Established OK Engineering. Co., Ltd
2000	Started the research and development of fine bubbles
2006 Sept.	Developed the loop flow fine bubble generation nozzle
2006	First patent application of Loop flow OK Nozzle
2008	Second patent application of Loop flow OK Nozzle
2009	Started participating in the lecture of the Japanese Society for Multiphase Flow
2011 May.	Joined the Japanese Society for Multiphase Flow as a regular member
2012 Jan.	Research and development of fine bubble generating nozzle became a lifework
2012 May. 25	Obtained a patent Patent No. 5002480 Blog
2012 Aug. 8	The third patent application
2012 Aug.	Joined FBIA at the time of establishment_ Fine Bubble Industries Association (FBIA)
2013	Started dedicating to research and development of OK Nozzle
2014 Apr.	The fourth patent application
2015 Jan. 27	PCT international application to the Japan Patent Office
2015 Feb.	Taiwan patent application and PCT international patent application
2015–	Started the development of "draft beer server self-help cleaning system" with national manufacturing subsidized project, optimizing OK nozzle for draft beer server, which was released in 2018.

Company Information

OK Engineering Osaka Terada based Nozzle-Design Company



Dec. 19 2017 Terada-cho Osaka

Company Overview

Trade Name	OK Engineering Co., Ltd.
Office (Experiment / Exhibition)	102 Grace Terada-cho, 9-8, Kokubu-cho, Tennoji-ku, Osaka-City, Osaka, Japan, 543-0044
Head Office	1-3-3-603, Terada-cho, Tennoji-ku, Osaka-city, Osaka, Japan, 543-0045
Representative	Takeshi Matsunaga Profile
Bank-account	Osaka Shinkin Bank head office, Mitsuissumitomo Bank

Company History

1988	Establishment of OK Engineering. Co., Ltd –Designing exclusive machine tools
2000	Started research and development of fine bubbles
2006 Sept.	Development of loop flow fine bubble generation nozzle
2006	First patent application of Loop flow OK Nozzle
2008	Second patent application of Loop flow OK Nozzle
2009	Started participation in the lecture of the Japanese Society for Multiphase Flow
2011 May.	Became the regular member of the Japanese Society for Multiphase Flow
2012 Jan.	Research and development of fine bubble generating nozzle became a lifework to Mr. Matsunaga
2012 May. 25	Obtained a patent Patent No. 5002480 Blog
2012 Aug. 8	The third patent application
2012 Aug.	Joined FBIA at the time of its establishment Fine Bubble Industries Association (FBIA) ⇒ Fine bubble Video by FBIA
2013	Started dedicating to research and development of OK Nozzle
2014 Apr.	The fourth patent application
2015 Jan. 27	PCT international application to the Japan Patent Office
2015 Feb.	Taiwan patent application/PCT international patent application
2015	Started the development of “draft beer server self-help cleaning system” with national manufacturing subsidized project, optimizing OK nozzle for draft beer server, which was released in 2018.
2018	Started producing PTFE OK Nozzle for semiconductor industry.

2022 Apr.	Obtained EP Patent. (16 countries)
2022 Oct.	Currently, patents from 32 countries in total. Also obtaining patents from Brazil and Mexico within the year.
2023 May	Five staff operation including CEO and new oversea division staff.

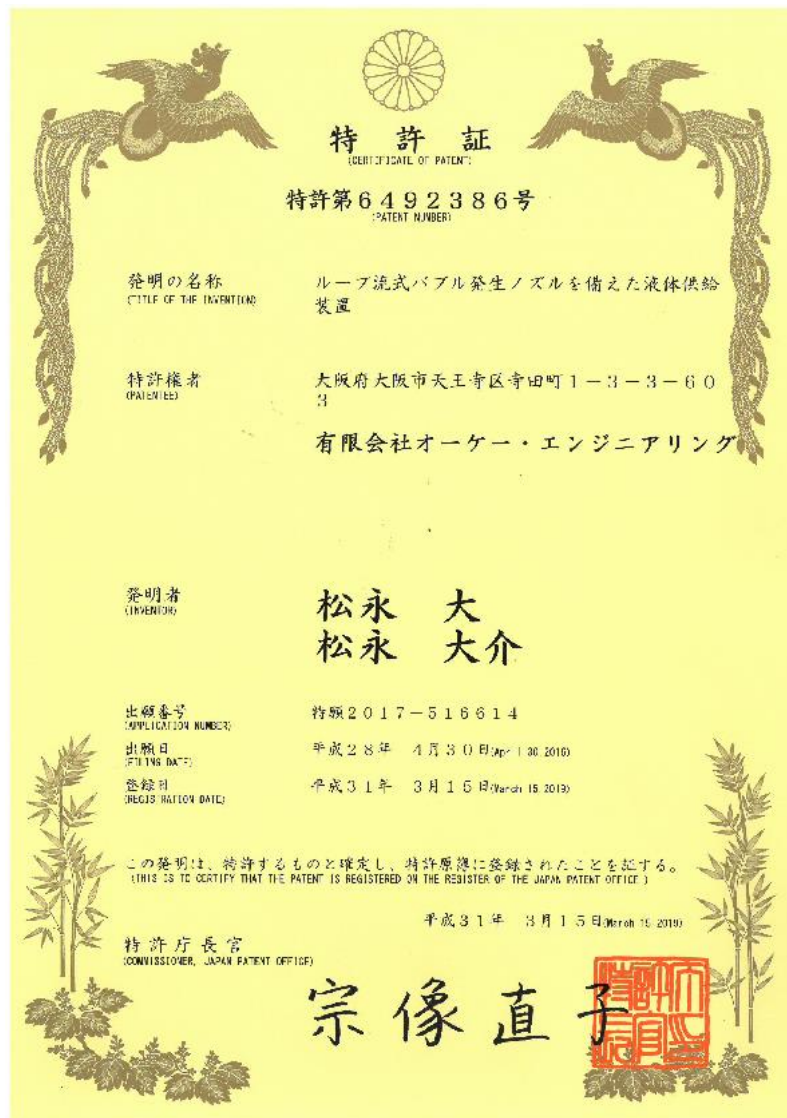


Patents and trademarks

I . OK Nozzle for draft beers

Obtained a patent for the OK Nozzle for draft beer server on March 15, 2019.

Receiving the national "manufacturing subsidy", three years were spent for its research and development.



II . Trademarks

Trademark registration:

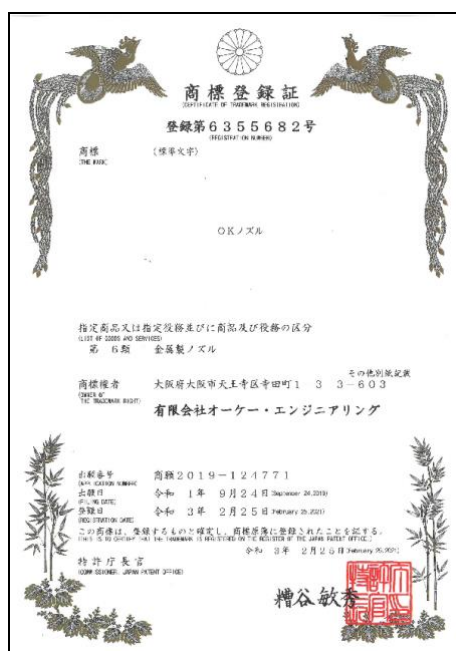
1) "Loop flow OK Nozzle"
on November 29, 2013



2) "Loop flow nozzle"
on December 4, 2020



3) "OK Nozzle"
on February 25, 2021



III. Loop flow OK Nozzle patent application–Practical type, in 2008

Obtained a patent on May 25, 2012. Patent No. 5002480



IV. Patent for the improved ver. of Seawater OK Nozzle

PCT international application to the Japan Patent Office on Jan. 27, 2015.

- Eventually, the number of world patents will be of about 34 countries.

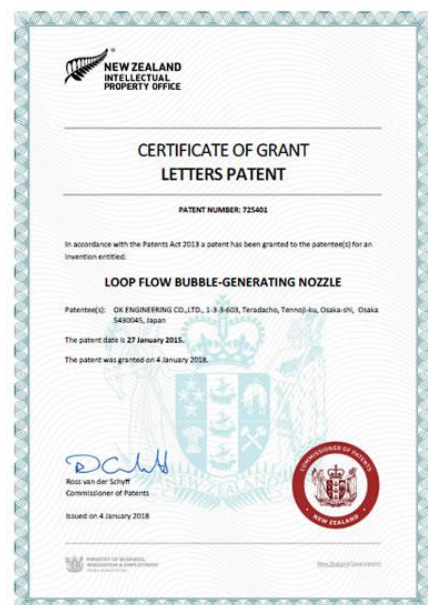
1) Obtained on July 7, 2017.

Patent No. 6167321



3) Russian patent. May 2018.

2) Patent in New Zealand



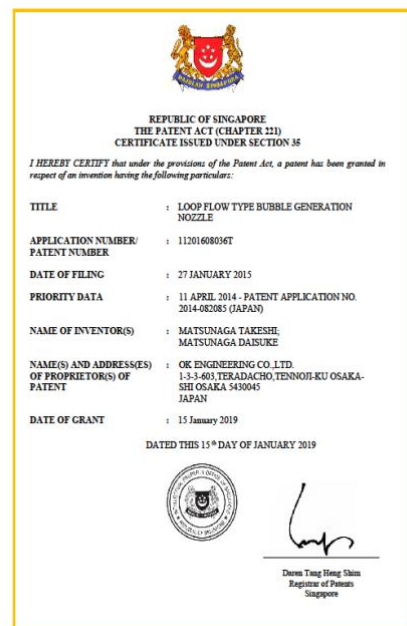
4) US patent. June 2018



5) Canadian patent. September 2018



6) Singapore patent. January 2019



7) Australian patent 1, January 17th, 2019

Australia patent 2, December 24th, 2020

8) Republic of China patent on March 11st, 2019

9) The Republic of Philippines patent, May 17th, 2019

10) People's Republic of China patent, October 1st, 2019

- 11) Malaysia patent, September 23rd, 2020
- 12) Republic of Korea patent, December 10th, 2020
- 13) State of Israel patent, December 31st, 2020
- 14) Indonesia patent, March 2021
- 15) Vietnam, September 2021
- 16) – 31) EU: Patents by 16 countries including Germany, U.K and France
- 32) India patent October 7th 2022

There was a delay in patent processing system due to the pandemic. However, we finally obtained the EU patent on April 27th, 2022. Within the year, obtaining Brazil and Mexico patents, total patents will be from 34 countries.



European Patent

SDG Certificate by FBIA (Fine bubbles Industry Association)

SDGs 認証書

FBIA SDGs 認証制度

認証番号： RUM0016/SDGs0001

認証者名： 有限会社OKエンジニアリング
大阪市天王寺区寺田町 1-1-3-603

認証日： 2021年10月5日

有効期限： 2024年10月4日

認証製品： ループ流式ファインバブル発生OKノズル 6L~1200L

ファインバブルの種類：マイクロバブル・ウルトラファインバブル

SDGs ゴール・ターゲット：

ゴール	ターゲット
	2. 1
	6. 3、6. 4
	9. 4
	12. 2、12. 4
	14. 1、14. 4

* ゴール・ターゲットの産業分類・種別は別紙

マークの表示：下記マークの使用を許可する



以上のとおり製品を認証したことを証します。

2021年10月5日

一般社団法人ファインバブル産業会

会長 森川 智



FBIA Registration Certificate

登 録 証

FBIA 製品登録制度

登録番号： RUM0016

登録者名： 有限会社OKエンジニアリング
大阪市天王寺区寺田町 1-1-3-603

登 録 日： 2021 年 9 月 27 日

有効期限： 2024 年 9 月 26 日

登録製品： ループ流式ファインバブル発生 OK ノズル 60mL～1200L

マークの表示：下記マークの使用を登録期間中許可する



一般社団法人ファインバブル産業会

会 長 森川 智



Our Philosophy and the Prospect

1) Philosophy

As mentioned in the greetings by our CEO, we would like to protect the global environment by utilizing the various effects of fine bubbles and providing technologies that help solve problems that are occurring on the earth today such as environmental pollution, food shortage and energy efficiency issues.

2) Prospect

The loop flow OK Nozzle has been developed by utilizing our Engineer/CEO's 40 years-experience in designing exclusive machine tools. In particular, the field of fine bubble applications is so wide that we are currently focusing on manufacturing "Custom order OK Nozzles" to support each purpose. Fine bubbles are a new technology, and are still at the basic experimental stage, mostly using small OK Nozzles in Japan and in overseas, but currently moving to implementation in practice. The market for the fine bubble industry is expanding year by year, and the PCT patent was applied predicting the worldwide spread of fine bubbles.

This business will surely be an opportunity to create new industries. In addition, we are making an effort to work with our partner companies in order to operate our small enterprise.

