Modular Nanobubble Generator

Fawoo Nanotech

CES Innovation Awards 2025 Honoree

Fawoo NANOTECH

June 2025

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1. Modular Nanobubble Generator

* **Modular nanobubble generator**

- Nanobubbles can be generated by simply connecting to existing pipelines.
- Depending on the injected gas, it can be used in a variety of ways.

Simple system configuration

Simplified structure for easy installation and maintenance / Modular combination available

Energy efficiency

Connection to existing water supply lines / Powerless or low-power nanobubble supply

Increased efficiency through gas usage

Maximizing reaction efficiency by injecting gas during nanobubble generation

Increased dissolved oxygen

Hazardous substance removal

pH control

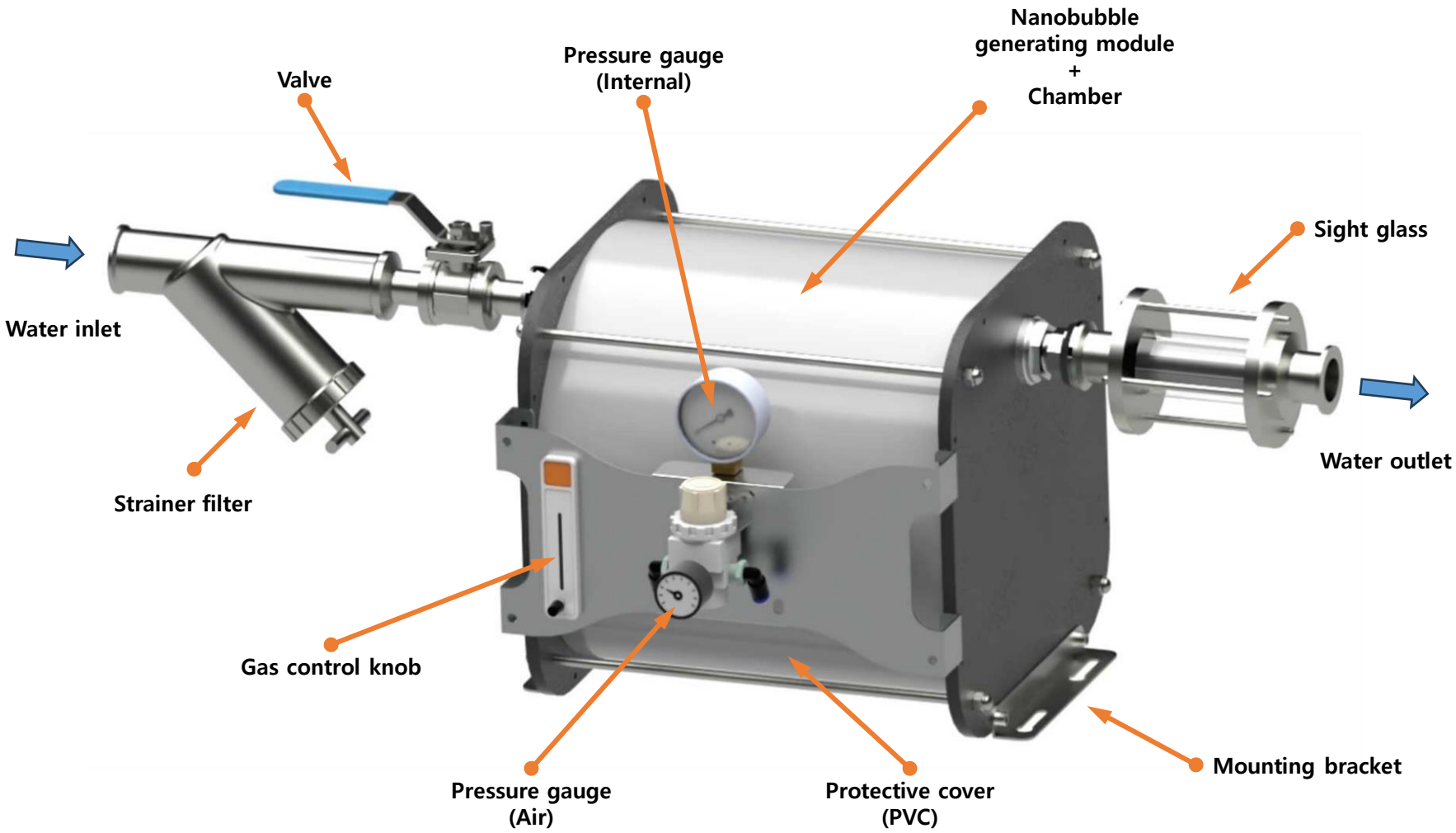
Slightly alkaline (pH 8.0)

→ Slightly acidic (pH 5.5-6.5)

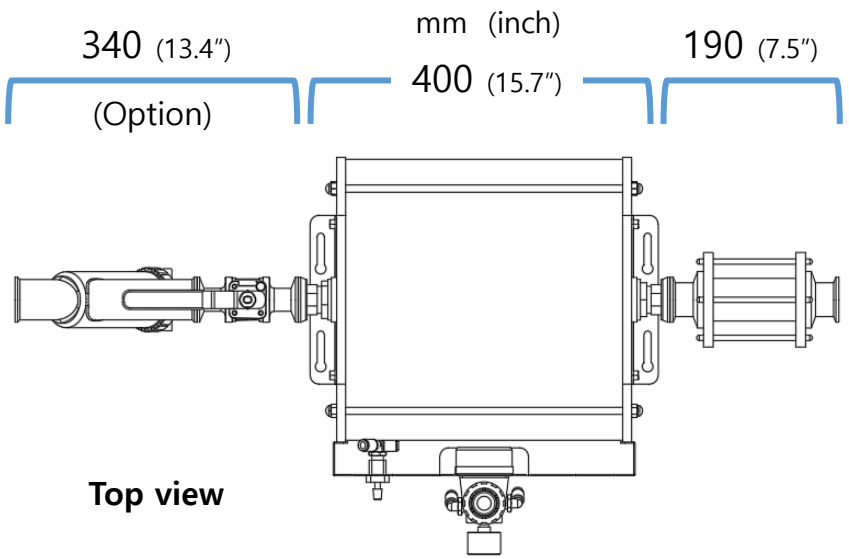
Decreased dissolved oxygen

For inquiries regarding the use of ozone, chlorine dioxide, hydrochloric acid, or other gases, please contact us.

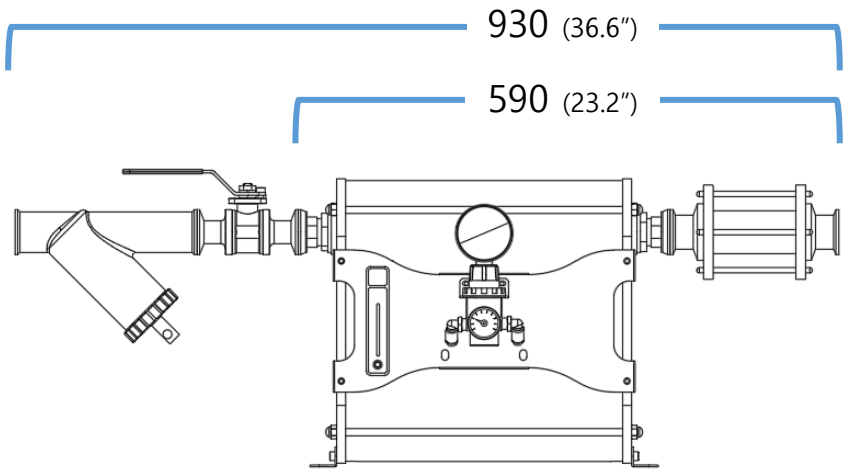
2. Device Configuration: FN-XM1 (1/3) – Key Components



2. Device Configuration: FN-XM1 (2/3) – Overall Dimensions



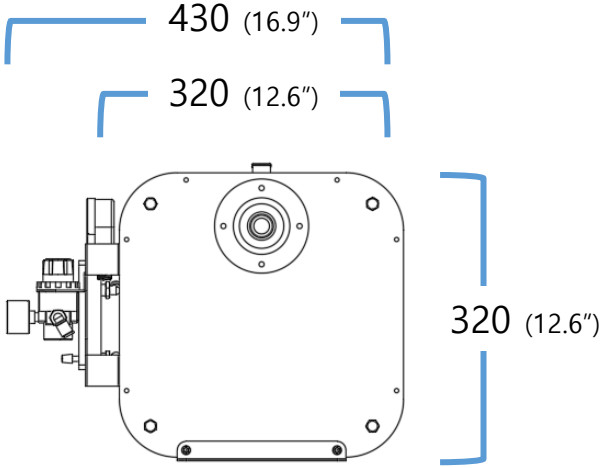
Top view



Front view

* Specifications of the product, including various parts and configurations, are subject to change without prior notice for quality improvement.

Flow rate	20~25 ton/day
	When connecting a 350W pump
Input gas	O_2 / CO_2 / N_2 etc.
Option	Strainer filter
Size (mm)	W590, D430, H320 (without valve and strainer filter)
Weight (kg)	13kg / (All: 19kg)
Notes	NanoTube: Ø25
Connection specifications	Inlet / Outlet: 25A (Sanitary - 1.5S)

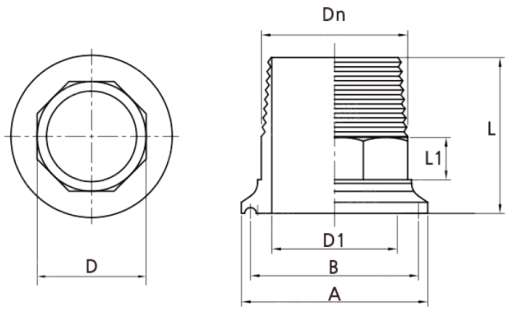


Right side view

2. Device Configuration: FN-XM1 (3/3) – Connection Method

※ Verify on-site standards before pipe connection.

Sanitary + Gasket + Clamp: 1.5S-25A (Standard)



1.5S x 25A

D1: 26.8mm
B: 43.5mm
A: 50.5mm

Sight glass

: STS304 + Glass

(Option)

Ball valve

: STS304

Option

or

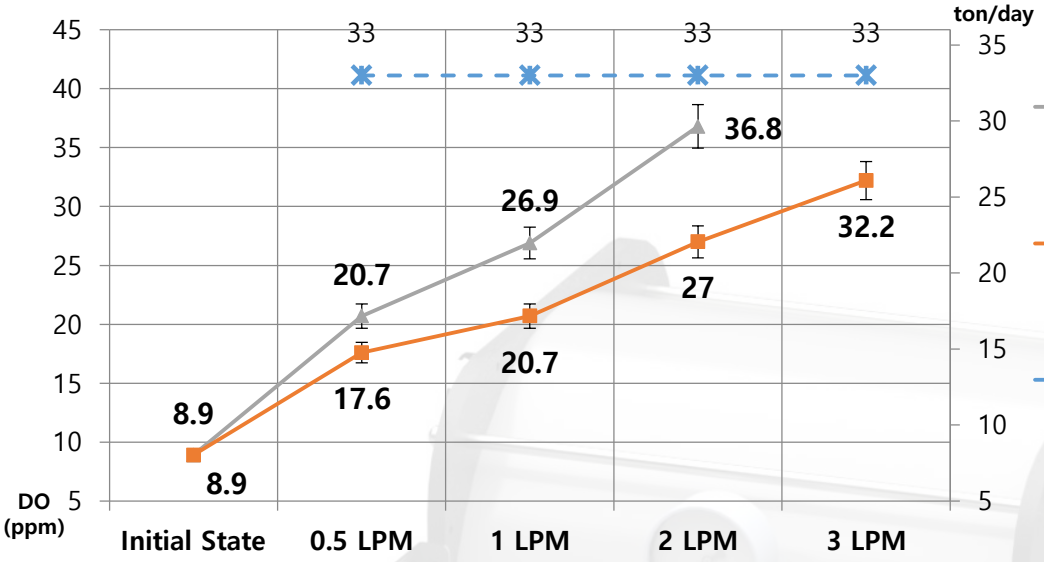
(Option)

Strainer filter–Y type

: STS304 + STS316

3. Gas Dissolution Measurement: FN-XM1 (1/2)

* Tap water quality (Bucheon, South Korea): pH: 7.3 / DO: 8.9 / Water temperature: 19.5~19.8°C
* Pump specifications: PW-S354SMA, 350W / 220V / 60Hz (Wilo Pumps Ltd)



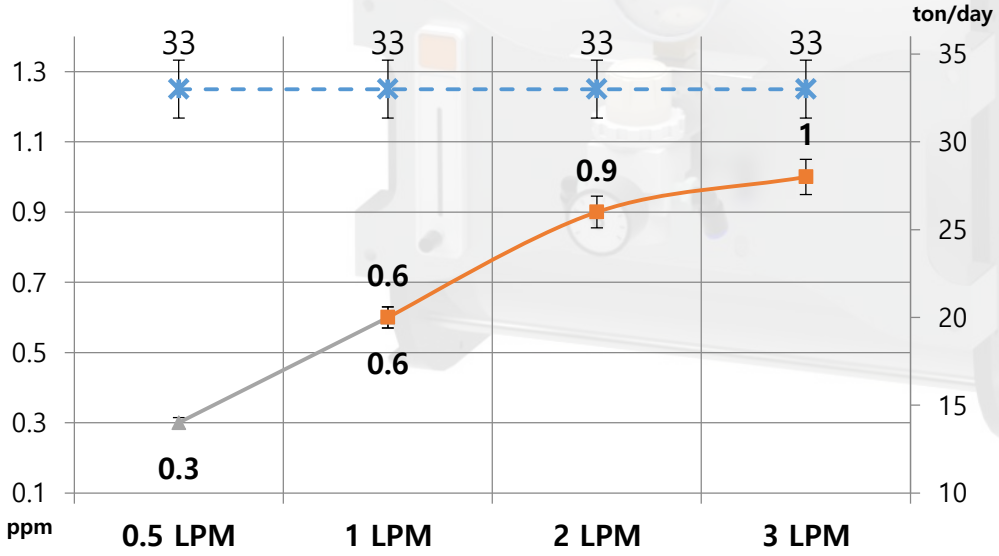
O_2

DO Concentration

DO 8.9

- **DO 36.8** (2LPM, Injection before pump)
- **DO 32.2** (3LPM, Injection into device)

* DO Meter: HI 9147-04 (HANNA Instruments)



H_2

H2 Concentration

0 ppm

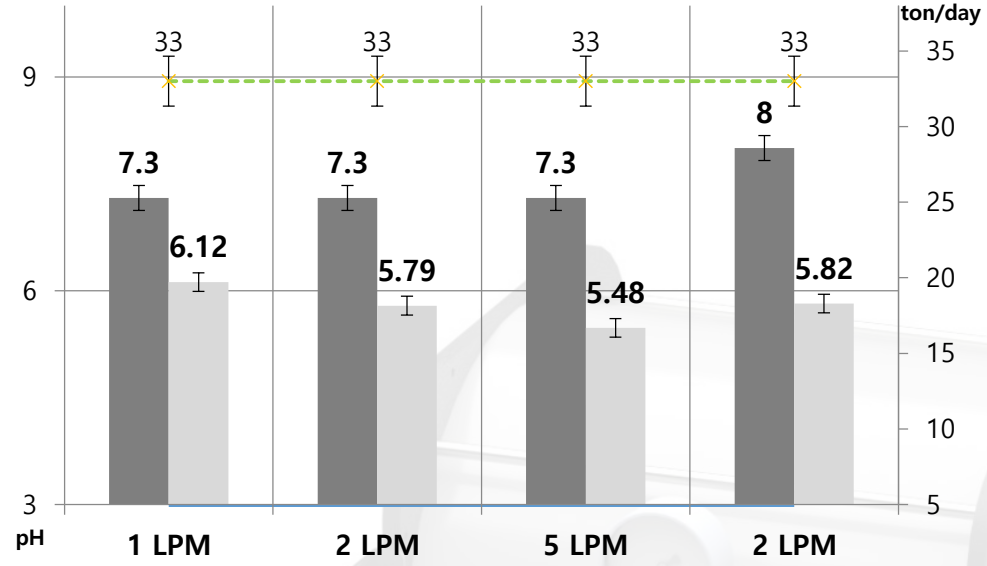
- **0.6 ppm** (1LPM, Injection before pump)
- **1.0 ppm** (3LPM, Injection into device)

* Hydrogen analyzer: Detection reagent (Miz company limited-Japan)

* Please note that measured values can vary depending on:
  Water quality, water temperature, pump specifications, operating conditions, etc.

3. Gas Dissolution Measurement: FN-XM1 (2/2)

* Tap water quality (Bucheon, South Korea): pH: 7.3 / DO: 8.9 / Water temperature: 19.5~19.8°C
* Pump specifications: PW-S354SMA, 350W / 220V / 60Hz (Wilo Pumps Ltd)



Before: Initial State (pH)

After: CO2 Injection into device (pH)

Flow rate (ton/day)

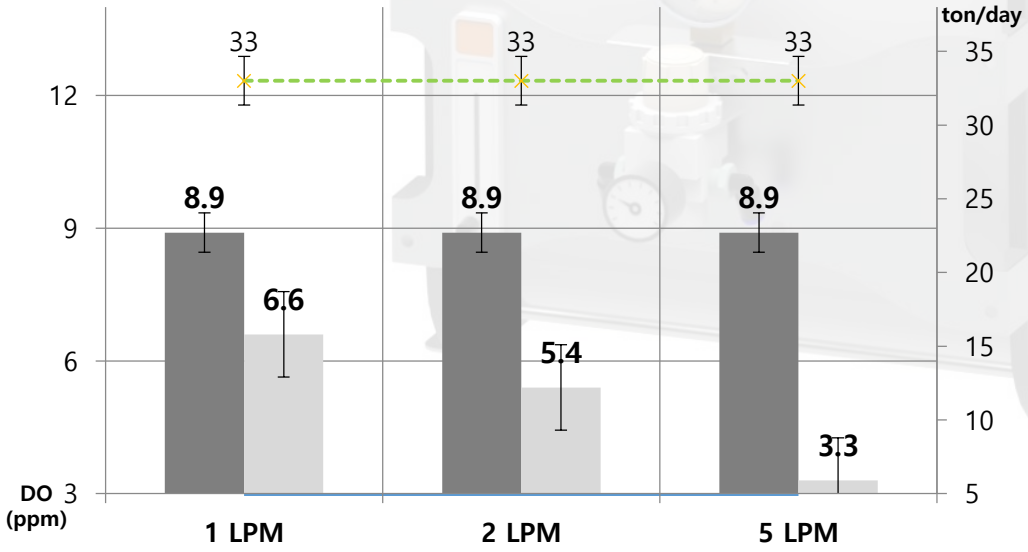
* pH Meter: pH Testr30 (OAKTON Instruments)

CO_2

pH decrease

pH 7.3 → **pH 5.79** (2LPM, Injection into device)

pH 8.0 → **pH 5.82** (2LPM, Injection into device)



Before: Initial State (DO)

After: N2 Injection into device (DO)

Flow rate (ton/day)

* DO Meter: HI 9147-04 (HANNA Instruments)

N_2

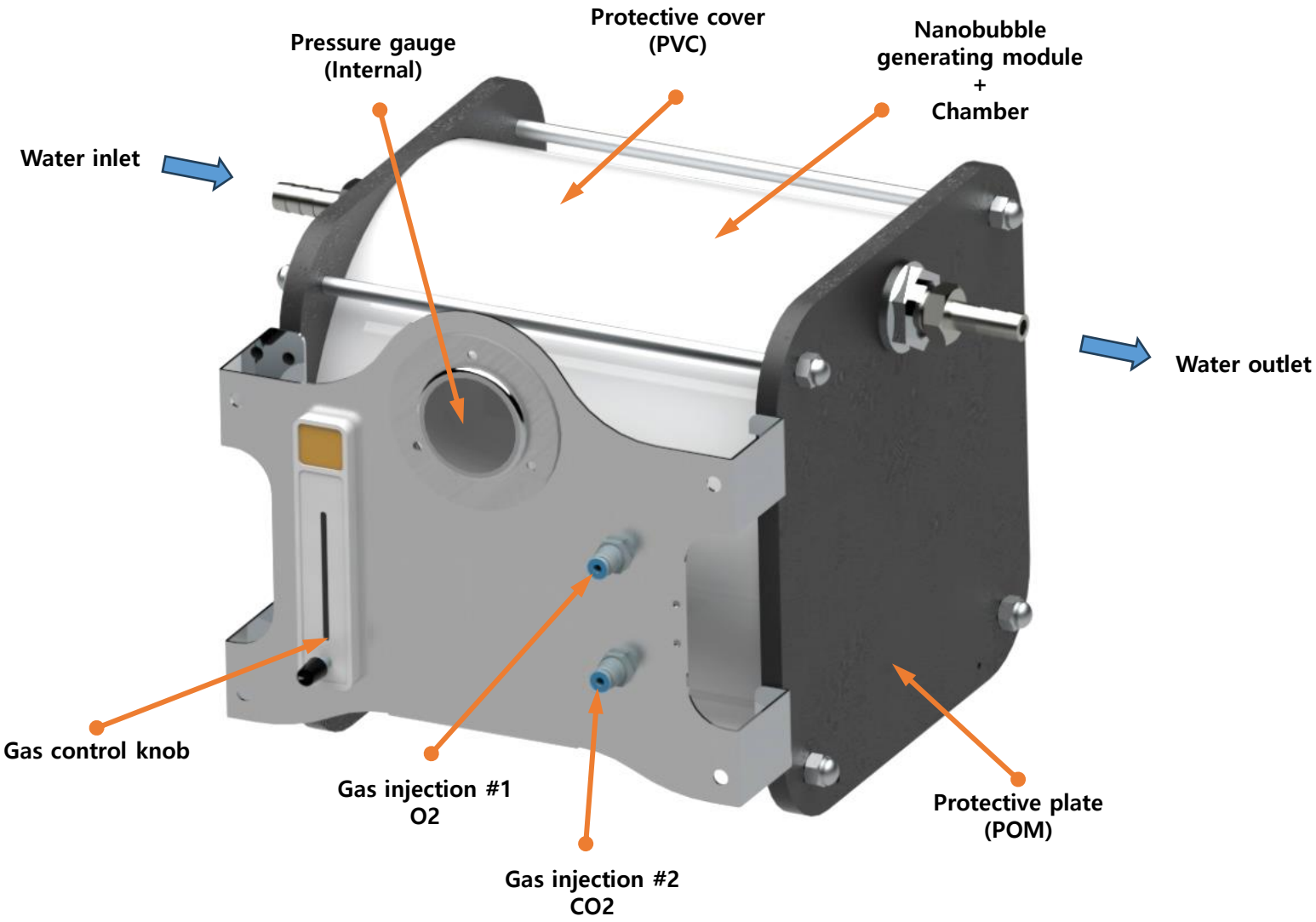
DO decrease

DO 8.9 → **DO 6.6** (1LPM, Injection into device)

DO 8.9 → **DO 3.3** (5LPM, Injection into device)

* Please note that measured values can vary depending on:
  Water quality, water temperature, pump specifications, operating conditions, etc.

4. Device Configuration: FN-XM2 (1/2) – Key Components

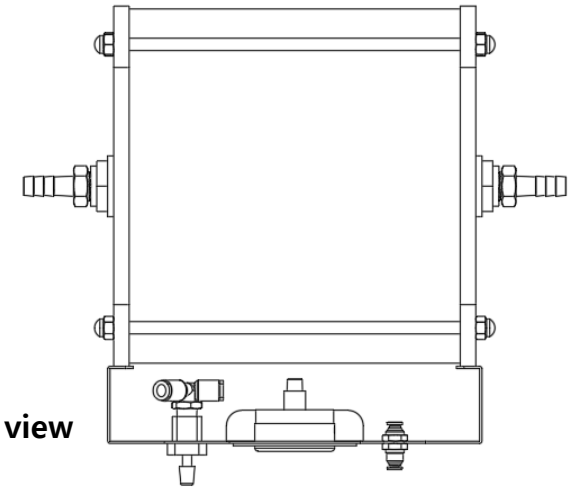


4. Device Configuration: FN-XM2 (2/2) – Overall Dimensions

* Specifications of the product, including various parts and configurations, are subject to change without prior notice for quality improvement.

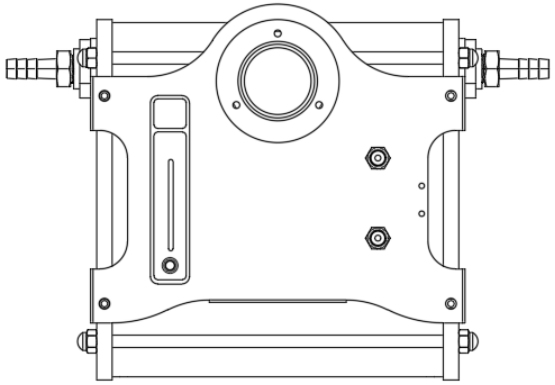
mm (inch)

352 (13.8″)



Top view

244 (9.6″)

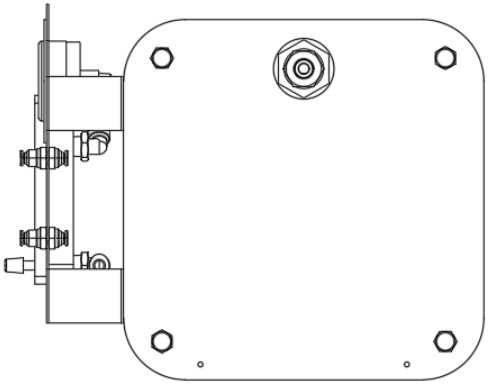


Front view

Flow rate	5 L/min (7.2 ton/day)
	When connecting a diaphragm pump
Input gas	O_2 / CO_2
Option	N/A
Size (mm)	W352, D310, H244
Weight (kg)	Net. 6kg
Notes	NanoTube: Ø15
Connection specifications	Inlet / Outlet (Hose nipple - Ø13)

310 (12.2″)

234 (9.2″)

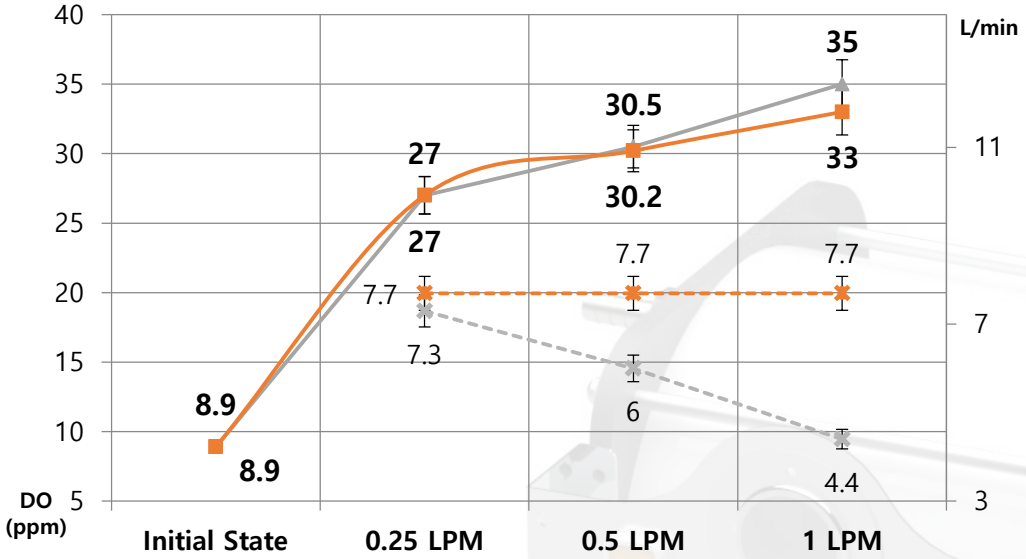


244 (9.6″)

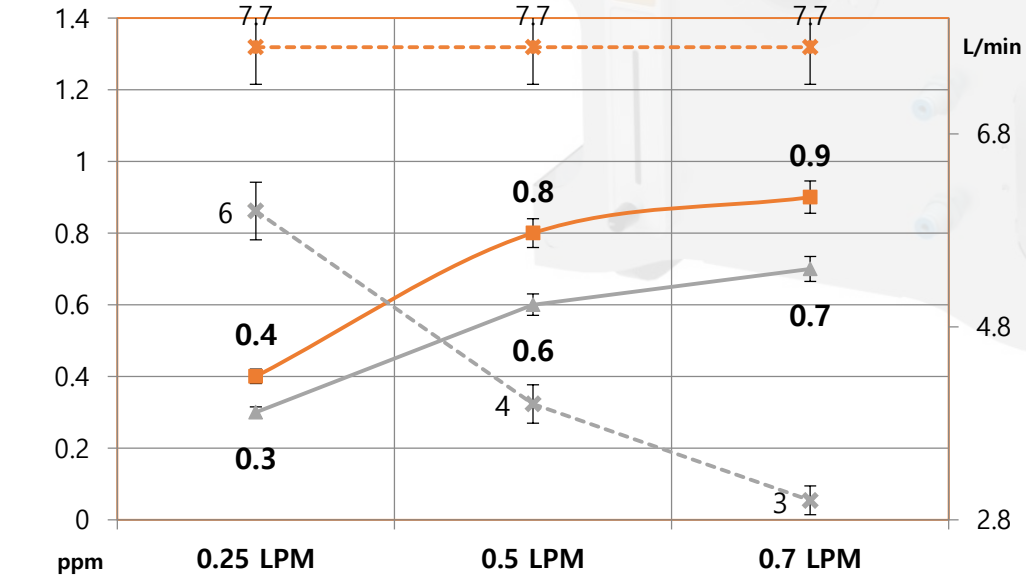
Right side view

5. Gas Dissolution Measurement: FN-XM2 (1/2)

* Tap water quality (Bucheon, South Korea): pH: 7.3 / DO: 8.9 / Water temperature: 19.5~19.8°C
* Pump specifications: SFDP1-040-055-42DC / 12V, 6A (SEAFLO)



* DO Meter: HI 9147-04 (HANNA Instruments)



* Hydrogen analyzer: Detection reagent (Miz company limited-Japan)

* Please note that measured values can vary depending on:
  Water quality, water temperature, pump specifications, operating conditions, etc.

O_2 DO Concentration

DO 8.9

- **DO 35** (4.4 L/min) — (1LPM, Injection before pump)
- **DO 33** (7.7 L/min) — (1LPM, Injection into device)

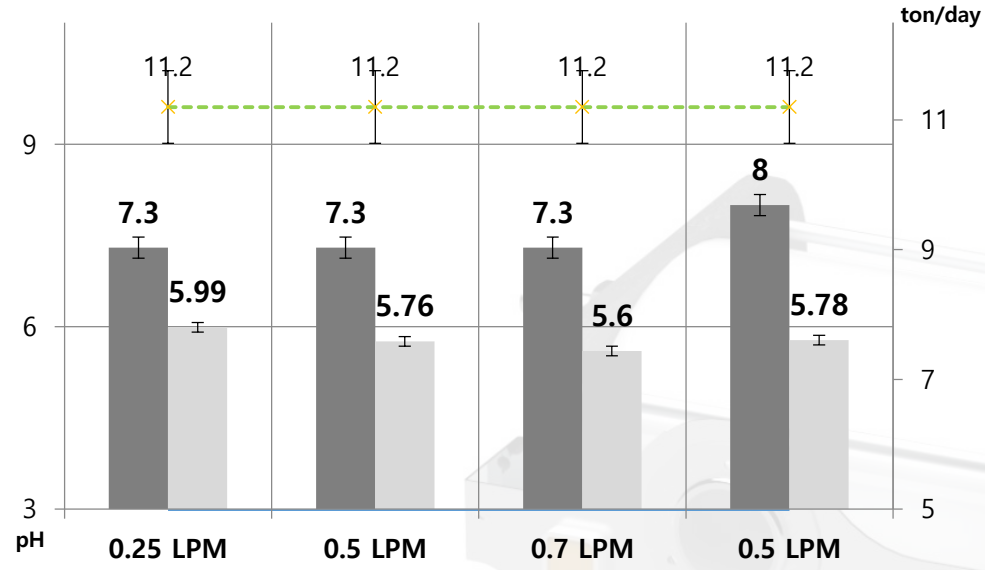
H_2 H_2 Concentration

0 ppm

- **0.7 ppm** (3L/min) — (0.7LPM, Injection before pump)
- **0.9 ppm** (7.7 L/min) — (0.7LPM, Injection into device)

5. Gas Dissolution Measurement: FN-XM2 (2/2)

* Tap water quality (Bucheon, South Korea): pH: 7.3 / DO: 8.9 / Water temperature: 19.5~19.8°C
* Pump specifications: SFDP1-040-055-42DC / 12V, 6A (SEAFLO)



Before: Initial State (pH)

After: CO2 Injection into device (pH)

Flow rate (ton/day)

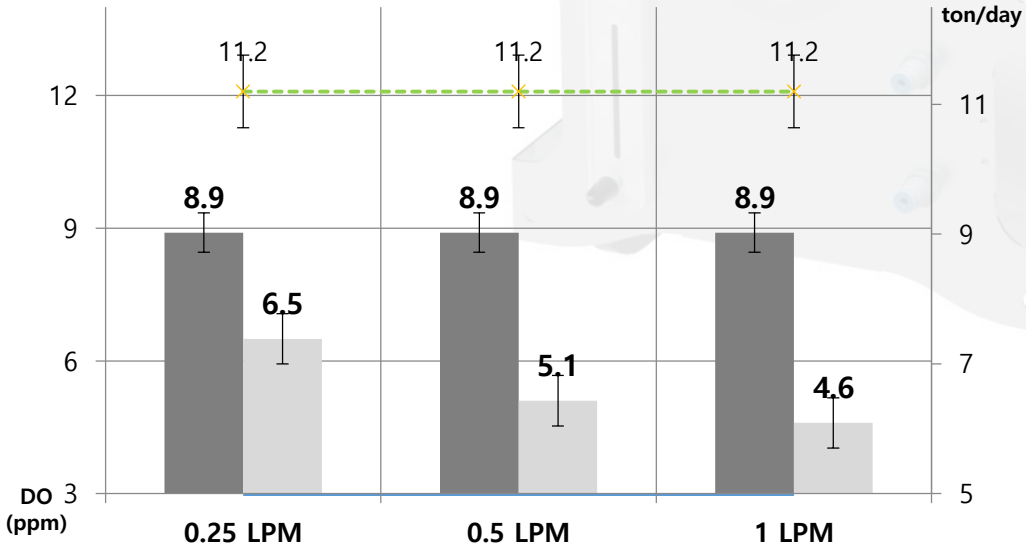
CO_2

pH decrease

pH 7.3 → **pH 5.76** (0.5LPM, Injection into device)

pH 8.0 → **pH 5.78** (0.5LPM, Injection into device)

* pH Meter: pH Testr30 (OAKTON Instruments)



Before: Initial State (DO)

After: N2 Injection into device (DO)

Flow rate (ton/day)

N_2

DO decrease

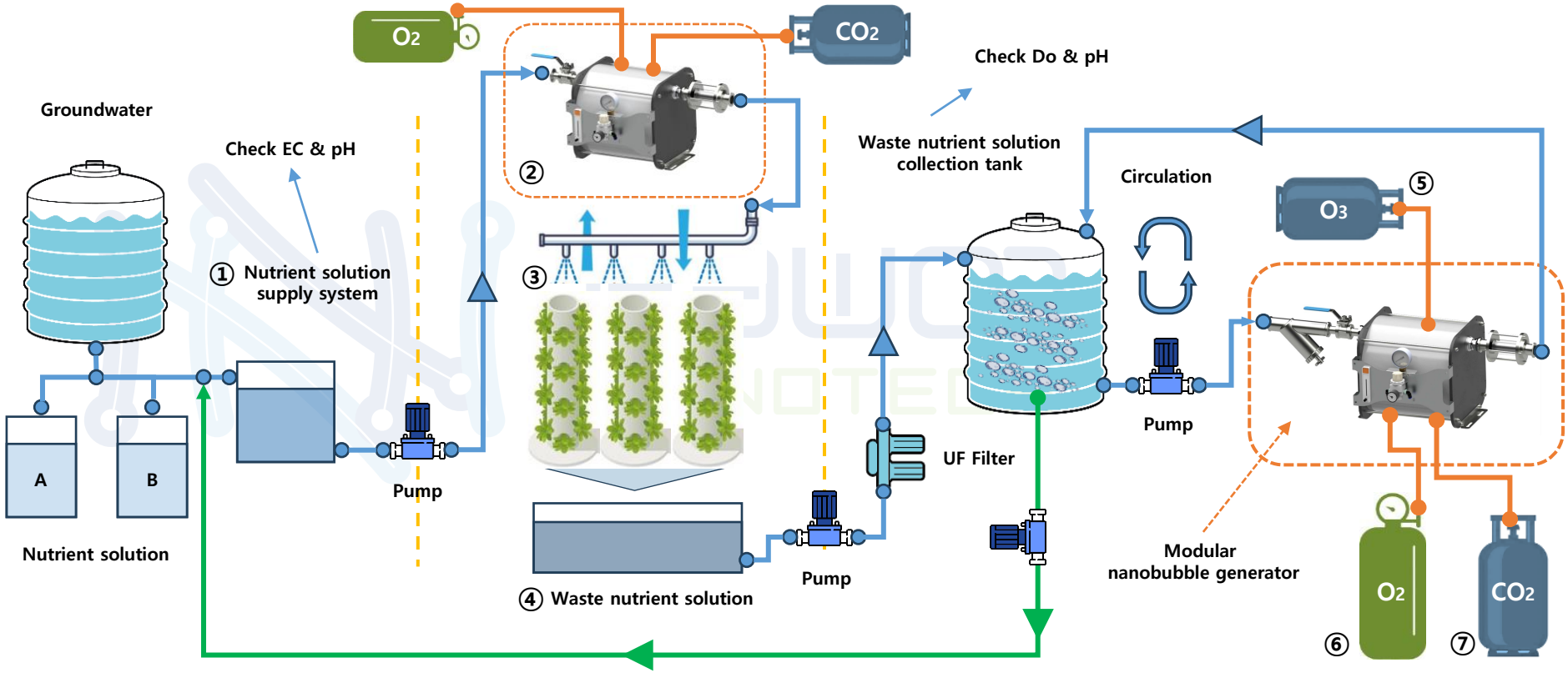
DO 8.9 → **DO 6.5** (0.25LPM, Injection into device)

DO 8.9 → **DO 4.6** (1LPM, Injection into device)

* DO Meter: HI 9147-04 (HANNA Instruments)

* Please note that measured values can vary depending on:
  Water quality, water temperature, pump specifications, operating conditions, etc.

6. Application Method (1/2) – Recirculating Hydroponics



① Groundwater, nutrient solution A, and nutrient solution B are mixed, followed by verification of nutrient solution concentration (EC) and pH.

② Oxygen and carbon dioxide injection **increases dissolved oxygen (DO)** for crop growth and **regulates / stabilizes pH** (5.5~6.5).

③ Nutrient solution is supplied via methods like drip irrigation and aeroponics.

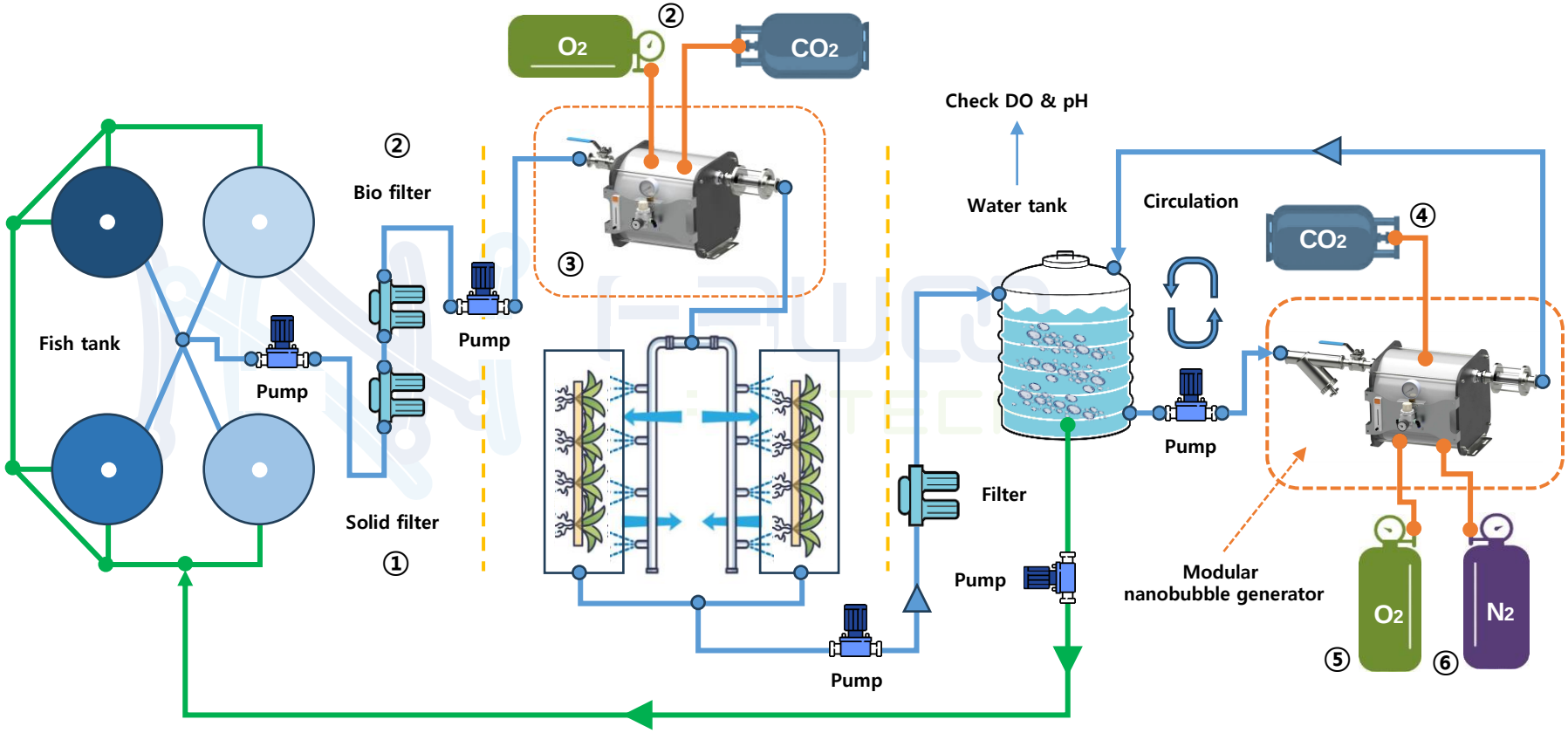
④ Waste nutrient solution, discharged after crop absorption during growth stages, is filtered by a UF filter and stored in a collection tank.

⑤ **Hazardous substances** in waste nutrient solution are **removed** using nanobubble **ozonated** water (pathogen inactivation, algae, odor).

⑥ Nanobubble **oxygenated** water **increases dissolved oxygen (DO)** and **promotes crop growth**.

⑦ Nanobubble **carbonated** water **decreases pH**, **improving nutrient absorption efficiency**, thereby enhancing environmental protection and recycling efficiency.

6. Application Method (2/2) – Aquaponics



① & ② Remove fish waste and other suspended solids through a solid filter. Convert harmful nitrogen compounds into nitrates using a bio filter.

③ Oxygen and carbon dioxide injection can **increase DO** necessary for crop growth, and enable **pH control and stabilization** (pH 5.5~6.5).

④ Using nanobubble **CO2** water **lowers pH** (to be checked alongside item ⑤/⑥).

- Concentration verification for each fish species is required (pH 6.0~7.0).

⑤ Utilize nanobubble **oxygen** water to **raise DO**; mandatory DO verification prior to fish tank water supply (to be checked alongside item ⑥).

⑥ Utilize nanobubble **nitrogen** water to **decrease DO**; mandatory DO verification prior to fish tank water supply (to be checked alongside item ⑤).

Redefine the Future:

Small yet Potent, Nanobubble Technology

Fawoo
NANOTECH

Fawoo
Nanobubble Generator

Large Capacity, Real-Time
Nanobubble Water Generation

High-Quality and High-Density Nanobubbles

Carbon Dioxide Massive Dissolution / Ozone Water
Hydrogen Nanobubble Water / Degassed Water

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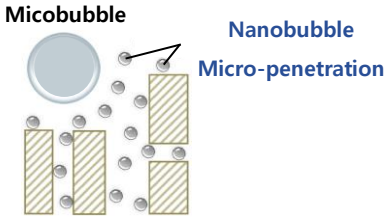
Types of Bubbles (1/2)

* **Bubble**

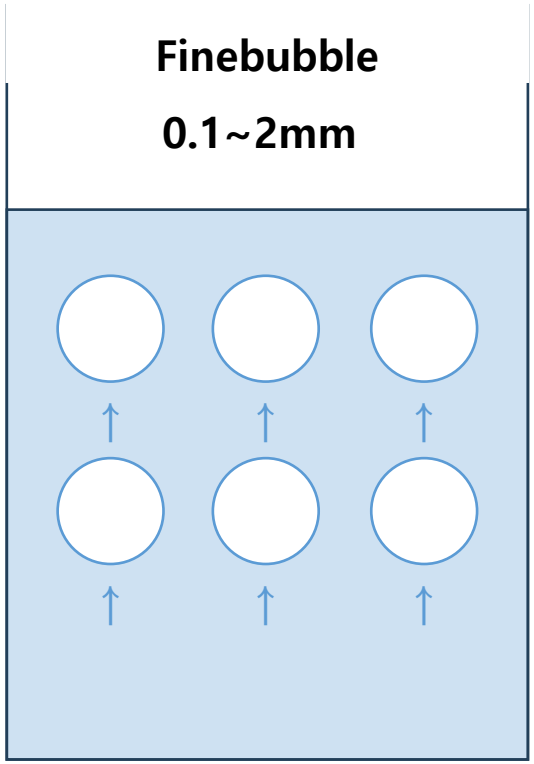
: A spherical space where gas is trapped within water.



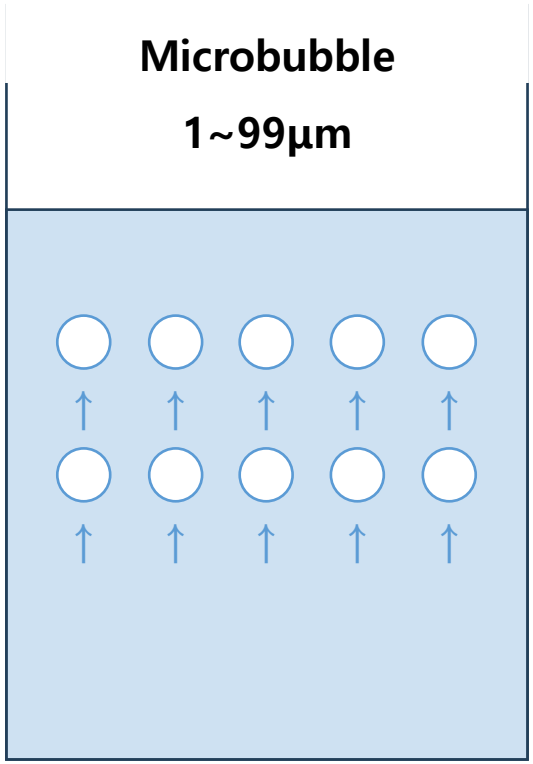
Wide, uniform gas (air) distribution

Efficient aeration (movement) possible

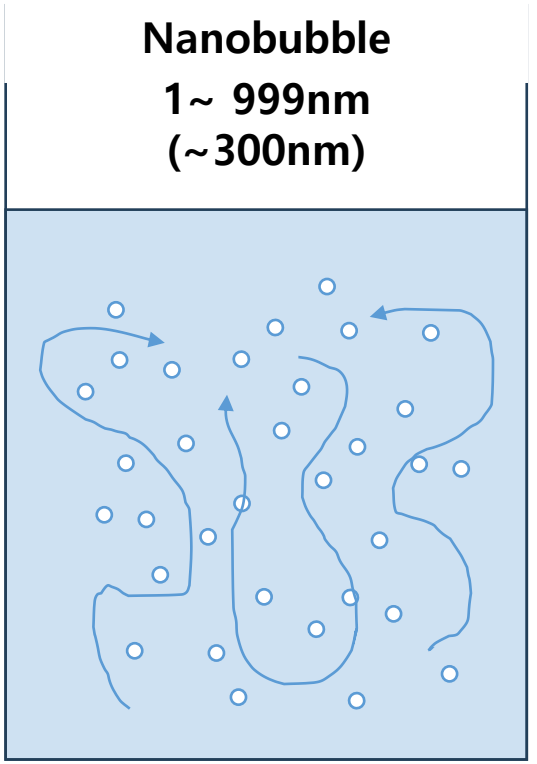
Long-lasting effect



Rise / Burst at the surface



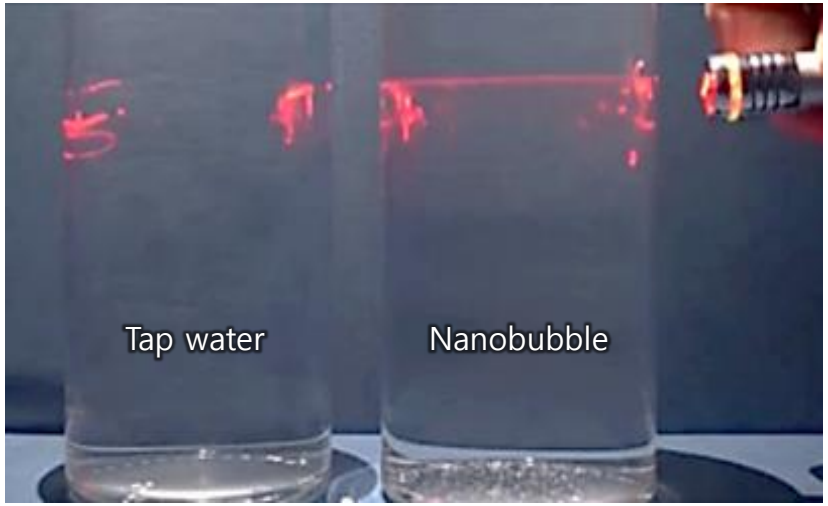
Rise slowly / Burst at the surface



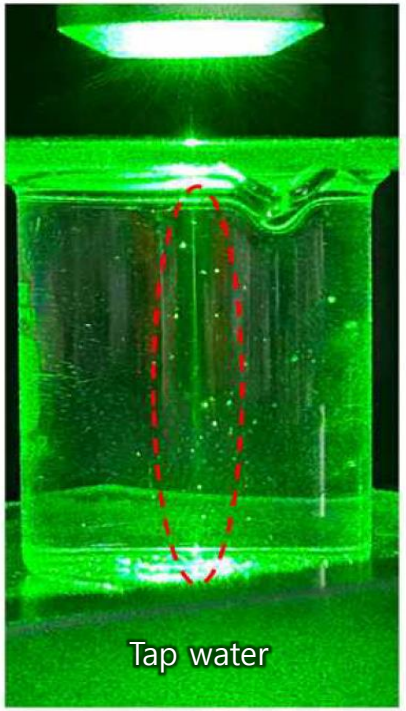
Brownian motion /

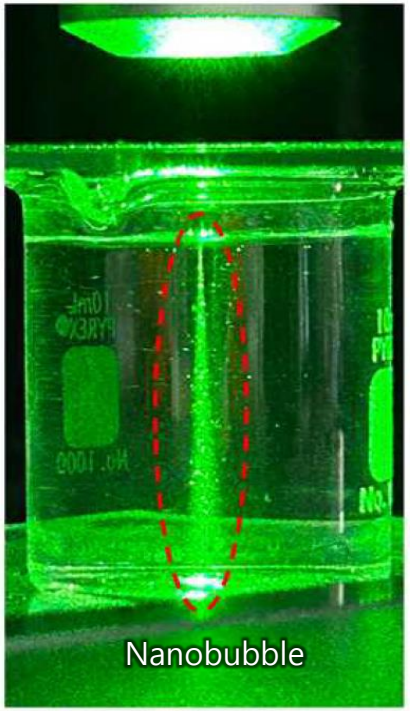
Random movement throughout the water

Types of Bubbles
(2/2)



Scattering is visible to the naked eye after laser (532nm, 488nm) irradiation.





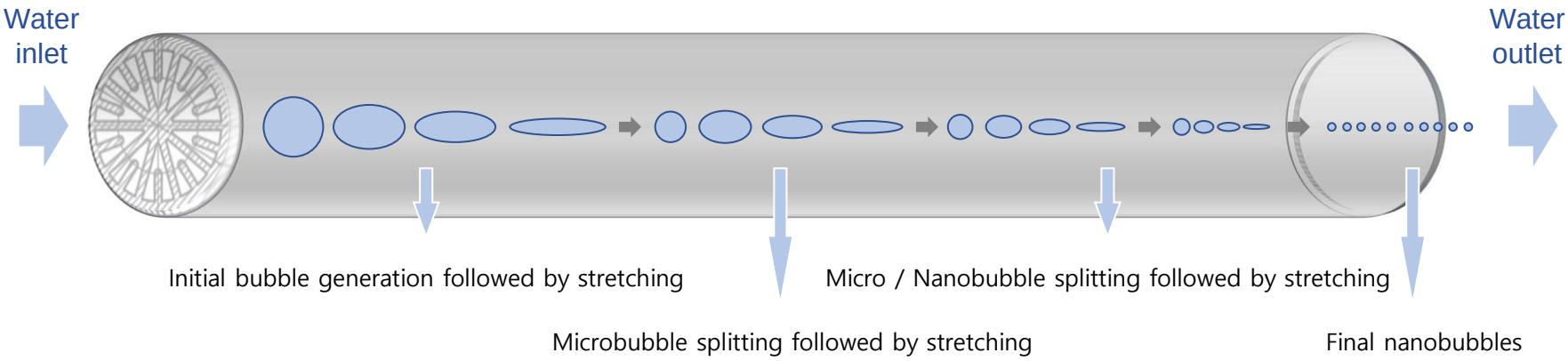
Korea Institute of Civil Engineering and Building Technology (KICT)

Generated using a Fawoo Nanotech's device

Nanobubble Generation Principle – Fluid Path Member Using Friction

Fluid path surface friction

(International application number: PCT / KR2020 / 004646)



Completed in 18 countries

including Korea, Japan, and Canada

(Under examination in the US, EU, etc.)

Patent protection

Capable of international response

Nanobubble Measurement – Fluid Path Member Using Friction

Published on the international preprint server arXiv

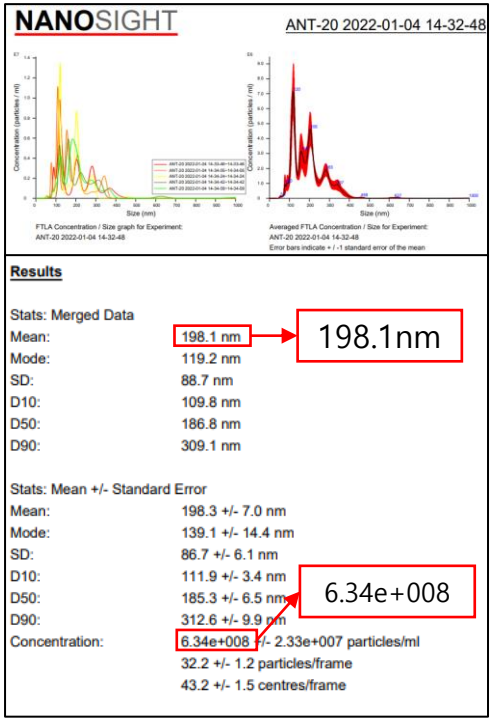
'Generation of high concentration nanobubbles based on friction tubes' (Oct. 24, 2023)

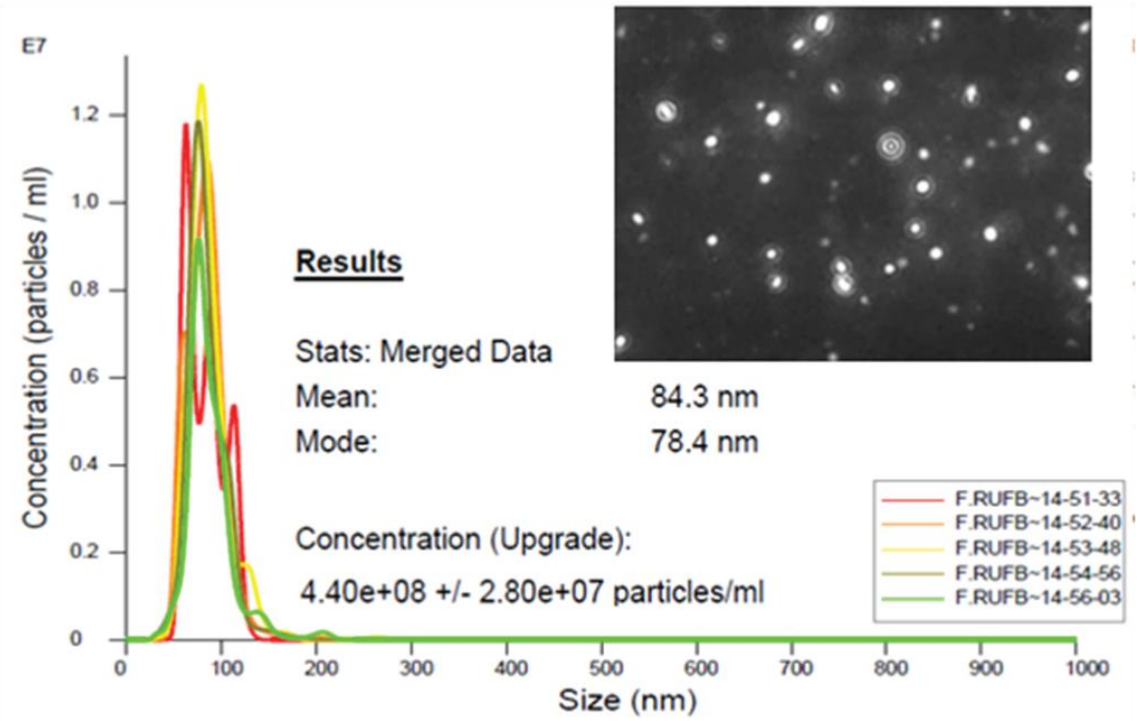
Nanoparticle measurement:
Nanosight LM-10 / NS300 (Malvern Panalytical, UK)

- **Number concentration:**

  Approximately 200~600 million particles/ml (up to 5.6 billion)

- **Average size: Under 150nm**





Company Introduction (1/2)
– Company Overview, Core Technology, Partner Company & Key Products

Company Overview

Fawoo Nanotech Co., Ltd.

- Establishment date: Mar. 2020 (Bucheon-si, Gyeonggi-do)
- Number of employees: 9
- Capital stock: 1.15 Billion KRW
- Technology business evaluation grade: A+ (Nov. 2022)

Core Technology

Owns original patent technology for nanobubble generation using surface friction

- Generates real-time / large-volume nanobubble water (world's only)
  - Average size: Approximately **150nm**
  - Number concentration: Approximately **200~600 million/ml** (**up to 5.6 billion**)
- Absolute superiority in quality, production volume, and cost-effectiveness compared to competitors.
  - Energy saving and durability secured
- Korea: 13 patents filed, 6 registered
- International: 3 patents filed in 32 countries including the US, Japan, and EU
  2 patents registered in 18 countries.

SURFACE FRICTION TECHNOLOGY®

Partner Company

Selected as a 'Cooperative Startup' by K-water (Oct. 2023)

- Joint product development, provision of demonstration sites, planned launch under a joint brand with K-water.

K-water Cooperative startup 협력스타트업

Key Products

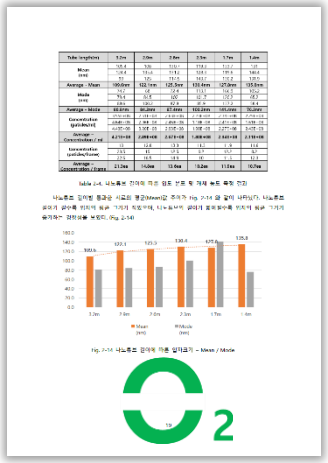
B2B industrial nanobubble generators & B2C household application products

- B2B: Applicable to **CCU (Carbon Capture and Utilization)** as a chemical catalyst, and various other industries.
- B2C: Nanobubble shower hose, built-in / external modules (**no power required**)

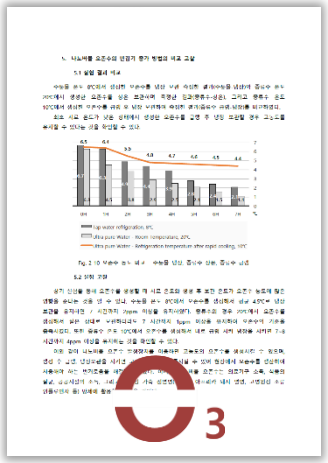
Company Introduction (2/2)
– Published 5 papers in international academic journals

Published 5 demonstration papers based on surface friction original patent technology

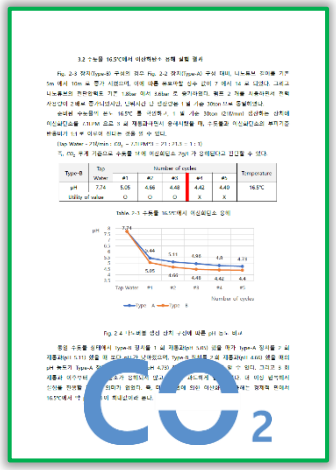
1. Generation of high concentration nanobubbles based on friction tubes
2. Friction tubes to generate nanobubble ozone water with an increased half-life for virucidal activity
3. Nanobubble-based carbon dioxide massive dissolution using friction tubes and real time reaction
4. A study on the generation of hydrogen nanobubble water and the increase in solubility using friction method
5. A study on the deaeration effect of N2 nanobubbles using friction tube



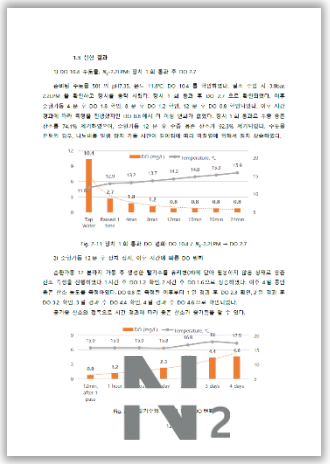
Increased gas solubility



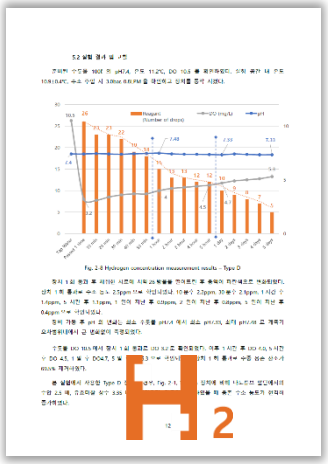
Increased
ozone water half-life



Large-scale
CO_2 dissolution



Nitrogen nanobubble
degassing effect



Increased hydrogen
nanobubble solubility

Published on 'arXiv' (2 papers) and 'Research Square' (3 papers):
1 paper on nanobubble generation principle, 4 demonstration papers by gas type

Company History

Currently pursuing collaborations in various eco-friendly chemical and energy fields by leveraging Fawoo's original nanobubble technology

Established in Mar. 2020

- ❖ Venture company
- ❖ Excellent technology evaluation company (NICE, KIBO)
- ❖ Owns a corporate-affiliated research institute
- ❖ K-water cooperative startup

2019

- Completed production of industrial large-capacity NBG for each field
- Joined Daegu national water industry cluster
- **Completed development of industrial NanoBubble Generator**

2020

- COVID-19 / influenza A inactivation test
- Creative Innovation Award in K-Quarantine Expo 2020
- Industrial FNT-203 KC certification acquired
- • Safety test after spraying NB O3 water
- • NB O3 water skin irritation primary test
- **Fluid path friction method patent**
- • 2 domestic patents registered
- • 3 PCT applications
- • Including US, Japan, and EU
- • Currently proceeding with applications in 33 countries (nanotubes)

2021

- • Registration of agricultural materials
- • Government support project
- Developed NB hydrogen water device
- • Clinical trial skin improvement effect verification (KTR)
- • Verification of cleaning and alkali effect (KATRI)
- Industrial SNT KC certification acquired
- • Developed a household shower hose
- • Developed 2 types of small industrial nanobubble generators (SNT)

2022

- Development of ultra-large capacity products (10,000 tons or more)
- Automatic bathing system incorporating NanoHose (Daewon Inmul Co., Ltd.)
- **Rotational friction method patent**
- Applied for in 16 countries
- Registered agricultural machinery and established a sales company
- • Lake / river purification demonstration project
- • Development of CCU application technology
- **Established a corporate-affiliated research institute**

2023

- **5 papers published on arXiv**
- CO_2 capture test (won bid and delivered to Company P)
- **Selected as a K-water cooperative startup**
- Successful test production of sodium bicarbonate from Sox removal wastewater (P/H/T Group)
- **NanoTube insert patent application** (16 countries)
- **Domestic patent application for large-scale gas dissolution**

2024

- **Participation in CCU Mega Project (hosted by Ministry of Science and Technology)**
- **Successful CO_2 concrete experiment (KICT)**
- Pipe scale removal experiment (Apr.: S Corp. / Aug.: P Corp.)
- Development of wastewater treatment / purification system

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Fawoo Nanotech Co., Ltd.

Product Name
: **Nanobubble Generator**

Product Category
: **Sustainability & Energy/Power**