NAKASHIMA
Fine Bubbles

Dev & Mfr : NAKASHIMA & Co., Ltd.

Cornerstone technology for optimizing fish health and growth

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The Mechanisms of Eutrophication

DO Management in Aquaculture

Dissolved oxygen (DO) is the gaseous oxygen dissolved in water and is an important indicator of the oxygen needs of aquatic organisms.
When DO falls below 5-6 mg/L in freshwater, oxygen levels required by aquatic organisms are reduced resulting in hypoxic conditions. Stress from high ammonia, nitrite toxicity, low dissolved oxygen, high carbon dioxide and other water quality problems can prevent fish from eating adequately and cause significant yield reductions. Dissolved oxygen levels of 1-2 mg/L can adversely affect fish growth and even cause death. In addition, hypoxia can severely affect the physiological and immune responses of fish making them more susceptible to disease.
Therefore, in modern aquaculture production systems where fish are released in concentrated high densities, attention must be paid to DO levels to prevent disease outbreaks.

Key factors affecting water quality

Temperature

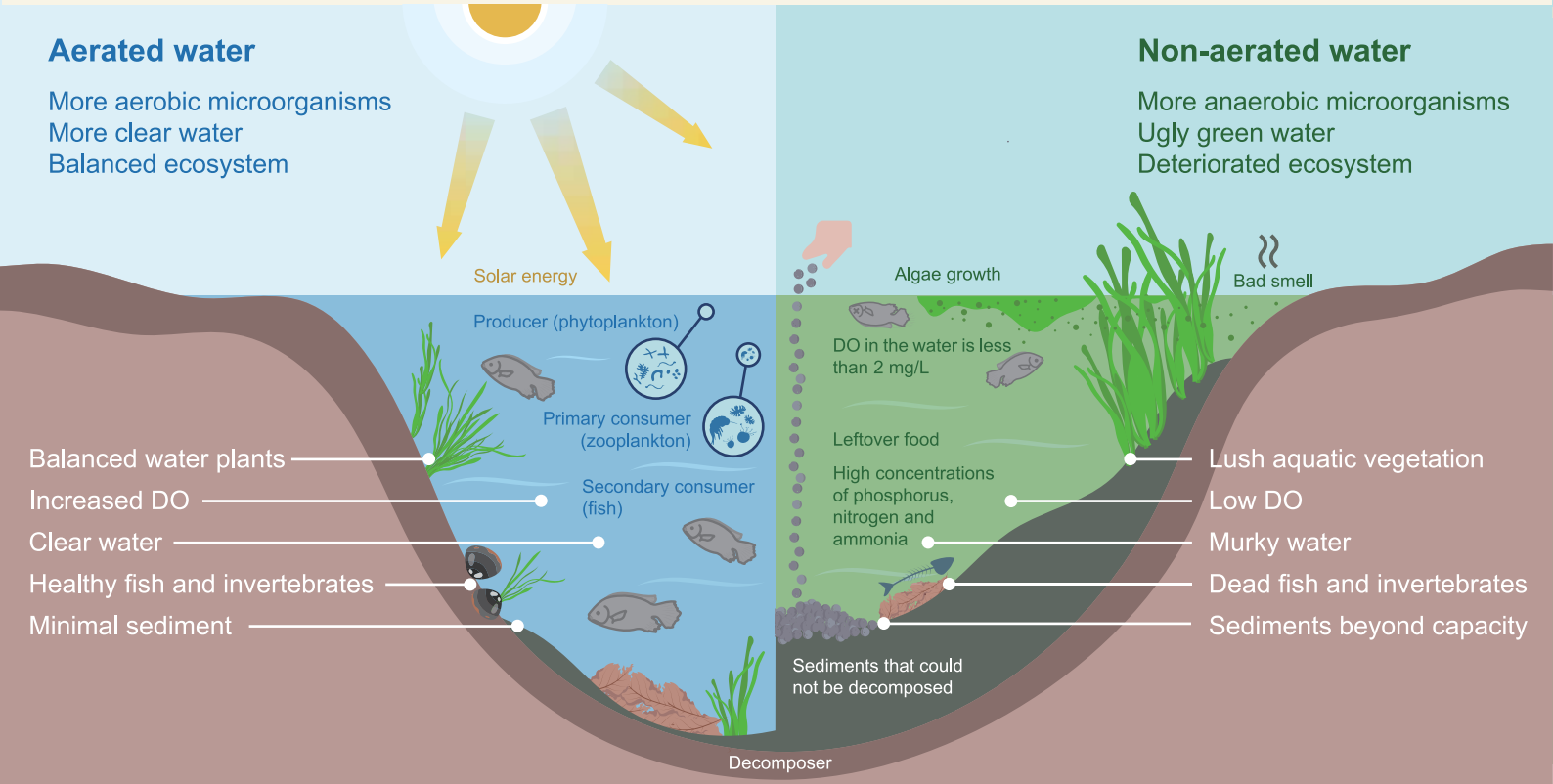
Fish use twice as much dissolved oxygen at 30°C than at 20°C, so DO management is more important in warm summer water than in cold winter water.

Plankton

Plankton is at the bottom of the plant chain and is responsible not only for promoting fish growth but also for clouding the water and preventing the growth of undesirable aquatic plants.

Dissolved Oxygen

DO is the most important water quality parameter in cultured fish. Photosynthesis by phytoplankton is the primary source of dissolved oxygen in cultured fish.



What Are Fine Bubbles in Aquaculture?

Fine bubbles are microscopic bubbles with a diameter of less than 100μm. In the aquaculture industry, they have evolved beyond mere "bubbles" to become a cornerstone technology for optimizing fish health and growth while creating an ideal rearing environment.
The three primary advantages are as follows:

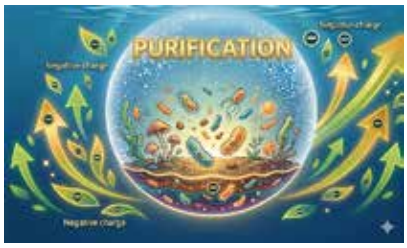
Superior Oxygen Retention

Fine bubbles (FB) fundamentally transform how we combat hypoxia, the most critical risk in aquaculture. Unlike conventional aeration, where large bubbles quickly escape to the surface, these microscopic bubbles remain suspended for extended periods. This results in exceptionally high oxygen dissolution efficiency ensuring stable dissolved oxygen levels even in high-density environments. By eliminating oxygen-depleted zones, FB provides a secure and reliable foundation for intensive fish farming.

Enhanced Growth and Yield

By stimulating fish metabolism, fine bubbles naturally boost appetite and ensure that feed is efficiently converted into quality muscle and fat. This optimization significantly shortens the cultivation period required to reach market size improving farm turnover. Furthermore, maintaining a stable, low-stress environment strengthens natural resistance to disease. This leads to significantly higher survival rates and superior yields directly enhancing the overall profitability and sustainability of the operation.

Water Quality Improvement



Ensuring oxygen reaches the tank bottom activates aerobic microorganisms, which suppresses the buildup of sludge and harmful ammonia from waste. Additionally, because these bubbles carry a negative electrical charge, they attract positively charged impurities and float them to the surface for easy removal. This dual action of deep oxygenation and physical purification maintains a pristine environment, reduces the need for water changes, and ensures long-term ecosystem health.

Improving Shrimp Farming Efficiency via FB

This report summarizes the demonstration data from Go Cong District, Tien Giang Province regarding the improvement of farming efficiency and profitability through the introduction of Fine Bubbles (FB).

Location : Go Cong District, Tien Giang Province, Vietnam
Setup : Four test ponds (Area: 10 ×10m^2, Depth: 1.5m)

Test Configurations:

Paddlewheel only (Control)

Paddlewheel + FB (Fine Bubble)

Paddlewheel + FB + Blower

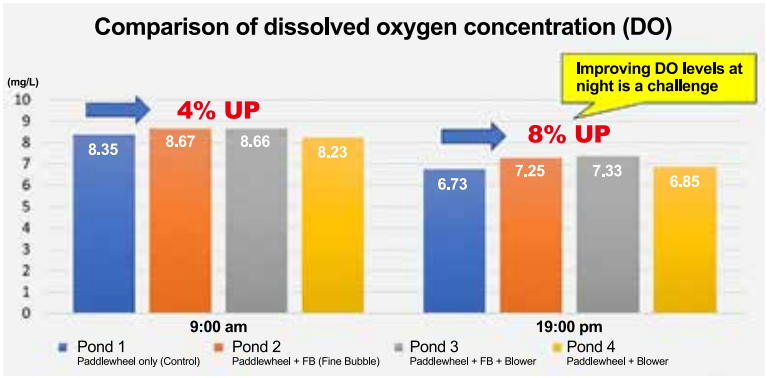
Paddlewheel + Blower

Effects on Growth and Water Quality

Ponds equipped with FB technology showed significant improvements compared to the standard paddle wheel-only environment.

Harvest Weight (Day 101) : Setting Pond 1 (Control) as 100%, Pond 2 (FB) reached 151% and Pond 3 (FB + Blower) reached 148%.

Note: Pond 4 (Blower only) plummeted to 27% due to disease outbreak boosted DO levels by up to 43%.



Dissolved Oxygen (DO) Levels: FB ponds maintained the highest DO levels in both morning and evening (4% to 8% higher than the control).

Using an Oxygen Concentrator (O_2-PSA) further boosted DO levels by up to 43%.

Economic Simulation (Based on 2 Ponds of 1,400m^2)

The introduction of FB (Fine Bubble) technology improves survival rates and feed efficiency leading to a substantial increase in profit.

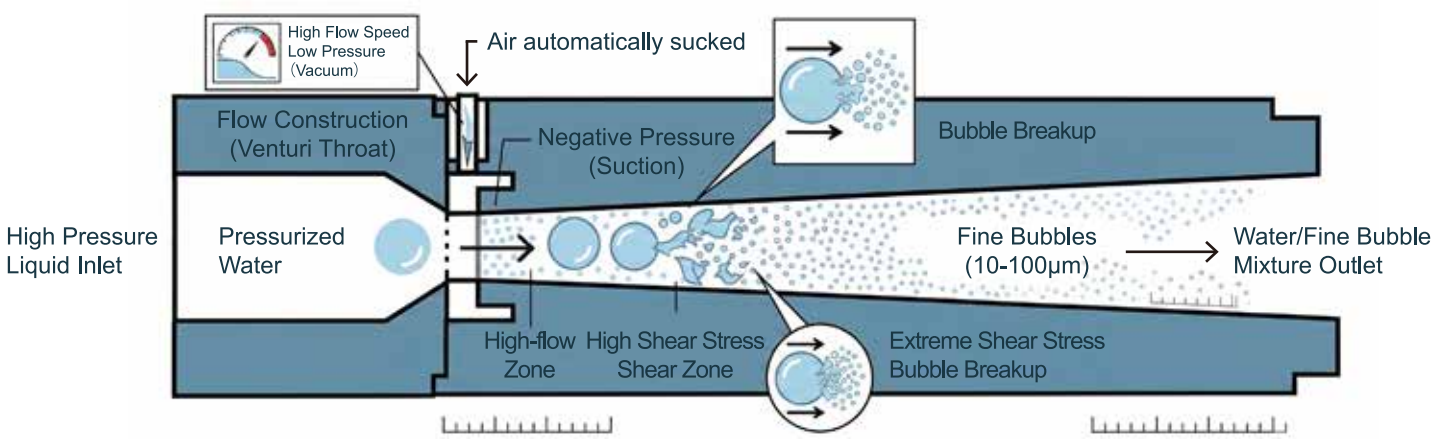
Item	Without FB	With FB	IMPROVE
Survival Rate	70%	92%	+22%
Feed Conversion Ratio	1.4	1.3	Improved
Total Harvest Volume	7.8 tons	10.3 tons	32% UP
Gross Profit (JPY)	2,365,000	3,502,000	48% UP

Conclusion

Implementing FB technology stabilizes dissolved oxygen levels significantly increasing shrimp survival rates and reducing disease risks. This results in a high economic impact with a 48% increase in gross profit +267,195 THB (+1,137,000 JPY).

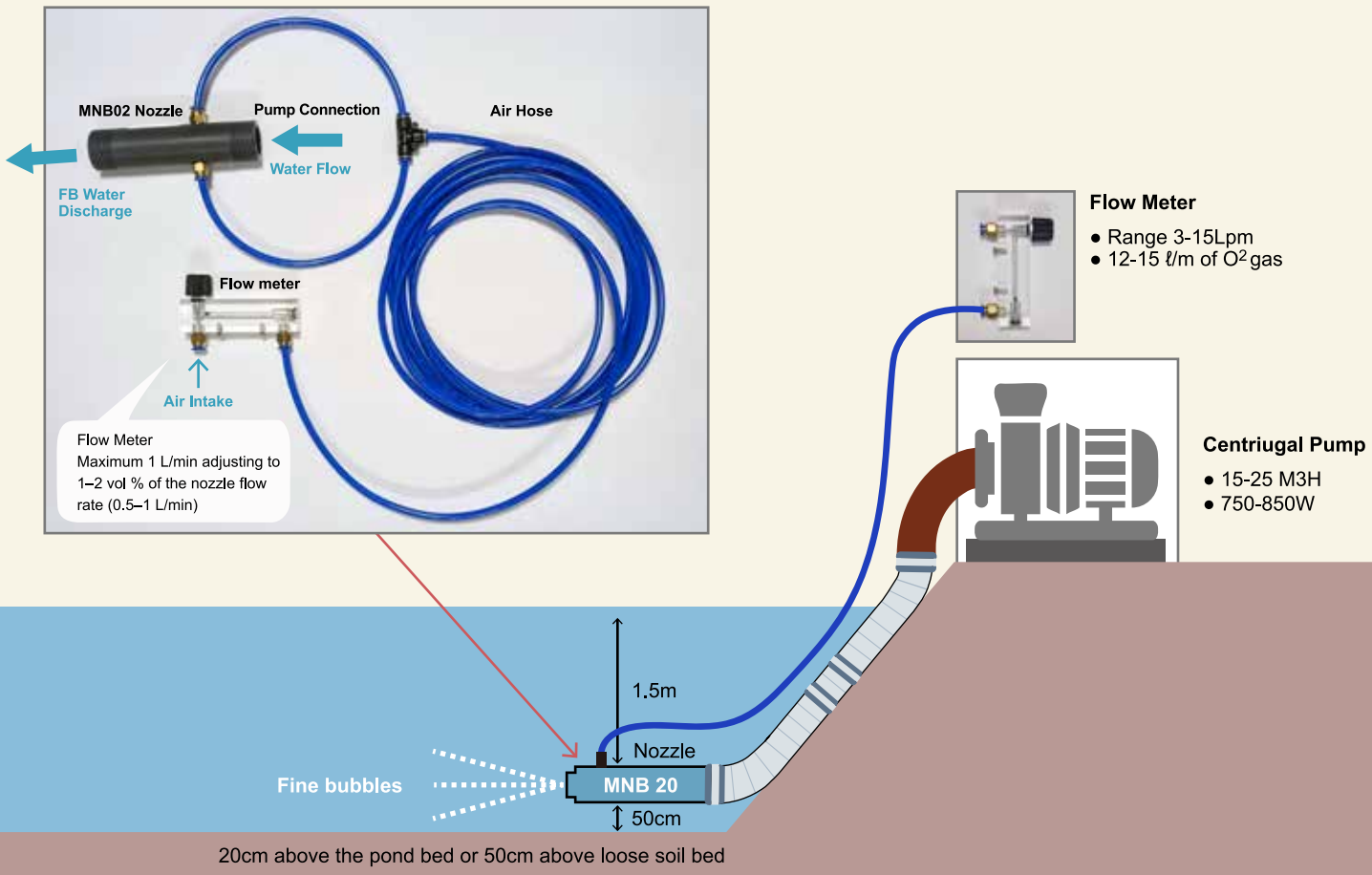
Mechanism

The Nakashima's FB Series utilizes a specialized venturi structure to automatically ingest and disperse gas making microbubble generation simpler than ever. When liquid enters the nozzle, the narrow internal passage forces the fluid to speed up generating a powerful suction effect. This negative pressure pulls gas into the stream, where the extreme shear stress of the high-speed flow instantly shatters it into fine microbubbles.



Installation Example

Use a land-based centrifugal pump and connect it to the FB nozzle via pipes or hoses. Ensure the nozzle is kept at a height of 20–50 cm from the bottom rather than resting directly on it.



Water purification environment using Biofloc

Utilizing fine bubbles to optimize the Biofloc Technology (BFT) environment is a highly logical approach in closed-loop aquaculture.
Biofloc is a groundbreaking system in which microbial communities (such as bacteria and protozoa) form flocs (clumps) that purify ammonia and other substances in the culture water while simultaneously serving as a food source. This is where “high-density oxygen supply” becomes crucial, and fine bubbles play a key role.

Chinese FB Ammonia Data

P1	
T1	2.0
T2	2.0
T3	2.0
T4	
T5	2.0
T6	
T7	4.0
T8	4.0
T9	2.0
T10	0.0
T11	1.0
T12	4.0
T13	
T14	1.0
T15	4.0
T16	4.0
T17	
T18	1.0
T19	4.0
T20	4.0
T21	4.0
Ave.	**2.65**

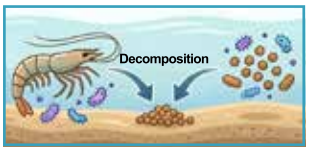
※8-Point Scale

Nakashima FB Ammonia Data

P1	1.0
T1	1.0
T2	2.0
T3	2.0
T4	
T5	0.5
T6	0.5
T7	
T8	1.0
T9	0.5
T10	1.0
T11	0.5
T12	
T13	
T14	2.0
T15	1.0
T16	
T17	1.0
T18	0.3
T19	
T20	
T21	0.0
Ave.	**0.95**

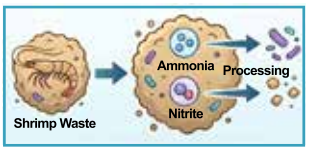
IR **-64%**

The Biofloc method is an innovattive aquaculture practice that minimizes chemical use and manages water quality through the symbiosis of microorganisms.



Decompose waste and residual feed from shrimp using microorganisms.

Form dense microbial aggregates known as “Bioflocs”.



Process nitrogenous compounds (ammonia, nitrite) from Shrimp waste using the biofloc.

Optimizing the aquaculture environment while significantly reducing water exchange frequency.

Key benefits of biofloc aquaculture

Benefits	Details
Water Quality Improvement	Microorganisms break down harmful substances such as ammonia, stabilizing water quality.
Minimizing Water Changes	In principle, water changes are rarely required cutting water usage by over 90%.
Feed Efficiency	Since the floc itself serves as food for the shrimp, feeding efficiency can be improved.
Disease Prevention	Beneficial microorganisms suppress the growth of harmful bacteria reducing the risk of disease
Reduced Environmental Impact	Minimal wastewater discharge lowers the risk of marine pollution
Utilization of Byproducts	Flocs are highly nutritious and can be used for other fish species

Size Uniformity in Improving FCR

In aquaculture management, achieving Uniformity among post-larvae shrimp is essential for optimizing the Feed Conversion Ratio (FCR). When shrimp sizes are consistent, the following four mechanisms maximize feed efficiency:

1. Reduced Competition and Stress

- **Suppression of Hierarchical Stress**: Significant size variations lead to dominance by larger individuals, which prevents smaller shrimp from accessing feed.
- **Efficient Energy Allocation**: Uniform sizing ensures equal access to feed reducing energy wasted on "fighting" or "escaping" and directing those calories toward growth instead.

2. Precision Feed Management

- **Optimal Pellet Size**: Feed is designed for specific mouth sizes. Uniformity ensures all individuals can consume the pellets efficiently preventing feed disintegration and water pollution caused by uneaten fragments.
- **Accurate Biomass Calculation**: A uniform population allows for more precise estimation of total biomass preventing both overfeeding and underfeeding.

3. Synchronized Molting and Higher Survival Rates

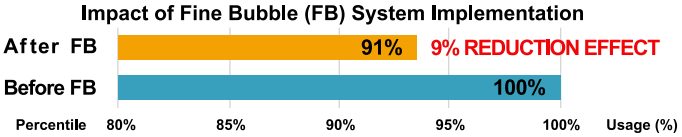
- **Prevention of Cannibalism**: In non-uniform environments, larger shrimp often prey on smaller individuals during their vulnerable post-molting stage.
- **Maximizing Harvestable Weight**: Synchronized molting cycles reduce losses to cannibalism ensuring that the feed provided translates directly into survival and total harvest weight.

4. Optimized Metabolic Efficiency

- **Synchronized Nutritional Intake**: A uniform population shares similar metabolic rates allowing the entire group to utilize the protein and energy in the feed at peak efficiency simultaneously.

Impact of Fine Bubble (FB) Technology

Switching from conventional blowers to FB nozzles facilitates the following measurable improvements:



Size Uniformity:
While standard blowers result in significant size variation, FB produces smaller bubbles that do not interfere with the shrimp's feeding allowing 80.0% of individuals to reach a uniform, ideal size (2g / approx. 7cm).

FCR Reduction:
Uniform growth allows for optimized feeding resulting in a 9% reduction in FCR lowering it from 1.5 to 1.37.

Item	Conventional	After FB Intro	Effect
Size Uniformity (2g)	50%	80%	Suppresses growth variation
FCR (Feed Conversion Ratio)	1.50	1.37	9% cost reduction
DO Value (Dissolved Oxygen)	4.0ppm	8.5 ppm	Over 2× oxygen levels
Overall Growth Rate	Standard	+20%	Enhanced productivity

Specification

The nozzles are available in two types: SUS316L and PVC.

Model		MNB02	MNB06	MNB10	MNB20	MNB30
Generation Method		Shear	Shear	Shear	Shear	Shear
Total Length (mm)		133	177	198	216	214
Flow Rate	(m^3/h)	2	6	10	20	30
	(ℓ/min)	33	100	166	333	500
Pump Output (W)		100-120	100-250	400-750	750-1500	1500-2200
Connection Dia.		25A	32A	40A	40A	50A
		(34.0mm)	(42.7mm)	(48.6mm)	(48.6mm)	(60.0mm)
		3/4B	1*1/2 B	1*1/2 B	1*1/2 B	2*1/2 B
Water Volume		~30m^3	~100m^3	~150m^3	~300m^3	~500m^3