

# Advanced Oxygenation in Aquaculture Systems



## Overview

Efficient oxygenation is a critical parameter governing aquatic health, biological activity, and system productivity. Conventional aeration systems often fail to maintain stable dissolved oxygen (DO) levels, leading to stress, inefficiencies, and operational challenges.

This case study, conducted in collaboration with the Kerala University of Fisheries and Ocean Studies (KUFOS), evaluates the effectiveness of NICO Nanobubble Oxygen (NB-O<sub>2</sub>) technology in delivering rapid, stable, and sustained oxygenation under controlled aquaculture conditions.

## Project Details

- **Institution:** Kerala University of Fisheries and Ocean Studies (KUFOS)
- **Application:** Aquaculture Oxygenation (Tilapia Culture)
- **Technology:** NICO Nanobubble Oxygen (NB-O<sub>2</sub>) System
- **Study Duration:** 3 Months
- **Comparison:** Conventional Aeration vs NB-O<sub>2</sub> Treatment



## Significance of Dissolved Oxygen Stability

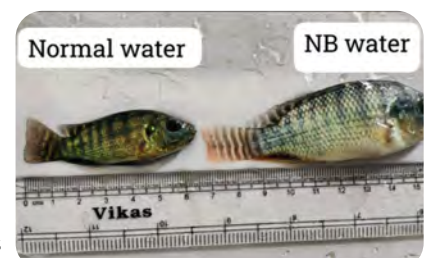
- Dissolved oxygen (DO) directly governs biological performance, with optimal systems requiring >5–6 mg/L for stability and >8 mg/L for high-efficiency operation
- Low DO levels (<3 mg/L) can lead to stress, reduced metabolic activity, and up to 30–50% productivity loss in biological systems
- Fluctuating DO conditions increase mortality risks and system instability, especially during peak load or nighttime conditions
- Poor oxygen availability promotes accumulation of toxic by-products such as ammonia (NH<sub>3</sub>) and organic intermediates
- Conventional aeration systems typically exhibit low oxygen transfer efficiency (OTE ~10–30%), resulting in significant gas loss
- Oxygen supplied through coarse bubbles is often lost within seconds, leading to inefficient utilization (<20–40%)
- Non-uniform oxygen distribution creates localized anaerobic zones, affecting up to 20–40% of the effective treatment volume
- Continuous aeration results in high energy consumption (up to 50–70% of total operational cost) in aeration-driven systems
- Efficient oxygenation systems can maintain DO stability for several hours (6–8 hrs), reducing the need for continuous operation
- Improved oxygen availability enhances biological efficiency, nutrient conversion, and overall system productivity by 20–60%

## NICO Nanobubble Solution

The NICO nanobubble oxygenation system was utilized in the study to generate ultra-fine oxygen bubbles (<200 nm), enabling efficient gas transfer and sustained oxygen availability within the system.

Key operational features:

- **Rapid Oxygen Infusion:** DO levels increased to ~15 ppm within 10 minutes
- **Peak Oxygenation:** Initial DO peaks reached up to 20 ppm
- **Extended Stability:** DO maintained at ~6 ppm for up to 8 hours
- **Optimized Operation:** Oxygenation cycles standardized at 10 minutes every 8 hours



Unlike conventional aeration, nanobubbles remain suspended in water, enabling continuous oxygen availability and significantly reducing gas wastage.

### Performance Outcomes

Parameter	Unit	Conventional Aeration	NICO NB-O <sub>2</sub> System
Time to Increase DO	-	Gradual, inefficient	<b>Rapid (10 min to reach ~15 mg/L)</b>
Peak DO Levels	ppm	Limited	<b>Up to 20 ppm</b>
DO Stability	mg/L (duration)	Short-lived	<b>Sustained (~6 mg/L for 8 h)</b>
Oxygen Distribution	-	Non-uniform	<b>Uniform across water column</b>
Aeration Frequency	time cycle	Continuous	<b>Intermittent (10 min / 8 h)</b>
Oxygen Utilization Efficiency	%	Low	<b>High</b>

### Conclusion

The study conclusively demonstrates that NICO's nanobubble technology provides a highly efficient, stable, and energy-optimized oxygenation solution compared to conventional aeration systems. The ability to rapidly elevate dissolved oxygen levels and sustain them over extended periods represents a significant advancement in aquatic system management.