NANOBUBBLE INDIA CO.

Case Study

Enhancing Oxygenation Efficiency and Stability in Aquaculture Using Nanobubble Technology

Overview

Maintaining stable dissolved oxygen (DO) levels is critical for aquaculture productivity, fish health, and system efficiency. Conventional aeration systems often struggle to provide uniform and sustained oxygenation, especially under high stocking densities and dynamic loading conditions.

This case study evaluates the performance of NICO Nanobubble Technology in enhancing dissolved oxygen levels and stability under controlled aquaculture conditions, with comparative assessment against conventional aeration systems.

Project Details

- **Application:** Aquaculture (Shrimp Culture System)
- **Location:** Tamil Nadu, India
- **Infrastructure:** Multiple HDPE-lined culture tanks (~1000 m^3 each)
- **Water Source:** Seawater intake and borewell (clean water trials)
- **Operational Mode:** Recirculation through nanobubble injection system
- **Study Approach:** Comparative evaluation across two experimental setups: conventional aeration (blower + paddle wheel) vs nanobubble-only oxygenation system

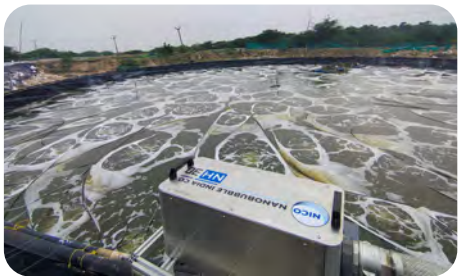
Pre-Implementation Challenges

Prior to optimized nanobubble implementation, the system exhibited several operational challenges:

- Inconsistent dissolved oxygen levels, especially under mixed aeration conditions
- Rapid oxygen loss due to bubble escape and drainage systems
- Interference from conventional aeration (diffusers and paddle wheels) reducing oxygen retention
- Inefficient oxygen utilization, requiring continuous aeration
- Non-uniform oxygen distribution across the culture tank
- Limited ability to sustain high DO levels over extended durations

NICO Nanobubble Solution

The study utilized NICO nanobubble systems configured for oxygen-based operation, designed to generate ultra-fine bubbles (<200 nm) capable of remaining suspended and enhancing oxygen transfer efficiency



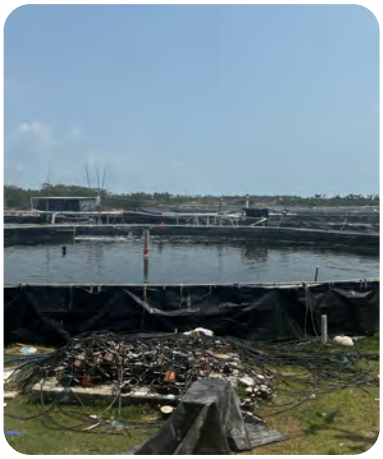
Two configurations were evaluated:
Phase 1: Hybrid System (Nanobubble + Conventional Aeration)
- Nanobubble system integrated with diffusers and paddle wheel aeration
- Observed interference leading to reduced nanobubble longevity

Phase 2: Optimized System (Nanobubble-Only Operation)

- Nanobubble system operated as the sole oxygen source
- Clean water input ensured minimal disturbance and improved bubble stability

Performance Outcomes

Parameter	Unit	Conventional / Hybrid System	Nanobubble-Only System
DO Stability	-	Fluctuating	**Stable and increasing**
Peak DO Levels	mg/L	~5–6	**Up to 15.3**
Oxygen Retention	-	Low (rapid loss)	**High (sustained levels)**
Distribution	-	Non-uniform	**Uniform across tank**
System Efficiency	-	Limited	**Significantly improved**
Operational Dependency	-	Continuous aeration required	**Reduced dependency**



Impact Analysis

The optimized nanobubble implementation resulted in significant performance improvements:

- **High DO Achievement:** Ability to reach and sustain **DO levels up to ~15 mg/L**
- **Improved Oxygen Retention:** Reduced oxygen loss due to stable nanobubble suspension
- **Enhanced System Stability:** Consistent oxygen availability across the culture tank
- **Reduced Energy Dependency:** Lower reliance on continuous blower and paddle wheel operation
- **Improved Process Efficiency:** Better oxygen utilization compared to conventional aeration
- **Infrastructure Insight:** Highlighted the importance of system design compatibility for maximizing nanobubble performance

Conclusion

The study demonstrates that NICO nanobubble technology significantly improves oxygenation efficiency in aquaculture systems when operated under optimized conditions. While conventional aeration systems can disrupt nanobubble stability, a properly configured nanobubble-only system delivers superior dissolved oxygen levels, enhanced stability, and improved operational efficiency.

This case study highlights the importance of system design alignment and confirms that nanobubble technology offers a high-performance alternative to conventional aeration, particularly for applications requiring sustained and efficient oxygen delivery.