NICO NANOBUBBLE INDIA CO.

Case Study

Enhancing Aeration Efficiency Using NICO Nanobubble Technology

Overview

Aeration is the most energy-intensive process in biological wastewater treatment, often accounting for a significant portion of operational costs. Conventional aeration systems typically exhibit low oxygen transfer efficiency, leading to higher energy consumption and sub-optimal treatment performance.

This case study evaluates the effectiveness of NICO Nanobubble Technology in improving aeration efficiency, enhancing biological treatment performance, and reducing energy consumption in a large-scale Moving Bed Biofilm Reactor (MBBR) system.

Project Details

- **Process:** MBBR (Post-anoxic to aeration stage)
- **Location:** Chennai, India
- **Application Mode:** Side-stream nanobubble loop
- **Side-stream Flow:** 5–7 MLD
- **Operational Duration:** July – August 2025
- **Objective:** Maintain DO ≥ 4 mg/L and improve aeration efficiency using high transfer nanobubbles

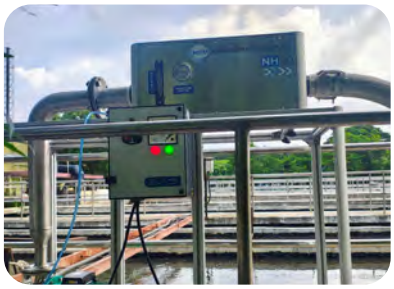
Pre-Installation Challenges

Prior to nanobubble integration, the system exhibited typical limitations associated with conventional aeration:

- Low oxygen transfer efficiency (SOTE ~12–15%), resulting in higher energy demand
- Difficulty in maintaining stable DO levels, especially under variable loading conditions
- Higher BOD/COD residuals, indicating incomplete biological oxidation
- Inefficient nitrification performance, due to oxygen limitations
- Poor solids settling, leading to elevated TSS in treated water
- High energy consumption, contributing significantly to operational expenditure

NICO Nanobubble Solution

The study utilized the NICO VARUNA nanobubble system in a side-stream configuration, designed to generate ultra-fine gas bubbles with enhanced interfacial characteristics.

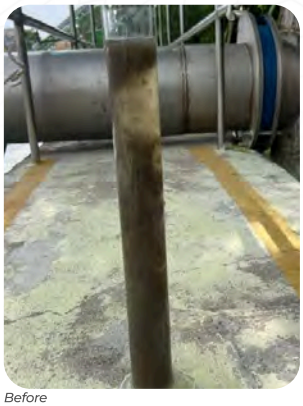


Key functional advantages:

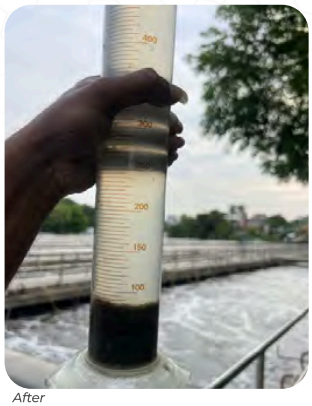
- **High Oxygen Transfer Efficiency:** Achieved SOTE of ~50–60% in wastewater conditions
- **Rapid DO Enhancement:** DO levels increased to 4.2–4.8 mg/L within 30–40 minutes
- **Improved Gas Utilization:** Enhanced mass transfer reduced oxygen wastage
- **Uniform Oxygen Distribution:** Eliminated localized oxygen deficiency zones
- **Process Intensification:** Supported enhanced microbial activity and faster kinetics

Performance Outcomes

Parameter	Unit	Before Nanobubble	After Nanobubble
BOD	mg/L	< 30	**< 10**
COD	mg/L	< 100	**< 50**
Total Nitrogen	mg/L	< 20	**< 15**
Ammoniacal Nitrogen	mg/L	< 20	**< 10**



Before



After

Impact Analysis

The implementation of nanobubble technology resulted in significant process and operational improvements:

- **Enhanced Biological Treatment Efficiency:** Improved BOD/COD removal due to better oxygen availability
- **Improved Nitrification Performance:** Reduction in ammonia and nitrogen species
- **Better Solids Separation:** Significant reduction in TSS due to improved floc characteristics
- **Stable DO Regime:** Rapid and sustained oxygen levels improved process reliability
- **Optimized System Performance:** Balanced aerobic–anoxic cycling without process disruption

Conclusion

The study demonstrates that NICO's nanobubble technology significantly enhances aeration efficiency and biological treatment performance in large-scale wastewater systems. By improving oxygen transfer, reducing energy consumption, and enhancing process stability, the technology provides a scalable and economically viable solution for modern wastewater treatment plants.

The successful implementation confirms that nanobubble-based aeration can serve as a high-efficiency alternative to conventional aeration systems, enabling both operational optimization and long-term sustainability.