

BIO-ORGANIC CATALYST
THE POWER IN NATURE®



BIO-CATALYTIC INTERFACIAL ENGINEERING

The Bio-Catalytic Bubble Shell

How yeast extracts and a non-ionic surfactant convert a passive film into a reactive interfacial platform, creating a functionalized microbubble.

< 1 mm

Microbubbles, formed below CMC

≈ 5× DO

0.1–2.8 → 6.0–9.9 ppm, Kikkoman plant

18,000 → 160
mg/L

FOG in a grease trap, 24 h

30 years

Patented, proven in the field



Two ingredients, one breakthrough

BOC pairs a clarified yeast fermentation extract with a non-ionic surfactant. Neither works alone; together they change how water behaves at every gas-liquid interface — and that is the whole product.

FERMENTATION SUPERNATANT · ~20 % w/w

The bio-organic component

- *S. cerevisiae* grown 2–5 days on molasses, malt and a magnesium salt, then centrifuged clear
- Carries amino acids, oligopeptides, B-vitamins, glucans and minerals (P, K, Mg, Zn)
- No live cells, no active enzymes, no pro-enzymes
- Preserved (sodium benzoate); pH adjusted to 3.5–4.0

NON-IONIC SURFACTANT · ~9 % w/w

The interfacial component

- Amphiphilic, uncharged; PC3 Organic uses a plant-based surfactant
- Lowers gas-liquid interfacial tension so very small bubbles can form
- Compatible with, and enhancing of, biological reactions — not a biocide
- Dosed at 1–4 ppm of finished product in the treated water

Composition as described in the BOC / Neozyme patent family (US 5,879,928; US 12,364,268). Plant- and mineral-derived, NSF certified, made in the USA.



Four steps from dose to result

At 1–4 ppm, BOC self-assembles into functionalized microbubbles that carry oxygen through the whole water column and bring a reactive surface into contact with fats, biofilm and sulfide.

01

Aggregation

Supernatant biomolecules and surfactant are both amphiphilic. They cluster into low-molecular-weight aggregates — “the nuclei for microbubble formation” — even below the surfactant's normal CMC.

02

Functionalized shell

Supernatant components “interfere with the ability of the nonionic surfactants to create a well-organized micellar shell”. The result is a loosely packed shell that is more gas-permeable than a tidy micelle.

03

Oxygen reservoir

Sub-millimetre bubbles rise slowly and release gas gradually, dispersing oxygen through the bulk. Water reads above Henry's Law saturation because the bubble population is a second oxygen store.

04

Reactive interface

Oxygen delivered across the shell drives cleavage of ester and glycosidic bonds in fats and biofilm matrix; native microbes generate the enzymes in situ. Slime layers dissolve and the H₂S source goes with them.



Inside the functionalized microbubble

A “highly reactive” shell of surfactant and yeast-derived biomolecules around a core of air. The shell is deliberately disordered — and that disorder is what makes it work.

BULK WATER	<i>treated water · dissolved O_2 · native microbes</i>
LOOSELY PACKED SHELL	<i>non-ionic surfactant · peptides · amino acids · minerals</i>
AIR CORE	<i>gas reserve · released gradually into the bulk</i>
LOOSELY PACKED SHELL	<i>disordered micelle → high gas permeability</i>
BULK WATER	<i>organic matter · fats · biofilm in contact with the shell</i>

Why the shell is different

A well-ordered surfactant micelle is a tight barrier. Supernatant biomolecules sit between the surfactant molecules, so the shell holds “fewer molecules” per unit area and gas crosses it more easily.

Why bubbles form at all

Non-ionic surfactant “blended with biosurfactants” from the fermentation “significantly alters bubble behaviour”, allowing microbubbles below the estimated CMC of the surfactant alone.

Why it matters

Every microbubble becomes a mobile reactor: an oxygen store that travels with the water, and a reactive skin that meets organic matter wherever it is — not just at the diffuser.

Shell definition and sub-millimetre bubble size from US 10,681,914 / 12,364,268 and US 5,879,928.



Smaller bubbles, at a fraction of the dose

BOC delivers the kind of bubble aeration engineers pay for — at a concentration where an ordinary surfactant would do nothing at all.

SIZE · < 1 mm

More surface, longer in the water

Halving the diameter doubles the gas-liquid contact area for the same air, and small bubbles rise far more slowly — so each one has time to give up its oxygen before it vents. Fine-bubble physics, pushed further.



3 mm
2,000 m²/m³
rises ≈ 25 cm/s



1 mm
6,000 m²/m³
rises ≈ 15 cm/s



0.1 mm
60,000 m²/m³
rises ≈ 0.5 cm/s

DOSE · BELOW THE CMC

Surfactant behaviour at a fraction of surfactant dose

The critical micelle concentration (CMC) is the level a surfactant must reach before it self-assembles and starts changing how bubbles behave. Below it, a surfactant on its own does very little.

BOC forms microbubbles “below estimated CMCs for the surfactants used”, because the yeast-derived biomolecules and the surfactant assemble together. That is the synergy made visible — and it is why:

- 1–4 ppm is a working dose, not a trace
- No foaming, no detergent behaviour in the process
- Low cost per m³ treated

Gas-liquid surface area per m³ of gas = $6 / d$. Rise speeds are indicative values for clean water. Sub-CMC microbubble formation per US 5,820,758.



More oxygen than water should hold

Henry's Law caps dissolved oxygen at about 10 ppm in ambient water. BOC-treated water routinely reads higher — and has for thirty years — because the microbubble population is a second oxygen store the water carries with it.

A

Two oxygen stores, not one

Once the dissolved fraction is saturated, “at least another 10 ppm oxygen within small bubbles would be available.” The microbubble population is a dispersed reserve that a DO probe in the tank sees as sustained supersaturation.

B

Slow rise, thin film, delayed release

Small bubbles “rise more slowly than large bubbles, allowing more time for a gas to dissolve”, and as bubbles shrink the liquid film around them thins so “transfer of gas into the bulk is no longer impeded.” Oxygen is delivered through the volume, not just at the diffuser.

~10 ppm**HENRY'S LAW SATURATION, AMBIENT****> 2×****BEYOND HENRY'S LAW, PER PATENT****5-fold****DO RISE, SOY-SAUCE PLANT**

Quotes from US 5,879,928 and US 11,772,996. Sustained supersaturation is BOC field experience across wastewater, aquaculture and lake applications.



Catalysis without chemicals or enzymes

BOC adds no enzymes, bacteria or biocides. It works like a functionalized surfactant: concentrating oxygen and reactants at the interface, and letting the biology already in the water do the rest, faster.

A

A concentrating platform

Amphiphilic clusters give “a platform for reactions to occur by increasing localized concentrations of reactants, lowering the transition energy required for a catalytic reaction to occur.” The shell brings oxygen, substrate and native microbes together.

B

Oxidative cleavage of fats and matrix

Oxygen delivered across the shell breaks “the ester bonds linking glycerol and fatty acids” and the glycosidic bonds that hold biofilm together. Fats, oils and grease stop accumulating and start dissolving.

C

Biofilm and sulfide control

“The biological film growth (slime layers) is dissolved away, thereby eliminating a critical source of dissolved sulfides.” With DO held above 1.1 ppm, H_2S does not evolve from the water — the odour benefit follows from the oxygen benefit.

Documented since 1996



SETTING	MEASURE	RESULT
Soy-sauce plant wastewater (Kikkoman)	Dissolved oxygen	0.1–2.8 ppm → 6.0–9.9 ppm ($\approx 5\times$)
Industrial wastewater	BOD · TSS	810 → 140 mg/L · 380 → 48 mg/L
Restaurant grease trap, 24 h aerated	FOG · TSS	18,000 → 160 mg/L · 19,400 → 410 mg/L
Bench fat blend (tallow, vegetable fat, lard), 24 h	Fat content vs control	$\approx 50\%$ reduction
Hydrocarbon-contaminated soil, 6 days	Total hydrocarbons	1,800 → 400 ppm (-78%)
Septic tank, 4 days	Toluene · p-xylene	1,695 → 45 $\mu\text{g/L}$ · 243 → 7.9 $\mu\text{g/L}$ (-97%)
Livestock manure	Odour · VFA · O ₂ demand	-31% · -10% · -25%

Worked examples from the founding patents (US 5,849,566; 5,879,928; 5,885,950).



An ordinary bubble vs. a BOC bubble

ATTRIBUTE	CONVENTIONAL BUBBLE	FUNCTIONALIZED MICROBUBBLE
Shell	Well-ordered surfactant monolayer	Disordered surfactant + supernatant biomolecules
Formation	Requires surfactant above its CMC	Forms below the surfactant's CMC
Size	Millimetres	Sub-millimetre ("less than 1 mm")
Gas permeability	Tight barrier	"More gas permeable than a well-organized micelle"
Oxygen delivery	At the diffuser; rises and vents	Dispersed through the bulk; delayed release
DO reading	Capped at Henry's Law	Sustained above saturation (dissolved + reserve)
Reactivity	None	Oxidative cleavage of ester / glycosidic bonds
Enzymes	None	None supplied — generated in situ by native biology

Right-hand column drawn from the BOC / Neozyme patent family.

Bio-Catalytic Bubble Shell

1 COMPOSITION



Fermentation Supernatant ~20% w/w

- *S. cerevisiae*, molasses, malt, magnesium salt, centrifuged clear
- carries amino acids, oligopeptides, B-vitamins, glucans, minerals
- preserved (sodium benzoate)
- pH 3.5–4.0, no live cells, no enzymes



Non-Ionic Surfactant ~9% w/w

- amphiphilic, uncharged, plant-based
- lowers gas-liquid interfacial tension for very small bubbles
- enhances biological reactions
- dosed at 1–4 ppm

2 HOW IT WORKS: 4-Step Process

1 Aggregation

- Superintendent biomolecules and surfactant clustering into low-molecular-weight aggregates ("nuclei") even below normal CMC

2 Functionalized Shell

- Supernatant components interfere with nonionic surfactants, creating a loosely packed, gas-permeable shell (disordered micelle)

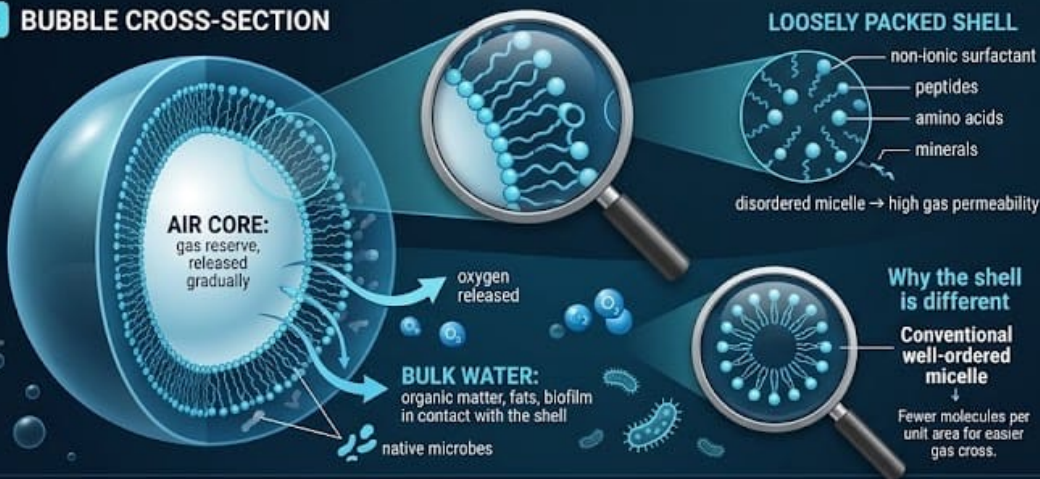
3 Oxygen Reservoir

- Sub-millimetre bubbles rising slowly and releasing gas gradually, dispersing oxygen through the bulk
- Water reads above Henry's Law saturation with a second oxygen store

4 Reactive Interface

- Oxygen delivered across the shell drives cleavage of ester and glycosidic bonds in fats and biofilm matrix
- Native microbes generate enzymes *in situ*, dissolving slime layers and the H_2S source

3 BUBBLE CROSS-SECTION



4 KEY METRICS

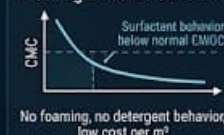
Size



<1mm microbubbles: more surface, longer in water, rises far more slowly

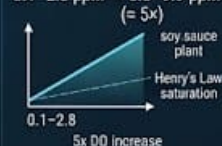
1–4 ppm

Working Dose Below CMC



DO Rise

0.1–2.8 ppm → 6.0–9.9 ppm (= 5x)



FOG Reduction

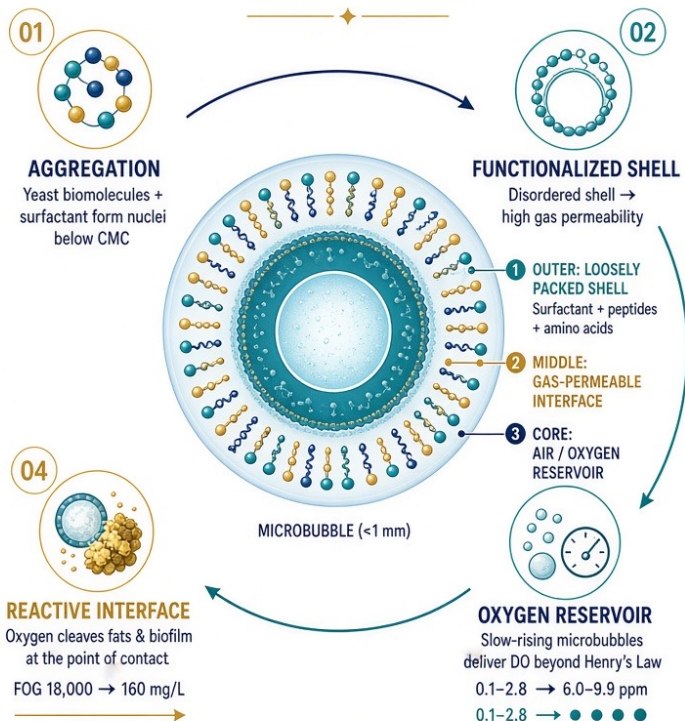
18,000 → 160 mg/L



Bio-Catalytic Bubble Shell



How yeast extract + non-ionic surfactant create
a functionalized microbubble.



	≈5× Dissolved Oxygen		FOG reduction in 24 h		30 years patented & proven
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Two ingredients. One platform. 1–4 ppm.

IN ONE LINE



Every bubble a dispersed oxygen reservoir and a reactive interface.

A fermentation supernatant and a non-ionic surfactant, dosed at parts per million, self-assemble into loosely packed microbubbles that carry oxygen through the water column and bring it to bear on fats, biofilm and sulfide at the point of contact — without enzymes, bacteria or biocides.



Oxygen

sustained above
saturation



Fats & FOG

ester bonds cleaved



Biofilm

slime layers dissolved



Sulfide & odour

suppressed at DO > 1.1
ppm