COMPARISON NORMALIZED TO 1 ft³ OF AIR IN CLEAN WATER

BUBBLE CATEGORY	FINE BUBBLE	COARSE BUBBLE	COARSE BUBBLE	TRANSITIONAL BUBBLE	MACRO BUBBLE	MACRO BUBBLE	MACRO BUBBLE
EQUIVALENT BUBBLE DIAMETER (inches)	1/8	1/4	1	4	11.82	13.53	17.04
BUBBLE VOLUME (ft³)	0.000000591	0.00000473	0.000303	0.0194	0.500	0.750	1.500
SURFACE AREA AVAILABLE FOR OXYGEN TRANSFER (ft² per ft³ of Air)	576	288	72	18	6.09	5.32	4.22
BUBBLE RISE VELOCITY (ft/s)	0.35	0.50	1.23	1.40	1.77	2.40	4.30
BUOYANT POWER INDEX (ft·lbf/s) (= 62.4 × Velocity)	21.8	31.2	76.8	87.4	110.4	149.8	268.3
RELATIVE MIXING EFFECTIVENESS (Normalized to 1/4 in Coarse Bubble = 1.00×)	0.70×	1.00×	2.46×	2.80×	3.54×	4.80×	8.60×
NUMBER OF BUBBLE RELEASES REQUIRED TO DELIVER 100 ft³ OF AIR	169,000,000+	21,000,000+	330,000	5,160	200	133	67
RELATIVE OXYGEN TRANSFER POTENTIAL (Normalized to Fine Bubble = 1.00×)	1.00×	0.50×	0.125×	0.031×	0.0106×	0.0092×	0.0073×

↓ 99% REDUCTION FROM FINE TO 1.5 ft³ MACRO

↑ INCREASES 12× FROM FINE TO 1.5 ft³ MACRO

↑ INCREASES 12× FROM FINE TO 1.5 ft³ MACRO

↑ INCREASES 8.6× FROM COARSE (1/4 in) TO 1.5 ft³ MACRO

FROM MILLIONS OF EVENTS TO DOZENS OF POWERFUL DISPLACEMENT EVENTS

↓ 99% REDUCTION FROM FINE TO 1.5 ft³ MACRO

SAME AIR VOLUME – DRAMATICALLY DIFFERENT OUTCOMES

FINE BUBBLES – OPTIMIZED FOR OXYGEN TRANSFER



- ✓ High Surface Area
- ✓ High Oxygen Transfer
- ✓ Low Buoyant Power
- ✓ Low Mixing Effectiveness
- ✓ Best for Aeration

O_2

MILLIONS OF SMALL EVENTS – HIGH SURFACE AREA – LOW ENERGY

LARGE BUBBLES – OPTIMIZED FOR HYDRAULIC MIXING



- ✓ Low Surface Area
- ✓ Low Oxygen Transfer
- ✓ High Buoyant Power
- ✓ High Mixing Effectiveness
- ✓ Best for Mixing

DOZENS OF POWERFUL EVENTS – HIGH ENERGY – STRONG MIXING

THE DESIGN PRINCIPLE

AIR SHOULD BE SELECTED FOR ITS INTENDED PURPOSE → O_2 FINE BUBBLES MAXIMIZE OXYGEN TRANSFER → LARGE BUBBLES MAXIMIZE HYDRAULIC MIXING → COMBINING BOTH TECHNOLOGIES FOR WHAT THEY DO BEST DELIVERS THE MOST EFFICIENT TREATMENT SYSTEM