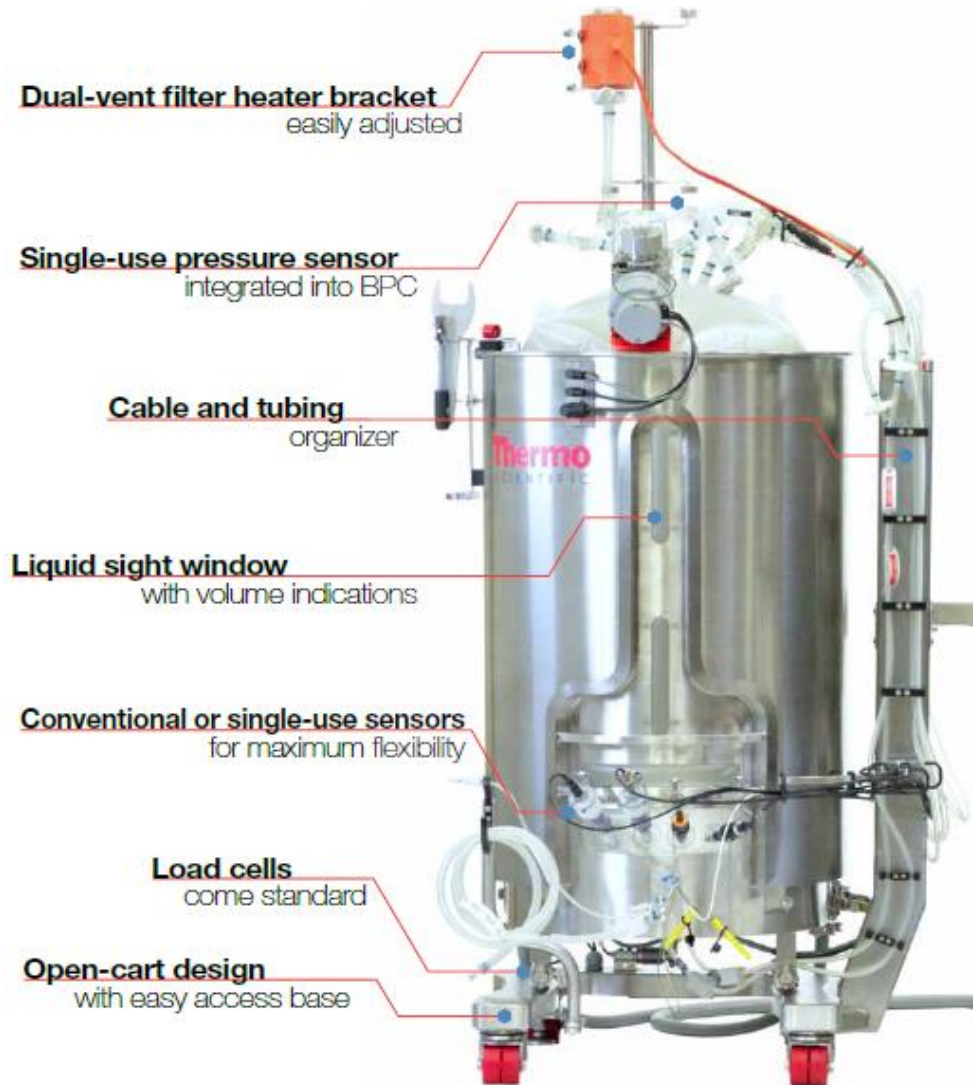




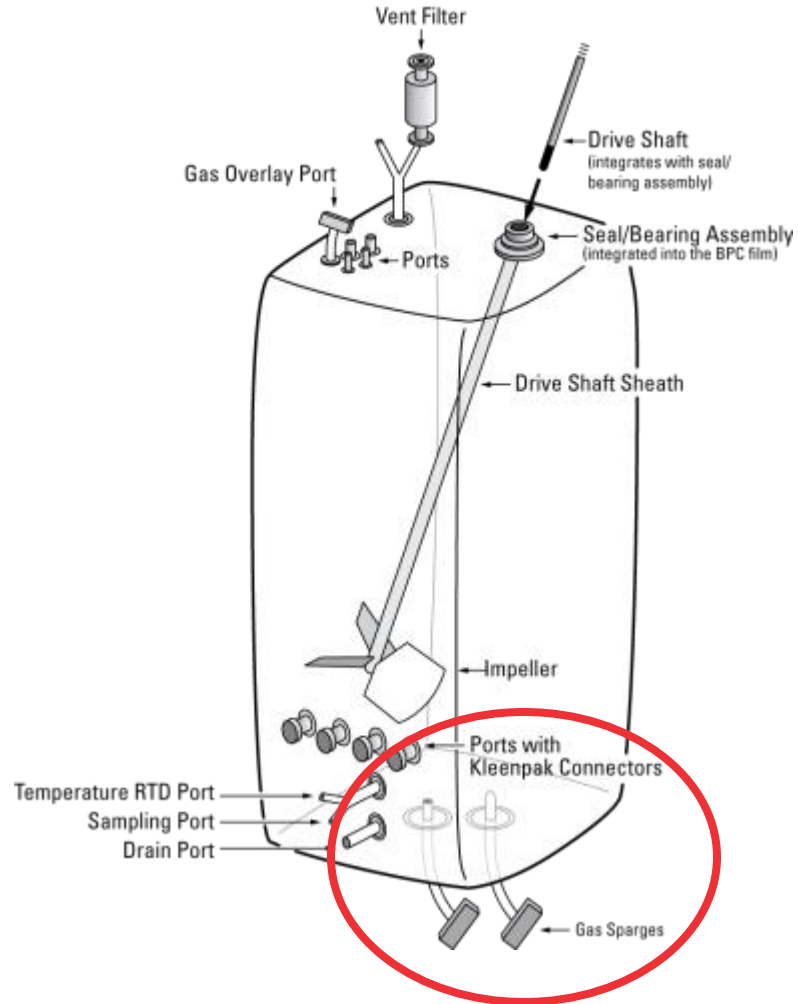
ThermoFisher
S C I E N T I F I C

Sparging Technology

Bioreactor Vessel Design



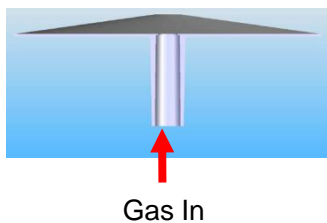
Single-Use Bioreactor BPC



The Evolution of Single-Use Sparger Designs

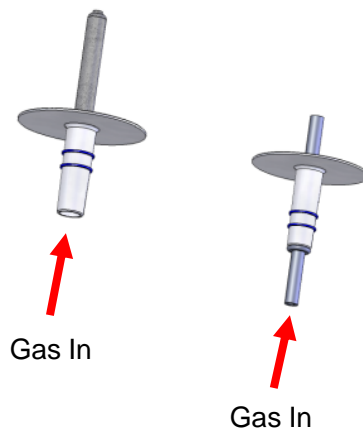
First Generation

- Tyvec membrane sparger
- Single sparger design



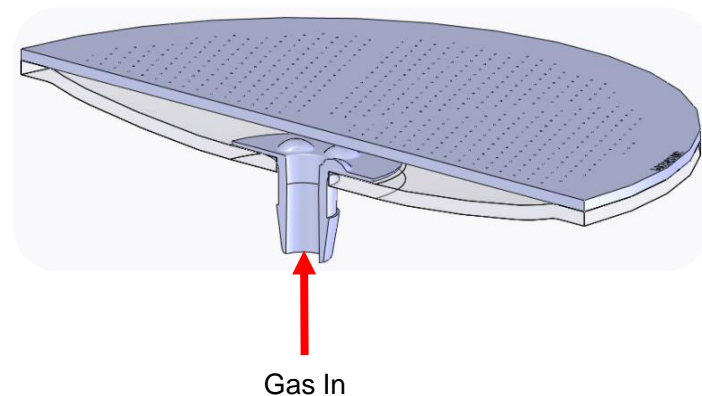
Second Generation

- Porous frit and open pipe spargers
- Dual sparger design



Third Generation

- Porous frit and drilled hole spargers
- Dual sparger design



A new standard for sparger performance

New Dual Sparger – Design

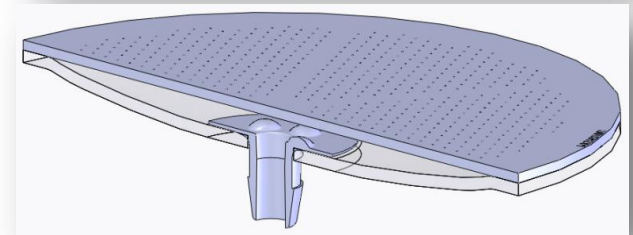
Sparging has significant effect on oxygen transfer and carbon dioxide stripping which affects cell growth and productivity

Micro-sparger

- Porous frit sparger (frit) that uses a sintered PVDF design with pore sizes in the range of 20 to 40 μ m

Macro-sparger

- Film based sparger disc with laser drilled pores of specific hole sizes relative to the S.U.B. bioprocess container, referred to as a drilled hole sparger (DHS)



Performance, flexibility and ease of use

CO₂ Stripping vs. O₂ Delivery Ratio

CO₂ produced by cells and is added to control pH

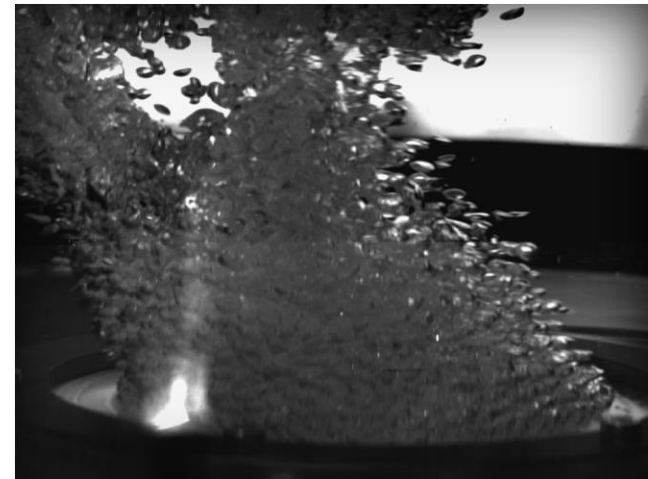
- At some point the CO₂ production becomes greater than stripping

Why do we care?

- Dissolved CO₂ → Carbonic acid
 - Lowers vessel pH
 - Base is added; vessel osmolality increases

CO₂ ~transparent to cell membrane:

- Lowers cell pH
- Cells expend energy to handle excess CO₂



CO₂ buildup negatively affects cell growth and product yield

Standard Dual Sparger Configuration

Porous Frit (Micro) and Drilled Hole (Macro) Spargers

S.U.B. BioProcess Container Part Numbers	System Size	Drilled Hole Sparger Configuration	Porous Frit Sparger Configuration
SH30985.01	50L	1 x DHS with 360 x 178µm holes	1 x frit with 20 to 40µm holes
SH30985.02	100L	1 x DHS with 570 x 178µm holes	1 x frit with 20 to 40µm holes
SH30985.03	250L	1 x DHS with 760 x 233µm holes	1 x frit with 20 to 40µm holes
SH30985.04	500L	1 x DHS with 980 x 368µm holes	1 x frit with 20 to 40µm holes
SH30985.05	1,000L	1 x DHS with 1,180 x 445µm holes	1 x frit with 20 to 40µm holes
SH30985.07	2,000L	2 x DHS with 690 x 582µm holes (1,380 holes)	2 x frit with 20 to 40µm holes
SH30985.08	2,000L w/condenser	2 x DHS with 690 x 582µm holes (1,380 holes)	2 x frit with 20 to 40µm holes

Tailored pore sizes by S.U.B. volume

Critical factors determine rated working volume

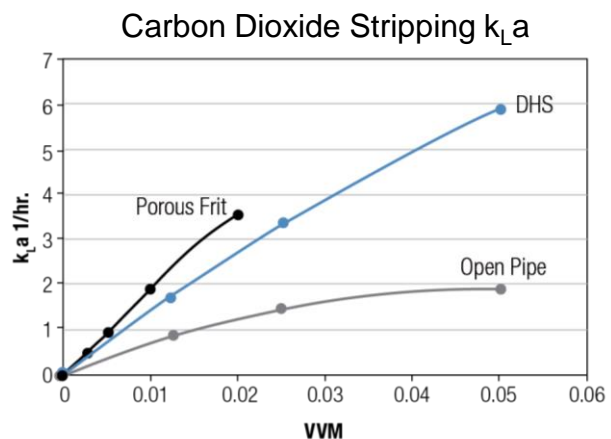
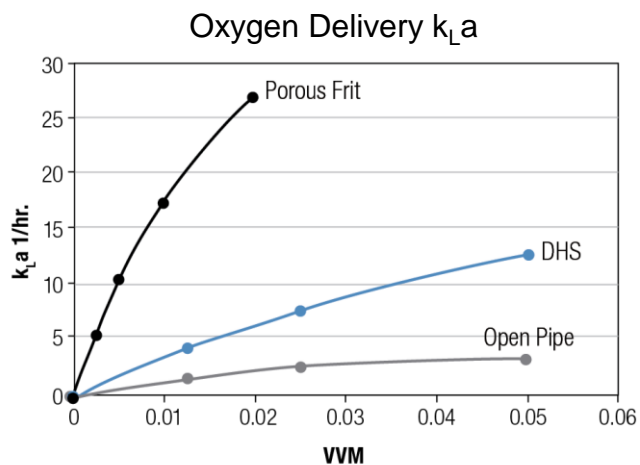
- Hole Size
- Hole Count
- Pore Distribution

Design Advantages

- Produces constant bubble size regardless of the gas flow delivered to the bioreactor
- Creates specific, uniform, macro bubbles ranging from approximately 1.9 to 3.4mm
- Scalable O₂ k_La and CO₂ stripping
- Achieves consistent performance, better process scaling, and reduced foam generation

Sparging provides better process performance

Sparging Performance



Scalable O_2 kLa and CO_2 stripping at dissolved oxygen (DO) set-points of 30 to 50% of air saturation

- Predict the potential effects of parameter changes under controlled conditions
- Frit sparger creates smaller air bubbles offering the best performance for O_2 delivery at lower flow rates
- Drilled hole sparger can be used at higher flow rates to offer better CO_2 stripping

Data is from a 250L S.U.B. and is representative of mass transfer performance for all S.U.B.s from 50 to 2,000L

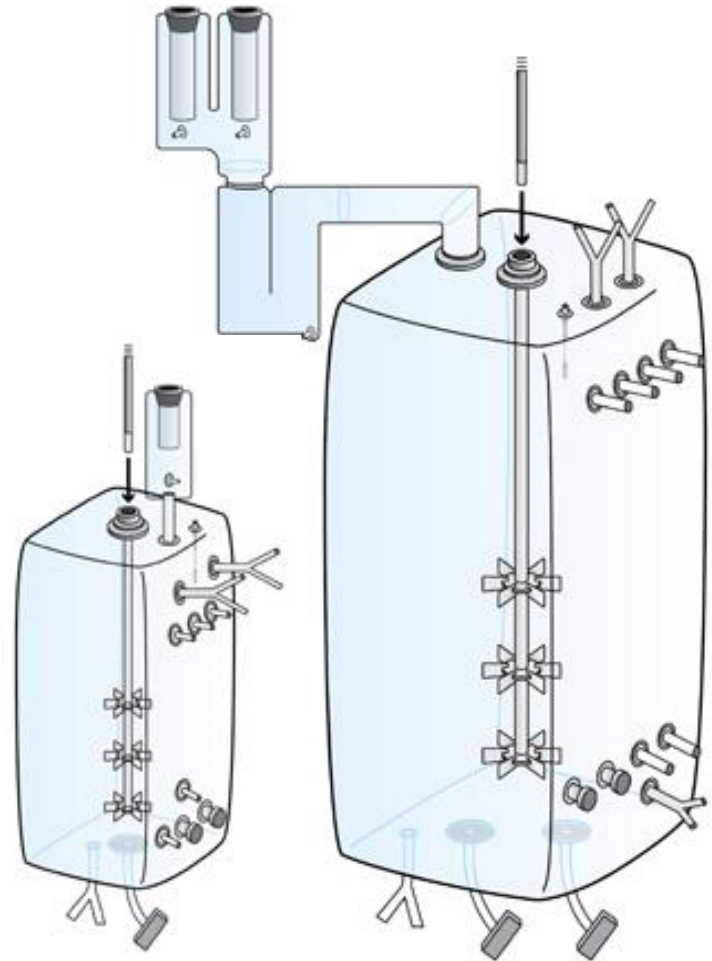
Optimize your specific processes

SPARGER IN SINGLE USE FERMENTORS

S.U.F. Chamber Design

Drilled Hole Sparge designed for high velocity, high O₂ transfer to meet microbial fermentation needs

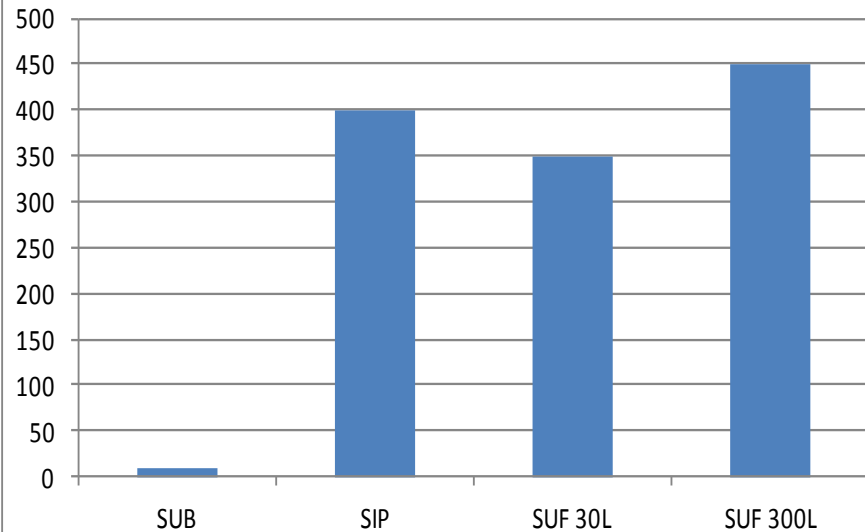
- 30L 1xDHS 25 holes at 0.062"dia (1.58mm)
- 300L 2xDHS 50 holes at 0.125"dia (3.18 mm)



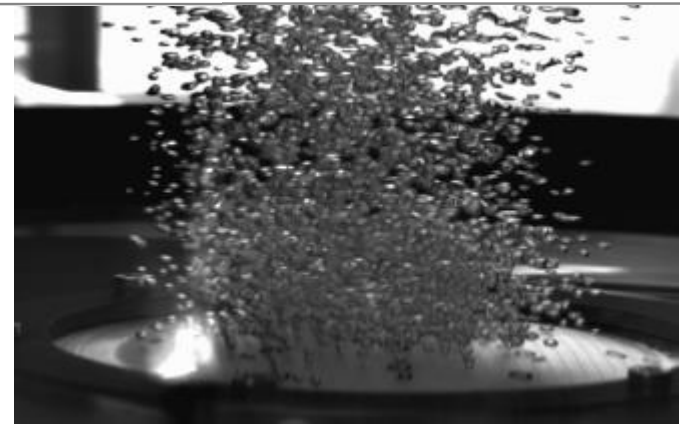
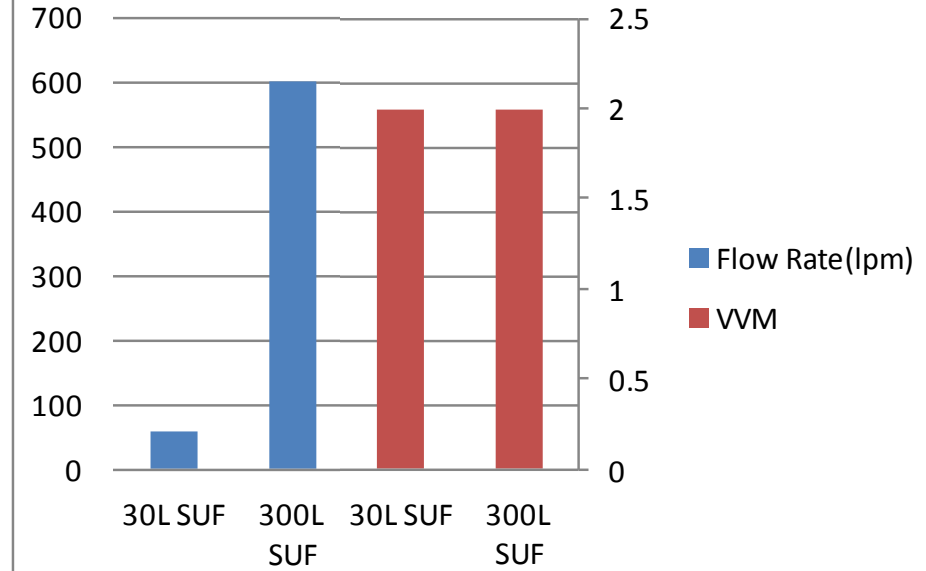
Illustrations of 30L and 300L S.U.F. BPC with condenser and foam sensor

Aeration: Sparging and $k_L a$

KLA Performance (Air)



Air Flow





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