SAMBA ITT

John Chew & Jannis Wenk

Department of Chemical Engineering

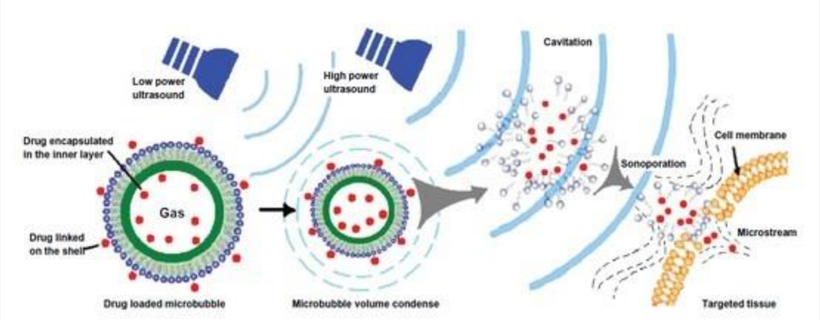
Water Innovation & Research Centre

CASE

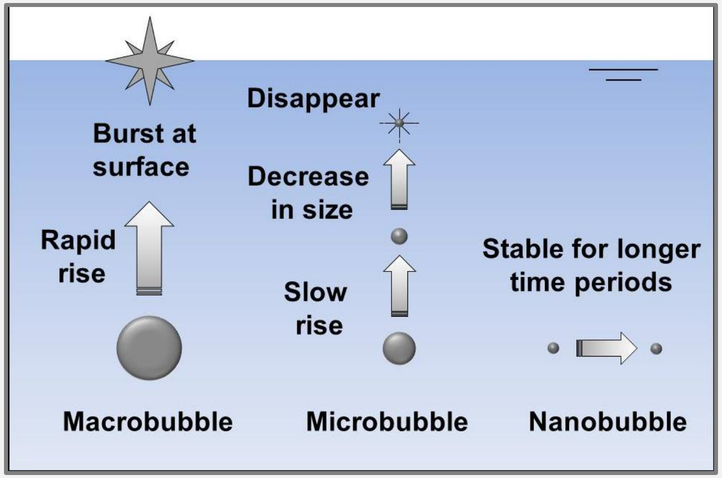
Friday, 24 February, 2017

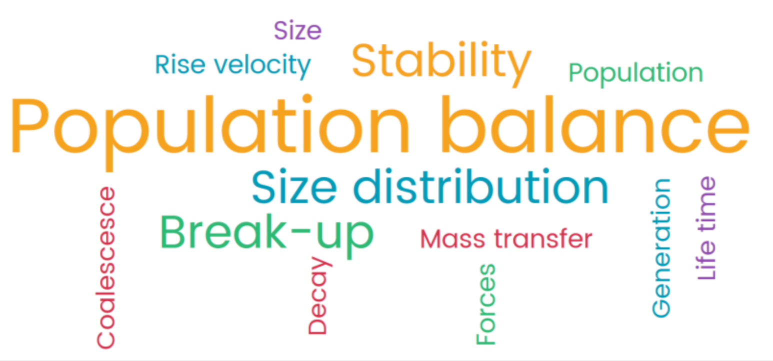
Dynamics of Fine Bubbles

Gas-Liquid



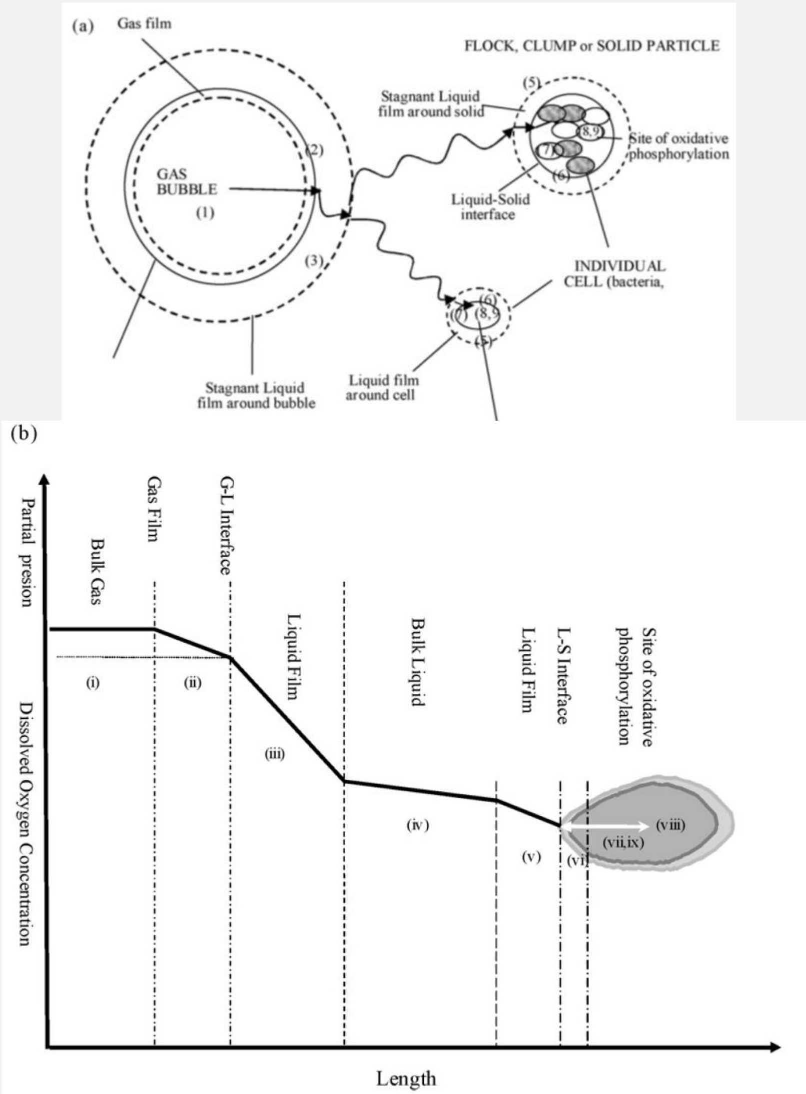
Size of Bubbles





Dynamics of Fine Bubbles

Transport Mechanisms



Garcia-Ochoa et al. (2010) *Biochemical Engineering Journal* **49** pp. 289–307

Governing Equations

Generalised Rayleigh-Plesset (R-P)

$$\frac{p_B(t) - p_\infty(t)}{\rho_L} = R\frac{d^2R}{dt^2} + \frac{3}{2}\left(\frac{dR}{dt}\right)^2 + \frac{4\nu_L}{R}\frac{dR}{dt} + \frac{2S}{\rho_L R}$$

With impurities, R-P becomes

$$\frac{p_{vap}(T_\infty) - p_\infty(t)}{\rho_L} + \frac{p_{vap}(T_B) - p_\infty(t)}{\rho_L} + \frac{p_{Go}}{\rho_L}\left(\frac{T_B}{T_\infty}\right)\left(\frac{R_o}{R}\right)^3$$
$$= R\frac{d^2R}{dt^2} + \frac{3}{2}\left(\frac{dR}{dt}\right)^2 + \frac{4\nu_L}{R}\frac{dR}{dt} + \frac{2S}{\rho_L R}$$

Population balance – multiple size group

$$\frac{\partial \rho_G \varepsilon_G f_i}{\partial t} + \nabla \cdot (\mathbf{u}_G \rho_G \varepsilon_G f_i) = \rho_G S_i \quad i = 1,2 \ldots . M$$

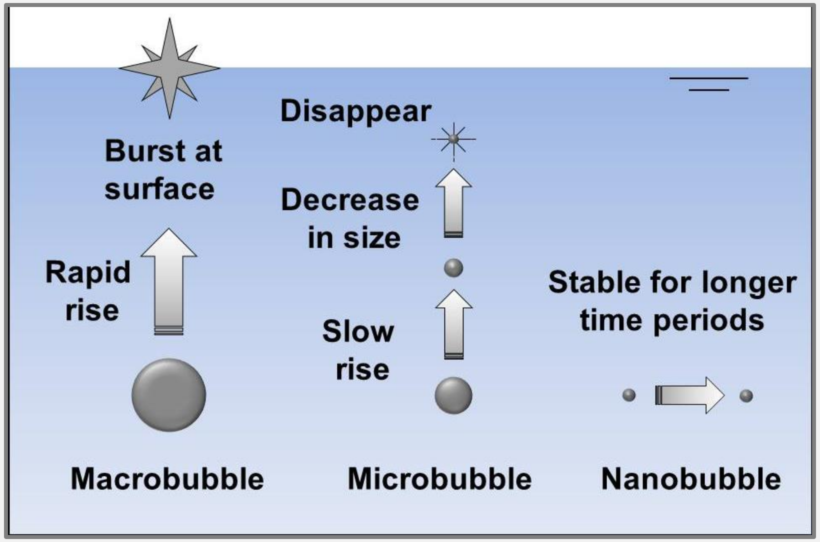
Transport mechanism

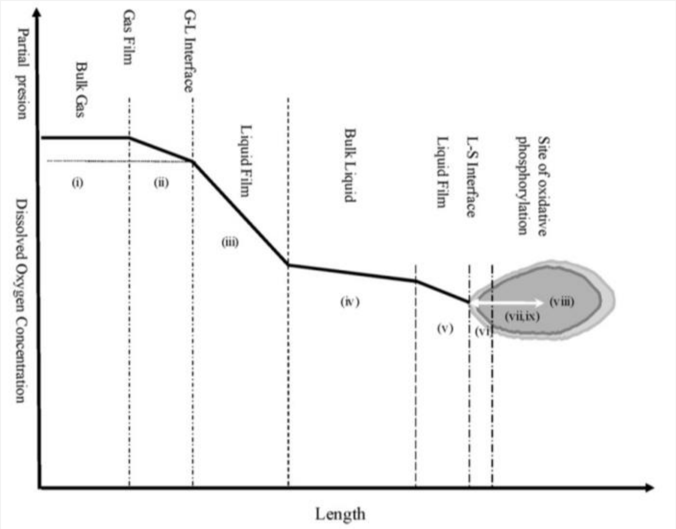
$$\frac{1}{K_L a} = \frac{1}{H \cdot k_G a} + \frac{1}{E \cdot k_L a}$$

Reaction kinetics
Coalescence
Break-up
Turbulence
Non-Newtonian

Dynamics of Fine Bubbles

Key Questions to Answer





- Use R-P equation to describe the growth and break-up of microbubbles
- Population balance to model bubble size distribution
- Main resistance to mass transfer

SAMBA ITT

John Chew & Jannis Wenk

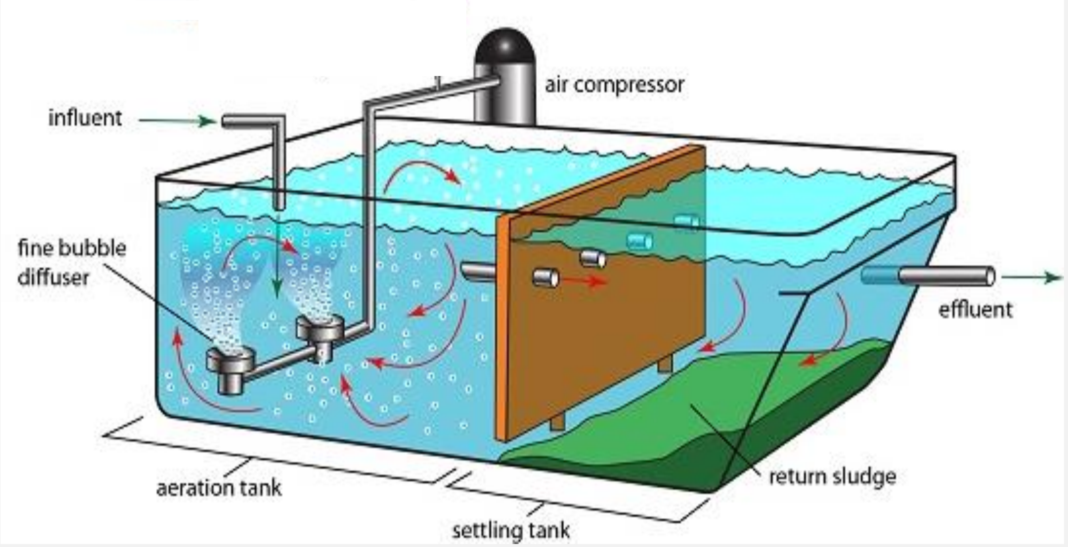
Department of Chemical Engineering

Bubble-less Ozonation

Wastewater Treatment

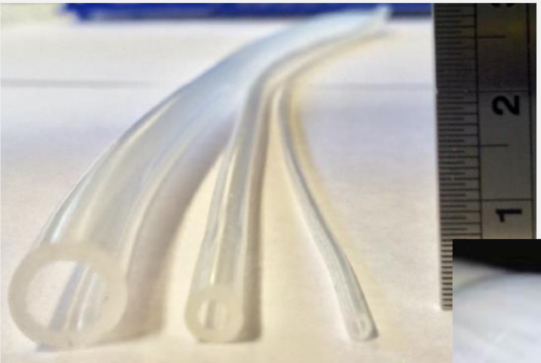
Ozone – powerful oxidant

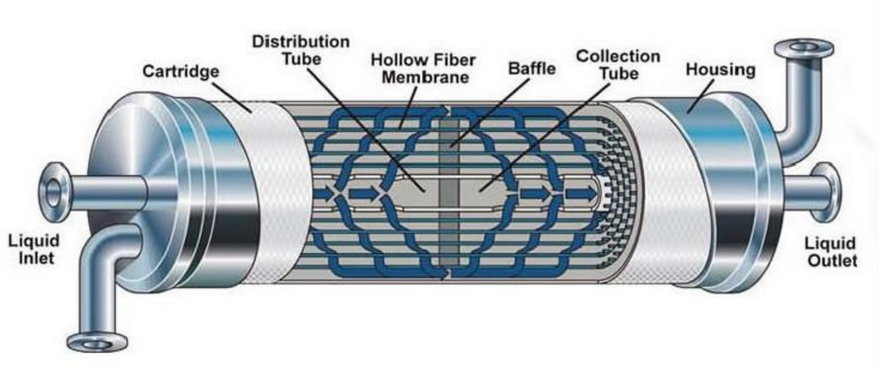
- **Eliminate micro-pollutants from wastewater**
- **Pollutant degradation through oxidation**
- **Reacts with a large number of compounds**
- **No storage or handling of chemicals**



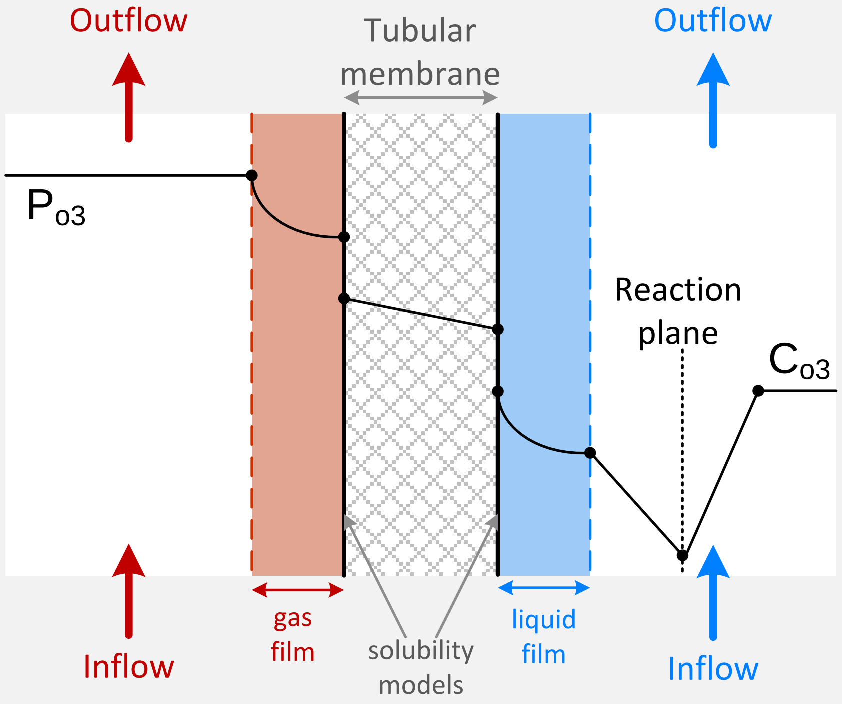
Bubble-less Ozonation

Membrane Contactor



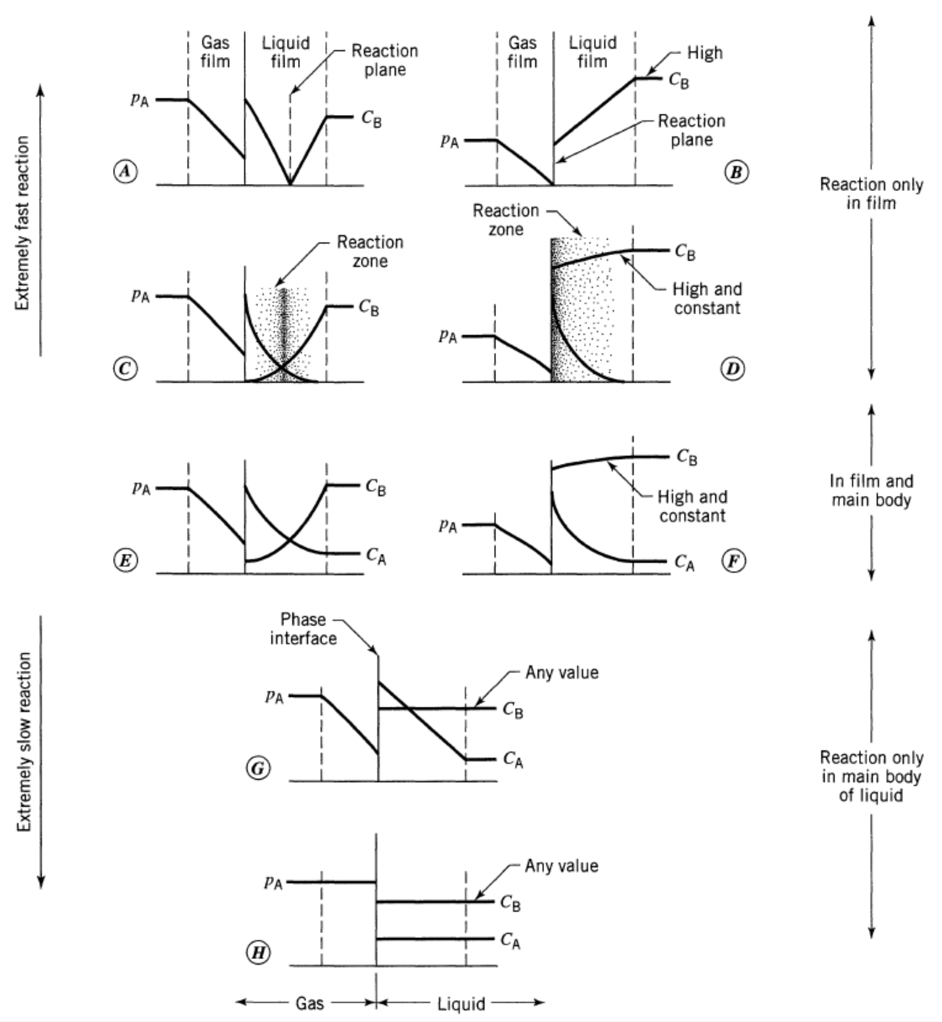


Transport & Reaction Kinetics



Bubble-less Ozonation

Key Questions to Answer



O. Levenspiel (1999) *Chemical Reaction Engineering. Wiley & Sons.*

- How reaction kinetics affect concentration profiles?
- Most suitable membrane – geometry and type
- Correlations for prediction