Derivation of Bubble Surface Area Flux (S_b) and Bubble Surface Area per Unit Tank (Cell) Volume (A_b)

Both these terms are introduced in *Wills' Mineral Processing Technology* (*Ed* 8) without derivation. The derivations are provided here. Both terms are used in relating flotation rate constant to operating conditions.

1. Bubble surface area flux (S_b)

The definition of bubble surface area flux is bubble surface area generated per unit time per unit cross-sectional area of cell. From the definitions in Figure 1 we can write:

$$S_b = n_b \cdot S/A_T \tag{1}$$

where n_b is the number of bubbles per unit time passing through the cell; S is surface area per bubble (assuming spheres): $S = \pi \cdot D_b^2$, where D_b is often equated with D_{32} (the Sauter mean bubble diameter), and A_T the cross-section area of the tank (cell). The number of bubbles per unit time passing through the cell n_b is given by:

$$n_b = Q_g/V_b$$

where Q_g is volumetric flowrate of gas to cell, and V_b the volume per bubble: $V_b = \pi D_b^3/6$. Substituting into Eq (1) we derive:

$$S_b = \frac{6Q_g/\pi D_b^3}{A_T} \cdot \pi D_b^2$$

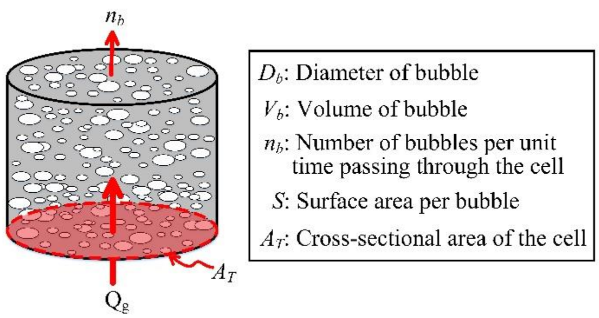

Figure 1. Measures of bubble swarm to derive S_b

Introducing gas superficial velocity J_g, the volumetric air flowrate (Q_g) divided by cell cross-sectional area (A_T) (i.e., $J_g = Q_g/ A_T$), we derive:

$$\boldsymbol{S_b = \frac{6J_g}{D_b}}$$

2. Bubble surface area per unit volume of cell (A_b)

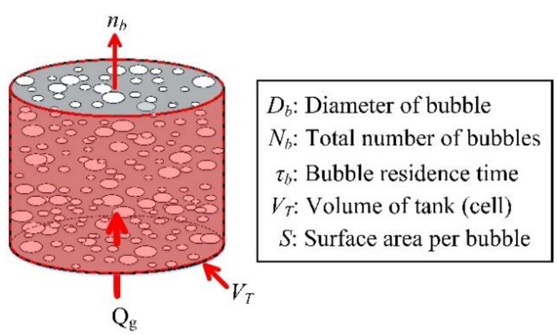

Figure 2. Measures of bubble swarm to derive A_b

From this definition, from Figure 2 we can write:

$$A_b = N_b \cdot S/V_T \tag{2}$$

where N_b is given by:

$$N_b = n_b \cdot \tau_b$$

where n_b (again) is number of bubbles per unit time passing through the cell, and τ_b the retention time of a bubble in the cell, which is given by:

$$\tau_b = \frac{V_T \cdot \varepsilon_g}{Q_g}$$

where ε_g is the gas holdup (as a fraction) (i.e., τ_b is the gas volume in the cell divided by the volumetric gas flowrate through the cell). Substituting for N_b and S gives:

$$A_b = \frac{6Q_g/\pi D_b^3}{V_T} \cdot \frac{V_T \cdot \varepsilon_g}{Q_g} \cdot \pi D_b^2$$

which simplifies to:

$$\boldsymbol{A_b = \frac{6\,\varepsilon_g}{D_b}}$$