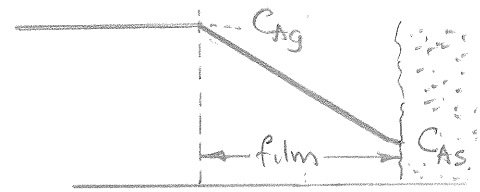
17.1 For the mass transfer step

$$-r_A'' = -\frac{1}{S}\frac{dN_A}{dt} = k_g(C_{Ag} - C_{As}) \quad \text{--- (i)}$$



For the reversible reaction step

$$-r_A'' = k_s(C_{As} - C_{Ae}) \quad \text{--- (ii)}$$

Combining (i) and (ii) to eliminate the unknown C_{As} gives

$$-r_A'' = \frac{1}{1/k_g + 1/k_s}(C_{Ag} - C_{Ae}) \longleftarrow$$

17.3 For the interface between gas bubbles and liquid

$$(-r) = -\frac{1}{V}\frac{dN}{dt} = k_{Al}\, a_i (C_{Ai} - C_{Al}) \quad \text{--- (i)}$$

k_{Al}: gas-liquid mass transfer coefficient

a_i: area of gas-liquid interface per volume of reactor

For the interface between the solid catalyst particles & the surrounding liquid

$$(-r) = -\frac{1}{V}\frac{dN}{dt} = k'_{Al}\, a_s (C_{Al} - C_{As}) \quad \text{--- (ii)}$$

k'_{Al}: liquid-solid mass transfer coefficient

a_s: area of liquid-solid interface per volume of reactor

For surface reaction

$$(-r) = -\frac{1}{V}\frac{dN}{dt} = k_1 C_{As} a_s \quad \text{--- (iii)}$$

Combining (i) (ii) & (iii), eliminating the intermediate concentrations C_{Al} & C_{As} gives, on manipulation

$$(-r) = -\frac{1}{V}\frac{dN}{dt} = \frac{1}{\frac{1}{k_{Al}a_i} + \frac{1}{k'_{Al}a_s} + \frac{1}{k_s}} C_{Ai} \longleftarrow$$

$(-r)$: rate based on unit volume of reactor

This expression is the special case of Eq 22.2 for slurry reactors.
