# LIST OF FIGURES

# LIST OF TABLES

# NOMENCLATURE

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|---|---|
| A | gaseous species that is being absorbed into the liquid B in equation (2.34) |
| [A] | local concentration of A at any point in the liquid phase, kmol.m$^{-3}$ |
| [A$^*$] | concentration of dissolved gas A at gas-liquid interface, in equilibrium with gas at interface, kmol.m$^{-3}$ |
| [$A_0$] | concentration of A in bulk of liquid, kmol.m$^{-3}$ |
| a | gas-liquid interfacial area per unit volume of liquid, m$^{-1}$ |
| AMP | 2-amino-2-methyl-1-propanol |
| B | base in reaction (2.2); or dissolved reactive species present in the liquid phase (equation (2.34)) |
| [B] | local concentration of B at any point in the liquid phase, kmol.m$^{-3}$ |
| [$B_0$] | concentration of species B in bulk of the liquid, kmol.m$^{-3}$ |
| D | diffusivity, m$^2$.s$^{-1}$ |
| $D_A$ | diffusivity of dissolved gas A in the liquid phase, m$^2$.s$^{-1}$ |
| $D_B$ | diffusivity of reactant B, m$^2$.s$^{-1}$ |
| $D_{CO_2}$ | diffusivity of dissolved $CO_2$ in the liquid phase, m$^2$.s$^{-1}$ |
| $D_{N_2O}$ | diffusivity of dissolved $N_2O$ in the liquid phase, m$^2$.s$^{-1}$ |
| $D_i$ | diffusivity of species i in the liquid phase, m$^2$.s$^{-1}$ |
| $D_{CO_2-water}$ | diffusivity of $CO_2$ in water, m$^2$.s$^{-1}$ |
| $D_{CO_2-amine}$ | diffusivity of $CO_2$ in amine solution, m$^2$.s$^{-1}$ |
| $D_{N_2O-amine}$ | diffusivity of $N_2O$ in amine solution, m$^2$.s$^{-1}$ |
| $D_{N_2O-water}$ | diffusivity of $N_2O$ in water, m$^2$.s$^{-1}$ |
| $d_c$ | diameter of the wetted wall contactor, m |
| DEA | diethanolamine |
| DIPA | di-2-propanolamine |
| E | enhancement factor defined by equation (2.36), dimensionless |
| $E_{CO_2}$ | enhancement factor for absorption of $CO_2$, dimensionless |
| $E_\infty$ | enhancement factor for an infinitely fast reaction regime defined by equations (2.41) and (2.42) |
| f | vapour pressure of liquid, kPa |
| g | gravitational acceleration, m.s$^{-2}$ |
| H | Henry's constant, kPa.m$^3$.kmol$^{-1}$ |
| $H_i$ | Henry's constant of species i, kPa.m$^3$.kmol$^{-1}$ |
| $H_{CO_2}$ | Henry's constant for $CO_2$, kPa.m$^3$.kmol$^{-1}$ |

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|---|---|
| $H_{N_2O}$ | Henry's constant for $N_2O$, kPa.m$^3$.kmol$^{-1}$ |
| $H_{CO_2-water}$ | Henry's constant of $CO_2$ in water, kPa.m$^3$.kmol$^{-1}$ |
| $H_{CO_2-amine}$ | Henry's constant of $CO_2$ in amine solution kPa.m$^3$.kmol$^{-1}$ |
| $H_{N_2O-amine}$ | Henry's constant of $N_2O$ in amine solution, kPa.m$^3$.kmol$^{-1}$ |
| $H_{N_2O-water}$ | Henry's constant of $N_2O$ in water, kPa.m$^3$.kmol$^{-1}$ |
| h | absorption length, m |
| Ha | Hatta number defined by equation (2.38) |
| $K_i$ | equilibrium constant of reaction i |
| $k_i$ | rate coefficient of reaction i |
| $k_{-i}$ | reverse rate coefficient of reaction i |
| $k_{ij}$ | forward rate coefficient for reaction j, equations (4.10) – (4.12) and equations ( 5.1) –(5.6) |
| $k_1$ | pseudo-first-order rate constant for reaction between A and B, s$^{-1}$ |
| $k_2$ | second order rate constant for reaction between A and B, m$^3$.kmol$^{-1}$.s$^{-1}$ |
| $k_b$ | rate coefficient for reaction (2.2) |
| $k_g$ | gas phase mass transfer coefficient, kmol.m$^{-2}$ s$^{-1}$ kPa$^{-1}$ |
| $k_L$ | liquid phase mass transfer coefficient, m.s$^{-1}$ |
| $k_L^{/}$ | liquid phase mass transfer coefficient in presence of chemical reaction, m.s$^{-1}$ |
| $k_{mn}$ | rate constant for reaction, m$^{th}$ order in A and n$^{th}$ order in B, (m$^3$/kmol)$^{m+n-1}$ s$^{-1}$ |
| l | fractional liquid volume holdup of B phase, dimensionless |
| MEA | monoethanolamine |
| MDEA | N-methyldiethanolamine |
| m | order of reaction with respect to species A |
| n | order of reaction with respect to species B |
| $N_{Re}$ | liquid film Reynolds number |
| P | total pressure, kPa |
| $p_A$ | partial pressure of species A, kPa |
| $p_{CO_2}$ | partial pressure of $CO_2$, kPa |
| PZ | piperazine |
| $PZCOO^-$ | piperazine monocarbamate |
| $PZ(COO^-)_2$ | piperazine dicarbamate |
| Q | quantity of gas absorbed by unit area in time of contact θ, kmol.m$^{-2}$ |
| q | total rate of absorption, kmol.s$^{-1}$ |
| $R_A$ | specific rate of absorption of species A, kmol.m$^{-2}$.s$^{-1}$ |
| $R_{CO_2}$ | specific rate of absorption of $CO_2$, kmol.m$^{-2}$.s$^{-1}$ |

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|---|---|
| $r_{CO_2}$ | rate of reaction defined by equation (2.4) |
| $S_1$, $S_2$ | coefficients in equation (3.13) |
| s | fractional rate of surface-renewal, $s^{-1}$ |
| T | temperature, K |
| t | time, of the order of contact, s |
| TEA | Triethanolamine |
| u | velocity of the liquid element at any depth from surface, $m.s^{-1}$ |
| $u_s$ | velocity at surface, $m.s^{-1}$ |
| $u_i^0$ | concentration of species i in the liquid phase, $kmol.m^{-3}$ |
| $u_i^*$ | initial liquid bulk concentration of species i, $kmol.m^{-3}$ |
| u | interfacial concentration of $CO_2$ in the liquid, $kmol.m^{-3}$ |
| $V_G$ | volumetric gas flow rate, $m^3.s^{-1}$ |
| $V_L$ | volumetric liquid flow rate, $m^3.s^{-1}$ |
| $\upsilon_L$ | volume of clear liquid, $m^3$ |
| w | film thickness, m |
| $w_{PZ}$ | mass fraction of PZ in solution |
| $w_{MDEA}$ | mass fraction of MDEA in solution |
| $w_{AMP}$ | mass fraction of AMP in solution |
| x | independent spatial variable, m |
| $x_i$ | mole fraction of species i in equation (4.5) |
| $\alpha$ | parameter defined by equations (3.19) and (3.25) |
| $\alpha_1$ | initial $CO_2$ loading of the solution in equation (4.18), kmol $CO_2$/kmol total amine |
| $\delta$ | thickness of diffusion film, m |
| $\phi_L$ | fractional liquid volume holdup of B-phase, dimensionless |
| $\eta$ | viscosity of the mixture in equation (3.14), mPa.s |
| $\lambda$ | reaction plane location measured from the interface, m |
| $\mu$ | viscosity of liquid, $kg.m^{-1}.s^{-1}$ or mPa.s |
| $\theta$ | contact time, s |
| $\rho$ | density of the liquid, $kg.m^{-3}$ |
| $\nu$ | stoichiometric coefficient in equation (2.34) |