

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(إِنَّ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لآيَاتٍ لِّأُولِي الْأَلْبَابِ الَّذِينَ  
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## Nomenclature

$A$	Limiting reactant
$A_b$	Cross sectional area of bubble phase ( $m^2$ )
$Ar$	Dimensionless argon concentration
$a$	Catalyst surface area per unit volume of the reactor ( $\frac{m^2}{m^3}$ )
$Bi$	Biot number
$C_{pg}$	Heat capacity of bulk gas ( $\frac{J}{kg.K}$ )
$C_{pf}$	Average heat capacity of gas ( $\frac{J}{kg.K}$ )
$C_{pc}$	Heat capacity of the coolant ( $\frac{J}{kg.K}$ )
$C_{pm}$	Heat capacity of the metal ( $\frac{J}{kg.K}$ )
$C_{ps}$	Heat capacity of catalyst ( $\frac{J}{kg.K}$ )
$C_j$	Bulk Concentration of component j in the gas phase ( $\frac{mol}{m^3}$ )
$C_{s,j}$	Surface Concentration of component j ( $\frac{mol}{m^3}$ )
$D_a$	Axial dispersion coefficient ( $\frac{m^2}{sec}$ )
$d_b$	Bubble diameter (m)
$D_r$	Radial dispersion coefficient ( $\frac{m^2}{sec}$ )
$D_e$	Effective diffusivity ( $\frac{m^2}{sec}$ )
$D_p$	Equivalent diameter of catalyst particle (m)
$dp$	Catalyst diameter (m)
$d_r$	Diameter of reactor (m)
$d_i$	Inside diameter of tube (m)
$d_o$	Outside diameter of tube (m)

$E$	Activation energy ( $\frac{J}{mol}$ )
$f_j$	Fugacity of component j (atm)
$g$	Gravitational acceleration ( $m/sec^2$ )
$H$	Expanded bed height (m)
$h$	Time (hour)
$(H_{bd})_b$	Interphase heat transfer coefficient between bubble and dense phase ( $J/m^3 \text{ sec K}$ )
$(K_{bd})_{jb}$	Interphase mass transfer coefficient between bubble and dense phase ( $sec^{-1}$ )
$N_j$	Molar flow rate of component j leaving reactor (Kmoles/sec)
$N_{jb}$	Molar flow rate of component j in the bubble phase (Kmoles/sec)
$N_{jd}$	Molar flow rate of component j in the dense phase (Kmoles/sec)
$N_{jF}$	Molar flow rate of component j in the fresh feed to fluidized bed reactor (Kmoles/sec)
$P$	Reactor pressure (bar)
$Q_F$	Volumetric flow rate of total feed reactor ( $m^3/sec$ )
$Q_b$	Volumetric flow rate of bubble phase gas ( $m^3/sec$ )
$Q_d$	Volumetric flow rate of exit dense phase gas ( $m^3/sec$ )
$Q_{dF}$	Volumetric flow rate of inlet dense phase gas ( $m^3/sec$ )
$R$	The gas constant ( $m^3 \text{ pa/gmol.K}$ )
$r_{NH_3}$	Ammonia rate of reaction ( $kgmol \text{ of } NH_3/h.m^3 \text{ of catalyst bed}$ )
$T_b$	Bubble phase temperature (K)
$T_d$	Dense phase temperature (K)
$T_{exit}$	Fluidized bed exit temperature (K)
$T_F$	Feed gas temperature (K)
$u_b$	Superficial gas velocity of bubble phase gas (m/sec)

$u_0$	Superficial gas velocity of fresh feed gas (m/sec)
$u_{mf}$	Superficial gas velocity of fresh feed gas at minimum fluidization (m/sec)
V	Volume of overall reactor ( $m^3$ )
$x_{jF}$	Mole fraction of component j in fresh feed (dimensionless)
Z	Distance along bed height (m)
$\delta$	Bubble phase volume as a fraction of total bed volume (dimensionless)
$\varphi_j$	Fugacity coefficient of component
$\Delta H_r$	Heat of reaction (J/gmol)
$\rho_g$	Density of gas ( $kg/m^3$ )
$\rho_p$	Density of solid particles ( $kg/m^3$ )
$\varepsilon_{mf}$	Dense phase voidage at minimum fluidization conditions (dimensionless)
$\mu$	Viscosity (kg/m.sec)