1.3.12 Transport properties

Name	*Symbol*	*Definition*	*SI unit*	*Notes*
flux (of a quantity X)	J_X, J	$J_X = A^{-1}\mathrm{d}X/\mathrm{d}t$	(varies)	(1)
volume flow rate	q_V, $\dot{V}$	$q_V = \mathrm{d}V/\mathrm{d}t$	$\mathrm{m^3\ s^{-1}}$	
mass flow rate	q_m, $\dot{m}$	$q_m = \mathrm{d}m/\mathrm{d}t$	$\mathrm{kg\ s^{-1}}$	
mass transfer coefficient	k_d		$\mathrm{m\ s^{-1}}$	
heat flow rate	Φ	$\Phi = \mathrm{d}q/\mathrm{d}t$	W	
heat flux	J_q	$J_q = \Phi/A$	$\mathrm{W\ m^{-2}}$	
thermal conductance	G	$G = \Phi/\Delta T$	$\mathrm{W\ K^{-1}}$	
thermal resistance	R	$R = 1/G$	$\mathrm{K\ W^{-1}}$	
thermal conductivity	λ, k	$\lambda = J_q/(\mathrm{d}T/\mathrm{d}l)$	$\mathrm{W\ m^{-1}\ K^{-1}}$	
coefficient of heat transfer	h, (k, K, α)	$h = J_q/\Delta T$	$\mathrm{W\ m^{-2}\ K^{-1}}$	
thermal diffusivity	a	$a = \lambda/\rho c_p$	$\mathrm{m^2\ s^{-1}}$	
diffusion coefficient	D	$D = -J_n/(\mathrm{d}c/\mathrm{d}l)$	$\mathrm{m^2\ s^{-1}}$	

The following symbols are used in the definitions of the dimensionless quantities: mass (m), time (t), volume (V), area (A), density (ρ), speed (v), length (l), viscosity (η), pressure (p), acceleration of free fall (g), cubic expansion coefficient (α), temperature (T), surface tension (γ), speed of sound (c), mean free path (λ), frequency (f), thermal diffusivity (a), coefficient of heat transfer (h), thermal conductivity (k), specific heat capacity at constant pressure (c_p), diffusion coefficient (D), mole fraction (x), mass transfer coefficient (k_d), permeability (μ), electric conductivity (κ) and magnetic flux density (B).

(1) The flux of molecules to a surface, J_N, determines either the rate at which it would be covered if each molecule stuck, or the rate of effusion through a hole in the surface. In studying the exposure, $\int J_N\,\mathrm{d}t$, of a surface to a gas, surface scientists find it useful to use the product of pressure and time as a measure of the exposure since this product is proportional to the number flux, J_N, times the time $J_N t = (1/4)C\bar{u}\,t = (\bar{u}/4kT)pt$, where C is the number density of molecules, $\bar{u}$ their average speed, k the Boltzmann constant and T the thermodynamic temperature. The unit langmuir (symbol: L) corresponds to the exposure of a surface to a gas at 10^{-6} torr for 1 second.

Name	*Symbol*	*Definition*	*SI unit*
Reynolds number	Re	$Re = \rho v l/\eta$	1
Euler number	Eu	$Eu = \Delta p/\rho v^2$	1
Froude number	Fr	$Fr = v/(lg)^{½}$	1
Grashof number	Gr	$Gr = l^3 g\alpha\Delta T\rho^2/\eta^2$	1
Weber number	We	$We = \rho v^2 l/\gamma$	1
Mach number	Ma	$Ma = v/c$	1
Knudsen number	Kn	$Kn = \lambda/l$	1
Strouhal number	Sr	$Sr = lf/v$	1
Fourier number	Fo	$Fo = at/l^2$	1
Péclet number	Pe	$Pe = vl/a$	1
Rayleigh number	Ra	$Ra = l^3 g\alpha\Delta T\rho/\eta a$	1
Nusselt number	Nu	$Nu = hl/k$	1