Dimensionless parameters

Engineering Fluid Mechanics

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Primary dimension	Notation	Example unit	
		SI	U.S.
Mass	M	kg	lbm
Length	L	cm	in
Time	t	s	s
Temperature	T	degree K	degree F
Current (electrical)	I	A (amps)	A (amps)
Quantity of light	C	candela	candela
Quantity of matter	N	mol	mol

Primary dimensions

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$\{\tau\}$ - SHEAR STRESS - $\frac{F}{A}$

$F = M \cdot a = M \cdot \frac{L}{t^2}$

$A = L^2$

$$\{\tau\} = \frac{M \cdot L}{t^2 \cdot L^2} = \frac{M}{t^2 \cdot L} = \{M^1 t^{-2} L^{-1}\}$$

Primary dimensions

$$\sum \vec{F} = \sum_{out} \beta \dot{m} \vec{V} - \sum_{in} \beta \dot{m} \vec{V}$$

$$\{F\} = \left\{\frac{M \cdot L}{t^2}\right\} = \left\{\frac{M}{t}, \frac{L}{t}\right\} - \left\{\frac{M \cdot L}{t\,t}\right\}$$

$$\{M^1 L^1 t^{-2}\} \simeq \{M^1 L^1 t^{-2}\}$$

Dimensional homogeneity

Dimensionless parameters

$$\{\text{DIMENSIONLESS PARAMETER}\} = \{1\} = \{M^0 L^0 t^0 T^0 \ldots\}$$

$$f = \frac{8\tau_w}{\rho V^2}$$

$$\{f\} = \frac{\{M^1 L^{-1} t^{-2}\}}{\{M^1 L^{-3}\}\{L^2 t^{-2}\}} = \{M^0 L^0 t^0\}$$

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$$Re = \frac{\rho V L}{\mu}$$

$$\{Re\} = \frac{[M^1 L^{-3}][L^1 t^{-1}][L^1]}{[M^1 L^{-1} t^{-1}]} = \frac{M^1 L^{-1} t^{-1}}{M^1 L^{-1} t^{-1}}$$

$$\{Re\} = \{M^0 L^0 t^0\}$$

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$$F_D = \frac{1}{2} C_D \rho V^2 A$$

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$$F_D = \frac{1}{2} C_D \rho V^2 A$$

$$C_D = \frac{2F_D}{\rho V^2 A}$$

$$\{C_D\} = \frac{[M^1 L^1 t^{-2}]}{[M^1 L^{-3}][L^2 t^{-2}][L^2]} = \frac{[M^1 L^1 t^{-2}]}{[M^1 L^1 t^{-2}]}$$

$$\{C_d\} = \{M^0 L^0 t^0\}$$

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