Table 17.3 Summary of Convection Heat Transfer Correlations for External Flow

Flow	Coefficient	Correlation[a]		Range of Applicability
Flat plate				
Laminar	—	$\delta = 5x\,\mathrm{Re}_x^{-1/2}$	(17.21)	
	Local	$\mathrm{Nu}_x = 0.332\,\mathrm{Re}_x^{1/2}\,\mathrm{Pr}^{1/3}$	(17.23)	$0.6 \le \mathrm{Pr} \le 50$
	—	$\delta_t = \delta\,\mathrm{Pr}^{-1/3}$	(17.24)	
	Average	$\overline{\mathrm{Nu}}_L = 0.664\,\mathrm{Re}_L^{1/2}\,\mathrm{Pr}^{1/3}$	(17.26)	$0.6 \le \mathrm{Pr} \le 50$
Turbulent	Local	$\delta = 0.37x\,\mathrm{Re}_x^{-1/5}$	(17.27)	$\mathrm{Re}_x \le 10^8$
	Local	$\mathrm{Nu}_x = 0.0296\,\mathrm{Re}_x^{4/5}\,\mathrm{Pr}^{1/3}$	(17.28)	$\mathrm{Re}_x \le 10^8$, $0.6 \le \mathrm{Pr} \le 60$
	Average	$\overline{\mathrm{Nu}}_L = 0.037\,\mathrm{Re}_L^{4/5}\,\mathrm{Pr}^{1/3}$	(17.32)	$\mathrm{Re}_{x,c} = 0$, $0.6 \le \mathrm{Pr} \le 60$
Mixed	Average	$\overline{\mathrm{Nu}}_L = (0.037\,\mathrm{Re}_L^{4/5} - 871)\mathrm{Pr}^{1/3}$	(17.31)	$\mathrm{Re}_{x,c} = 5 \times 10^5$, $10^5 \le \mathrm{Re}_L \le 10^8$ $0.6 \le \mathrm{Pr} \le 60$
Cylinders[b]	Average	$\overline{\mathrm{Nu}}_D = C\,\mathrm{Re}_D^m\,\mathrm{Pr}^{1/3}$ (Table 7.2)	(17.34)	$\mathrm{Pr} \ge 0.70$
	Average	$\overline{\mathrm{Nu}}_D = 0.3 + \{0.62\,\mathrm{Re}_D^{1/2}\,\mathrm{Pr}^{1/3} \times [1 + (0.4/\mathrm{Pr})^{2/3}]^{-1/4}\} \times [1 + (\mathrm{Re}_D/282{,}000)^{5/8}]^{4/5}$	(17.35)	$\mathrm{Re}_D\,\mathrm{Pr} > 0.2$
Sphere	Average	$\overline{\mathrm{Nu}}_D = 2 + (0.4\,\mathrm{Re}_D^{1/2} + 0.06\,\mathrm{Re}_D^{2/3})\mathrm{Pr}^{0.4}(\mu/\mu_s)^{1/4}$	(17.36)	$3.5 < \mathrm{Re}_D < 7.6 \times 10^4$ $0.71 < \mathrm{Pr} < 380$

[a]Thermophysical properties are evaluated at the film temperature, $T_f = (T_\infty + T_s)/2$, for all the correlations except Eq. 17.36. For that correlation, properties are evaluated at the free stream temperature T_∞ or at the surface temperature T_s if designated with the subscript s.

[b]For the cylinder with noncircular cross section, use Eq. 17.34 with the constants listed in Table 17.2.