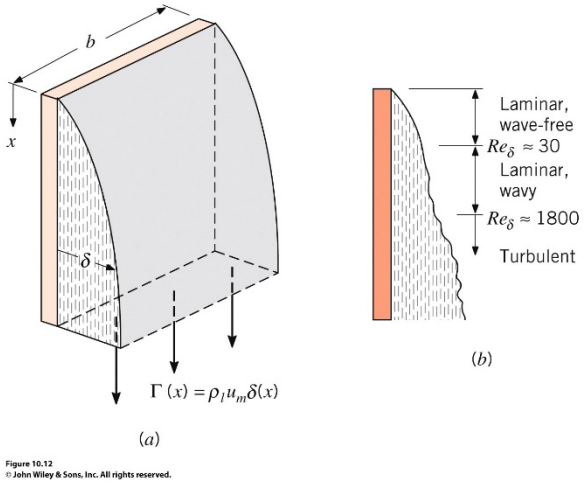
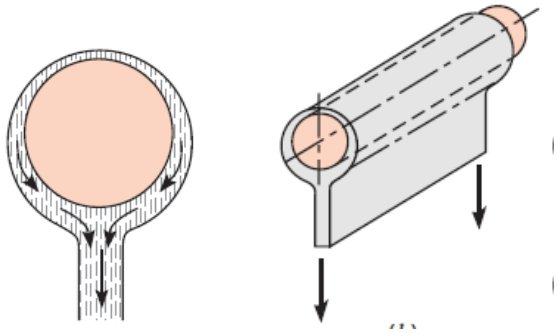
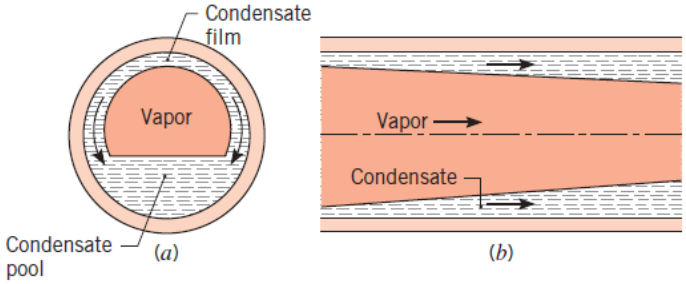
Chapter 5

Table 1: Film condensation [a]

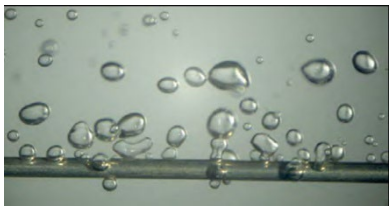
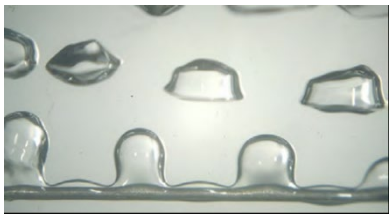
Geometry	Recommended Correlation	Restrictions
1-Vertical plate [b]  	$h'_{fg} = h_{fg} + 0.68c_{p,l}(T_{\text{sat}} - T_s)$ **Vertical** (10.32) (10.42)-(10.45) **Inclined** above + $(g \rightarrow g\cos\theta)$	Laminar, Ja < 0.1, $1 \le Pr \le 100$ $\rho_l \gg \rho_v$ $\rho_l \gg \rho_v$
2-Spheres & cylinders (external condensation) 	(10.46) $h'_{fg} = h_{fg} + 0.68c_{p,l}(T_{\text{sat}} - T_s)$ Sphere: C = 0.826 Cylinder: C = 0.729 **vertical tier of N horizontal unfinned tubes** (10.49), n = -1/6 **Inclined** above + $(g \rightarrow g\cos\theta)$ **Finned tube** (10.48)	$(L/D > 1.8\tan\theta)$
3-Horizontal tube (internal condensation)  	(10.50) **a) low vapor velocity** (10.46), C = 0.555 $h'_{fg} = h_{fg} + 0.375c_{p,l}(T_{\text{sat}} - T_s)$ **b) high vapor velocity** (10.51)[c]	$Re_{v,i} < 35000$ $\dot{m}/A > 500 kg/s.m^2$

[a] Fluid properties at film temperature $(T_f = (T_s + T_{\text{sat}})/2)$, and h_{fg} and vapor properties (ρ_v) at T_{sat}

[b] May be used for condensation on the inner or outer surface of a vertical tube of radius $R \gg \delta$.

[c] All properties at T_{sat}

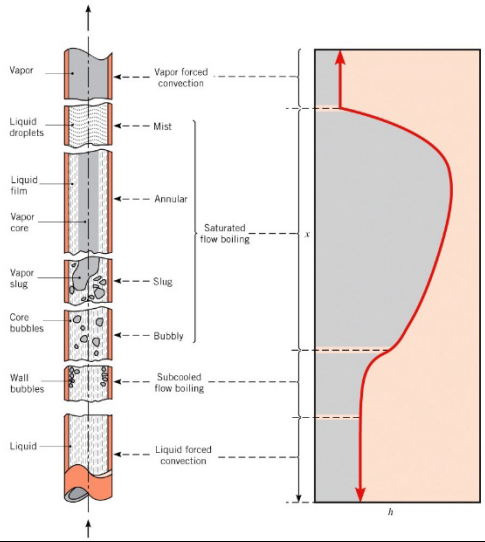
Table 2: Pool boiling

Geometry	Recommended Correlation	Restrictions
1-Free convection boiling ($\Delta T_e \leq \Delta T_{e,A}$) $\Delta T_{e,A}$~5°C	**Natural convection relations**	
2-Nucleate boiling [a] ($\Delta T_{e,A} \leq \Delta T_e \leq \Delta T_{e,C}$) $\Delta T_{e,C}$~30°C 	(10.5) and Table 10.1 **Critical heat flux** (10.6) Large horizontal plate: C = 0.149 Sphere, cylinder, and others: C = 0.131 **Minimum heat flux** (10.7) C = 0.09	Clean surface $Bo^{-1/2} > 0.2$ moderate pressures
3-Film boiling [b] ($\Delta T_e \geq \Delta T_{e,D}$) $\Delta T_{e,D}$~120°C 	(10.8) $h'_{fg} = h_{fg} + 0.80 c_{p,v}(T_s - T_{sat})$ Horizontal cylinder: C = 0.62 Sphere: C = 0.67 **Including Radiation ($T_s \geq 300°C$)** (10.9)-(10.11)	

[a] All properties at T_{sat}

[b] Vapor properties at system pressure and film temperature ($T_f = (T_s + T_{sat})/2$), and ρ_l and h_{fg} at T_{sat}

Table 3: Forced convection boiling

Geometry	Recommended Correlation	Restrictions
1- Flow over a cylinder in cross-flow	critical heat flux: (10.12)-(10.14)	
2-Flow in tubes [a] 	**single-phase forced convection region** (8.62) [a] **saturated flow boiling region** max (10.15a,10.15b), (10.16) and Table 10.2 $Fr \lesssim 0.04, f(Fr) = 2.63\, Fr^{0.3}$. and otherwise, $f(Fr) = 1$ $Fr = (\dot{m}''/\rho_l)^2/gD$ h_{sp} from (8.62) [a]	turbulent flow turbulent flow $Co = \sqrt{\sigma/(g[\rho_l - \rho_v])}/D_h \lesssim 1/2$ smooth tubes

[a] All properties at T_{sat}