Summary of Chen's correlation for boiling heat transfer to saturated fluids in convective flow

Original paper: Chen, J. C. (1966). Correlation for boiling heat transfer to saturated fluids in convective flow. Industrial & Engineering Chemistry Process Design and Development, 5(3), 322-329.

$$\mathrm{h} = \mathrm{h}_{\mathrm{micro}} + \mathrm{h}_{\mathrm{macro}}$$

$$\mathrm{h}_{\mathrm{macro}} = 0.023(Re_l)^{0.8}(Pr_l)^{0.4}\left(\frac{k_l}{D}\right)F$$

F is defined as $\left(\frac{\mathrm{Re}}{\mathrm{Re_l}}\right)^{0.8}$, $\mathrm{Re} = \mathrm{Re_l}\mathrm{F}^{1.25}$ is the effective Reynolds number for the two-phase flow.

$$\mathrm{h}_{\mathrm{micro}} = 0.00122\left(\frac{\mathrm{k_l^{0.79}C_{pl}^{0.45}\rho_l^{0.49}g_c^{0.25}}}{\sigma^{0.5}\mu_l^{0.29}\lambda^{0.24}\rho_v^{0.24}}\right)(\Delta T)^{0.24}(\Delta P)^{0.75}S$$

S is defined as the ratio of the effective superheat to the total superheat of the wall:

$$\mathrm{S} = \left(\frac{\Delta \mathrm{T_e}}{\Delta T}\right)^{0.99}$$

σ is the vapor-liquid surface tension, λ is the latent heat of vaporization, $\Delta\mathrm{T} = \mathrm{T_w} - T_{sat}$, ΔP is the difference in vapor pressure corresponding to ΔT ($\frac{\Delta \mathrm{P}}{\Delta \mathrm{T}} = \frac{\lambda\rho_v}{\mathrm{T}}$, Clausius and Clapeyron equation).

$$\mathrm{F} \approx 3 * \frac{1}{\mathrm{x_{tt}}}^{0.684} \quad (\mathrm{x_{tt}} < 5)$$

$\mathrm{x_{tt}}$ is Martinelli parameter $\left(\frac{1-\mathrm{x}}{\mathrm{x}}\right)^{0.9}\left(\frac{\rho_v}{\rho_l}\right)^{0.5}\left(\frac{\mu_l}{\mu_v}\right)^{0.1}$

$$\mathrm{F} = 1 \ (\mathrm{x_{tt}} \geq 5)$$

$$\mathrm{S} \approx -0.5\log_{10} Re + 2.9 \ \ (\mathrm{Re} < 4\mathrm{e}5)$$

$$\mathrm{S} = 0.1 \ (\mathrm{Re} \geq 4\mathrm{e}5)$$