Two Phase Flows

(Section 15)

PRESSURE DROP IN SUBCOOLED BOILING

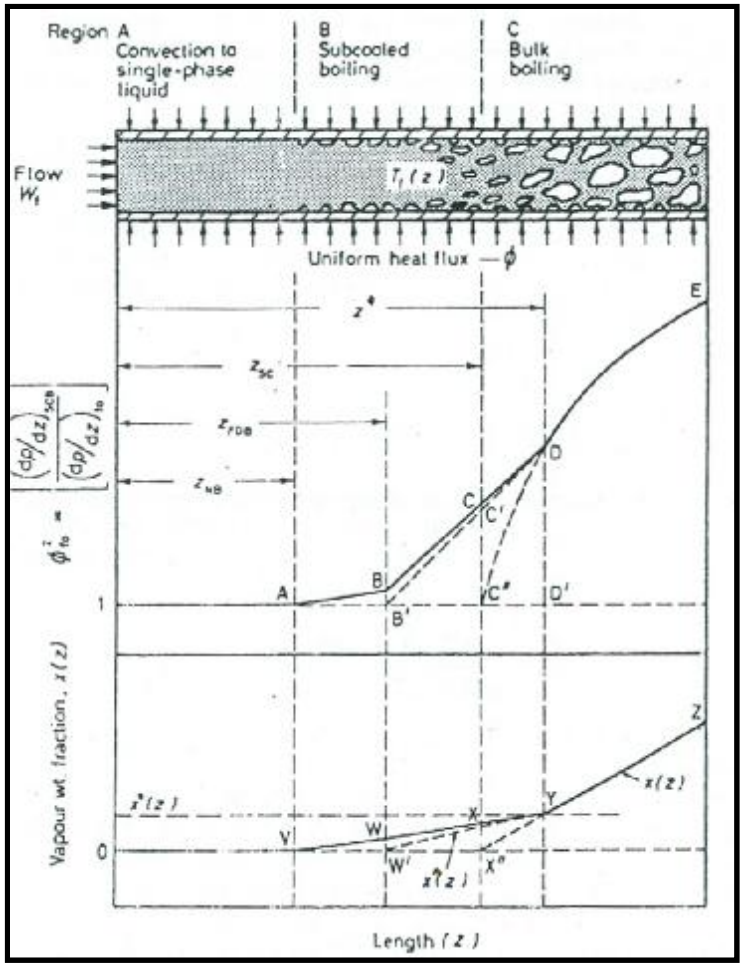
By: Prof. M. H. Saidi

Center of Excellence in Energy Conversion

School of Mechanical Engineering

Sharif University of Technology

Pressure drop in subcooled boiling



Slightly subcooled region:

$$z < z_{FDB} \text{ or } x'(z) = 0$$

$$\Delta T_{SUB}(z) > \Delta T_{SUB}(z)_{FDB}$$

$$z_d < z < z^*$$

$$x'(z) = \frac{4}{DGi_{fg}}\left[\frac{f}{1+e}\right](z - z_d)$$

$$z^* = \frac{Gc_{pf}D}{4}\left[\frac{(\Delta T_{SUB})_i}{f} + \frac{h}{Gev_f}\right]$$

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$z > z^*$

$$x(z) = \frac{4f}{DGi_{fg}}(z - z_{SC})$$

$$x(z^*) = \frac{Gc_{pf}Dh}{4Ge\,v_f}$$

$$f_{fo}^2 = \frac{(1 - x(z))^{1.75}}{(1 - a)^2}$$

Highly subcooled region:

$$t_W = \frac{1}{2} r_f u_{f\infty}^2 \left[2.87 + 1.58 \ln\left(\frac{z}{e}\right) \right]^{-2.5}$$

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Experimental works:

$$\left[\left(\frac{dp}{dz}\right)_{SCB}\Big/\left(\frac{dp}{dz}\right)_{fo}\right]_T = fn\left[1-\frac{\Delta T_{SUB}}{\Delta T_{SUB}\left(z_{NB}\right)}\right] = fn\left(\frac{z-z_{NB}}{z_{SC}-z_{NB}}\right)$$

$$\left[\left(\frac{dp}{dz}\right)_{SCB}\Big/\left(\frac{dp}{dz}\right)_{fo}\right]_T = \cosh\left[a'\left(1-\frac{\Delta T_{SUB}}{\Delta T_{SUB}\left(z_{NB}\right)}\right)\right]$$

$$a' = 1.2 + 4.6\left(\frac{f}{10^6}\right)$$

$$\frac{f}{f_{SAT}} = \frac{T_f\left(z\right)-T_{fi}}{T_{SAT}-T_{fi}} = \left[\frac{\left(\Delta T_{SUB}\right)_i - \Delta T_{SUB}\left(z\right)}{\left(\Delta T_{SUB}\right)}\right]$$

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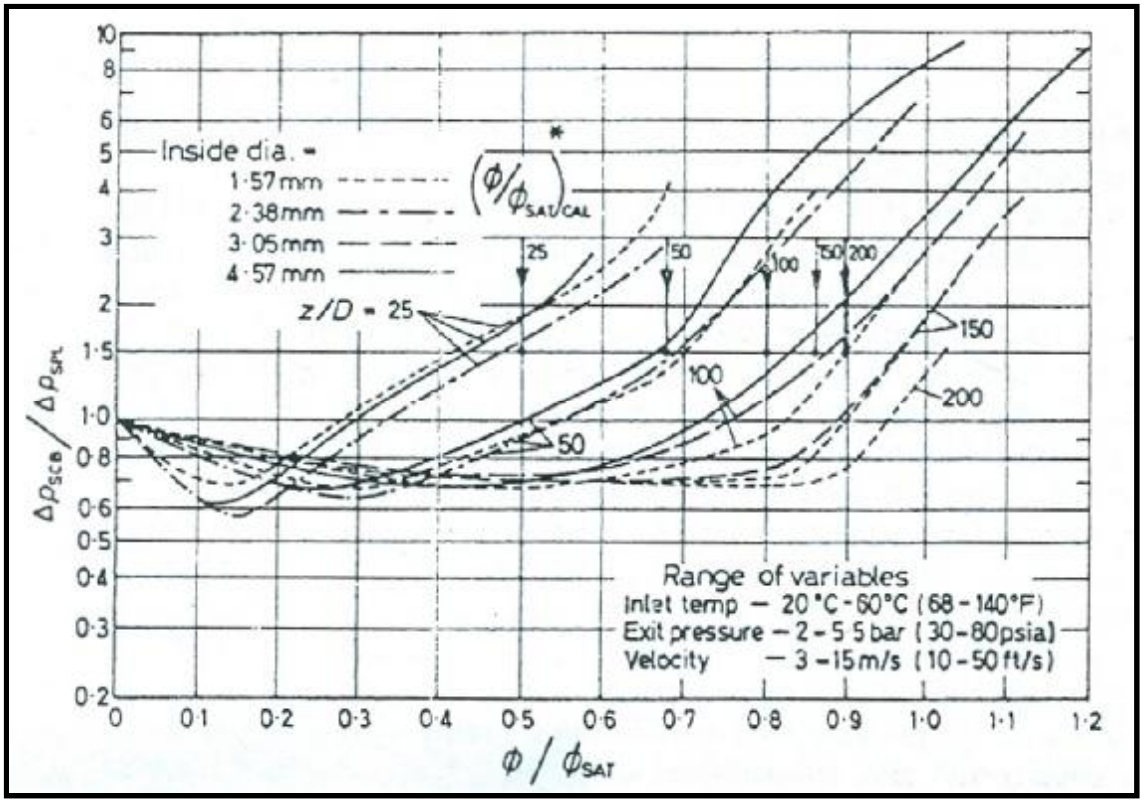

$$\left(\frac{f}{f_{SAT}}\right)^{*}=\left[\frac{\left(\Delta T_{SUB}\right)_i-\Delta T_{SUB}\left(z\right)_d}{\left(\Delta T_{SUB}\right)}\right]$$

$$f_{SAT}=\frac{Gc_{pf}D}{4z}\left(\Delta T_{SUB}\right)_i$$

$$\left(\frac{f}{f_{SAT}}\right)^{*}=\frac{1}{1+\left[\left(\frac{hc_{pf}}{4v_f}\right)\Big/\left(\frac{z}{D}\right)\right]}$$