Exercises – Serie 2

Equilibrium of a nucleus

1. Write the equilibrium condition for a spherical nucleus of radius R, containing gas and vapor, within a liquid at rest at the pressure p_∞.
2. Assuming an isothermal transformation and a constant mass of gas, find the equation of the curve $p_\infty(R)$ as a function of the parameters p_{g0} and R_0.
3. Find the radius R_c at which the curve $p_\infty(R)$ is minimum. Compute the corresponding pressure at this minimum. This pressure is the critical pressure p_c (or Blake threshold pressure).
4. Let us consider 3 bubbles of radius R_0 =1mm, 1µm and 1nm, in equilibrium at $p_{\infty 0} = 1$ bar. Compute the corresponding pressure of the gas p_{g0} inside each bubble (we assume a temperature of 20°C → $p_v = 2300\ Pa, S = 0.072\ \ N/m$).
5. Find the critical radius and the critical pressure corresponding to each bubble. Are the bubbles in a stable equilibrium?
6. The difference $p_v - p_c$ represents the static delay to cavitation of a nucleus. Compute this quantity for each bubble. Sketch the general form of the curve representing the static delay to cavitation as a function of the critical radius.
7. Using *Matlab* or *Excel*, plot the curve $p_\infty(R)$ corresponding to each bubble.