22.06 **ENGINEERING OF NUCLEAR SYSTEMS - Fall 2010**

Problem Set 6

Pure Substance Model and Two-Phase Flow Basics

1) Using the steam tables (or the phase diagram of water), identify the phases corresponding to the following P-T combinations:
   a) P=1.0 MPa, T=150°C
   b) P=9.0 MPa, T=320°C
   c) P=0.1 MPa, T=-10°C

   Same as above for the following P-h combinations:
   d) P=9.0 MPa, h=1500 kJ/kg
   e) P=7.0 MPa, h=2100 kJ/kg
   f) P=7.0 MPa, h=3000 kJ/kg

   - Determine the temperature and quality (x) for states d and e.
   - Put states a, b, d, e and f on a qualitative T-s diagram (show the isobar line for each state).

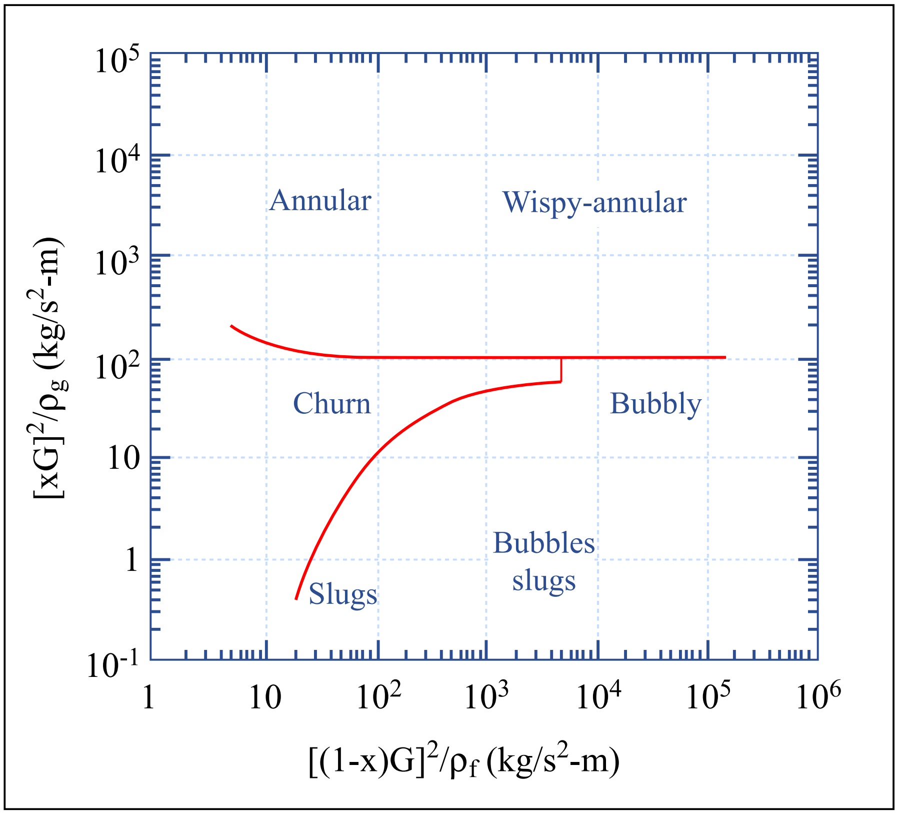
2) The coolant density in a BWR fuel assembly must be kept reasonably high to ensure sufficient neutron moderation. Assuming a minimum required coolant (mixture) density ρ_m=200 kg/m^3, determine the maximum acceptable void fraction and flow quality in the BWR fuel assembly. Assume S=2; the BWR operating pressure is 7.0 MPa.

3) In a BWR fuel assembly the flow quality ranges from zero (no steam) at the inlet to x~0.13 at the outlet. Using the two-phase flow map in Figure 1 below, determine the flow regime at the following values of the flow quality, x=0.01, x=0.03 and x=0.10 (corresponding to various intermediate axial locations within the fuel assemblies). The coolant mass flow rate in the fuel assembly is $\dot{m}$=16 kg/s; the fuel assembly flow area is A=91 cm^2. The BWR operating pressure is 7.0 MPa.

4) Consider the flow of a liquid-vapor mixture in a vertical channel. Using your physical intuition, determine whether S>1, S~1 or S<1 for each of the following flow regimes:

   - Bubbly flow (upward)
   - Bubbly flow (downward)
   - Dispersed bubbly flow (upward)
   - Dispersed bubbly flow (downward)
   - Plug flow (upward)
   - Annular flow (upward)

- Mist flow (upward)
- Mist flow (downward)



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