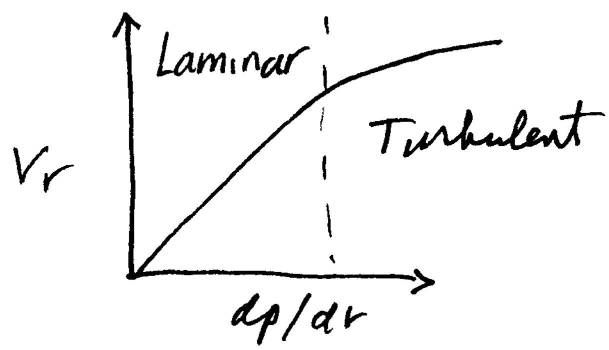
Petroleum Engineering 311
Test 5

February 12, 2003

1. Sketch a graph of v_r vs dp/dr for the radial flow of a real gas. Indicate the laminar and turbulent flow regimes. HINT: $v_r = \frac{k}{\mu}\frac{dp}{dr}$



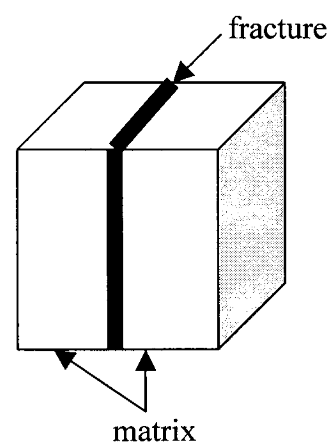
2. Give two examples of non-darcy flow. List causes and practical implications of each.

a) Gas slippage — mean free path of gas molecules → diameter of pores — must account for in Lab when determining k air

b) Inertial & Turbulent Effects — acceleration/deceleration of gas molecules in pore throats/pores — high pressure gradients — must accoat for in Lab and field in high rate gas flow

3. Flow is assumed to occur *parallel* to the bedding planes in a radial, layered system and *normal* to the bedding planes in a radial, composite system.

4. Consider linear, parallel flow in a fractured formation. See sketch at right. Assume fluid flows into the front face of the cube and flows through the matrix and the fracture in parallel. Let the total cross-sectional area be the sum of the matrix and fracture cross-sectional areas; i.e., $A_t = A_{ma} + A_f$, and the permeability of the matrix and fracture be k_{ma} and k_f, respectively.



Find an expression for the average permeability, $\bar{k}$.

$$q_t = q_{ma} + q_f \quad , \quad \Delta p_t = \Delta p_{ma} = \Delta p_f$$

$$\frac{\bar{k} A_t \Delta p_t}{\mu L} = \frac{k_{ma} A_{ma} \Delta p_{ma}}{\mu L} + \frac{k_f A_f \Delta p_f}{\mu L} \Rightarrow$$

$$\bar{k} = \frac{k_{ma} A_{ma} + k_f A_f}{A_t}$$