Petroleum Engineering 311
Test 4

February 5, 2003

1. In class, we derived the following Darcy flow equation for horizontal, linear flow of a real gas at standard conditions,

$$q_{sc} = \frac{T_{sc}}{p_{sc}T}\frac{kA}{L}\left[\frac{m(p_1)-m(p_2)}{2}\right], \text{ or } q_{sc} = C\frac{kA}{TL}[m(p_1)-m(p_2)],$$

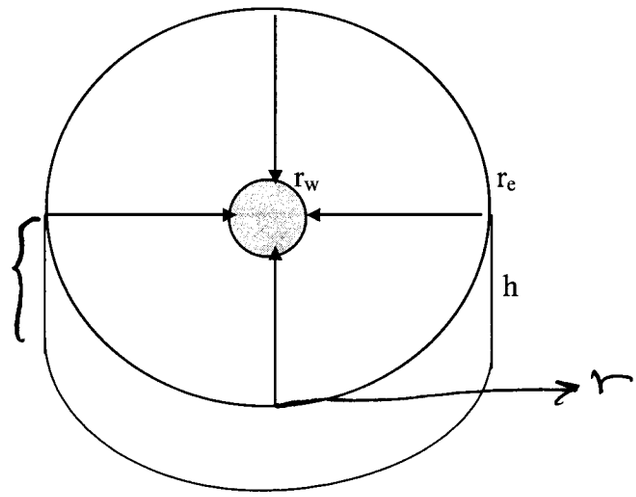
where m(p) is real gas flow potential and has units of $psia^2/cp$. Find the value of C and its units for calculation of q_{sc} (scf/day) in the state of Louisiana, where standard conditions are 60°F and 15.025 psia.

Some useful constants are: $1.1271 \times 10^{-3}\ \frac{bbls \cdot cp}{md \cdot ft \cdot day \cdot psi}$, $5.61458\ \frac{ft^3}{bbl}$, and 0°F = 459.67°R

Units of C are $\frac{cp \cdot ft^3 \cdot {}^\circ R}{md \cdot ft \cdot day \cdot psia^2}$

$$C = \frac{1}{2}\left|\frac{1.1271\times10^{-3}\ bbls\cdot cp}{md\cdot ft\cdot day\cdot psia}\right|\left|\frac{(60+459.67)^\circ R}{15.025\ psia}\right|\left|\frac{5.61458\ ft^3}{bbl}\right| = 0.10944\ \frac{cp\cdot ft^3\cdot {}^\circ R}{md\cdot ft\cdot day\cdot psia^2}$$

2. Consider the sketch of a right cylindrical shaped volume of rock with thickness h, drained by a vertical well with radius r_w.



a. Derive the Darcy flow equation for horizontal, radial flow of an incompressible fluid.

b. List your assumptions.

Flow area

a. Derivation

$$v_s = \frac{q_s}{A} = -\frac{k}{\mu}\left(\frac{dp}{ds} - \rho g\frac{dz}{ds}\right)$$

$$\frac{q_r}{2\pi rh} = \frac{k}{\mu}\frac{dp}{dr}$$

$$q_r\int_{r_w}^{r_e}\frac{dr}{r} = \frac{2\pi kh}{\mu}\int_{p_w}^{p_e}dp$$

$$q_r = \frac{2\pi kh(p_e-p_w)}{\mu \ln r_e/r_w}$$

b. Assumptions

$ds = -dr$, $A = 2\pi rh$ (h const), $\frac{dz}{ds} = 0$

Darcy law applies (darcy flow, ss flow (q const), nonreactive fluid (k = const), single (S = 1)

isothermal conditions (μ const)

~~single~~ incompressible fluid