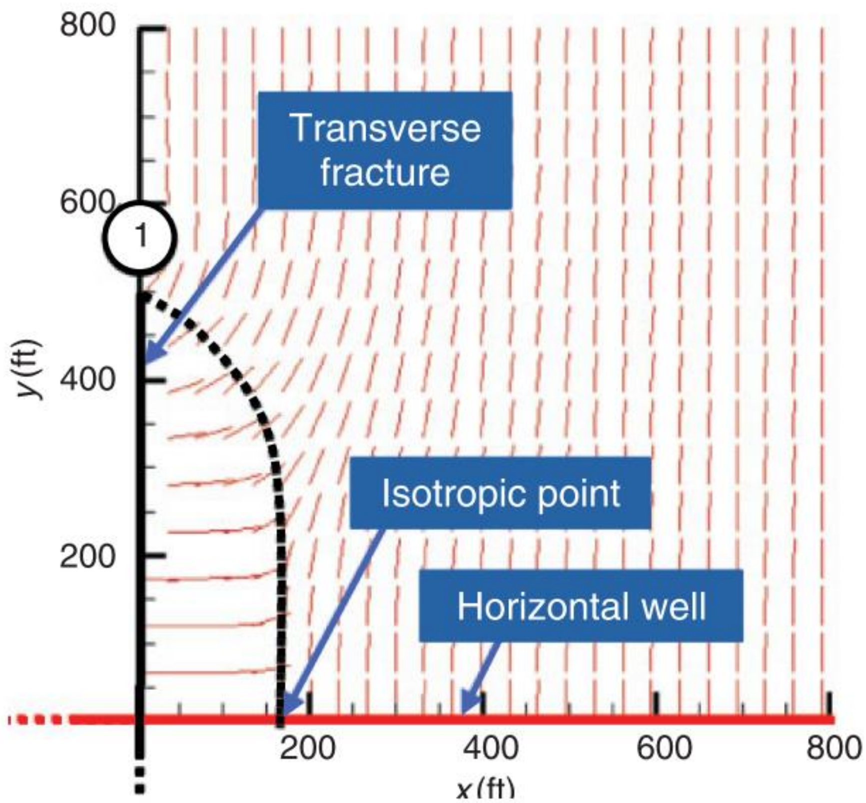
Project #8: Hydraulic Fracturing

1) <u>Stress shadows and interference</u>

Read the paper "Roussel, N. P., & Sharma, M. M. (2011). Optimizing fracture spacing and sequencing in horizontal-well fracturing. *SPE Production & Operations*, *26*(02), 173-184."

(a) Calculate the point of principal stress reversal (isotropic point in Fig. 11) with a constant pressure and plane-strain solution utilizing your FreeFEM++ linear elasticity code. Use all parameters as in Table 1. <u>Note</u>: $\Delta S_{yy} = \nu\ (\Delta S_{xx}+\Delta S_{zz})$

(b) Repeat (a) for fracture width 6mm, 8mm, and 10 mm. Plot stress reversal distance as a function of fracture width



S_{Hmax} direction around a propped hydraulic fracture (Roussel and Sharma, 2011)

2) Coupled hydraulic fracturing modeling

A single hydraulic fracture treatment will be performed in a tight sandstone. The hydraulic fracture height is expected to be h_f = 170 ft. The tight sandstone has a plane-strain modulus E' = 8.9 MMpsi. The (two-wing) injection rate will be 50 bbl/min (constant) during 1 hour.

Compute:

a. The expected fracture half-length x_f, fracture width at the wellbore $w_{w,0}$, and net pressure p_n as a function of time with the PKN model (no leak-off) assuming the fracturing fluid has a (constant) viscosity 2 cP.

b. The expected fracture half-length x_f, fracture width at the wellbore $w_{w,0}$, and net pressure p_n as a function of time with the PKN model (no leak-off). Now the fracturing fluid has a viscosity 2 cP with no proppant (initial 10 min), and increases in steps of 10 min with 2 cP in each step (due to increasing proppant concentration).

c. What should you do to your solution in order to consider leak-off? Justify and explain briefly the algorithm to calculate x_f, $w_{w,0}$, and p_n.

Hint: convert all quantities to the SI system first

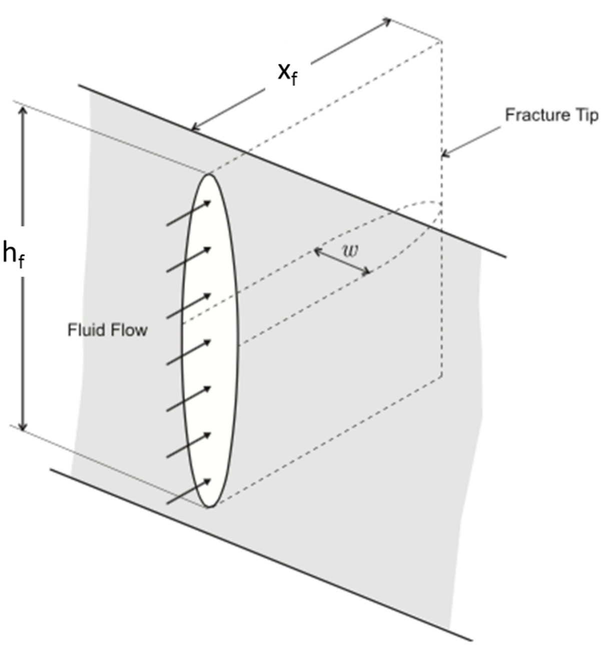


Fig. 1. Schematic showing PKN fracture geometry.

Figure: Adachi et al. 2007

(1) Linear elasticity
(2) Negligible Toughness
(3) No leak-off
(4) Laminar flow, constant injection rate

- Fracture half-length

$$x_f = 0.524\left(\frac{i^3 E'}{\mu\, h_f^4}\right)^{1/5} (t)^{4/5}$$

- Maximum width at the wellbore

$$w_{w,0} = 3.04\left(\frac{i^2 \mu}{E' h_f}\right)^{1/5} (t)^{1/5}$$

- Net Pressure at the wellbore

$$p_{n,w} = 1.52\left(\frac{E'^4\, i^2 \mu}{h_f^6}\right)^{1/5} (t)^{1/5}$$