



UNCONVENTIONAL RESERVOIR ENGINEERING PROJECT
COLORADO SCHOOL OF MINES



Research Summary

A Trilinear Flow Model for Fractured Horizontal Shale-Gas Wells

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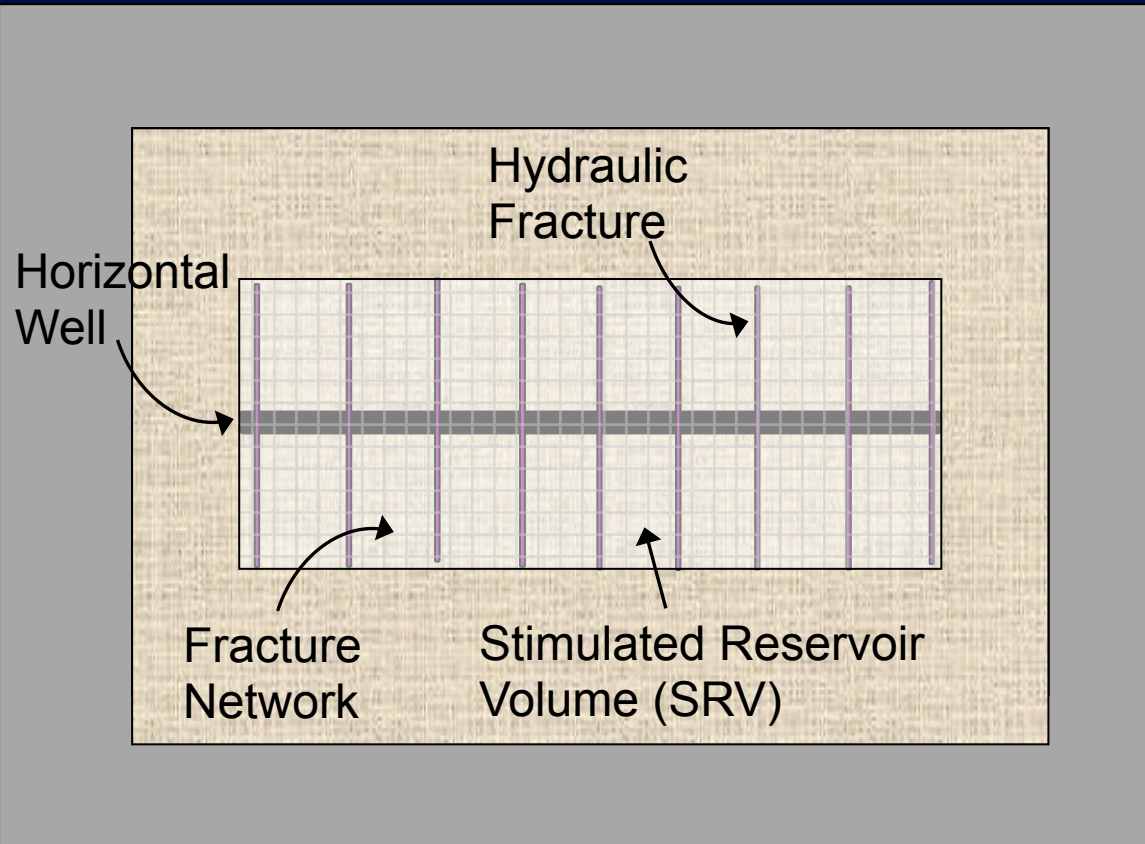


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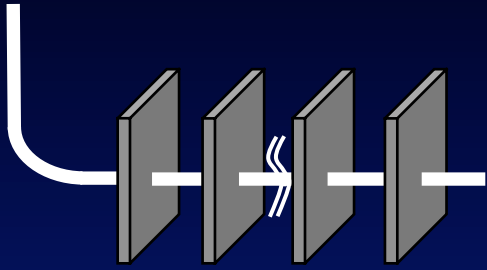
Kick-Off Meeting, November 16, 2012, Golden, Colorado

Trilinear Flow Model for Fractured Horizontal Wells

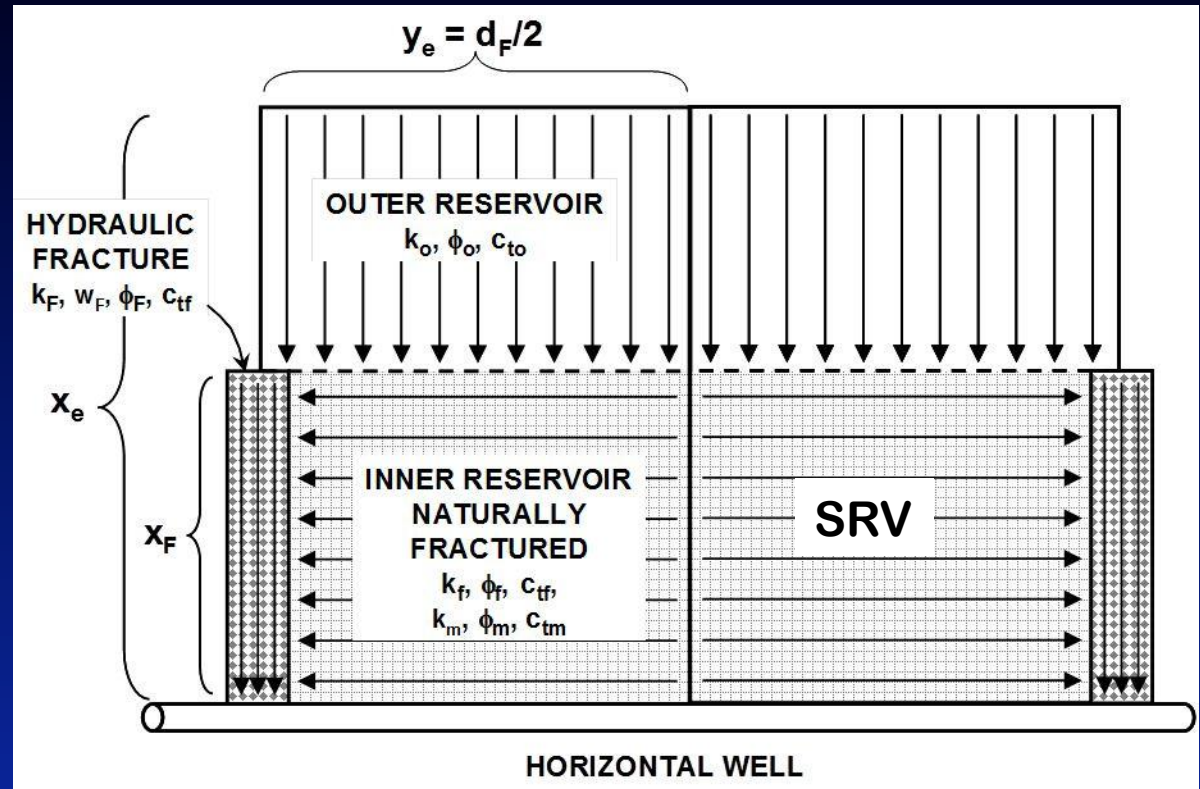
Representation of SRV as Dual-Porosity Medium



Trilinear Flow Model for Fractured Horizontal Wells



Flow convergence is essentially linear in the fractures and between the fractures. Outer reservoir response will also be linear initially.



Linear flows in three contiguous flow regions are coupled



Trilinear Flow Model for Fractured Horizontal Wells

$$\bar{p}_{wD} = \frac{\pi}{C_{FD}s\sqrt{\alpha_F} \tanh(\sqrt{\alpha_F})} + s_c$$

$$\alpha_F = \frac{2\beta_F}{C_{FD}} + \frac{s}{\eta_{FD}}$$

α_F and β_F are functions of matrix, hydraulic fracture, and natural fracture properties,

$$\beta_F = \sqrt{\alpha_R} \tanh[\sqrt{\alpha_R}(y_{eD} - w_{FD}/2)]$$

$$\alpha_R = \frac{\beta_R}{C_{RD}y_{eD}} + u \quad \beta_R = \sqrt{s/\eta_{RD}} \tanh[\sqrt{s/\eta_{RD}}(x_{eD} - 1)]$$

$$u = sf(s) \quad f(s) = 1 + \sqrt{\frac{\lambda\omega}{3s}} \tanh\left(\sqrt{\frac{3\omega s}{\lambda}}\right) \quad f(s) \text{ defines fluid transfer from matrix to fractures}$$



Trilinear Flow Model for Fractured Horizontal Wells

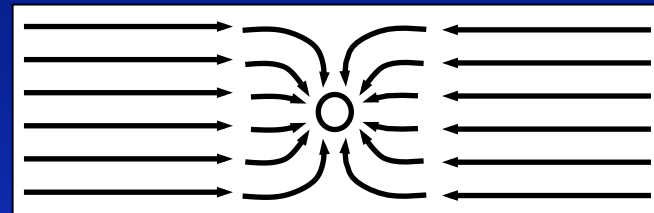
Trilinear model assumes linear flow toward the horizontal well and fracture intersection (similar to a vertical well fracture).

Because the actual intersection is a small circular region, this causes a flow choking skin.

$$\bar{p}_{wD} = \frac{\pi}{C_{FD} s \sqrt{\alpha_F} \tanh(\sqrt{\alpha_F})} + s_c$$

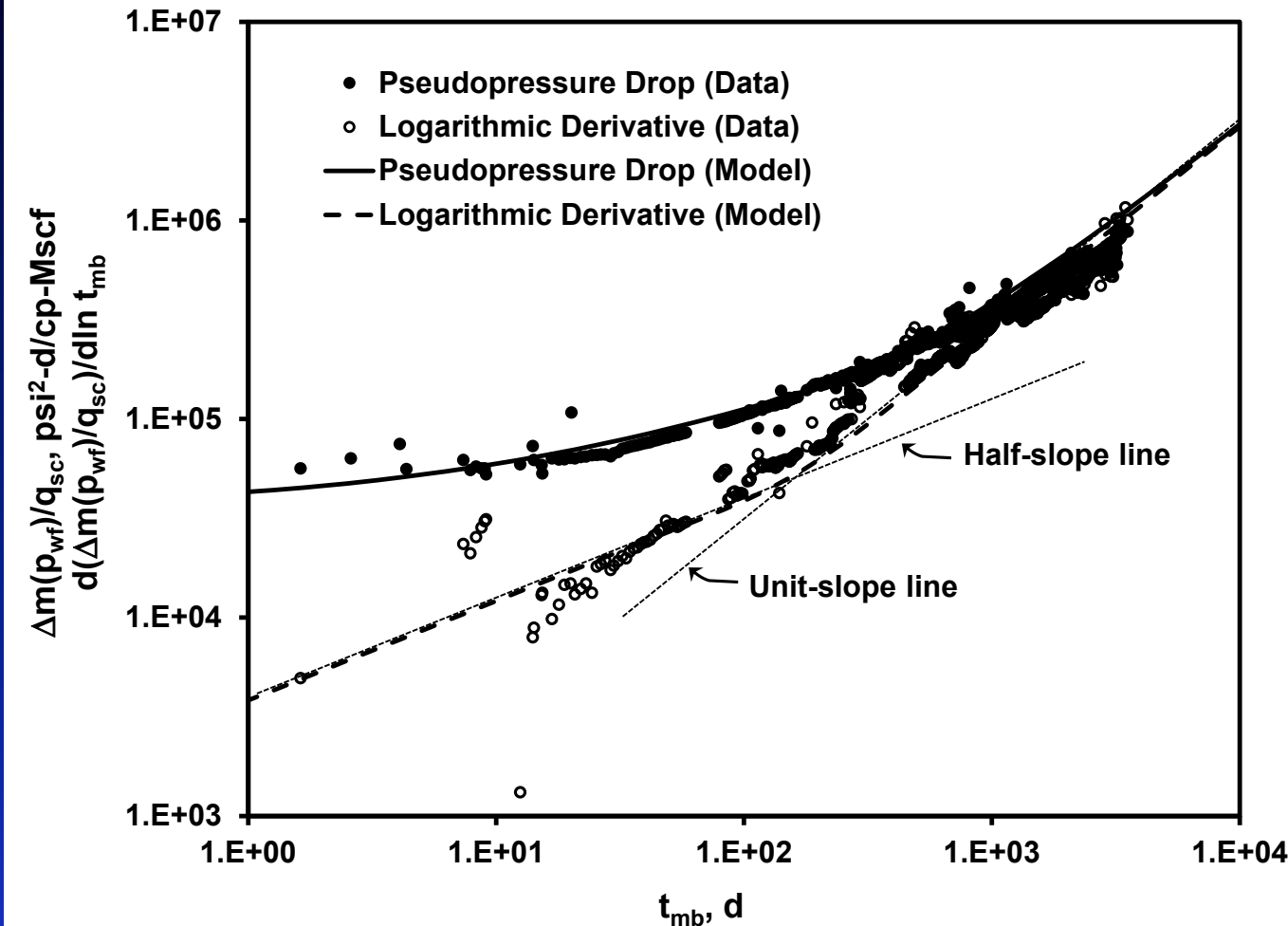
Flow choking skin

$$s_c = \frac{k_I h_I}{k_F w_F} \left[\ln \left(\frac{h}{2r_w} \right) - \frac{\pi}{2} \right]$$



Trilinear Flow Model for Fractured Horizontal Wells

Transient Data Analysis by Trilinear Flow Model



SPE 125043
Brown et al., 2009



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Effect of Reservoir-Fracture Density on Productivity

