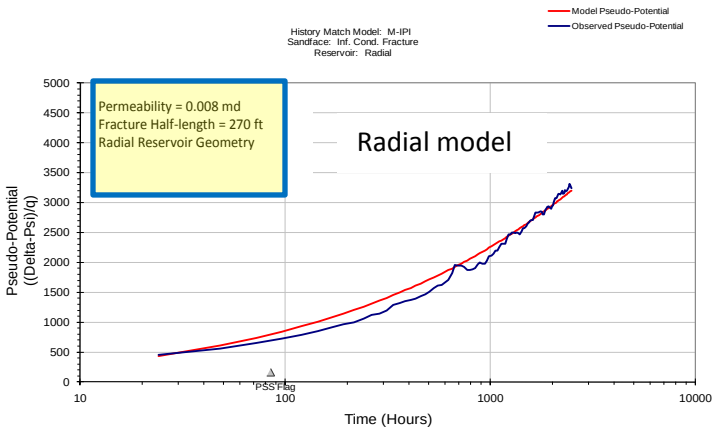
Analytical vs. Finite Difference Simulators

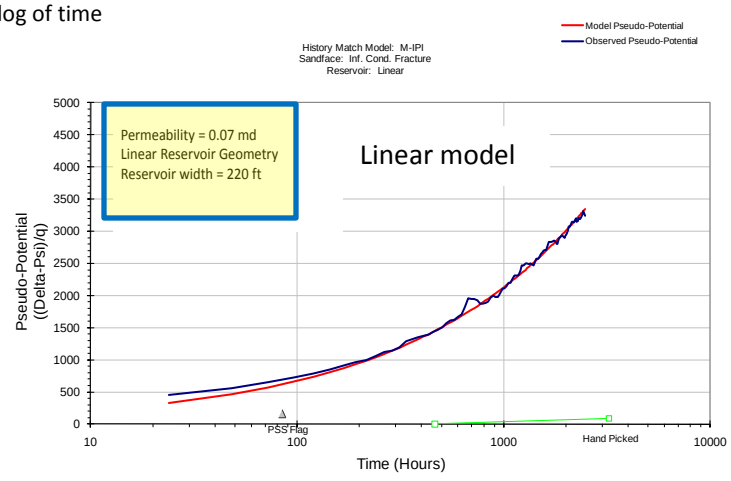
Analytical Model: A mathematical tool with closed form solutions where the solutions are used to describe changes in a system. Examples of analytical solutions include productivity curves (log-log, square root of time, MDH, Cartesian).

Finite Difference Model: A mathematical tool that uses a numerical time-stepping procedure to address nonlinearities by using appropriate diffusion equations to solve for non-Darcy flow, changes in fluid properties, multi-phase flow, etc.



Normalized inverse productivity index: semi-log of time

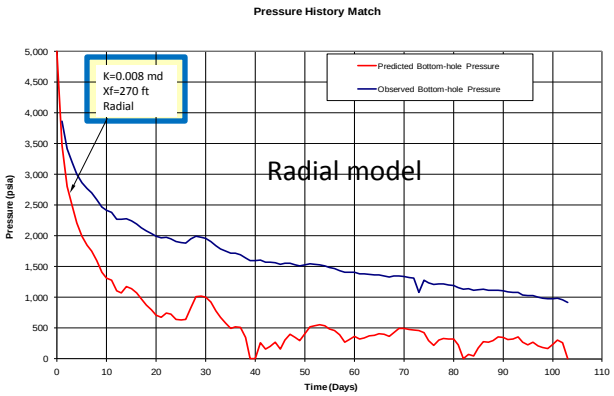
Analytical models have significant uniqueness problems, especially as they pertain to linear flow. It is not possible to determine the difference between fracture linear flow, reservoir linear flow and linear flow associated with horizontal wellbore architecture with an analytical model. Often times, there are several solutions that yield good "matches". The finite difference model can be used in conjunction with the analytical model to bracket the solution and yield a unique solution.



Normalized inverse productivity index: semi-log of time

Finite difference simulators necessary to verify uniqueness

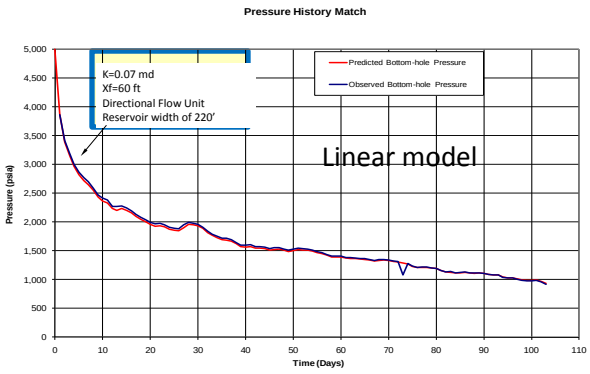
Using identical match parameters from analytical simulators in a finite difference model exposes the severe uniqueness issues with analytical models.



Finite difference bottom-hole pressure history match

Different solutions

Different matches



Finite difference bottom-hole pressure history match

Why is this important?

If reservoir parameters are identified using *only analytical models, significant errors can occur* and lead to inappropriate development of the reservoir. Understanding your reservoir is key to optimizing the money spent to maximize productivity.