

Fetkovich Aquifer Drive @model

Motivation

The most accurate way to simulate [Aquifer Expansion](#) (or shrinkage) is [full-field 3D Dynamic Flow Model](#) where [Aquifer Expansion](#) is treated as one of the fluid phases and accounts of geological heterogeneities, gas fluid properties, [relperm](#) properties and heat exchange with surrounding rocks.

Unfortunately, in many practical cases the detailed information on the [aquifer](#) is not available which does not allow a proper modelling of [aquifer](#) expansion using a geological framework.

Besides many practical applications require only knowledge of cumulative water influx from [aquifer](#) under pressure depletion.

This allows building an [Aquifer Drive Models](#) using analytical methods.

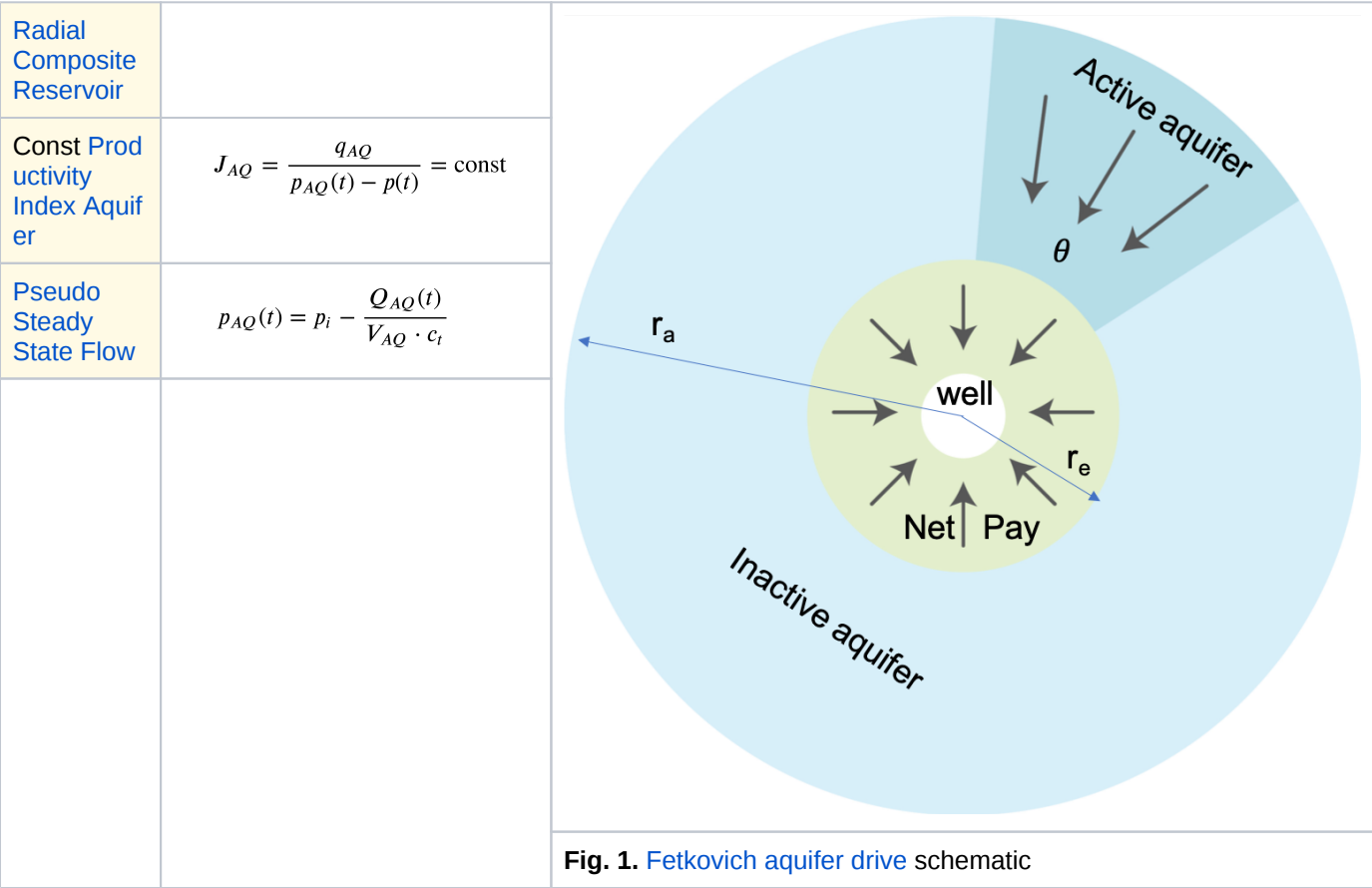
Inputs & Outputs

Inputs		Outputs	
$p(t)$	field-average formation pressure at time moment t	$Q_{AQ}^{\downarrow}(t)$	cumulative subsurface water influx from a quifer
p_i	initial formation pressure	$q_{AQ}^{\downarrow}(t) = \frac{dQ_{AQ}^{\downarrow}}{dt}$	subsurface water flowrate from aquifer
J_{AQ}	aquifer Productivity Index		
$\tau = \frac{c_t V_{\phi}}{J_{AQ}}$	aquifer relaxation time		

Detailing Inputs	
$J_{AQ} = \frac{\theta}{2\pi} \cdot \frac{2\pi\sigma}{\ln \frac{A_{AQ}}{A_e} + 0.75}$	aquifer Productivity Index
θ	central angle of net pay area aquifer contact
σ	aquifer transmissibility
A_e	net pay area
A_{AQ}	aquifer area
$\tau = \frac{V_{AQ} c_t}{J_{AQ}}$	aquifer relaxation time
$c_t = c_r + c_w$	aquifer total compressibility

c_r	aquifer pore compressibility
c_w	aquifer water compressibility
$V_{AQ} = A_e \cdot h \cdot \phi$	aquifer volume
h	aquifer effective thickness
ϕ	aquifer porosity

Physical Model



Mathematical Model

$(1) \quad \tau \cdot \frac{dQ_{AQ}^l}{dt} + Q_{AQ}^l = c_t V_\phi \cdot [p_i - p(t)]$	$(2) \quad q_{AQ}^l(t) = \frac{dQ_{AQ}^l}{dt}$
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which can be explicitly integrated:

$$(3) \quad Q_{AQ}^l(t) = J_{AQ} \exp\left(-\frac{t}{\tau}\right) \int_0^t [p_i - p(\xi)] \exp\left(\frac{\xi}{\tau}\right) d\xi$$

Assumption #1 = Const [Productivity Index Aquifer](#):

$$q_{AQ} = \frac{dQ_{AQ}}{dt} = J_{AQ} \cdot (p_{AQ}(t) - p(t))$$

Assumption #2 = [Pseudo Steady State Flow](#):

$$p_{AQ}(t) = p_i - \frac{Q_{AQ}}{c_t V_\phi}$$

Eliminating $p_{AQ}(t)$ one arrives to [\(1\)](#).

See Also

[Petroleum Industry](#) / [Upstream](#) / [Subsurface E&P Disciplines](#) / [Field Study & Modelling](#) / [Aquifer Drive](#) / [Aquifer Drive Models](#)

Reference

1. Fetkovich, M.J. 1971. A Simplified Approach to Water Influx Calculations—Finite Aquifer Systems. J Pet Technol 23 (7): 814–28. SPE-2603-PA. <http://dx.doi.org/10.2118/2603-PA>