Gas Cap Drive @model

Motivation

The most accurate way to simulate Gas Cap expansion (or shrinkage) is full-field 3D Dynamic Flow Model where Gas Cap expansion is treated as one of the fluid phases and accounts of geological heterogeneities, gas fluid properties, rel perm properties and heat exchange with surrounding rocks.

Unfortunately, in many practical cases the detailed information on the Gas Cap is not available.

Besides many practical applications require only knowledge of one element of the Gas Cap expansion process – a pressure support and not the sweep in the invaded zones.

This allows building a Gas Cap Drive @model using analytical methods.

Inputs & Outputs

Inputs		Outputs	
$p(t)$	field-average formation pressure at time moment t	$Q_{GC}(t)$	Cumulative Gas Cap expansion at surface conditions
p_i	Initial formation pressure	$q_{GC}(t) = \frac{dQ_{GC}}{dt}$	Instantaneous Gas Cap expansion flowrate at surface conditions
V_{GC}	Initial Gas Cap reserves at surface conditions		
$Z(p)$	Gas Cap compressibility factor at pressure p		

Physical Model

Isothermal expansion	**Uniform pressure depletion in Gas Cap**
$T = \mathrm{const}$	$p_{GC}(t) = p(t)$

Mathematical Model

(1) $Q_{GC}(t) = V_{GC} \cdot \left(1 - \frac{B_{gi}}{B_g(p)} \right) = V_{GC} \cdot \left(1 - \frac{Z_i}{p_i} \, \frac{p}{Z(p)} \right)$	(2) $q_{GC}(t) = \frac{dQ_{GC}}{dt}$

where

$B_g(p)$	Gas formation volume factor at pressure p
$B_{gi} = B_g(p_i)$	Gas formation volume factor at Initial formation pressure p_i
$Z_i = Z(p_i)$	Gas Cap compressibility factor at Initial formation pressure p_i

Proxy Models

Ideal Gas ($Z(p) = 1$)	
(3) $$Q_{GC}(t) = V_{GC}\left(1 - \frac{p}{p_i}\right)$$	(4) $$q_{GC}(t) = -\frac{V_{GC} \cdot p_i}{p^2(t)} \cdot \frac{dp}{dt}$$
In this case the only parameter of the gas cap model is its initial volume V_{gi}	

See Also

Petroleum Industry / Upstream / Subsurface E&P Disciplines / Field Study & Modelling / Gas Cap Drive

[Depletion] [Saturated oil reservoir]