Dual-layer IPR with dynamic fracture

Consider a water injector with main pay in Reservoir Layer #1 and spontaneous fracture extending down to Reservoir Layer #2 (see **Fig. 1**).

Assume that fracture is not fixed and requires surplus pressure Δp_f to get opened against the rock burden.

When injection bottomhole pressure p_{wf} is below fracture opening value $p_{wf} < \Delta p_f$ then water is going to the main pay only (Reservoir Layer #1) and flow radially around the well.

When injection bottomhole pressure p_{wf} is above fracture opening value $p_{wf} > \Delta p_f$ then water is going to the fracture and then gets distributed between Reservoir Layer #1 and Reservoir Layer 2

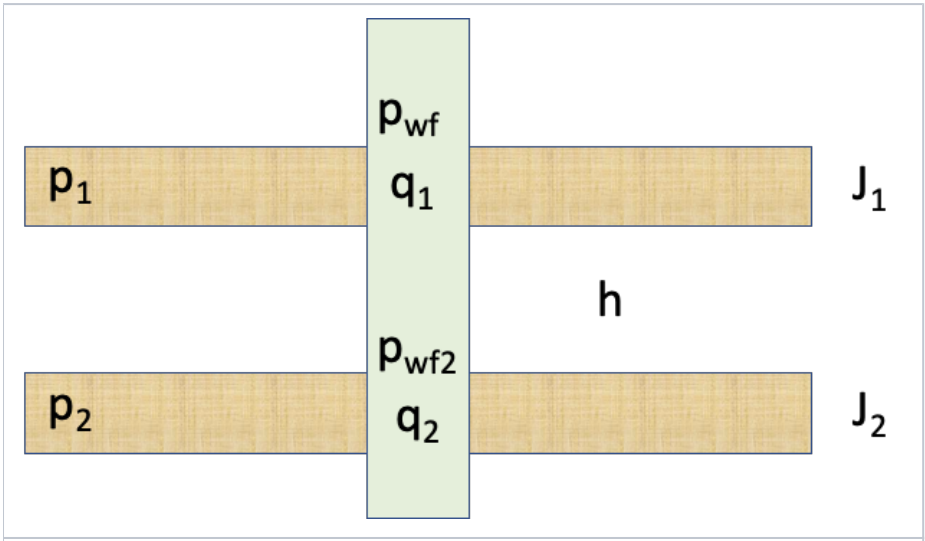

Fig. 1. Dual-layer well schematic

(1)	$q = q_1 + q_2$	(2)	$p_{wf} = p_e + q/J$	(3)	$J = J_1 + J_2$

(4) $$p_e = \Delta p_f + \frac{J_1 \cdot p_1 + J_2 \cdot (p_2 - \delta p_2)}{J_1 + J_2}$$

(5) $$p_e = \frac{J_1 \cdot p_1 + J_2 \cdot p_c}{J_1 + J_2}$$

(6) $$p_c = \left(1 + \frac{J_1}{J_2}\right) \Delta p_f + p_2 - \delta p_2$$

where

Well		
	q	total subsurface flowrate of the well

	J	total well productivity Index
	p_e	apparent formation pressure of dual-layer formation
	h	true vertical height between the layers tops
	ρ	wellbore fuid density
	g	gravity constant
	Δp_f	fracture opening pressure
Layer #1		
	p_{wf}	bottom-hole pr4essure at Layer #1 top
	q_1	total subsurface flowrate of the Layer #1
	p_1	formation pressure of the Layer #1
	J_1	productivity Index of the Layer #1
Layer #2		
	$p_{wf2} = p_{wf} + \rho\, g\, h$	bottom-hole pr4essure at Layer #2 top
	q_2	total subsurface flowrate of the Layer #2
	p_2	formation pressure of the Layer #2
	J_2	productivity Index of the Layer #2

(7) $$p_{wf,1} = p_{wf} = \Delta p_f + p_1 + q_1/J_1$$
(8) $$p_{wf,2} = p_{wf} + \delta p_2 = \Delta p_f + p_2 + q_2/J_2$$

This leads to

(9) $$q_1 = J_1 \cdot (p_{wf} - p_1 - \Delta p_f)$$
(10) $$q_2 = J_2 \cdot (p_{wf,2} - p_2 - \Delta p_f) = J_2 \cdot (p_{wf} - (p_2 + \Delta p_f - \delta p_2))$$

and

(11) $$q = q_1 + q_2 = q_1 = J_1 \cdot (p_{wf} - (p_1 + \Delta p_f)) + J_2 \cdot (p_{wf} - (p_2 - \delta p_2 + \Delta p_f))$$
(12) $$q = (J_1 + J_2) \cdot p_{wf} - J_1 \cdot (p_1 + \Delta p_f) + J_2 \cdot ((p_2 - \delta p_2 + \Delta p_f))$$

or

(13) $$q = J \cdot (p_{wf} - p_e), \text{ where } J = J_1 + J_2 \text{ and } p_e = J^{-1} \cdot (J_1 \cdot (p_1 + \Delta p_f) + J_2 \cdot (p_2 - \delta p_2 + \Delta p_f))$$

or

(14) $$p_e = \Delta p_f + J^{-1} \cdot (J_1 \cdot p_1 + J_2 \cdot (p_2 - \delta p_2))$$

See Also

Petroleum Industry / Upstream / Production / Subsurface Production / Subsurface E&P Disciplines / Field Study & Modelling / Production Analysis / Productivity Diagnostics

[Production Technology / Well Flow Performance]

[Formation pressure (Pe)] [Multi-layer IPR]