Water Breakthrough Time Under Coning in a Vertical Well

Dimensionless cone height and time to water breakthrough in a vertical well with bottom water, and the critical rate, by two correlations.

Input parameters

Unit system: SI

Parameter	Value	Unit
Oil rate	120.00	bbl/d
Oil column thickness	80.000	ft
Perforated interval	20.000	ft
Water density	64.000	lb/ft³
Oil density	50.000	lb/ft³
Oil viscosity	1.5000	cP
Oil formation volume factor	1.2000	
Horizontal permeability	200.00	mD
Vertical permeability	40.000	mD
Porosity	20.000	%
Water-oil mobility ratio	0.80000	

Calculated results

Parameter	Value	Unit
Dimensionless cone height	3.0613	
Dimensionless breakthrough time (Sobocinski–Cornelius)	8.1250	
Time to breakthrough (Sobocinski–Cornelius)	3,735.9	d
Dimensionless breakthrough time (Bournazel–Jeanson)	3.5719	
Time to breakthrough (Bournazel–Jeanson)	1,642.4	d
Critical rate (Sobocinski–Cornelius)	105.28	bbl/d
Critical rate (Bournazel–Jeanson)	85.717	bbl/d

Notes for this case

- Bournazel–Jeanson predicts earlier breakthrough than Sobocinski–Cornelius; the two bracket field experience. Lower rates, shorter perforations at the top of the column, or a horizontal well delay breakthrough.

Formula and method

$$Z = \frac{0.492 \times 10^{-4} \Delta\rho\, k_h h (h - h_p)}{\mu_o B_o Q_o}, \quad (t_D)_{BT} = \frac{4Z + 1.75Z^2 - 0.75Z^3}{7 - 2Z} \text{ or } \frac{Z}{3 - 0.7Z}, \quad t_{BT} = \frac{20{,}325 \mu_o h \phi (t_D)_{BT}}{\Delta\rho\, k_v (1 + M^{\alpha})}$$

Variables

Q_o	Oil rate	m³/s
h	Oil column thickness	m
h_p	Perforated interval	m
ρ_w	Water density	kg/m³
ρ_o	Oil density	kg/m³
μ_o	Oil viscosity	Pa·s
B_o	Oil formation volume factor	-

k_h	Horizontal permeability	m²
k_v	Vertical permeability	m²
ϕ	Porosity	-
M	Water-oil mobility ratio	-
Z	Dimensionless cone height	-
$(t_D)_{BT,SC}$	Dimensionless breakthrough time (Sobocinski–Cornelius)	-
$t_{BT,SC}$	Time to breakthrough (Sobocinski–Cornelius)	s
$(t_D)_{BT,BJ}$	Dimensionless breakthrough time (Bournazel–Jeanson)	-
$t_{BT,BJ}$	Time to breakthrough (Bournazel–Jeanson)	s
$Q_{oc,SC}$	Critical rate (Sobocinski–Cornelius)	m³/s
$Q_{oc,BJ}$	Critical rate (Bournazel–Jeanson)	m³/s

Method and standards

Sobocinski–Cornelius and Bournazel–Jeanson (field units).

Assumptions and limits

- Homogeneous anisotropic reservoir; constant rate.

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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Reopens the calculator with the inputs of this report.