Transient Pressure Around a Well: Line-Source Ei Solution

Pressure at a radius and time around a well producing at constant rate in an infinite-acting reservoir (Ei line source), log approximation and stabilisation time.

Input parameters

Unit system: SI

Parameter	Value	Unit
Oil rate (stock tank)	400.00	bbl/d
Oil formation volume factor	1.2000	
Oil viscosity	1.2000	cP
Permeability	80.000	mD
Net pay thickness	20.000	ft
Porosity	18.000	%
Total compressibility	1.0000e-05	1/psi
Initial reservoir pressure	3,800.0	psi
Radius from the well (the wellbore radius for p_wf)	0.30000	ft
Time since the start of flow	5.0000	h
Drainage area (for the stabilisation time)	60.000	acre

Calculated results

Parameter	Value	Unit
Argument x = φμc_tr²/(4kt)	4.6079e-07	
Exponential integral $E_1(x)$	14.013	
Pressure at r and t	3,443.8	psi
Pressure drop	356.17	psi
Pressure by the log approximation	3,443.8	psi
Time to pseudo-steady state (circular area)	26.763	h

Notes for this case

- x < 0.01: the logarithmic (semilog) approximation is valid here.

Formula and method

$$p(r,t) = p_i - \frac{q_o B_o \mu_o}{4\pi k h} E_1(x), \quad x = \frac{\phi \mu c_t r^2}{4kt}, \quad E_1(x) \approx -\ln(1.781x) \ (x < 0.01), \quad t_{pss} = 0.1 \frac{\phi \mu c_t A}{k}$$

Variables

q_o	Oil rate (stock tank)	m³/s
B_o	Oil formation volume factor	-
μ_o	Oil viscosity	Pa·s
k	Permeability	m²
h	Net pay thickness	m
ϕ	Porosity	-
c_t	Total compressibility	1/Pa
p_i	Initial reservoir pressure	Pa
r	Radius from the well (the wellbore radius for p_wf)	m

t	Time since the start of flow	s
A	Drainage area (for the stabilisation time)	m²
x	Argument x = φμc_tr²/(4kt)	-
$-Ei(-x)$	Exponential integral $E_1(x)$	-
$p(r,t)$	Pressure at r and t	Pa
$p_i - p$	Pressure drop	Pa
p_{log}	Pressure by the log approximation	Pa
t_{pss}	Time to pseudo-steady state (circular area)	s

Method and standards

Constant-rate line-source solution of the diffusivity equation.

Assumptions and limits

- Infinite-acting, homogeneous reservoir; slightly compressible fluid; no skin.

Report details

Report reference	FCC-2VQP-HS9R (the same inputs always give the same reference)
Generated	23 November 2026, 17:26 UTC
Calculator	Transient Pressure Around a Well: Line-Source Ei Solution
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	4 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/chemical/reservoir-engineering/line-source-transient-pressure

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Reopens the calculator with the inputs of this report.