Gas Well Non-Darcy (Turbulence) Coefficient and Apparent Skin

Turbulence parameter, non-Darcy flow coefficient and rate-dependent skin of a gas well, giving the apparent skin s' = s + DQ (Hawkins and Jones).

Input parameters

Unit system: SI

Parameter	Value	Unit
Formation permeability	2.0000	mD
Permeability of the damaged zone	0.80000	mD
Radius of the damaged zone	1.5000	ft
Wellbore radius	0.30000	ft
Porosity	8.0000	%
Reservoir temperature	220.33	°F
Gas gravity (air = 1)	0.65000	
Gas viscosity at the bottom-hole pressure	0.018000	cP
Net pay thickness	60.000	ft
Gas rate	3,000.0	Mscf/d

Calculated results

Parameter	Value	Unit
Mechanical skin (Hawkins)	2.4142	
Turbulence parameter	2.5882e+10	1/ft
Non-Darcy flow coefficient, psi²/cp/(Mscf/d)²	1.8602	
Inertial flow factor, per Mscf/d	2.3085e-04	
Rate-dependent skin	0.69255	
Apparent skin s + DQ	3.1067	

Notes for this case

- Turbulence near a gas well acts like an extra skin that grows with rate. Multi-rate tests separate s and D by plotting apparent skin against rate. Jones's β correlation is a rough estimate; measured values vary by an order of magnitude.

Formula and method

$$\beta = 1.88 \times 10^{10} k^{-1.47} \phi^{-0.53}, \quad F = 3.161 \times 10^{-12} \frac{\beta T \gamma_g}{\mu_{gw} h^2 r_w}, \quad D = \frac{Fkh}{1422T}, \quad s' = s + DQ_g$$

Variables

k	Formation permeability	m²
k_{skin}	Permeability of the damaged zone	m²
r_{skin}	Radius of the damaged zone	m
r_w	Wellbore radius	m
ϕ	Porosity	-
T	Reservoir temperature	K
γ_g	Gas gravity (air = 1)	-
μ_{gw}	Gas viscosity at the bottom-hole pressure	Pa·s

h	Net pay thickness	m
Q_g	Gas rate	Nm³/s
s	Mechanical skin (Hawkins)	-
β	Turbulence parameter	1/m
F	Non-Darcy flow coefficient, psi²/cp/(Mscf/d)²	-
D	Inertial flow factor, per Mscf/d	-
DQ_g	Rate-dependent skin	-
s'	Apparent skin s + DQ	-

Method and standards

Non-Darcy flow coefficient (field units: ft, md, °R, cP, Mscf/d).

Assumptions and limits

- Radial flow; Jones β correlation.

Report details

Report reference	FCC-ZT4H-M22G (the same inputs always give the same reference)
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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/gas-well-non-darcy-skin

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Reopens the calculator with the inputs of this report.