Initial Water Injectivity of a Five-Spot Pattern (Muskat)

Base (initial) water injection rate and injectivity of a five-spot pattern full of oil, from thickness, permeability, oil relative permeability and well spacing.

Input parameters

Unit system: SI

Parameter	Value	Unit
Net thickness	25.000	ft
Absolute permeability	120.00	mD
Oil relative permeability at initial water saturation	0.85000	
Oil viscosity	3.0000	cP
Distance between injector and producer	933.00	ft
Wellbore radius	0.35400	ft
Injection pressure minus producing bottom-hole pressure	1,500.0	psi
Conductance ratio at the stage of the flood (1 at start)	1.4000	

Calculated results

Parameter	Value	Unit
Base (initial) injection rate	622.04	bbl/d
Base injectivity	0.41469	bbl/(d·psi)
Injection rate at the conductance ratio entered	870.86	bbl/d

Notes for this case

• Liquid-filled five-spot at the start of the flood (no free gas). As the flood proceeds the injectivity changes by the conductance ratio γ (Caudle and Witte), which depends on the mobility ratio and areal sweep; read it from their chart and enter it.

Formula and method

$$i_{base} = \frac{\pi h k k_{ro} \Delta p}{\mu_o \left[\ln(d/r_w) - 0.619\right]} \quad \left(= \frac{0.003541 h k k_{ro} \Delta p}{\mu_o \left[\ln(d/r_w) - 0.619\right]} \ \text{field} \right), \quad i_w = \gamma i_{base}$$

Variables

h	Net thickness	m
k	Absolute permeability	m²
k_{ro}	Oil relative permeability at initial water saturation	-
μ_o	Oil viscosity	Pa·s
d	Distance between injector and producer	m
r_w	Wellbore radius	m
Δp	Injection pressure minus producing bottom-hole pressure	Pa
γ	Conductance ratio at the stage of the flood (1 at start)	-
i_{base}	Base (initial) injection rate	m³/s
I_{base}	Base injectivity	m³/(s·Pa)
i_w	Injection rate at the conductance ratio entered	m³/s

Method and standards

Muskat's five-spot injectivity.

Assumptions and limits

- Liquid-filled five-spot; steady state.

Report details

Report reference	FCC-WVMF-G04T (the same inputs always give the same reference)
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Release checks	3 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/waterflood-five-spot-injectivity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.