Geothermal welltesting Testing with <u>downhole shutin</u> is a must!

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Welltest well A: production + buildup

Q_water, bottomhole pressure, wellhead pressure, wellhead temperature



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Welltest well A: buildup analysis

All measured data point towards wellbore physics ('wellbore storage')



Derivative of bottomhole pressure

ebn



A to B: wellhead pressure > vaporisation pressure \rightarrow liquid B: brine vaporizes C: vapor condenses

Fluid levels during the buildup; calculated using measured pressure data from downhole gauge, ESP gauge and wellhead gauges. Observation: > 500 meters of 'vacuum' has developed inside the well.

The major dip in the derivative corresponds with the deepest vaporwater interface in the well.

Conclusion:

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Wellhead pressure [bar]

0.1

0

The entire buildup of this welltest is dominated by wellbore physics, or 'wellbore storage effects' 4

Indications of wellbore storage effects





Very often (always?) observed in geothermal welltests: 1) <u>major dip 2</u>) <u>abrupt changes in trend 3</u>) <u>no stabilization</u> \rightarrow strong indication that all geothermal welltests are overprinted by wellbore storage effects, not reflecting true reservoir response.

How to get rid of wellbore storage

Solution: downhole shutin

A **downhole shutin device** fully eliminates all unwanted disturbances and only the true reservoir signal is recorded (which is always the only objective of a welltest).

Downhole shutin tools:

- Available since 1950's; commonly applied in O&G
- Up to 230 °C and 15000 psi
- E-line, slickline, coiled tubing, or DST
- Shut by automatic activation or remote control
- Annulus pressure operated, mechanical action (sliding sleeve or prong), pulse or acoustically operated, battery operated or clock mechanisms, single shutin or multiple shutins during same run
- Does not have to be expensive!



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Radial composite model		
Skin	1.1	-
kh (inner)	24.8	Dm
kh (outer)	8.9	Dm
Radius	90	m
Radius	90	

Double porosity model		
Skin	1.1	-
kh	24.8	Dm
Omega	0.9	m

Homogeneous model		
Skin	1.1	-
kh	24.8	Dm
Boundary	no	

Hydraulic frac model		
Skin	1.1	-
kh	18.3	Dm
Half length	914	m

Fault model		
Skin	9	-
kh	49.5	Dm
Fault distance	100	m

Channel model		
Skin	63	-
kh	212	Dm
Channel width	100	m



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SCAN Oranjeoord-01: downhole shutin





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Conclusion

Recommendation



- Never execute a welltest with a surface shutin; testing with a downhole shutin is a must!
- Reference, literature, numerical simulations, field cases: *Bruijnen, P.M. 2024. Numerical and analytical modelling of wellbore storage effects in low-enthalpy geothermal well tests. Geoenergy 2024-020, Vol.3. https://doi.org/10.1144/geoenergy2024-020*

