Thermal Conductivity Measuring Method for Water Filled Open Boreholes

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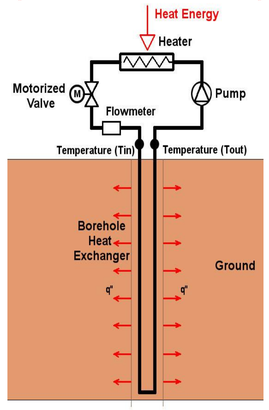
Highlights

- Probe TRT method is applied for determining thermal conductivity.
- Constant temperature is used to avoid convective movements of water.
- Thermal conductivities of layers are predicted from the slope of inverse of heat power in log time axis.

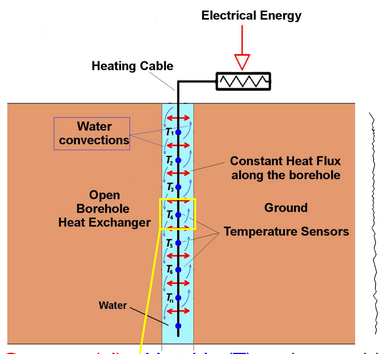
Methodology

Conventional TRT (Constant Heat Flux)



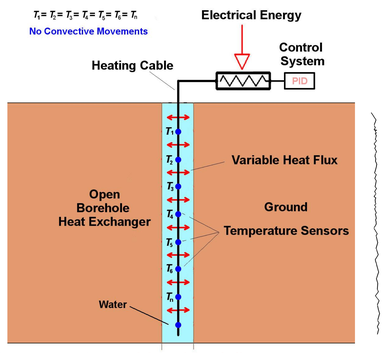
Constant (q') + Variable (T) ⟶ *k*

Constant Heat Flux in Probe Method

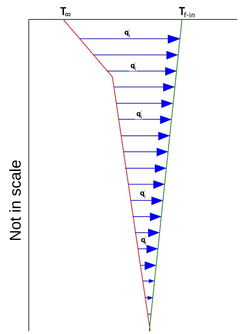


Constant (q') + Variable (T) ⟶ *layered k*

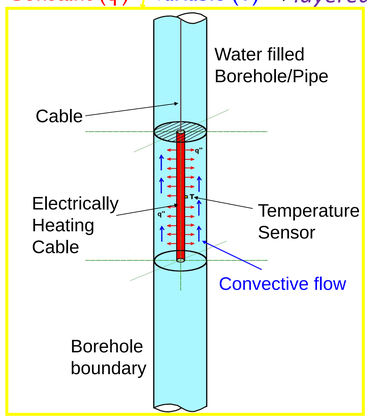
Constant Temperature in Probe Method



Constant (T) + Variable (q') ⟶ *layered k*



In conventional TRT heat fluxes along the borehole are not same.



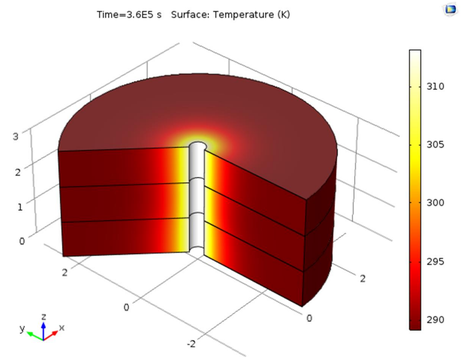
$$k = \frac{2.303}{4.m.\pi.(T_w - T_0)}$$

Aydin et.al. 2017

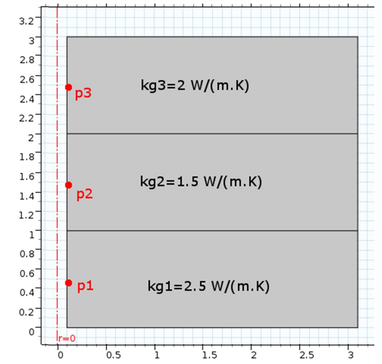
k – Thermal Conductivity [W/(m K)]
m – Slope of changings inverse of heat flux during the test (1/q)
T_w – Water Temperature
T_0 – Undisturbed Ground Temp.

Modeling & Results

A numerical model is built for validation of the method.

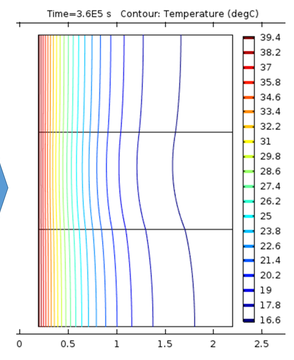


In COMSOL Multiphysics 2D-Axial Heat Transfer modul is used.

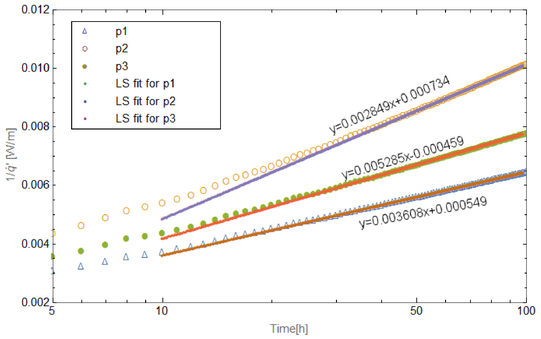


In the model different *k (therm. cond)* values entered for different layers.

Computation



Temperature distribution.



The model is run for 100 hours simulation. After solution is completed, heat flux magnitudes ($\dot{q}_n$) are calculated from observation points of p1, p2 and p3. Inverse of $\dot{q}_n$ values in logarithmic time axis show linear trend. From the slopes, *k* values are calculated as shown in table:

	T_w	T_0	*m*	*k*	% Dev
p1	40 °C	16 °C	0.002849	**2.68**	7.2
p2	40 °C	16 °C	0.005285	**1.44**	4.0
p3	40 °C	16 °C	0.003608	**2.12**	6.0

Conclusions

- Constant temperature probe method is developed for determining layered thermal conductivities of ground.
- Method is validated with numerical modeling.
- This method can be used for determining thermal conductivity for water filled open boreholes and middle deep boreholes.

Ref : Aydin, M., Onur, M., Sisman. A., 2017. A New Method for Constant Temperature Thermal Response Tests, 42. Workshop on Geothermal Reservoir Engineering, Stanford University / USA, 13-15 February 2017.