GEIE
Route de Soultz
F-67250 Kutzenhausen

Productivity Index (Thermosyphon)

Test 11jul05 at GPK2 and GPK4

Preliminary Interpretation with HEX-B

Internal Technical Note

25.07.2005
Ref. TN17.10/TM/TK

1. Aims

On 11th July 2005 a 7 days circulation test has been carried out, with GPK3 as injection borehole and GPK2 and GPK4 as production boreholes. Production was enabled only by buoyancy (thermosyphon). This study aims at an interpretation of the measured values at wellhead/surface for pressure, flow rate and temperature using the PT-profile simulator HEX-B. Specifically:

- Interpretation of the measured temperature by comparison with calculated values with the HEX-B.

- Calculation of the pressure at the casing shoe to determine the productivity index PI [l/s/MPa]

2. Test data
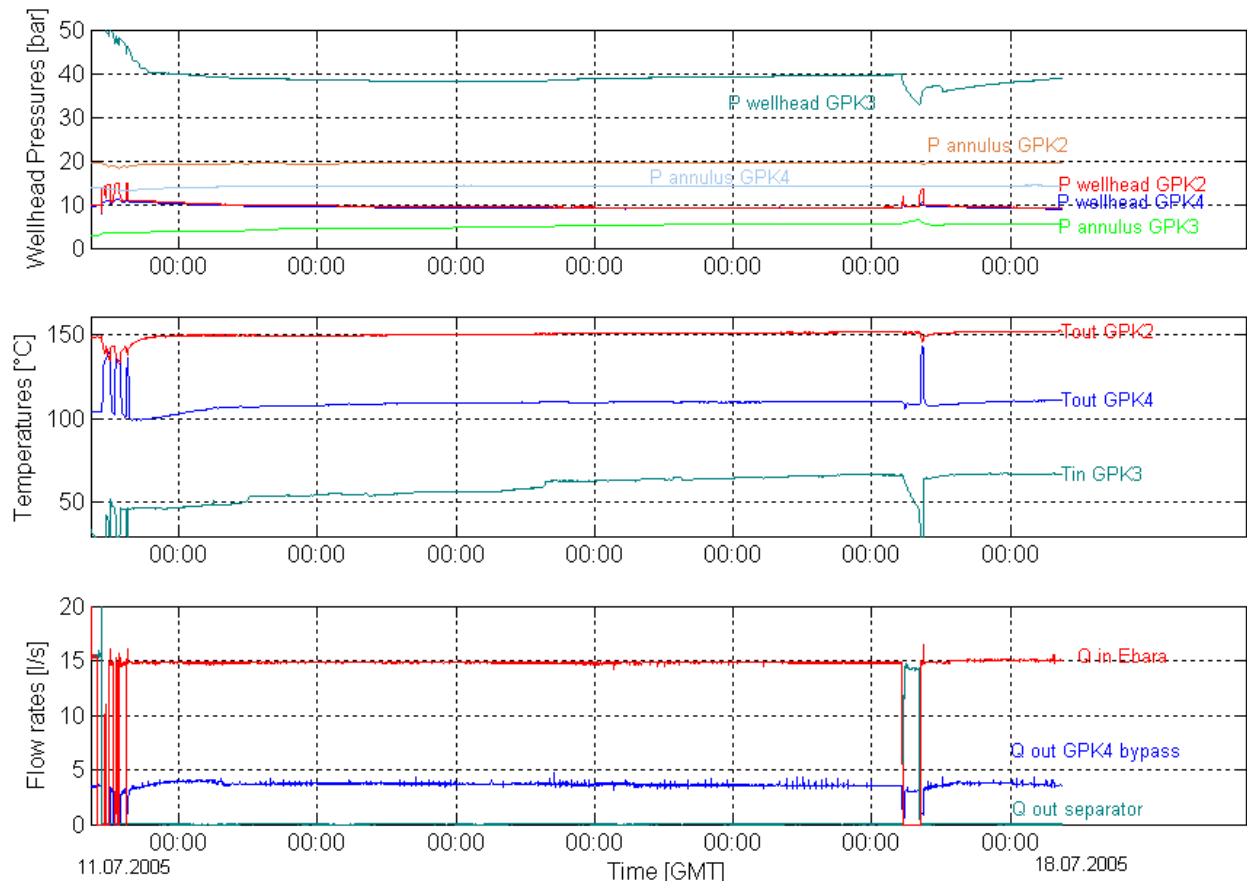
Figure 1 shows the test data from the circulation test.

Figure 1: Measured data of circulation test 11jul05.

3. Productivity Index GPK2

3.1.   HEX-B model of the borehole

For the production a reduced borehole model of GPK2 was used in HEX-B (see Table 1).

Table 1: Borehole/rock model in HEX-B for GPK2 production

	Bore hole parameters				Rock mass parameters	
	Depth section MD [m]		Inner radius [m]	Flow rate [% of injection rate]	Average wall roughness [mm]	Thermal conductivity [W/m K]	Specific heat capacity [J/m^{3}K]
Nr	from:	to:					
1	0	1500	0.08	100	0.15	3	2.2 10^6
2	1500	3800	0.08	100	0.15	4	2.2 10^6
3	3800	4430	0.08	100	0.15	3	2.2 10^6
4	4430	4800	0.11	90	1.00	3	2.2 10^6

3.2.   Approximation of initial conditions

A flow of 11.2 l/s (15 – 3.8 l/s) and the measured pressure (P_wellhead_GPK2 = 0.9 MPa) showed in Figure 1 have been used for the production simulation. As initial conditions the undisturbed values for the temperature have been used (Figure 5). The initial NaCl-molality has been adjusted, so that the fluid density at the surface attains for t = 0 a value of 1060 Kg/m^3.
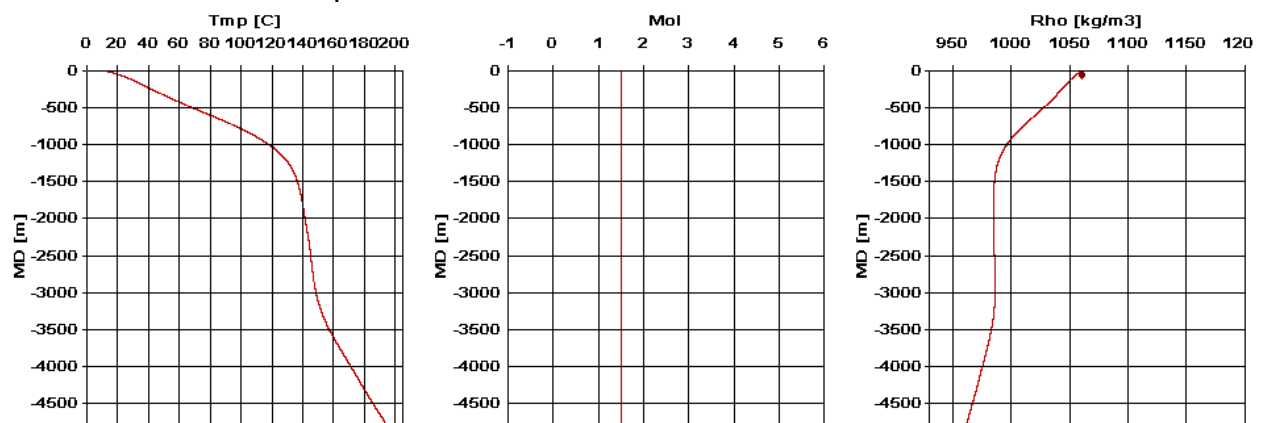For the initial wellhead pressure a value of 0 MPa has been used.

Figure 2:   Assumed initial profiles GPK2 for temperature and NaCl-molality and for the corresponding density. The red dots in the left graphic indicate measured temperature values.

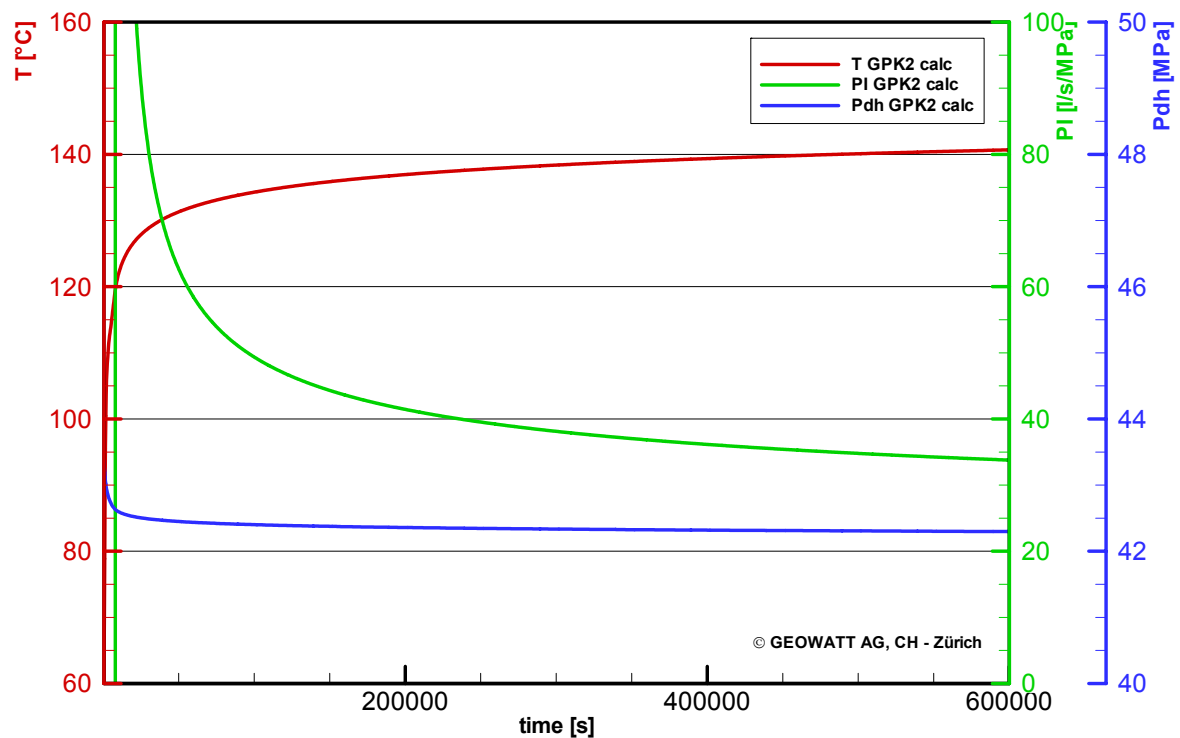## 3.3.   Productivity Index

Figure 3:   Calculated temperature (red line), Productivity Index PI (green line) and Pdh@4412 MD (blue line) of test 11jul05 at GPK2.
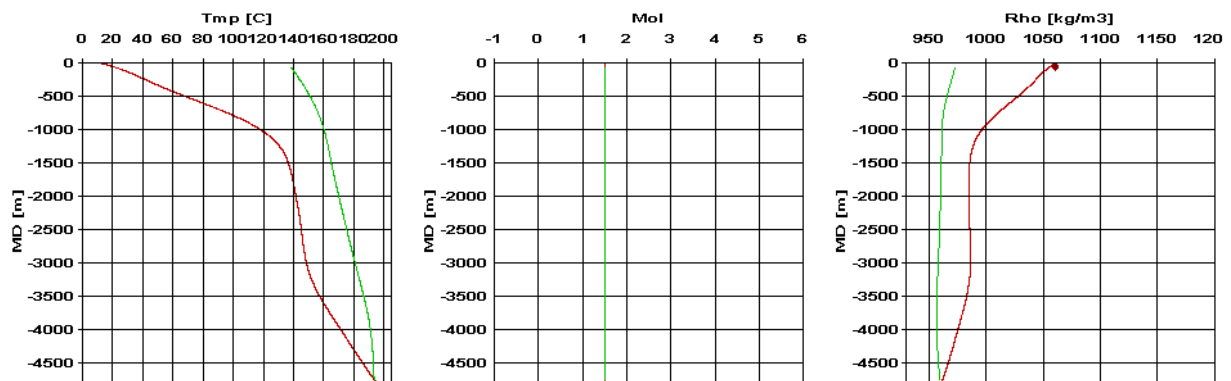

Figure 4:   Initial (red curves) and end profiles (after 600'000 s, green curves) for GPK2.

4. Productivity Index GPK4

4.1.   HEX-B model of the borehole

For the production a reduced borehole model of GPK4 was used in HEX-B (see Table 2).

Table 2:   Borehole/rock model in HEX-B for GPK4 production

	Bore hole parameters				Rock mass parameters	
Nr	Depth section MD [m] from: to:	Inner radius [m]	Flow rate [% of injection rate]	Average wall roughness [mm]	Thermal conductivity [W/m K]	Specific heat capacity [J/m^{3}K]
1	0 1500	0.11	100	0.15	3	2.2 10^6
2	1500 3800	0.11	100	0.15	4	2.2 10^6
3	3800 4756	0.11	100	0.15	3	2.2 10^6

4.2.   Approximation of initial conditions

The measured values of flow (Q_out_GPK4_bypass = 3.8 l/s) and pressure (P_wellhead_GPK4 = 0.9 MPa) showed in Figure 1 have been used for the production simulation. As initial conditions the undisturbed values for the temperature have been used (Figure 5). The initial NaCl-molality has been adjusted, so that the fluid density at the surface attains for t = 0 a value of 1038 Kg/m^3.
For the initial wellhead pressure a value of 0 MPa has been used.
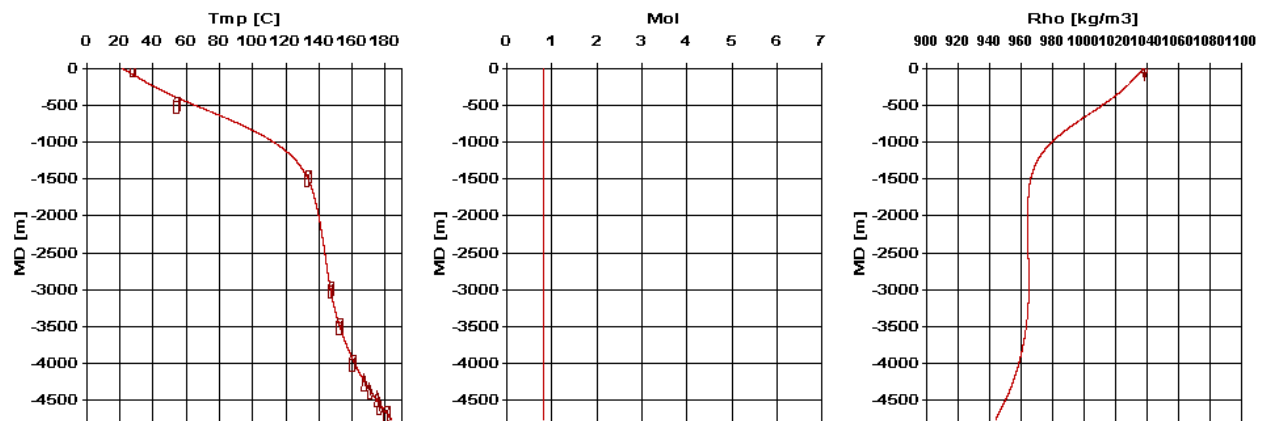

Figure 5:   Assumed initial profiles GPK4 for temperature and NaCl-molality and for the corresponding density. The red dots in the left graphic indicate measured temperature values.
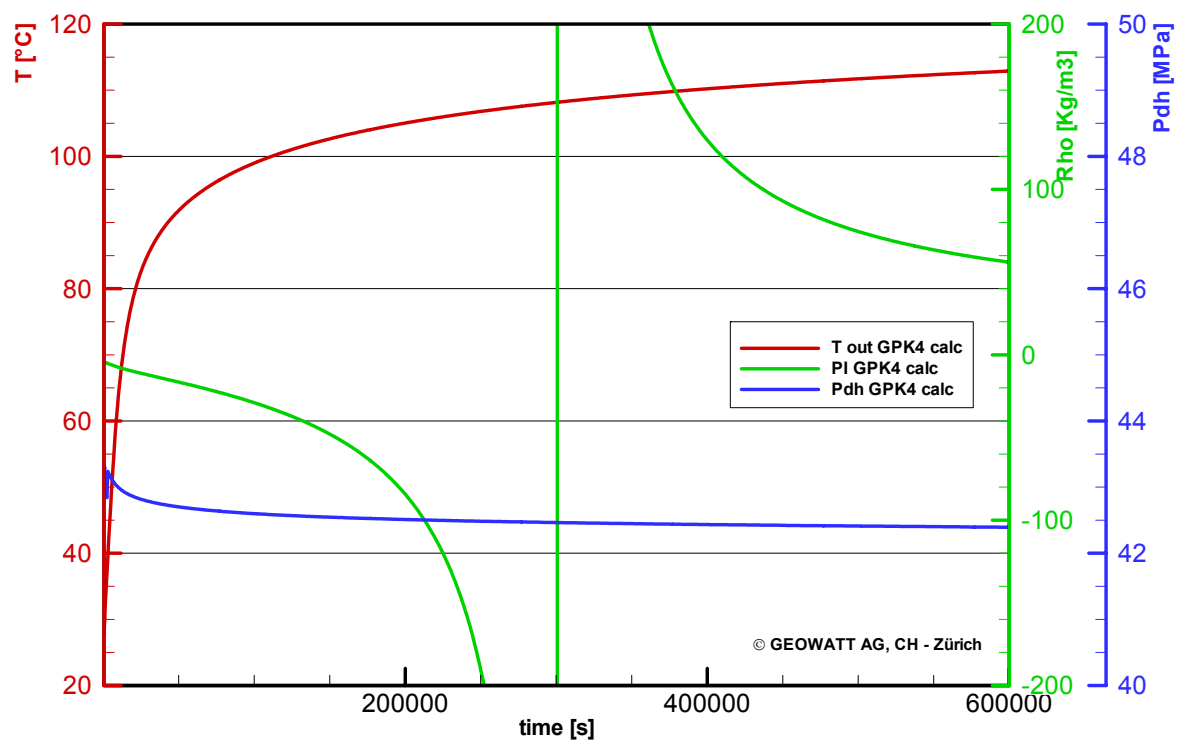
4.3.   Productivity Index

Figure 6:   Calculated temperature (red line), Productivity Index PI (green line) and Pdh@4756 MD (blue line) of test 11jul05 at GPK4.
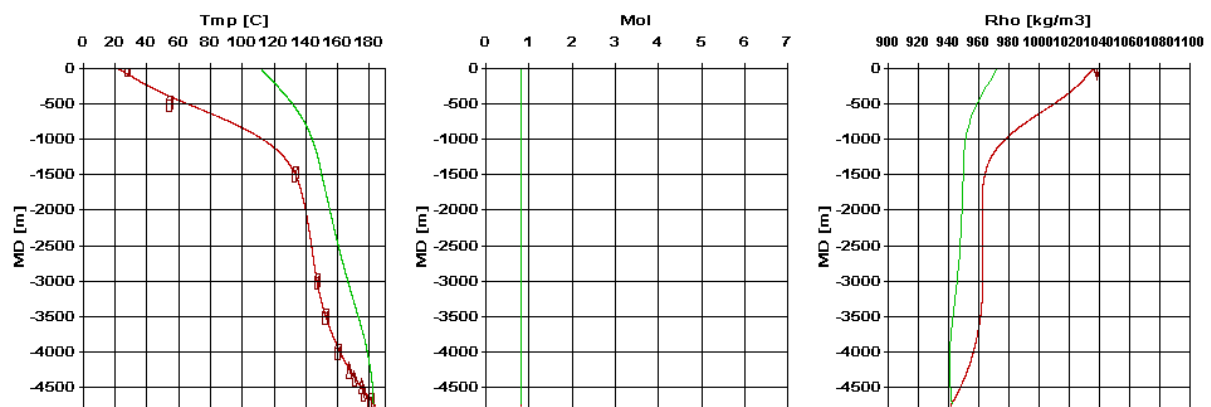

Figure 7: initial (red curves) and end profiles (after 600'000 s, green curves) for GPK4.