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GPK4 Chemical stimulation

Steprate 1 06April24

Steprate 2 06May29

Interpretation with HEX-B

Comparison with steprate 05Feb22

Technical Note - DRAFT

26.05.2006
Ref. TN17.17/CB/TM/

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1. Aims

Between 24th April 2006 and 29th May 2006, a chemical stimulation was performed in well GPK4 in order to enhance its productivity. The measured values at the wellhead/surface for pressure, flow rate, density and temperature shall be interpreted by computing the pressure at TVD 4500 m and to determine the injectivity index of GPK4 before and after the acidification of the well.

In order to evaluate the enhancement due to the acidification test, two steprate tests of about 3 days each were carried out in well GPK4: the first one began on 24th April 2006, and the second one on 29th May 2006, i.e. 10 days after the end of acid injection.

2. Data of the steprate tests

Figure 1 shows wellhead responses of well GPK4 recorded during injections.

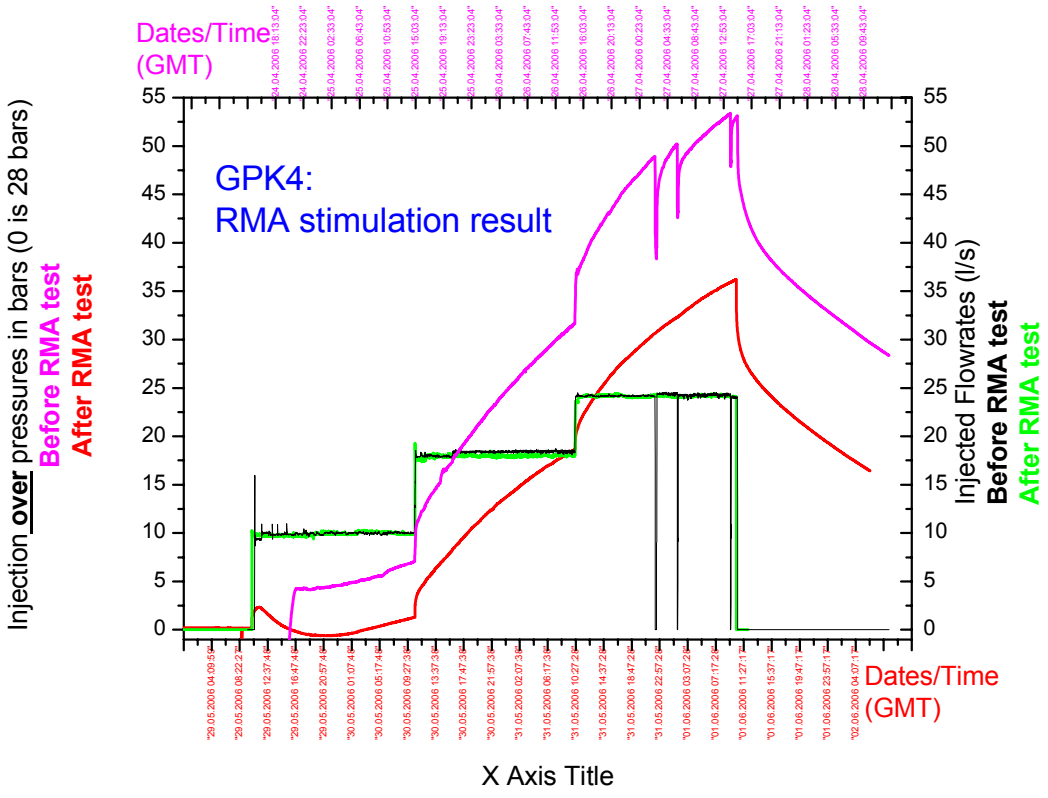

Figure 1: Measured data of both steprate tests (Wellhead pressures and flowrate)

Figure 2 shows the flowrate of the acidification test and the wellhead responses of all three wells GPK2, GPK3 and GPK4.

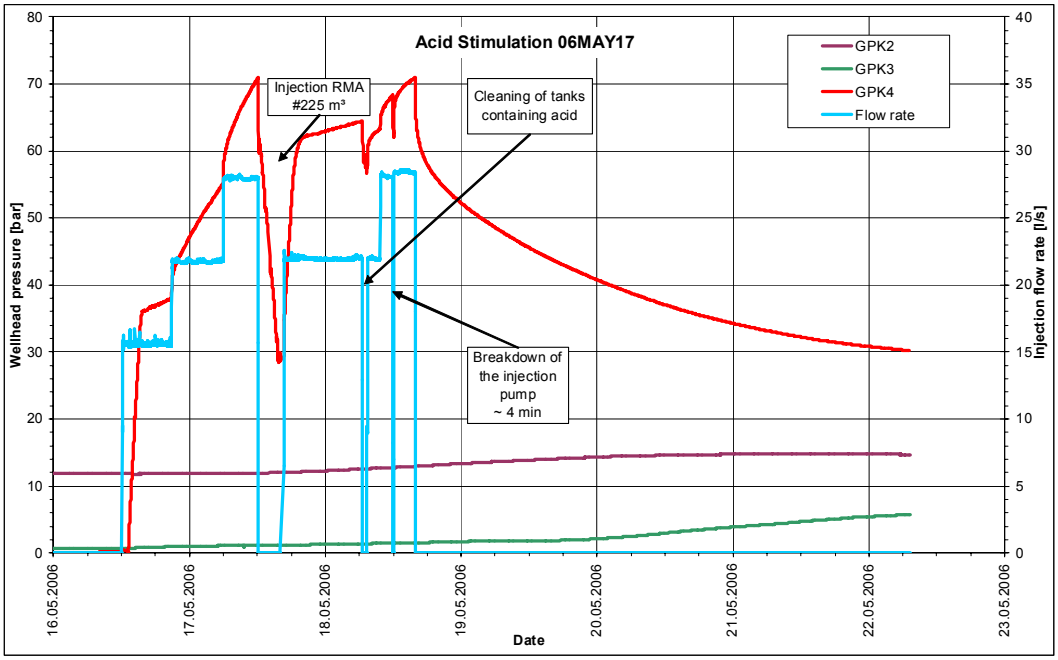

Figure 2: Acid injection and wellhead responses

3. HEX-B calculations for GPK4

3.1. Wellbore models

Model used for GPK4 is the same than the model used to compute the results of the circulation test of summer 2005 (see Table 1).

Bore hole parameters						Rock mass parameters	
Depth section MD [m] Nr	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	2.0	2.2 10^6
2	1500	3800	0.11	100	0.15	3.0	2.2 10^6
3	3800	4800	0.11	100	0.15	2.0	2.2 10^6

Table 1: Borehole/rock model in HEX-B for GPK4 production well

Well GPK4 was killed before the first injection test. A linear increase of NaCl-molality in the borehole was assumed in order to obtain a downhole initial pressure equivalent to 45.4 Mpa, that is the most reliable value for all three boreholes (see Figure 3)

The problem does not exist for the second steprate test, since NaCl-molality in the borehole was known as well as the wellhead pressure (see Figure 4).

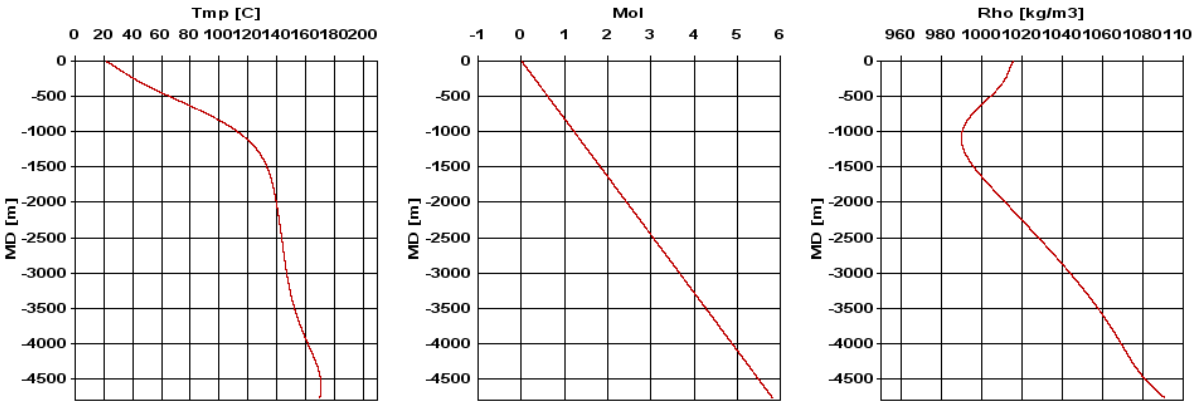

Figure 3: Initial conditions for Hex-B downhole values calculation for steprate 1 (06April24)

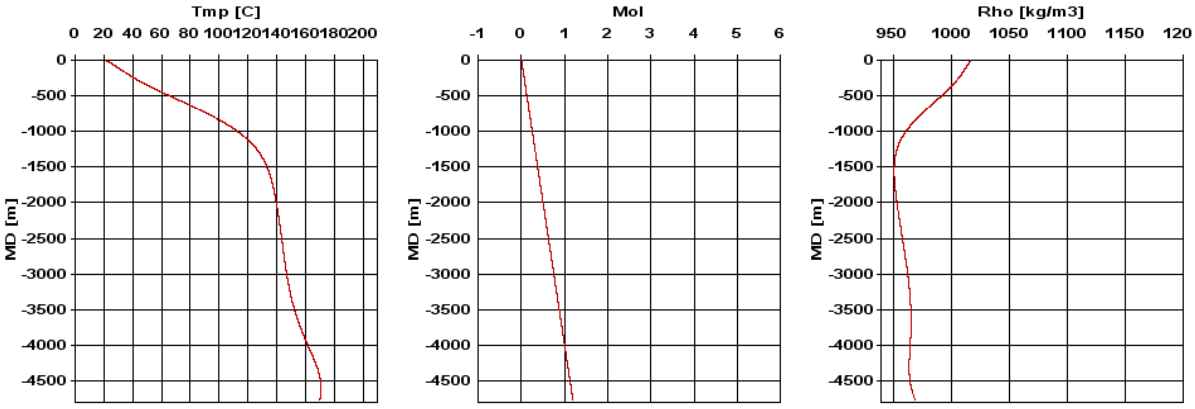

Figure 4: Initial conditions for Hex-B downhole values calculation for steprate 2 (06May29)

3.2. Results

Figure 5 and Figure 6 show calculated downhole overpressure and calculated injectivity index for the steprate tests.

The initial NaCl-molality profile in the borehole at the beginning of the first steprate test. Therefore calculated injectivity and downhole overpressure are not reliable as long as fluid of unknown NaCl-molality is in the well. With a borehole capacity of 180 m^3 and a flowrate of 10 l/s, this time is 18000 seconds.

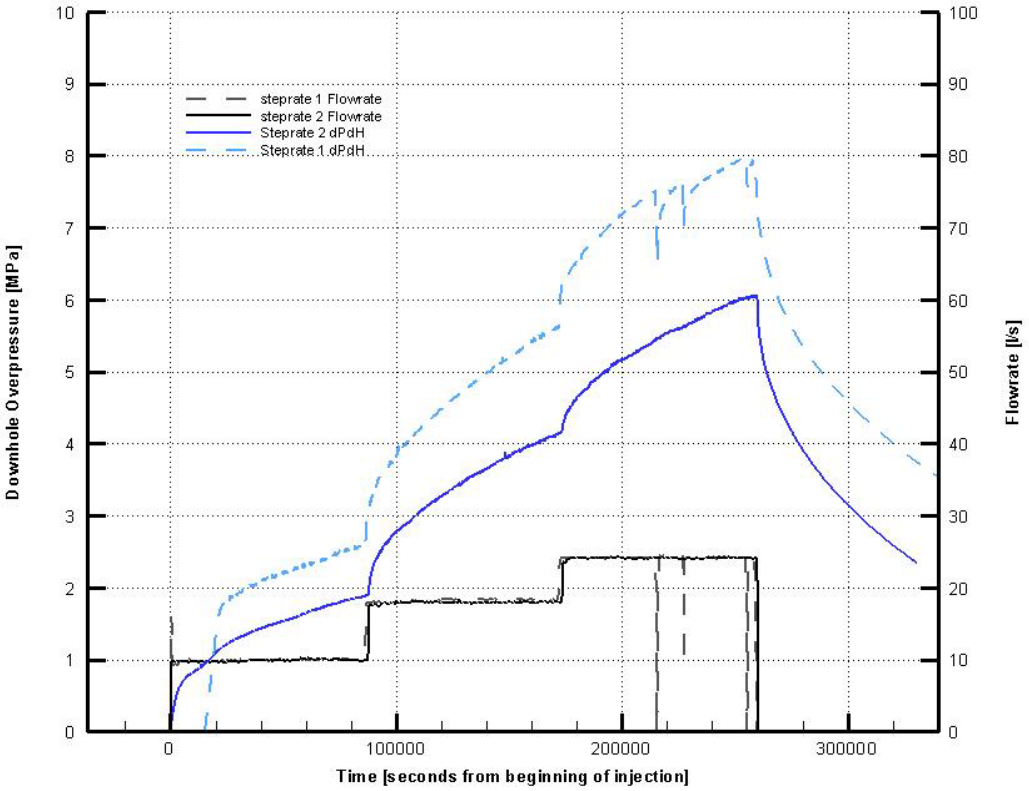

Figure 5: Downhole Overpressure in well GPK4 for both steprates tests

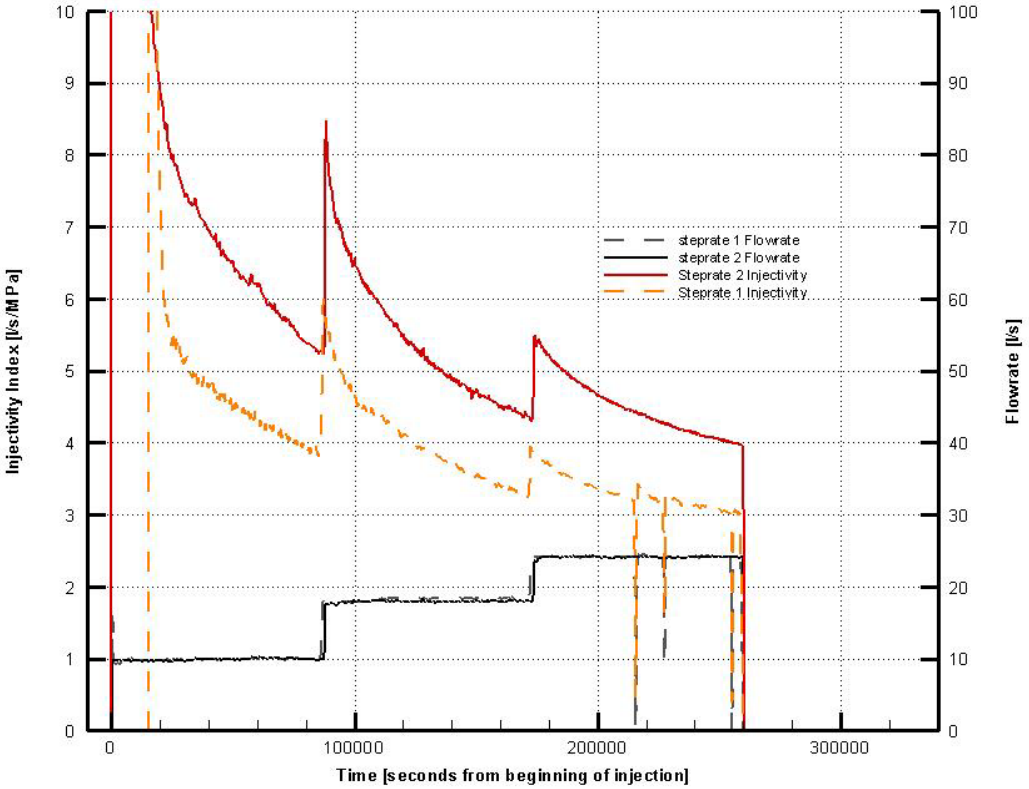

Figure 6: Injectivity index calculated in GPK4 for both steprate tests

3.3. Conclusion

One should notice that the steady state has not been reached during these step rate tests; therefore, injectivity indexes are noticeably high during the injections. Netherthless, one could conclude that the increase of injectivity due to the acid injection in well GPK4 is important; as injectivity curves are almost parallel, one can conclude that **injectivity of well GPK4 has been improved by about 30%.**

4. Comparison with steprate test 05Feb22

Steprate test of 22th February 2005 consisted of three injection steps. Downhole temperatures and downhole pressures are available form data; this allows us to compare computed temperature and downhole pressure values with measured data.

4.1. Comparison between computed values and measured datas

Figure 7 shows a comparison between computed downhole temperature and pressure and recorded downhole values. It can be observed that a significant difference exists between the computed temperature and measured downhole temperatures (10°C) with the first model. Therefore, a second wellbore model was set up in HEX-B, fitting recorded data better (see Figure 8). It can be observed on Figure 7 that the computed downhole pressure does not drastically change with the new model (max 1 to 2 bar difference between both models).

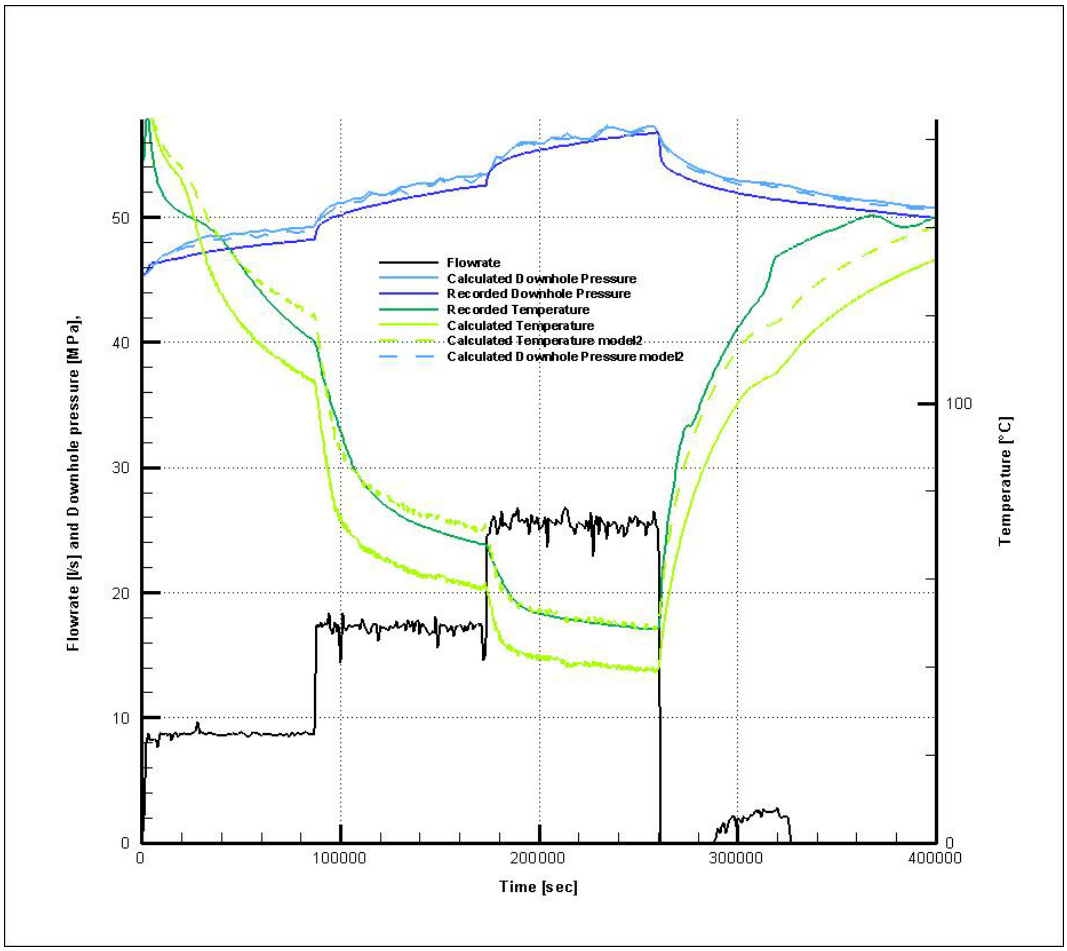

Figure 7: Comparison between computed and recorded downhole temperature and pressure.

An other observation is the difference (about 8 bars) between computed downhole pressure and recorded datas. This is due to the fact that downhole pressure is with Hex-B computed at 4500m TVD for each of the three steprate tests. In fact, the pressure sensor was parked during this steprate test at a depth of 4700m MD, i.e. 4436m TVD; this difference explains the fact that recorded pressure is about 7 bars lower than the computed downhole pressure.

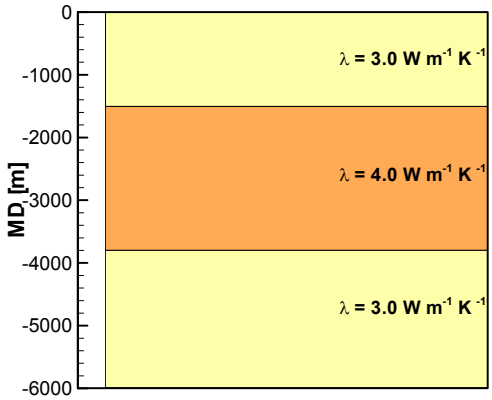

Figure 8: Wellbore conductivity (second model) used to compute downhole pressure and downhole temperature for the 05Feb22 steprate test.

4.2. Steprate 05Feb22, 06April24 and 06May29 comparison

Figure 9 shows computed downhole pressures for the three steprate tests. For each test, downhole overpressures are calculated at 4500m TVD.
One can observe on this figure that efforts made in order to enhance GPK4 injectivity since February 05 showed encouraging results. Downhole overpressures needed to inject a given flowrate was divided by a factor 2. This can also be observed on Figure 10, as injectivity at the end of the steprate test increased from 2 l/s/Mpa (05Feb22) to 4 l/s/Mpa (06May29).

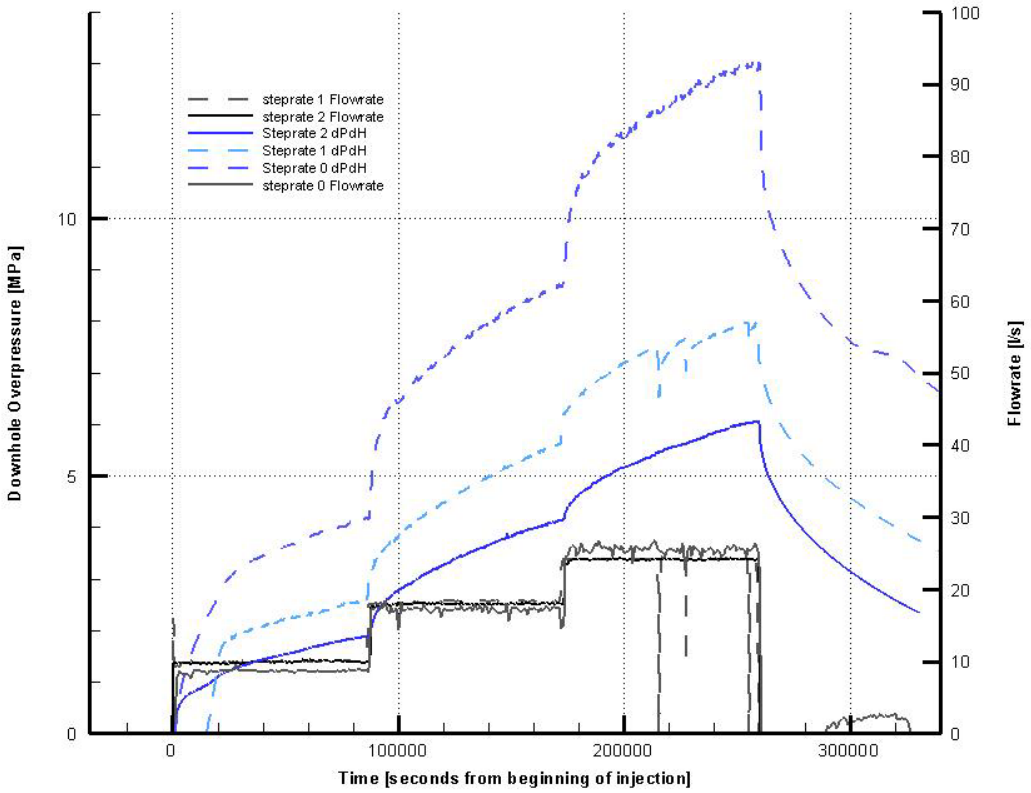

Figure 9: Computed downhole overpressures for steprate test 05Feb22 (steprate 0), 06April24 (steprate 1), and 06May29 (steprate 2)

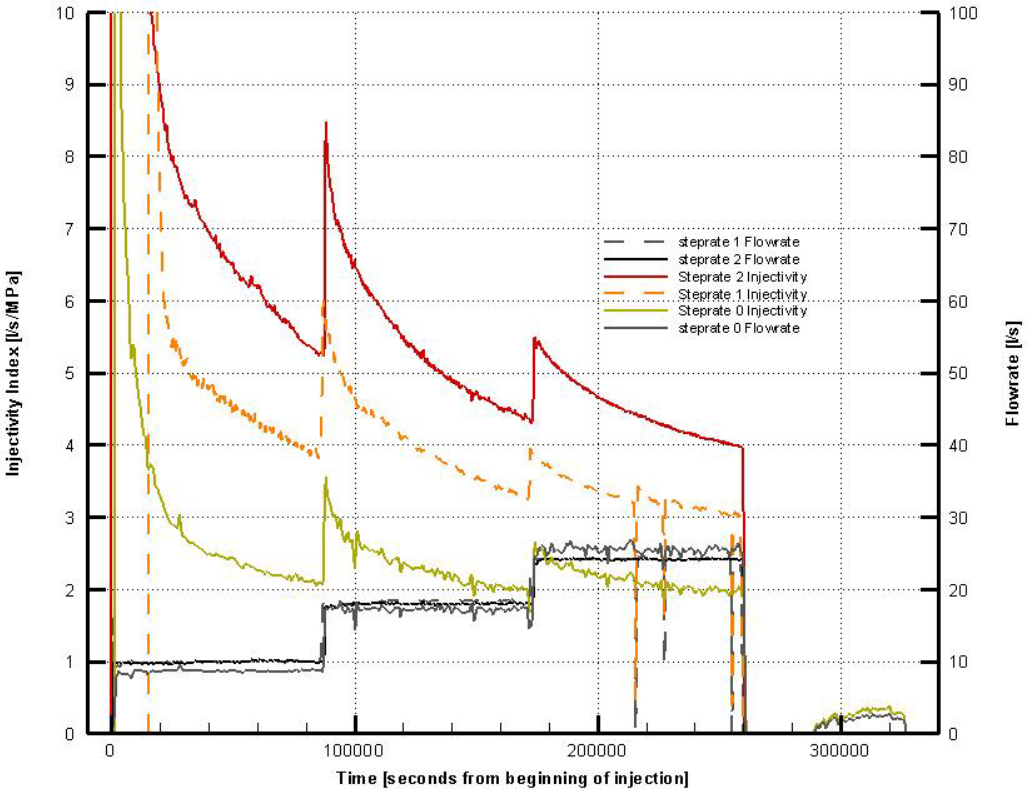

Figure 10: Computed injectivities of well GPK4 during steprate test 05Feb22 (steprate 0), 06April24 (steprate 1), and 06May29 (steprate 2)