Using the Pressure While Drilling Data to inform drilling decisions in the Kawerau and Rotokawa field, NZ

Morgane Le Brun[a], Lutfhie Azwar[b]

a. Independent

b. Mercury NZ Ltd

Morgane.Le.Brun.44@gmail.com

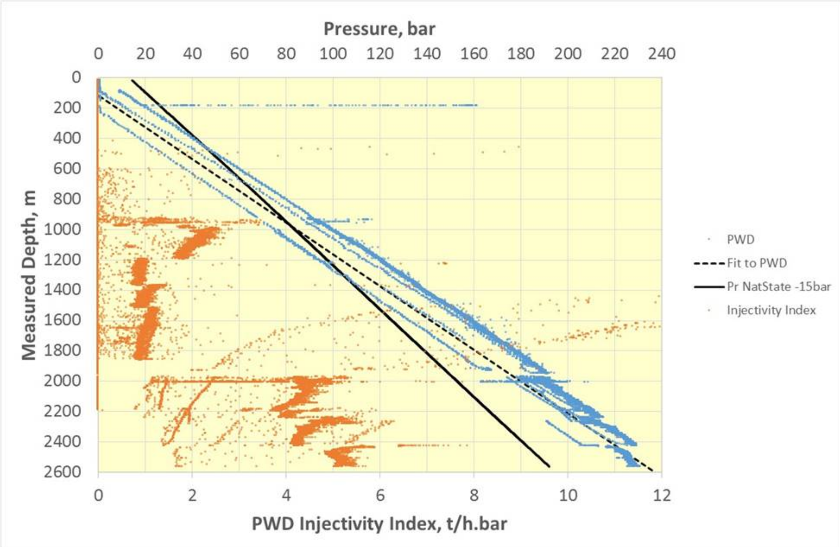
Keywords: Injectivity, Pressure While Drilling, Feedzones, Capacity modelling

ABSTRACT

During the 2016-2017 Mercury Ltd drilling campaign, one injection well and three production wells were completed at both Kawerau (KA55 and KA56) and Rotokawa (RK35 and RK36) geothermal fields in New-Zealand. This drilling campaign started with a depth target and an injection/production capacity target for each well. A regular update on the capacity of the well once drilling in the reservoir section was one key parameter to decide when to stop drilling and complete the well (i.e. decision to TD the well).

To improve drilling efficiency, the number of stage tests was reduced and a methodology was defined to calculate the wells capacity using the data from the Pressure While Drilling tool (PWD). This tool measures annular and pipe pressures using sensors within the Bottom Hole Assembly (BHA), these data give information in real time about the permeability and stability of the wellbore. The annular pressure data, combined with the fluid losses calculated while drilling the reservoir interval, were used to estimate the capacity of the well in real-time. This information about the capacity of the well enabled the TD decision to be based on more information and with less waiting time on data

The PWD data were analyzed in a two-steps process to estimate the well capacity while drilling. The first step was to estimate the injectivity index (II) of the well with the PWD data and the fluid losses in the wellbore, calculated using the flow in and out of the well recorded every 30 seconds while drilling. One method used the PWD data and reservoir pressure scenarios to calculate the II versus depth while drilling. The figure below shows the PWD data in blue, the II in orange calculated with the cold reservoir pressure (dotted line).



The other method didn't rely on the assumption on the reservoir pressure, it used the change in pressure recorded by the PWD tool at a particular depth when the injection rate in the well was changed for drilling purposes (e.g wiper trips, trip out). The comparison of the values obtained with these two methods helped better constrain the II of the well and reduce the need for stage tests. For the production wells, this II was used to estimate the Productivity Index (PI) by using a factor representing the expected decrease in permeability when producing the well, due to the reheating of the formation and change of fluid phase.

The second step was to translate the II or PI data into well capacity using an in-house wellbore modelling tool. This modelling enabled the simulation of possible scenarios of well capacity under operational conditions. For the injection wells, the II in t/h/bar obtained with the PWD data was changed into a formation II in m^3 to take into account the difference in viscosity between the cold river water injected while drilling and the hotter fluid that will be injected during the operation of the well. This II along with the well completion were used in the wellbore model to generate an injection curve and thus the expected capacity of the well. For the production well, the PI along with different reservoir pressure and fluid enthalpy scenarios were used in the wellbore model to obtain optimistic and pessimistic output curves and thus get a range of production capacity under operational conditions. This well capacity range was very valuable for determining well success and decision making during drilling (e.g., TD or side-track).

The use of the PWD data for well capacity estimation during this campaign highlighted two main areas of improvement for the future make-up wells. One area is the underestimation of the II with the PWD data compared to the completion test II. This underestimation lead to a conservative evaluation of the well capacity, understanding the source of this difference would improve the quality of information provided during the drilling of the well. The other area of improvement is the calculation of losses for the II calculation under partial losses conditions. In this drilling campaign, a paddle sensor was used to estimate the flow out of the well while drilling. The calibration of this paddle to obtain the flowrate was not always accurate, which increased the uncertainty on the II calculation. The flow out was checked with data from the mudloggers but the resolution of the losses was not as precise as the resolution of the PWD data. Partial losses conditions were generally linked to II value that were lower than the targeted II so changing the paddle sensor for a more accurate measurement with a flowmeter was not expected to change the decisions made during drilling.

This paper describes the results from the analysis and modelling from the PWD data collected in the different wells, and the benefits and limitations in the usage of the current PWD technology to inform the continuation of drilling during the drilling operation.

REFERENCES

Grant, M.A., Bixley, P.F., 2011. Geothermal Reservoir Engineering. 2nd Edition, Book, Academic Press

Grant, M.A, Clearwater, J., Quinao, J., Bixley, P., and Le Brun, M., 2013. Thermal stimulation of geothermal wells: a Review of Field Data. Proceedings, 38th Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, CA.

Siega, C., Grant, M.A., Bixley, P., Mannington, W.: Quantifying the effect of temperature on well injectivity, Proceedings, 36th New Zealand Workshop, Auckland, NZ

Clearwater, J., Azwar, L., Barnes, M., Wallis. I., Holt, R., 2015. Changes in injection well capacity during testing and plant start-up at Ngatamariki, Proceedings, World Geothermal Congress, Melbourne, Australia