Donnerstag, 2. März 2023, 16.30 Uhr
Panorama Saal EDEKA-Arena Kongress 1 - Tiefe Geothermie

Thursday, 2 March 2023, 4.30 pm
Panorama Hall EDEKA-Arena congress 1 - Deep Geothermal Energy

First successful demonstration Radial Drilling in a Geothermal well This is why innovation in deepp sub surface is so hard

Erste erfolgreiche Demonstration einer Radialbohrung in einer Geothermiebohrung
Aus diesem Grund ist Innovation in der Tiefe so schwierig

Dr. Ronald den Boogert, Radial Drilling Europe b.v.

In total six demonstrations all over the world were needed to modify the radial jetting technology to the geothermal application. This paper describes the difficulties of transferring a successful technology from the oil and gas market to the geothermal application.

Several studies calculate the theoretical performance increase of well stimulation with help of the radial jetting technology. The lower the performance of the well the better the performance increase which can vary between 30 and 300 % based on 800 meter lateral.

A standard well stimulation job can run within one week which in combination with an improvement of 30 % or more is in most cases an sharp improvement of the economics. So far only positive news and all traffic lights are on green to start running a nice innovation program.

The objective of any serious stimulation technology is to increase the contact surface between well bore and reservoir in a controlled manner. There are three options available. A microdrill, horizontal drilling and radial jetting. Radial Drilling Europe was involved in four well enhancement projects in this market. One in the United States of America, two in the Netherlands and in Belgium. Running from 1900 meter (1) 2600 meter (1) and 3900 meter (2).

With a large success rate the first well in the Netherlands was prepared as business as usual. The completion of the well was a little different as normal. The perforated cemented blank pipe was a wire wrapped pre-perforated pipe with a void between filter and reservoir. Cutting the casing was not always successful but out of 3 cuttings two seems to be OK. The trouble could have been caused if the mill enters the casing half in steel and the other part in one of the many perforations. A success rate of 66 % of the cutting process is acceptable. The real trouble started when the nozzle enters the void. It took much to look to make progress. The result must have been a large wash out which makes further penetration impossible. The question what caused the trouble, could it be the void or temperature stress. In several laboratorial test the void should not be any trouble up to 10 cm. The temperature stress is another story. Between

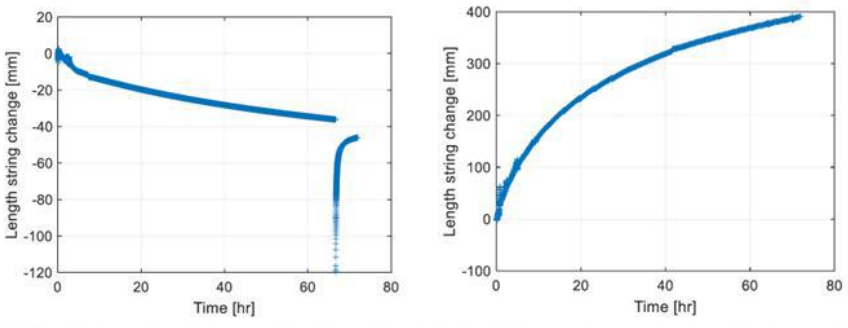


Figure 14: Length variation as function of time for the 1500 m well case (left) and 3000 m well case (right) assuming an expansion coefficient of 0.0166 mm/m and a string length of 1400 m and 2900 m respectively.

the cutting run and the jetting run about six hours time will pass just to run in and out the tools. TNO run a simulation and the results were astonishing. In a normal oil well of 1500 meter the temperature change is resulting in less than 10
mm change in length in 6 hours. The same program expect more than 10 times elongation in a 2900 meter deep well. The downhole tools have some fixation but stress of 100 mm is too much too handle for a standard fixation tool. Costs of running a demonstration are huge and an operator with a few wells cannot take the costs. The approach must be changed to keep everybody in the innovation boat.

In a second and third project the well depth was 4000 meter. We would like to have a more shallow one but no other well was available. One of the reservoir was the Balmatt Mol-GT-03 dry geothermal well. The reservoir was hard limestone. No coarse sample was available. The offered quarry sample showed different results. The risk was taken to run a test. To increase the chances of a positive outcome the microdrill was added and tested to the set of tools. The lab test showed a ROP of 1 meter per hour which is slow but could be successful in combination with an expected required length of 20 meter. More was done to turn this operation into a success. The traditional analog meters were extended with high precise pressure, load and vibration transmitters. The technology was available more or less on the shelve by several industry partners. However running proven technology in the industry is not a guarantee for trouble free operation on the rig floor. The equipment was tested on standard operations else where and finally a workable unit was available.

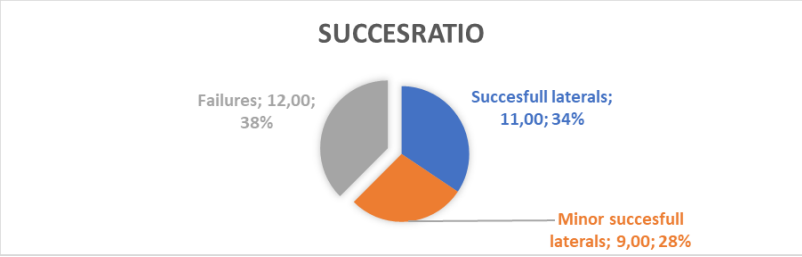
Unfortunately the combination of the acid, the CO2 and the high temperature ruined the shoe which blocked the way for the microdrill to enter the reservoir. The hard limestone was not sensible for the acid which resulted in a very low penetration of 1,5 meter in a run.

The third trial was a commercial one which results could not be shared.

After three unsuccessful attempts the expectations were downsized. The result was a focus on only one step of the project, jetting in an brand new open hole sandstone reservoir. Something which has been done before in an oil field.

The selected site is a geothermal plant in the Netherlands. The new well will be a producer and the old doublet will be used as two injectors with the hope that the new well will have double capacity. In total 32 runs have been made. In total 604 meter additional contact surface has been created which should increase the capacity with 60 %.

But this is only the begin. The well has an inclination of 21 % and the shoe and angle of 45 degrees which result in angle to the horizon varying from 24 degrees to 66 degrees. The reservoir has some thin layers of Anhydrite. The ideal path of the lateral is the 24 degrees one. The nozzle will touch the anhydrite on a large angle and testshow that the nozzle path will bent and continue. 34 % of the laterals follow this path and run at maximum hose length of 50 meter.



The opposite is a target in or very close by the anhydrite layer. The nozzle will not be able to make any progress or bent in the shoe which gives trouble as well (38 % of the cases).

28 % of the laterals made some meters. The idea is that they reached the Anhydrite on a small angle and the nozzle could not change the direction.

There is a lot to gain from this results. In the next program the orientation will be determined and or most likely a 90 degrees show will be used. The gyro will guide the nozzle in long

horizontal path of 100 meter, the 90 degrees shoe will make any direction successful. In that case 100 meter hoses can be used which will use only a few minutes more to run double length (100 % increase in length). The minor successful laterals will also be full length. The expectations are that with this small modifications the total length of the laterals can be three times as high until 1800 meter in the next project which must increase the capacity of the well with 100 % and at the same time decrease the energy consumption.

Meanwhile the data can be processed with machine learning tools. The machine learning tools need an enormous amount of datasets. There are now two machines running more or less continuously. A third data collector will be in place before the end of the year. There is hope that the load indicator will see if a lateral is following the dip or running downwards. Also the tool will be able to calculate the number of produced laterals on objective manner. Last but not least the tool will tell the operator which parameter he should change to increase the chance on a successful lateral.

The innovation lesson learned here is to start with small steps and have parties on board from different backgrounds. The small steps give people the chance to adapt and create support.

Note

Before end of the year the well test will be completed. Than the actual data will be compared by the observations. TNO will also make a calculation what the consequences will be if the number of
lateral meter will be increased to 1500 or even 3000 meter. This calculation will also be presented.