Geophysical Research Abstracts
Vol. 21, EGU2019-14770, 2019
EGU General Assembly 2019

Quantification of the real-time flow contribution of the fractures in fractured wellbores using Distributed Temperature Data

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Heat has been increasingly used as a tracer for characterization of the subsurface media both in fractured and porous aquifers. In fractured wellbore, understanding of the role of each fracture in total production of the fluid and the change of their contribution with change of the system conditions can help us increase our understanding about the system. Considering the fact that when fluid being produced from an aquifer, the produced fluid experiences changing temperatures with depth while it travels up toward the surface and this change is related to the fluid velocity (flow rate), fluid properties as well as wellbore and formation properties. Using the Distributed Temperature Sensing (DTS) which in fact allows to measure the temperature both in time and space along the fiber optic, one can perform real time flow profiling and see the change of flow in each fracture with time.

In this work, a wellbore heat transfer model for a water production scenario, based on the wellbore heat transfer model presented by Hasan, Kabir [1] has been implemented in the MATLAB ® software. The model considers steady state heat transfer inside the wellbore and transient heat transfer from the wellbore to the formation. We use this analytical model to back calculate the flow rate in each section of the wellbores and thus flow contribution of each fracture using the temperature profile inside the wellbore. The approach has been verified both numerically and experimentally. Distributed temperature data were recorded in different ambient and pumping flow rate in a fractured wellbore in Ploemeur site in Brittany, France. For cross validation, flow rates were also measured by Heat pulse flow meter.

The results show that model can predict real time contribution of each fracture to the total flow rate satisfactorily in different ambient and pumping rate. We also propose an automatic inflow zone (fracture/perforation location) detection which can help diagnosis of flowing zones (fracture locations). This model provides a basis for studying the transient behaviour and contribution of the fractures in different hydraulic conditions. For instance, the contribution of fractures in flow in different time of the years, studying the tidal effects on fracture flows, etc.

[1] Hasan, A. R., Kabir, C. S., & Wang, X. (2009). A robust steady-state model for flowing-fluid temperature in complex wells. SPE Production & Operations, 24(02), 269-276.