New Methods for Processing Fiber-Optic DAS and DTS Data

Payam Kavousi Ghahfarokhi and Timothy R. Carr
West Virginia University, Morgantown, WV, USA

Abstract

Oil and gas companies have started to invest in fiber optic technology to remotely monitor subsurface response to stimulation especially in shale reservoirs. Distributed Acoustic Sensing (DAS) and Distributed Temperature Sensing (DTS) are two fiber technologies that record vibration and temperature around the fiber, respectively. One issue is how to process and interpret the extremely large amounts of data acquired at every stage and cluster. We introduce improved work flows and new attributes to provide increased insights into stimulation efficiency during hydraulic fracture stimulation and subsequent production efficiencies. The DAS and DTS data covers the entire 28 stimulated stages of the shale gas lateral MIP-3H well near Morgantown, WV, which is part of the Marcellus Energy and Environment Laboratory (MSEEL). The DAS data was used to calculate energy and instantaneous frequency attributes for the DAS data along with low frequency energy events with duration of several hundred seconds, which are interpreted as long period long duration (LPLD) events. The proposed approaches to DAS data increases resolution and better illustrates changes in stimulation efficacy across individual clusters in a single stage and cross-stage fluid communication. Analysis of DTS data indicates that in areas of significant preexisting fractures stimulation fluid is transferred cross-stage during hydraulic fracturing between stages. DTS attributes through the production history can help explain stage by stage variations in gas and water production and the relationship to stimulation and geologic variations in the Marcellus Shale.

Research funded through the U.S. DOE National Energy Technology Lab (DOE Award No.: DE-FE0024297).

Conclusions

- Fiber-optic DAS and DTS Data can be processed and displayed using FIBPRO to improve display and analysis of the typically large data.
- DAS energy and attributes can show stimulation efficiency across different cluster in a stage and cross-flow between stages
- DTS attributes can be used to better understand cross-flow between stages and variation in production through time along the horizontal wellbore.
- Slip along preexisting fractures and small faults running at non-optimal orientations to Shmax strongly influence stimulation and subsequent production.
- The presence of long-period long-duration (LPLD) events is documented in the borehole geophone data of one of the MIP-3H stimulated stages. LPLD events are generally overlooked during the conventional processing of microseismic data, but they represent significant non-brittle deformation produced during hydraulic fracture stimulation.
- Application of machine learning algorithms have proven to be significantly useful for multi-scale big data analytics.