Monitoring the Pulse of a Well Through Sealed Wellbore Pressure Monitoring, a Breakthrough Diagnostic With a Multi-Basin Case Study

Authors	Kyle Haustveit (Devon Energy) | Brendan Elliott (Devon Energy) | Jackson Haffener (Devon Energy) | Chris Ketter (Devon Energy) | Josh O'Brien (Devon Energy) | Mouin Almasoodi (Devon Energy) | Sheldon Moos (Devon Energy) | Trevor Klaassen (Devon Energy) | Kyle Dahlgren (Devon Energy) | Trevor Ingle (Devon Energy) | Jon Roberts (Devon Energy) | Eric Gerding (Devon Energy) | Jarret Borell (Devon Energy) | Sundeep Sharma (Devon Energy) | Wolfgang Deeg (Formerly Devon Energy)

DOI	https://doi.org/10.2118/199731-MS
Document ID	SPE-199731-MS
Publisher	Society of Petroleum Engineers
Source	SPE Hydraulic Fracturing Technology Conference and Exhibition, 4-6 February, The Woodlands, Texas, USA
Publication Date	2020

Show more detail View rights & permissions

Abstract

Over the past decade the shale revolution has driven a dramatic increase in hydraulically stimulated wells. Since 2010, hundreds of thousands of hydraulically fractured stages have been completed on an annual basis in the US alone. It is well known that the geology and geomechanical features vary along a lateral due to landing variations, structural changes, depletion impacts, and intra-well shadowing. The variations along a lateral have the potential to impact the fluid distribution in a multi-cluster stimulation which can impact the drainage pattern and ultimately the economics of the well and unit being exploited. Due to the lack of low-cost, scalable diagnostics capable of monitoring cluster efficiency, most wells are completed using geometric cluster spacing and the same pump schedule across a lateral with known variations.

A breakthrough patent-pending pressure monitoring technique using an offset sealed wellbore as a monitoring source has led to advancements in

quantifying cluster efficiencies of hydraulic stimulations in real-time. To date, over 1,500 stages have been monitored using the technique. Sealed Wellbore Pressure Monitoring (SWPM) is a low-cost, non-intrusive method used to evaluate and quantify fracture growth rates and fracture driven interactions during a hydraulic stimulation. The measurements can be made with only a surface pressure gauge on a monitor well.

SWPM provides insight into a wide range of fracture characteristics and can be applied to improve the understanding of hydraulic fractures in the following ways:

Qualitative cluster efficiency/fluid distribution

Fracture count in the far-field

Fracture height and fracture half-length

Depletion identification and mitigation

Fracture model calibration

Fracture closure time estimation

The technique has been validated using low frequency Distributed Acoustic Sensing (DAS) strain monitoring, microseismic monitoring, video-based downhole perforation imaging, and production logging. This paper will review multiple SWPM case studies collected from projects performed in the Anadarko Basin (Meramec), Permian Delaware Basin (Wolfcamp), and Permian Delaware Basin (Leonard/Avalon).

File Size 2 MB **Number of Pages** 42

Agrawal, S., & Sharma, M. M. (2018, August 9). Impact of Pore Pressure Depletion on Stress Reorientation and Its Implications on the Growth of Child Well Fractures. Unconventional Resources Technology Conference. doi:10.15530/URTEC-2018-2875375

Almasoodi, M., Vaidya, R., & Reza, Z. (2019). Intra-Well Interference in Tight Oil Reservoirs: What do We Need to Consider? Case Study from The Meramec. Unconventional Resources Technology Conference.

Attia, A., Brady, J., Lawrence, M., & Porter, R. (2019, January 29). Validating Refrac Effectiveness with Carbon Rod Conveyed Distributed Fiber Optics in the Barnett Shale for Devon Energy. Society of Petroleum Engineers. doi:10.2118/194338-MS

Chen, C., & Raghavan, R. (2015). Transient flow in a linear reservoir for space–time fractional diffusion. Journal of Petroleum Science and Engineering, 128, 194-202.

Chen, X., & Shearer, P. M. (2011). Comprehensive analysis of earthquake source spectra and swarms in the Salton Trough, California. Journal of Geophysical Research: Solid Earth, 116(B9).

Chu, W., Scott, K., Flumerfelt, R., & Chen, C. C. (2018, September). A new technique for quantifying pressure interference in fractured horizontal shale wells. In SPE Annual Technical Conference and Exhibition. Society of Petroleum Engineers.

Ewing, T. E. and H.Christensen, 2016, Texas through time: Lone Star geology, landscapes, and resources: The University of Texas at Austin, Bureau of Economic Geology Udden Series No. 6, 431 p.

Ge Jin and Baishali Roy, (2017), "Hydraulic-fracture geometry characterization using low-frequency DAS signal," The Leading Edge 36: 975–980. https://doi.org/10.1190/tle36120975.1

Elliott, B., Manchanda, R., Seth, P., & Sharma, M. (2019, July 31). Interpreting Inter-Well Poroelastic Pressure Transient Data: An Analytical Approach Validated with Field Case Studies. Unconventional Resources Technology Conference. doi:10.15530/urtec-2019-449

Haustveit, K., Almasoodi, M., Al-Tailji, W., Mukherjee, S., Palisch, T., & Barber, R. (2019, July 31). Far-Field Proppant Imaging Offsetting Depletion: A STACK Case History. Unconventional Resources Technology Conference. doi:10.15530/urtec-2019-1035

Kampfer, G., & Dawson, M. (2016, June 26). A Novel Approach to Mapping Hydraulic Fractures Using Poromechanic Principles. American Rock Mechanics Association.

Kvale, E.P., Bowie, C.M., Flenthrope, C., Mace, C., Parrish, J.M., Price, B.J., Anderson, S., DiMichele, W.A. : Facies variability within a mixed carbonate-siliciclastic sea-floor fan (upper Wolfcamp Fm., Permian, Delaware Basin, New Mexico), (in press; preliminary version published online Ahead of Print27 June 2019: AAPG Bulletin, DOI:10.1306/06121917225.

Lagrone, K. W., & Rasmussen, J. W. (1963, July 1). A New Development in Completion Methods- The Limited Entry Technique. Society of Petroleum Engineers. doi:10.2118/530-PA

Playton, T. E. and C.Kerans, 2002, Slope and toe-of-slope deposits shed from a late Wolfcampian tectonically active carbonate ramp margin: Gulf Coast Association of Geological Societies, v. 52, p. 811-820.

Price, B.J., Pollack, A.C., Lamb, A.P., Peryam, T.C., Anderson, J.R.: Depositional interpretation and sequence stratigraphic control on reservoir quality and distribution in the Meramecian STACK play, Anadarko Basin, Oklahoma, USA, (in press; preliminary version published online Ahead of Print06 May 2019: AAPG Bulletin, DOI:10.1306/04301917411

Rainbolt, M. F., & Esco, J. (2018, January 23). Frac Hit Induced Production Losses: Evaluating Root Causes, Damage Location, Possible Prevention Methods and Success of Remediation Treatments, Part II. Society of Petroleum Engineers. doi:10.2118/189853-MS

Rezaei, A., Dindoruk, B., & Soliman, M. Y. (2019). On parameters affecting the propagation of hydraulic fractures from infill wells. Journal of Petroleum Science and Engineering, 182, 106255.

Sneddon, I.N. 1946. The Distribution of Stress in the Neighbourhood of aCrack in an Elastic Solid. Proc. Royal Soc. London, Ser. A. 187 (1009): 229-260. http://dx.doi.org/10.1098/rspa.1946.0077.

Shapiro, S. A., Dinske, C., & Rothert, E. (2006). Hydraulic-fracturing controlled dynamics of microseismic clouds. Geophysical Research Letters, 33 (14).

Somanchi, K., Brewer, J., & Reynolds, A. (2017, January 24). Extreme Limited Entry Design Improves Distribution Efficiency in Plug-n-Perf Completions: Insights from Fiber-Optic Diagnostics. Society of Petroleum Engineers. doi:10.2118/184834-MS

Spychala, Y. T., D. M. Hodgson, A. Pre´ lat, I. A. Kane, S. S. Flint, and N. P. Mountney, 2017, Frontal and lateral submarine lobe fringes: Comparing sedimentary facies, architecture and flow processes: Journal of Sedimentary Research, v. 87, no. 1, p. 75–96,

Ugueto C., G. A., Huckabee, P. T., Molenaar, M. M., Wyker, B., & Somanchi, K. (2016, February 1). Perforation Cluster Efficiency of Cemented Plug and Perf Limited Entry Completions; Insights from Fiber Optics Diagnostics. Society of Petroleum Engineers. doi:10.2118/179124-MS

Ugueto, G. A., Todea, F., Daredia, T., Wojtaszek, M., Huckabee, P. T., Reynolds, A., … Chavarria, J. A. (2019, September 23). Can You Feel the Strain? DAS Strain Fronts for Fracture Geometry in the BC Montney, Groundbirch. Society of Petroleum Engineers. doi:10.2118/195943-MS

Weddle, P., Griffin, L., & Pearson, C. M. (2018, January 23). Mining the Bakken II; Pushing the Envelope with Extreme Limited Entry Perforating. Society of Petroleum Engineers. doi:10.2118/189880-MS

Willingham, J. D., Tan, H. C., & Norman, L. R. (1993, January 1). Perforation Friction Pressure of Fracturing Fluid Slurries. Society of Petroleum Engineers. doi:10.2118/25891-MS