AAPG/SEG/SPWLA HEDBERG CONFERENCE
"Fundamental Parameters Associated with Successful Hydraulic Fracturing – Means and Methods for a Better Understanding"
DECEMBER 7-11, 2014 – AUSTIN, TEXAS

Shale Formation Re-Fracturing; What is Needed?

Ibrahim S. Abou-Sayed[1] and Ayman S. Abdelgawad[2]

[1]i-Stimulation Solutions, Inc., Sugar Land, TX, USA
[2]i-Stimulation Solutions, Inc., Dallas, TX, USA

Abstract

Multi-fractured horizontal wells in Shale plays exhibit, sometimes dramatic, performance decline due to deterioration in completion efficiency. This decline is caused by one or more of the following physical processes:

- Loss of effective fracture area due to crushing of the unpropped fracture length and near closure of that part of the fracture[1]
- Reduction in conductivity due to proppant embedment under increasing closure stresses on the fracture surfaces,
- Reservoir rock creep[2,3], and
- Permeability reduction under decreasing reservoir pressure[4,5]

These processes cause an adverse impact on the effective fracture dimensions and are controlled by pressure changes:

- Bottomhole Flowing Pressure – a local parameter at the wellbore
- Near wellbore pressure drop – an intermediate range parameter
- Far field reservoir pressure drop – a global parameter

The decline in the well performance is controlled by the way we drawdown the wells especially in early times. Looking back at historical production practices suggests that the industry practices may have damaged the hydraulic fracture effectiveness. The damage starts at the wellbore and spreads deeper in the reservoir as production time increases. In some cases, wells are drawn down so severely that tensile formation failure and casing damage happen very early in the life of the well as outlined by Suarez-Rivera, et.al.[6].

In order to overcome the reduced effective fracture dimensions, it is necessary to evaluate the performance of the multi-fractured horizontal wells and its remaining potential and the impact of re-fracturing. This can be achieved by RTA, PTA and developing an analog for the potential uplift with re-fracturing.

In this paper we discuss an analog model, developed from a statistically significant dataset of over 80 wells in the Haynesville Shale, for estimating the economic value, the potential uplift and the minimum threshold volume required. Also, we discuss methods to achieve this potential including implementation. Some of these points were presented by Jacobs[7] in a JPT article.

Further, for relatively mature shale plays, production optimization becomes critical to maintain volumes. Re-stimulation represents a significant production optimization opportunity to partially reverse completion effectiveness decline and enhance volumes. Re-stimulation could potentially lead to production acceleration; by re-opening the fractures, and enhanced reserves; by creating new stimulated volumes.

Technical Contributions:

The work is novel in the way it demonstrates:

- Concept of an effective analog to quantify potential value and economic viability of active re-stimulations
- Workflow for quantification of production uplift from passive re-stimulation
- Procedure for optimizing the timing and benefit from future candidate re-stimulation
- Fracture design to achieve effective re-stimulation of multi-fractured horizontal well

References:

1. Core Laboratories Consortium on Haynesville Shale, 2008 – 2011
2. Li, Yawei and Ghassemi, Ahmad, "Creep Behavior of Barnett, Haynesville, and Marcellus Shale," ARMA 12-330, 46th US Rock Mechanics / Geomechanics Symposium, Chicago, IL, USA, 24-27 June 2012
3. Sone, H., & Zoback, M. D., "Strength, Creep And Frictional Properties of Gas Shale Reservoir Rocks. American Rock Mechanics Association," ARMA 10-463, 44th US Rock Mechanics Symposium and 5th US-Canada Rock Mechanics Symposium, Salt Lake City, UT June 27–30, 2010
4. Díaz de Souza, O, et.al., "Integrated Unconventional Shale Gas Reservoir Modeling: A Worked Example From the Haynesville Shale, De Soto Parish, North Louisiana," SPE 154692, SPE Americas Unconventional Resource Conference – Pittsburgh, Pennsylvania – 5-7 June 2012
5. Vera, Fabian and Ehlig-Economides, Christine, "Diagnosing Pressure-Dependent-Permeability in Long-Term Shale Gas Pressure and Production Transient Analysis,", SPE 166152, 2013 SPE ATCE, New Orleans, Louisiana, September 30-October 2, 2013
6. Suarez-Rivera, Roberto, et.al., "Improving Horizontal Completions on Heterogeneous Tight Shales," CSUG/SPE 146998, Canadian Unconventional Resources Conference, Calgary, Alberta, Canada, 15-17 November 2011
7. Jacobs, Trent, "Mature Shale Wells Through Refracturing," JPT, April 2014