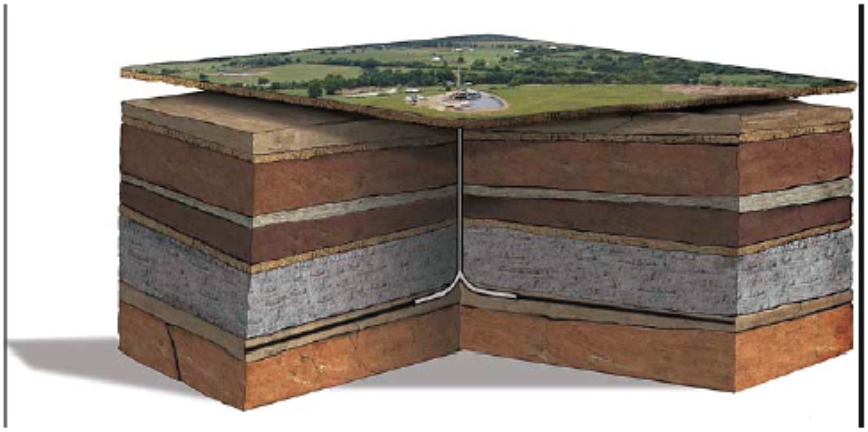
Gulf Coast Section



Timely Technical Presentations

Crack the Unconventional Code

Vetted Case Histories

High - Level Keynote Address

Network with Peers

SPE - GCS WESTSIDE STUDY GROUP PRESENTS A TECHNICAL WORKSHOP

CHALLENGES IN UNCONVENTIONAL RESERVOIR DEVELOPMENT

MARCH 29, 2017 (8:30AM - 4:30PM)

VENUE: CORE LAB (6323 Windfern), HOUSTON

SPE - GCS WESTSIDE STUDY GROUP
http://www.speges.org/events/3499/

Register by March 24, 2017

TECHNICAL PROGRAM COMMITTEE

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Unconventional reservoirs have now become the major portfolio for many oil and gas companies in the USA. From initial acreage capture to field development and beyond, operators face numerous challenges in identifying what makes these plays tick and how to exploit them for better returns on investment. With steeper production declines normally witnessed in unconventional reservoirs, completion designs have changed from moderately-sized fracture treatments to pumping tens of millions of pounds of proppant per well in an effort to aid faster acceleration in this low commodity priced environment. On the other hand, these changes directly impact reservoir drainage and infill patterns. Is there a simple answer? This one-day technical workshop is designed to provide operators and service companies an opportunity to present case studies/best practices/analyses on myriad topics in an effort to crack the unconventional code.

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Core Lab RESERVOIR OPTIMIZATION

HALLIBURTON

Time	Presenter	WSG- Chair
07:30-08:15	Light Breakfast/Registration Badge Pick Up	
08:15-08:30	Opening Remarks/Safety Orientation	
Session 1	***08:00-10:00 (Utica, California, Canada)***	***Buddy/Derek***
08:30 -09:00	HESS	
09:00-09:30	Chevron	
09:30-10:00	Encana	
10:00-10:30	***Coffee Break***	
Session 2	***10:30-12:00 (Reservoir/EOR)***	***Steve B/Brian***
10:30-11:00	PetroEdge	
11:00-11:30	Halliburton	
11:30-12:00	SLB	
12:00-13:00	***Lunch***	
Luncheon Key Note Speaker	***Nathan McMahan - ConocoPhillips***	
12:15-12:45	***Unlocking Opportunity: How Rapid Technological Advancements and Productivity Improvements are Impacting Unconventional Reservoir Development***	
Session 3	***13:00-14:30 (Permian/Eagle Ford)***	***Bharath/Purvi***
13:00-13:30	Oxy	
13:30-14:00	Devon Energy	
14:00-14:30	Core Lab	
14:30-15:00	***Coffee Break***	
Session 4	***15:00-16:30 (Bakken)***	***Steve L/Buddy***
15:00-15:30	Liberty Resources	
15:30-16:00	Marathon Oil	
16:00-16:30	ConocoPhillips	
16:30-17:00	***Closing Session/Wrap Up***	

Case Study of Completion Techniques in the Utica presented by Craig Cipolla, HESS

The impact of completion strategy on completion efficiency, fracture geometry and well productivity is still a topic of considerable debate. Optimizing the number and location of perforation clusters, number of stages, and treatment size requires a clear understanding of how these parameters effect fracture geometry and well productivity. A comprehensive evaluation of plug & perf and single entry point completions and treatment size was performed using a 5-well pad in the Utica. The evaluation included plug & perf completions with 4 perforation clusters and 3 perforations clusters and single entry point completions. Treatment size was varied by a factor of two to evaluate the effect of fluid volume on fracture length. Microseismic data were gathered on the completions in four of the five wells. The goal of this work was to answer a very important question, how does the number of perforation clusters per stage and treatment size effect fracture geometry and well productivity? The microseismic data provided a clear understanding of the relationship between treatment size and fracture length for each completion scenario. The microseismic data were used to calibrate hydraulic fracture models and the fracture geometries for each stage were discretely gridded in a reservoir simulation model to evaluate production for each completion scenario. The results of this work suggest that fracture length is primarily a function of the treatment volume per entry point (i.e. – perforation cluster) and single entry point completions DO NOT result in better completions – at least in this Utica pad.

Early Economic Learning for Unconventional Reservoir Development: Antelope Shale Case History presented by Amit Singh, Chevron

A completion and learning strategy with objective to maximize learning and identify optimal completion design in exploration phase with fewer wells in new unconventional fields impacts the overall project success. In Antelope Shale, 4 vertical Front End Loading (FEL) wells were drilled and completed with multi-stage hydraulic fracturing to evaluate economic production capabilities and to gather valuable information in early exploration phase for field development plan decision making. The completion strategy workflow guided identification and selection of important completion variables including different completion methods (multiple / single cluster per stage). The learning strategy helped in identification and application of economical high graded technologies in these wells, such as microseismic, tiltmeters, tracers, Diagnostic Fracture Injection Test (DFIT), etc.

In this talk, a case study of well completion and learning strategy in Antelope Shale would be shared, which guided decisions for future field development plan and completion strategy. Comparison of different completion methods using various indicators such as operational efficiency, economic impact, and production performance provided guidance to select the best alternative for future development. The fracture geometry results from integrated microseismic and tiltmeter analysis not only provided information on fracture half-length, height and orientation, but also confirmed effectiveness of some potential fracture barriers and presence of horizontal and vertical fracture components, which are critical for future horizontal well landing planning. Results from oil based tracer analysis proved instrumental in zonal contribution measurement and provided guidance to identify the zone of interest for future development. In new shale and tight rock fields, where the commerciality of the reservoir is yet to be established, well completion and learning strategy in exploration and early development phase can help meet value based objectives of the project while maximizing learning for future full field development.

High Yield FR pilot application in the Duvernay presented by Joel Fox, Encana

Over the last several year's stimulations in the Duvernay formation have required guar based, crosslinked gels to achieve higher sand concentration placements of 4-5 ppg. It is widely known in industry these gels cause significant damage to the proppant pack conductivity. Recently an intermediate viscosity system was piloted in the play using high yield FR fluid which is polymer based vs guar based. These systems do not develop the very high viscosities that the traditional XL Borate systems achieve. The challenge was would we be able to place the same sand densities with this lower viscosity fluid that was achieved with the high viscosity XL gel system.

Reservoir Engineering Aspects of Production Optimization for Unconventional Reservoirs presented by Stuart Cox, PetroEdge

The optimization of production from unconventional reservoirs is a multi-component process that requires proper characterization and understanding of the reservoir properties that control flow capacity, deliverability and economic returns. This presentation will address common questions such as:

- What are the reservoir parameters required to predict initial performance and evaluate completion efficiency?
- How can we determine if a change in completion practice has increase or accelerated recovery?
- How can public data be used to evaluate optimum lateral length and well spacing?

Well Spacing and Recovery Optimization in Unconventional Reservoirs: Challenges Faced and Solutions to Address Them presented by Kumar Ramurthy, Halliburton

Increasing the section recovery and lowering the breakeven cost is the main objective for operators in Unconventional reservoirs. This is being done in multiple ways like increasing the well count per section and/or by increasing the stage count per well along with massive increases in job size. Most of these approaches have been based on trial and error pilots. The real reason behind why such trials work or doesn't work has not been clearly understood, especially, the effects of well and frac interference and the production effect when the well count increases. This presentation will address some of these challenges from a sub-surface perspective so we can arrive at an engineered solution that will maximize the asset value.

Enhanced Oil Recovery in unconventional reservoirs – Are we there yet? presented by Karthik Srinivasan, Schlumberger

Average recovery factors from most unconventional reservoirs range from 5 to 15% depending on acreage quality, completion methodologies and well density. Some of the major challenges associated with getting the left over oil out of the ground include understanding wettability characteristics of the rock, relative permeability of oil and impact of fracturing fluids and other injection fluids on these characteristics. This presentation discusses the potential of enhanced oil recovery in unconventional reservoirs with a focus on drainage systems, gas injection, fracturing fluid modifications and some early work that is being experimented in some of the shale basins in the US.

High Density Completions – Fake News? presented by Ken Lizak, OXY

This discussion will focus on the use of fracture models in unconventional shale reservoirs. The presentation will touch on stimulated reservoir volume, natural fractures, discrete fracture networks, "high density" completions and stress shadowing. This presentation will attempt to answer the questions of "What is the value and what will be done different with this information

Frac Hit Observations in the Black Hawk Field - An Eagle Ford Case Study presented by Scott Bennett, Devon

Devon and BHP Billiton are jointly developing the Black Hawk field in Dewitt County. In this discussion, historical hydraulic interference across the field is presented, as well as the mitigation and monitoring techniques to address the challenges.

Core-Log Integration Techniques for the Development of a Petrophysical Model for the Wolfcamp Midland Basin presented by Randy Miller, Core Lab

The Wolfcamp section in the Midland Basin is a major target for oil production from horizontal wells. The prospective section is over 1000 feet thick and is typically subdivided into four intervals designated as the A, B, C and D, all of which have been the target of horizontals. The Wolfcamp is stratigraphically very heterogeneous being comprised of organic mudstones thinly to thickly interbedded with tight carbonate debrites and turbidites, and in some cases siliciclastics. Core analysis data reveal that the majority of the liquid hydrocarbons reside in the organic mudstones (source rocks). In addition, the wells commonly produce water in excess of load recovery.

Petrophysics in the Wolfcamp is very challenging due to 1) thin bed effects, 2) variations in matrix density, 3) identifying the source(s) or water production, and 4) determining moveable oil. In order to address these challenges Core Lab has analyzed 100 Wolfcamp cored pilot wells in the Midland Basin and integrated the data with open-hole well logs. These integration techniques will be presented along with the results and implications for horizontal well landing zones. The remaining challenges will also be discussed.

Mining the Bakken – Driving Cluster Efficiency Higher Using Particulate Diverters presented by Paul Weddle, Liberty

This paper focuses on the evolution of an advanced completion design utilizing solid particulate diverters resulting in a dramatic increase in the number of fracture initiation points as validated with RA tracers. The ultimate goal of this strategy is to increase capital efficiency by placing a dense fracture network more contained within the producing formation. The information contained in the paper should be of great benefit to completion engineers working across a variety of unconventional oil and gas basins.

It is generally proven that larger proppant volumes and more frac stages result in higher oil and gas recoveries, i.e., bigger is better. Practically the number of stages for a 9,500 ft. lateral (typical for the Bakken) is limited to 40 or 50 stages due to operational and cost limits. For advanced completion designs (complex fracture networks), the goal is not to just increase the stage count but to increase the number of initiation points (perforation clusters) that are effectively stimulated increasing the contacted fracture surface area. Challenges to executing this strategy include, but are not limited to; increased screen out risk, stress shadowing and geo-mechanical variability along the wellbore.

With volatile oil prices, continued innovation is necessary to sustain the unconventional shale success. In pursuit of better well performance AND lower capital costs, Liberty Resources has moved to a completion design that incorporates a high density perforating strategy and a focus on diversion methods to effectively stimulate each cluster. Solid particle diverter was utilized to increase perforation cluster efficiency. Production performance is encouraging and radioactive (RA) proppant tracers show that cluster stimulation efficiencies in excess of 85% can be achieved.

The unconventional shale revolution that began 15 years ago has successfully returned the United States to being a world leader in oil and gas production and technology. Completion designs have evolved significantly from the first early Barnett Shale completions and are now quite diverse. Variations in design are driven by the uniqueness of each basin's geologic and reservoir properties as well as operator bias. This diversity in completion methodologies has contributed significantly to technology advancement; the status quo is continually tested with new innovations. The Williston Basin was one of the first unconventional shale oil successes and it continues to contribute to the advancement of horizontal fracturing technology.

Bakken Refrac Evaluation: Investigating re-stimulation options in mature wells with existing lateral liner installations presented by Pete Lewis, Marathon Oil

Bakken Refrac Evaluation: Investigating re-stimulation options in mature wells with existing lateral liner installations. Marathon Oil has two types of vintage 4-1/2" lateral liner configurations in North Dakota: pre-perforated liners and laterals completed with 1st generation ball and sleeve technology (<20 stages). In effort to accommodate re-stimulation options, various technologies (diverters and inner liners) have been considered.

Technology driven type curve generation in Bakken presented by Hosein Kalaei, COP

One of the crucial aspect of unconventional resources is to investigate the long term well estimated ultimate recovery (EUR). Type curves (TC) play a crucial piece in quantifying a plan of development for a particular asset.
Generation of TC in Bakken used to be accomplished by rate-matching of individual wells using decline curve analysis (DCA) method. While DCA techniques allow quick and large scale evaluations, they have limitations in its applications to unconventional reservoirs (transient flow and rapidly changing flowing bottom hole pressures). Data driven empirical techniques such as DCA lack direct tie-in with reservoir parameters and rely completely on actual production data trend to allow for EUR extrapolation. As a result, it becomes very challenging to project EUR's when an asset undergoes a major shift in completion design, well spacing strategy and/or operating philosophy. For cases like these where we lack statistically sound production data, one can leverage learnings from more physics based approach such as simulation modeling, RTA, etc.

In COP Bakken, we conducted a rigorous simulation modeling study to help narrow reservoir uncertainty and quantify range of EUR. Findings from our data gathering (down hole pressure gauge, DFIT, PVT/GOR, RA tracer, etc.) were used to constrain our simulation model which was then calibrated using actual production data for the area of interest. This gave us more confidence on the predictive capability of the model which was then subsequently used to generate range of production profiles (stochastic workflow). In summary, the simulation derived EUR prediction workflow was used in conjunction with empirical DCA technique resulting in more confidence in the accuracy of EUR prediction.