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White Paper.

Energized Solutions: The EOR & IOR (E-I-O R) of Energized Fluids for Hydraulic Fracturing.

Abstract

Hydraulic fracturing along with horizontal drilling has revolutionized unconventional oil and gas production over the past decade. While significant strides have been made in the efficiency of drilling and completions during this period, the next generation of improvements will focus more on optimizing full field development. This optimization centers on the concept of the 3 E's: enhancing productivity (EUR), environmental footprint reduction, and improved economics of the field. Past case studies in unconventional reservoirs have shown that in well-designed hydraulic fracturing processes, energized fluids utilizing carbon dioxide (CO_2) or nitrogen (N_2) can reduce costs and improve well performance to achieve a lower unit cost of production. From a field-wide perspective, based upon historic uses of CO_2 and N_2 for Enhanced Oil Recovery (EOR), one can quickly discern how individual well stimulation treatments utilizing energized fluids can provide a leg up in the ultimate recovery of a reservoir. This paper will review case studies on the productivity and economics of various fracturing fluids in unconventional plays and then assess, in the EagleFord, relative costs of stimulations with various fracturing fluids and compare the simulated production results for each of those fluids. Optimizing individual well treatments and scaling up to full field development ensures the best economics for any fracturing fluid. With energized solutions, optimizing hydraulic fracturing treatment design brings the added benefit of EOR & IOR (Improved Oil Recovery) – the E-I-O R of energized fluids.

E-I-O R of energized fluids

With today's focus on liquids-rich plays for hydrocarbon production, hydraulic fracturing represents the most common method for primary oil recovery from unconventional reservoirs. As unconventional well completions have matured, the industry has made other significant strides in improving the efficiency of drilling and well completions. These improvements include:

- Pad drilling,
- Batch completions,
- Increasing depth and lateral lengths, which increases proppant loads and fluid volumes,
- Downspacing between laterals and clustering of stages, which effectively stimulates the rock with the highest potential.

Typical steps of production include Primary, Secondary (Improved), and Tertiary (Enhanced) Oil Recovery. In conventional oil plays, the stages of recovery are progressed with a view from individual well treatment to field-wide development, all while increasing the percentage of oil recovered from the formation.

With unconventional plays, declines of 75-85% within the first one to two years of initial production for large horizontal wells are typical. So advanced planning for an accelerated progression from primary to tertiary recovery must focus on optimizing full field development to ensure better recovery factors.

There are significant benefits to thinking strategically about how to develop the whole field, starting with primary recovery (drilling & completions), instead of just one well at a time. Focusing on full field development from the start affords the opportunity to optimize the stimulation program based on available fracturing fluid supply options, and to make better business decisions based on the greater size of the play. The result: significantly improved economic performance.

Hydraulic fracturing – yesterday, today, & tomorrow

Energized fluids -- fracturing fluid that includes at least one compressible, sometimes soluble, gas phase -- using CO_2 and/or N_2 have been successfully used for hydraulic fracturing over 40 years. Up until the early 2000s, about 30% of the hydraulic fracturing done in the U.S. used an energized fluid. Today that number is less than 3%.[1] The shift in the U.S. jobs done with an energized fluid corresponds with the onset of the unconventional revolution.

Table 1: Conventional wisdom and our evolving understanding of using water as a fracturing fluid.

	Conventional wisdom	Reality
Water	Cheap	Life cycle costs of water can be expensive. Reducing life cycle costs of water, including recycling or reuse, can require significant capital investment.
	Simple	Not 100% return of what pumped down. Managing flowback/production, reuse and recycling compounds the complexities.
	Works good enough	Least effective: Significant well decline curves due to proppant embedment caused by water exposure over time along with improper proppant placement. Can leave large, unpropped portions of fractures. Water saturation increases and damage in reservoirs can have a detrimental effect on long-term recovery out of reservoir. (particularly for unconventionals).
Investment	High IP	May lead to pre-mature depletion, reducing drawdown pressures to point of unable to overcome capillary pressures.
	Simple math to project outwards	Deceptive – early high IPs may be due to cherry picking of potential play, not necessarily an optimization of play (greatest long-term value). Will see transition over the next 3-5 years of valuations for investment to an Optimizing Full Field Development assessment.
Availability	Readily available	Water availability severely limiting in some regions. Some areas projected to get more severe. Fresh water sourcing reduction programs to continue.

As the unconventional revolution gained ground, water initially seemed “cheap,” readily available and forgiving. Energized fluids suffered from a perception, based upon acquisition costs, that they were significantly more expensive than water. And, as time went on, the rapid shift to horizontal drilling programs and their rapid growth meant there was not only a lack of readily sufficient volumes of energized components -- CO_2 and N_2 -- but also fewer experienced crews available to execute those programs.

Conventional wisdom (CW) regarding water’s initial attractiveness as the ultimate fracturing fluid system has, however, evolved with the unconventional revolution. Table 1 summarizes the CW versus today’s realities.

As Linde outlined in an earlier whitepaper, “A Day In The Life Of A Barrel Of Water,” water life cycle costs have risen significantly. This is especially true in areas now experiencing water shortages and droughts, as well as those areas with fewer regional disposal well options. At the same time, public awareness – and subsequent negative perception – of the sheer amount of water required for each well – typically between 2.5 and 5 million gallons but can run as high as 10 million gallons – has led some communities to begin requiring producers to disclose consumption figures.

It is interesting to note that despite this trend in the U.S., energized fracturing fluid use in Canada remains strong, hovering around 45%.[2] The Canadian experience has shown that energized fluids create more productive wells and are less costly than water-based only solutions, largely due to the reduction of water, chemicals, and proppant when using a fluid energized with CO_2 or N_2.

Other recent studies also indicate that fracturing with solutions energized by CO_2 or N_2 can economically achieve significantly more hydrocarbon recovery than non-energized approaches. One such study[3] found that use of energized fluids improved well performance by 1.6 to 2.1 times compared to non-energized solutions. Other recent publications on using CO_2 and N_2 fracturing fluid options also tout the benefits of their use in unconventional reservoirs (i.e., King 1982, Burke et al 2011, Gupta 2011).[4]

Across the spectrum from Primary to Tertiary Recovery, energized fluids play a role in improving overall field recovery and individual well productivity. (see Diagram 1 on page 4)

[2] The University of Texas at Austin Joint Industry Project on Hydraulic Fracturing and Sand Control, Source: Canadian Discovery Frac Database. Courtesy of Ferus Wellsite Cryogenic Solutions, 2013.

[3] Burke, L.H. and Nevison, G. W. 2011. Improved Hydraulic Fracture Performance with Energized Fluids: A Montney Example. Recovery-2011 CSPG CSEG CWLS Convention.

[4] King, G.E.: “Foam and Nitrofied Fluids: Stimulation Techniques and More,” SPE 14477, Distinguished Lecturer Paper, 1985/1986. Burke, L.H. and Nevison, G. W. 2011. Improved Hydraulic Fracture Performance with Energized Fluids: A Montney Example. Recovery-2011 CSPG CSEG CWLS Convention. Gupta, S. “Unconventional Fracturing Fluids : What, Where and Why”, Baker Hughes.

Energized fluids role in production phases highlighted in Diagram 1

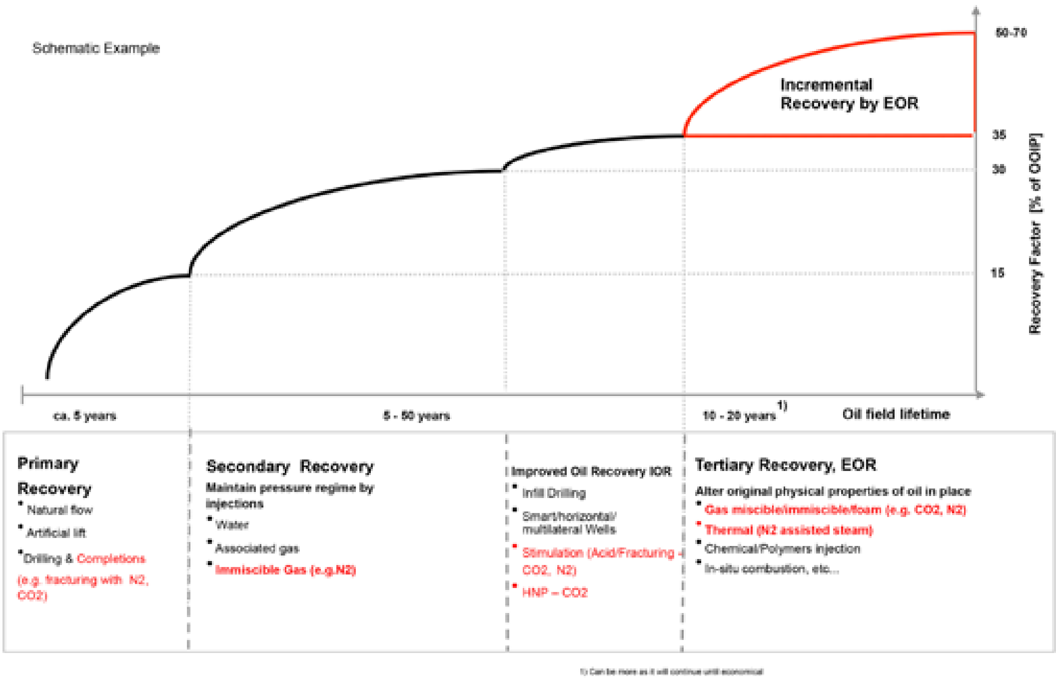


Diagram 1: The phases from Primary to Tertiary Oil Recovery include various methods of stimulation and re-stimulation from individual wells to a field-wide perspective. Highlighted are the areas where N_2 and CO_2 are utilized across the spectrum.

Hydraulic fracturing – room for improvement

When it comes to hydraulic fracturing, there is a lot of room to improve productivity and reduce costs. Pumping more sand and fluid into longer laterals is not thinking strategically. While bigger may make better wells, it is NOT getting optimal wells.

To realize the full potential value of the oil field and achieve the highest recovery factor, using energized fluids during each stage of the recovery process is the best way to achieve optimal results. But achieving a field's full potential value means optimizing recovery along with the costs of that production. Energized fluids offer the means to maximize the recovery factor and, if planned from a field-wide perspective, the means to optimize the cost of production.

To strive for the greatest Estimated Ultimate Recovery of the well in the most economically effective way, both performance and economy must be considered – the maximum productivity over time at the lowest overall cost.

Typically, EUR is projected over 10 years based on actual production rates taken at 30, 60 and 90 days. The decline curve – representing the drop in production over time – is projected from these actuals, with low, best and high estimates to cover the range of uncertainty.

Too often, much of the focus is on the well's initial performance. Encouraged by time-to-production using familiar techniques, e.g. water, producers may neglect to consider alternatives that could minimize the slope of the decline curve.

The benefits of energized fluids

Adding CO_2 or N_2 to the fracturing treatment has been shown to optimize overall productivity (increasing EUR), even though the initial acquisition cost of these gases can be higher than non-energized fluid (i.e., slick or acid water). But beyond their ability to improve the fracturing itself, energized fluids significantly boost flowback and production performance through enhanced clean-up and minimal fluid retention. They also boost production significantly in depleted formations.

Table 2 summarizes the performance of various hydraulic fracturing fluids.

Table 2: Summary of hydraulic fracturing fluids' performance from The University of Texas at Austin.[5]

Parameter	Slick Water	Linear Gel	Pure CO2	Pure N2	Foams	LPG
Fracture Creation	✓	✓	✓	✓	✓	✓
Wellbore Hydraulics	✓	✓	✓	✘	—	✓
Proppant Transport	✘	✓	—	✘	✓	✓
Proppant Conductivity	✘	✘	✓	✓	✓	✓
Fluid Recovery	✘	✘	✓	✓	✓	✓
Reservoir Compatibility	—	—	✓	✓	✓	✓
Safety Hazards	✓	✓	—	—	—	✘
Fluid Availability	✓	—	—	—	—	—
Cost	✓	✓	—	—	—	—

✓ good performance ✘ poor performance — unknown/field-dependent

To make the best decisions about field-wide EUR stimulation economics, it is necessary to compare and calculate the estimated total life cycle cost of the fluid options. This calculation must include not only the materials acquisition cost, but also the management, recovery, recycling, removal or disposal, labor and possible refracturing costs. These unit cost-per-production calculations can help determine situations in which a comparable investment in energized solutions delivers a superior value.

By investigating the potential of a variety of energized formulations versus water only-based fluids, an operator can further assess optimizing a field-wide development by examining:

- Current and future [potential] availability of liquid CO_2 and/or N_2
- Costs of implementing field-wide to improve economies of scale
- Assess productivity implications for those field-wide options

By far the biggest consideration is the sheer scale and scope of the program and the estimated volume of N_2 or CO_2 required to support the initial well completions and ongoing volumes required during production.

For hydraulic fracturing, liquid CO_2 and N_2 typically have been supplied from existing plant networks, whose current output is dedicated to serving a variety of industries in addition to oil and gas. When developing a field with horizontal wells to be fractured, the scale must be evaluated based upon the required tonnage, quality and supply proximity of energized fracturing fluid.

N_2, produced from air, can be field-sourced. But the cost of using CO_2 – the best proven solution for oil recovery – is heavily dependent upon the CO_2 source in terms of quantity needed, equipment to support and distance to the field. So optimizing the supply and distribution logistics for a field-wide play would likely require a dedicated CO_2 or N_2 source and program.

[5] "Energized Fractures in Shales/Tight Gas Sands", M. Sharma, L. Ribeiro (now with Statoil), D. Gala, University of Texas, Fracturing and Sand Control JIP, Annual Meeting, 2014.

Consider the following well program example:

- Horizontal Well, 32 stages, ~400 tons/stage (all 32 stages or just for 4 stages of toe)
- TPD, tons per day CO_2 or N_2 supply available from regional source
- TPM, tons per month

Depending upon regional supply, the following would apply to the well program example given:

Table 3: The number of 32 stage wells per month that could be fractured with an energized fluid utilizing CO_2 or N_2 based upon the availability of supply, using an average CO_2 plant output of about 300 tpd.

TPD	TPM	Quality	Tons/Well	Wells/Month
150	3750	70	12,250	0.31
		30	5,250	0.71
		70, toe	1,600	2.34
300	7500	70	12,250	0.61
		30	5,250	1.43
		70, toe	1,600	4.69
500	12500	70	12,250	1.02
		30	5,250	2.38
		70, toe	1,600	7.81

Approaching the use of energized fluids from a field-wide development perspective offers the ability to address fluid availability and dramatically improve productivity and economics. With that, the performance summary now becomes:

Table 4: Summary of hydraulic fracturing fluids' performance, factoring in availability, acquisition and management costs for energized fluids using a dedicated, field-wide development approach.

Parameter	Slick Water	Linear Gel	Pure CO2	Pure N2	Foams	LPG
Fracture Creation	✓	✓	✓	✓	✓	✓
Wellbore Hydraulics	✓	✓	✓	✘	—	✓
Proppant Transport	✘	✓	—	✘	✓	✓
Proppant Conductivity	✘	✘	✓	✓	✓	✓
Fluid Recovery	✘	✘	✓	✓	✓	✓
Reservoir Compatibility	—	—	✓	✓	✓	✓
Safety Hazards	✓	✓	—	—	—	✘
Fluid Availability	✓	—	✓	✓	✓	—
Cost	✓	✓	✓	✓	✓	—

✓ good performance ✘ poor performance — unknown/field-dependent

Hydraulic fracturing – programs of tomorrow: optimizing field-wide development with energized solutions

The 3Es of Enhancing and Improving Oil Recovery
The E-I-O-R of Hydraulic Fracturing
Hydraulic fracturing solutions using energized fluids provide the means for improving the 3Es. Energized fluids also can serve as an E-I-O R solution, optimizing the 3Es from a field-wide, reservoir perspective:

1. EUR — Improved overall recovery of OIP/GIP
2. Environmental — Reduce water & chemical footprint, emissions
3. Economics — Field-wide development scale up

Planning, preparation, and scale-up using energized fluids of CO_2 and/or N_2 for production enhancement of the initial unconventional well developments, refracs, or other IOR/EOR methods provides the means for significant optimization around the 3Es.

But in order to optimize individual well treatments and scale up to full field development, you must understand the pathway of what is possible for energized fluids in order to test the concept.

To make a business decision on a field-wide basis, the necessary phases of development include:
- 1: Initial candidate screening
- 2: Simulation and economic estimates
- 3: A Proof-of Concept (POC) field test to determine the progression to a Pilot Program.
- 4: A Pilot Program that validates the opportunity as a whole

The approach consists of the following cycle:

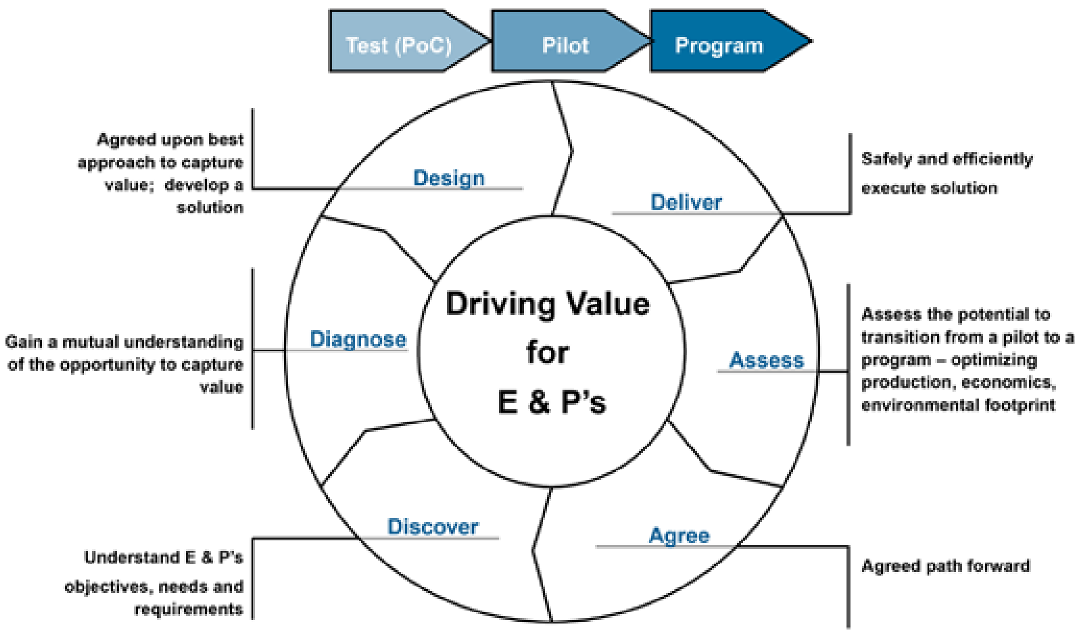


Diagram 2: Progression of a field-wide development program using an energized fluid of CO_2 and/or N_2 from initial proof-of-concept test to full program implementation.

The success of the Pilot Program, which must take into account long-term, cost-effective supply options, allows for the transition to the field-wide factory development phase.

These steps are summarized for an Energized Solutions program:

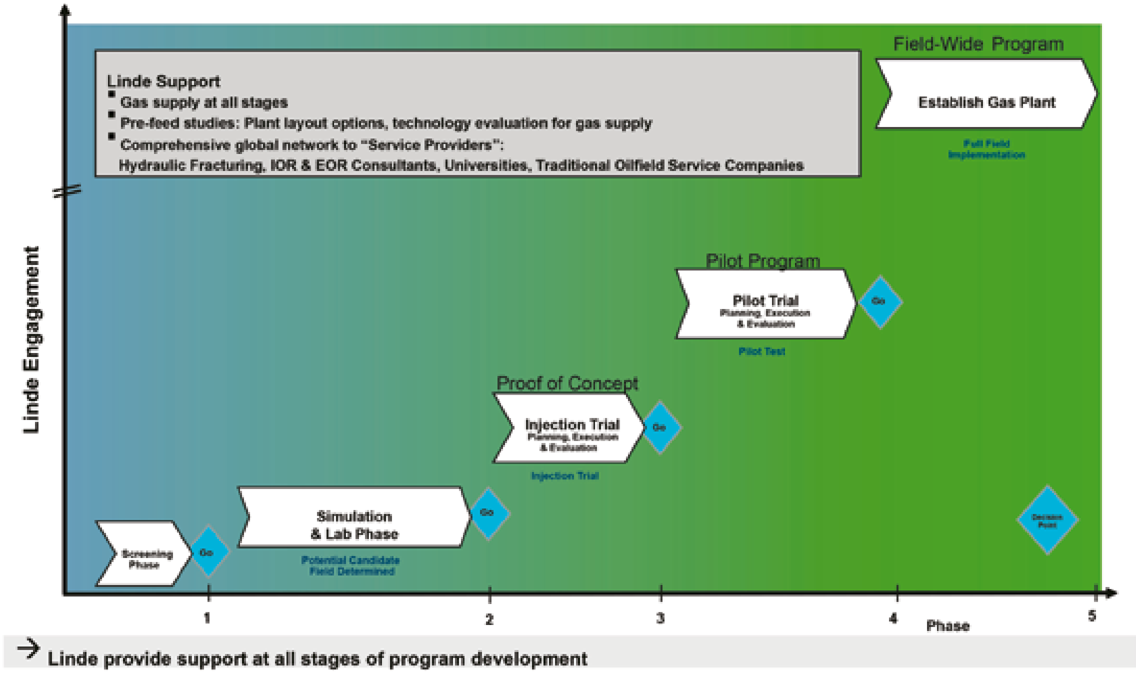


Diagram 3: Progression of a field-wide development program utilizing energized fluids (CO_2 & N_2). This process applies to initial drilling and completions, IOR, or EOR initiatives.

Since all program decisions are based upon productivity and economics, all decisions should take into account two key factors: the fracturing fluid selection based upon optimizing productivity, and the cost-effective availability and feasibility of the right mix of those energized fluids.

Productivity & economics of energized fluids for hydraulic fracturing – case studies

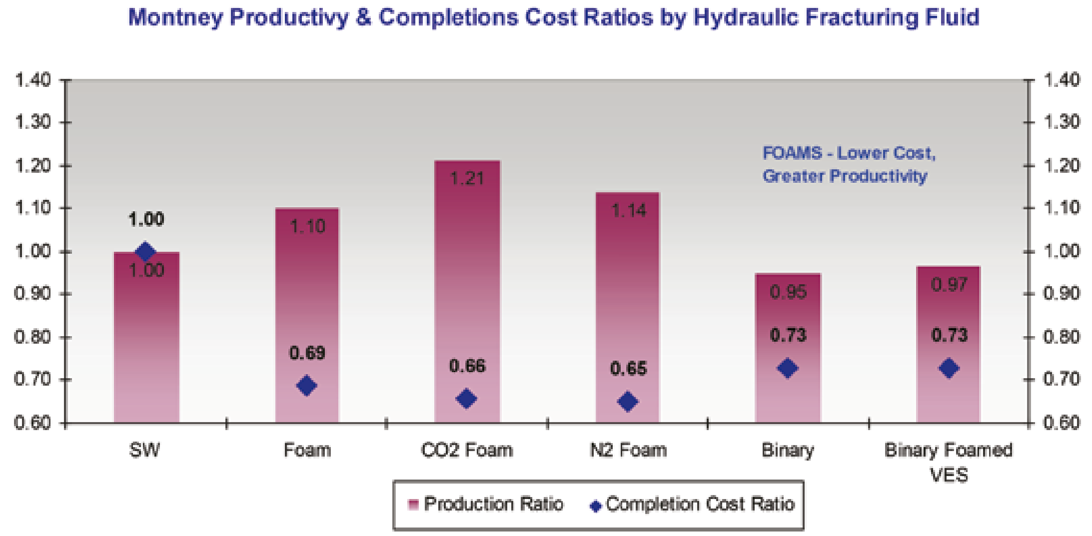
Research has shown that energized fluids provide a pathway to optimizing full field development, from fracturing of wells to scale up of well programs by delivering superior value at comparable costs to water. When you account for fluid lifecycle costs and increased productivity over time, using energized fluids effectively reduces unit production costs.

SPE 168632, by Reynolds, Bachman and Peters [6], is the most recent publication on the use of energized fluids utilizing CO_2 and N_2 in the Montney. From the published data, the calculated ratios of production and costs based upon the type of fracturing fluid, with slick water as the baseline, is as follows:

Table 5: Calculated ratios of production results and completions costs of varies fracturing fluids in the Montney relative water.

Montney		x(f)	EUR/x(f)	Prod Ratio to SW	PR Normalized	Completion Cost	Completion Cost Ratio
	SW	44		0.96	1.00	4357	1.00
	Foam	59.3		1.06	1.10	2995	0.69
	CO2 Foam	76.2		1.17	1.21	2872	0.66
	N2 Foam	65		1.10	1.14	2839	0.65
	Binary	36.5		0.91	0.95	3171	0.73
	Binary Foamed VES	39.1		0.93	0.97	3171	0.73

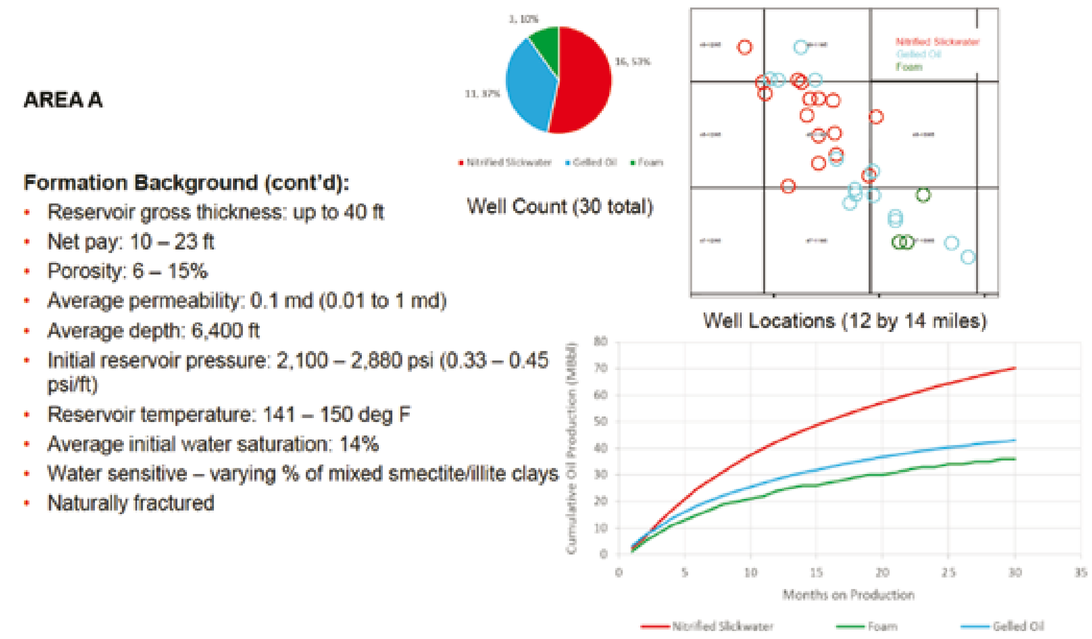
Plotting both in graphical form highlights the improvements of both productivity and costs of utilizing CO_2 and/or N_2 based fracturing fluids:

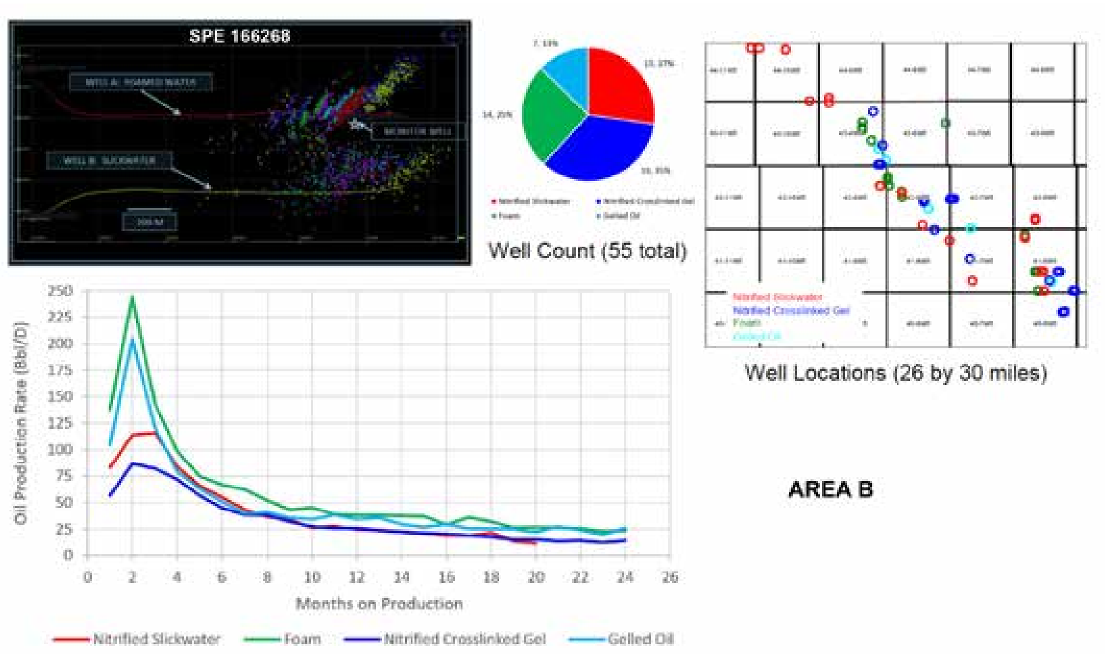


Graph 1: Results from Montney study highlight energized fluids utilizing CO_2 and N_2 for fracturing provide superior productivity at lower costs relative to SW – slick water.

[6] SPE 168632 - A Comparison of the Effectiveness of Various Fracturing Fluid Systems Used in Multi-Stage Fractured Horizontal Wells: Montney Formation, Unconventional Gas; M.M. Reynolds, Ferus Inc., R.C. Bachman, SPE, Taurus Reservoir Solutions Ltd., W.E. Peters, SPE, Ferus LP, 2014.

A study in the Cardium[7] (Alberta), presented by Sharma and AlTammar from the University of Texas, demonstrated the productivity of energized fluids compared to gelled oil. The results show nitrified slick water and foams provided the best productivity in various areas.



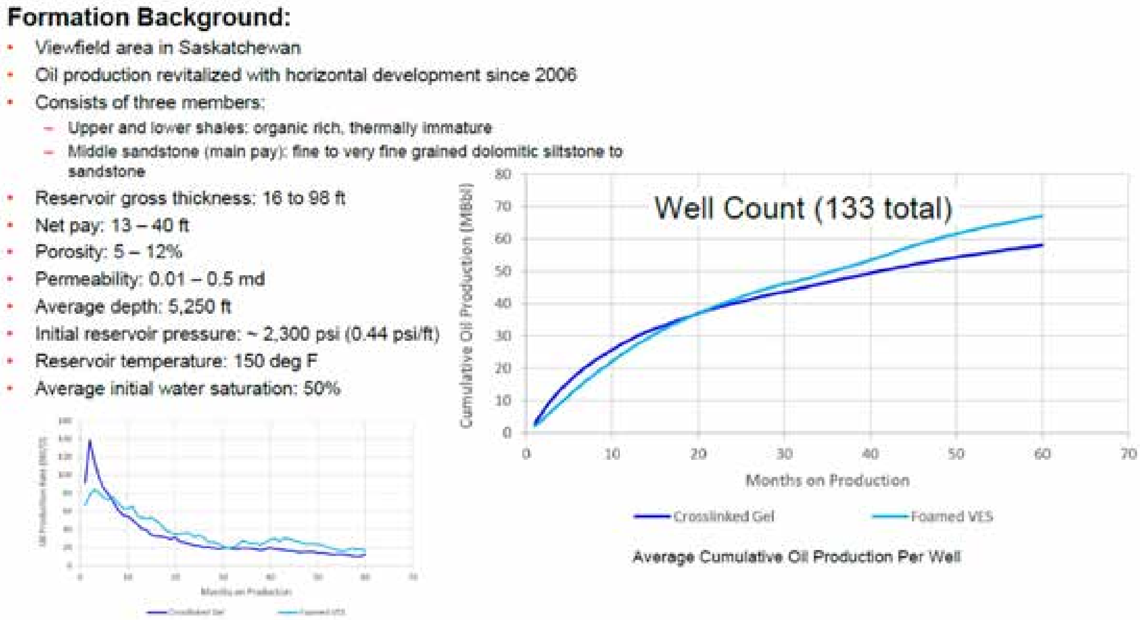


Graphs 2 and 3: Results from Cardium study highlight energized fluids of nitrified slick water and foams can provide superior productivity relative to other fracturing fluids. The seismic events reported in SPE 166268[8] for the region show the relative uniformity of the foam fractures versus the scattering of events with slick water.

[7] "Production Performance Evaluation of Energized Fracturing Fluids", M. AlTammar, M. Sharma, University of Texas, Fracturing and Sand Control JIP, Annual Meeting, 2014.

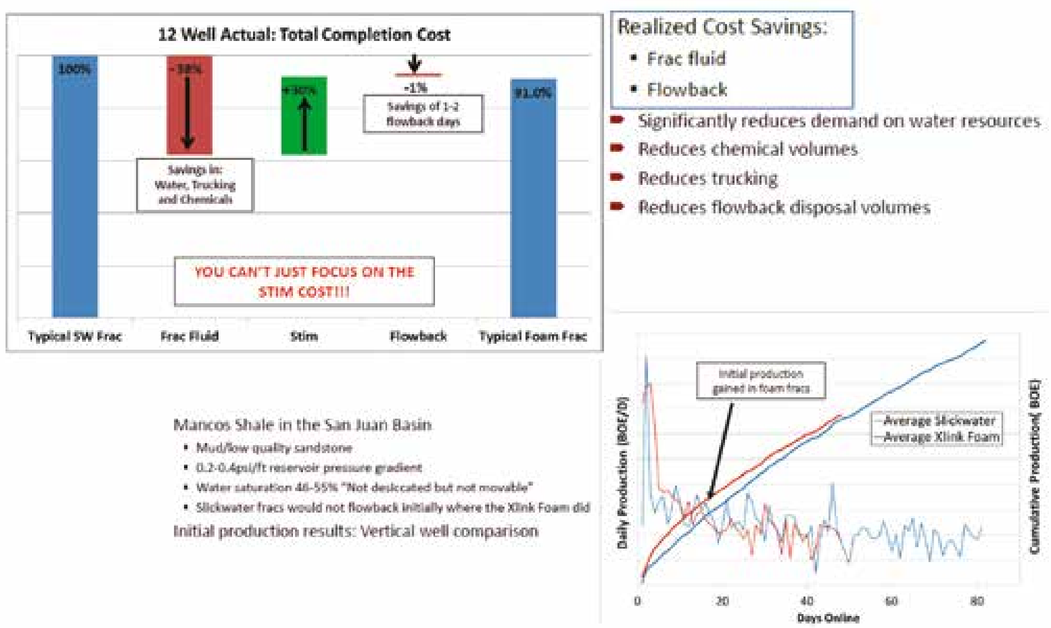
[8] SPE 166268 - An Unconventional Approach to a Conventional Field, how Slickwater has Changed the Game in the Cardium; Brad Lamson, SPE, Lightstream Resources Ltd., Don Keith, Lightstream Resources Ltd., Youssouf Zotskine, SPE, Calfrac Well Services Ltd., Keri Yule, SPE, Calfrac Well Services Ltd., 2013.

In the Bakken, results presented by Sharma and AlTammar from the University of Texas[9], showed energized fluids outperformed the productivity of crosslinked gel even though initial production (IP) of the gel started higher:



Graph 3: Results from Bakken study highlight energized fluids provide superior productivity relative to other fracturing fluids.

For the Mancos Shale in the San Juan Basin, foam fracturing has proven to be both more productive and less costly than slick water. Results below, from a ConocoPhillips[10] study, demonstrate the energized fluid benefits:



Graph 4: ConocoPhillips reports productivity improvements and economic benefits realized by using energized fluids for hydraulic fracturing.

[9] "Production Performance Evaluation of Energized Fracturing Fluids", M. AlTammar, M. Sharma, University of Texas, Fracturing and Sand Control JIP, Annual Meeting, 2014.

[10] ConocoPhillips, "Foam Flowback: Best Practices, R. Martin, SPE ATW Fracture Flowback, Nov. 2013

Productivity & economics of energized fluids for hydraulic fracturing – Eagleford pre-assessment

No two formations of unconventional reservoirs are alike. They are often characterized by significant variability within the same formation, which require varying stimulation techniques. Critical reservoir data includes insight into the permeability, pressure, water sensitivity, rock mechanics or formation stresses and natural fractures, leak-off, and temperature of the formation.

The University of Texas at Austin's eFrac Hydraulic Fracturing Simulator, whose unique design fully accounts for the compositional and phase behavior effects of an energized component, provides a way to simulate energized fracturing fluid performance. The result: a "cocktail" designed to be optimized for individual well characteristics.

Using that simulator, Linde evaluated the productivity and performance of various fracturing fluid formulations in the EagleFord formation.The following parameters for EagleFord were entered into the simulator:

Table 6: EagleFord parameters entered into eFrac simulator to evaluate alternative fracturing fluid performance.

Y(mod)	2000000		
P(ref)	0.25		
Toughness	1500		
Reservoir Properties:			
65	Surface T	5200	Pore Pressure
335	Reservoir T	0.3	Initial Water Saturation
1	Heat Capacity		
161.2	Density		
0.11	Porosity	80	Drainage Area
0.001	Permeability		

Results show an improved productivity index with Energized Fluids even when volumes of slick water are 7-52% higher:

Table 7: EagleFord results from eFrac simulator showing improved productivity index results from 8-27% higher than slick water even when fluid volumes are 7-52% higher for slick water.

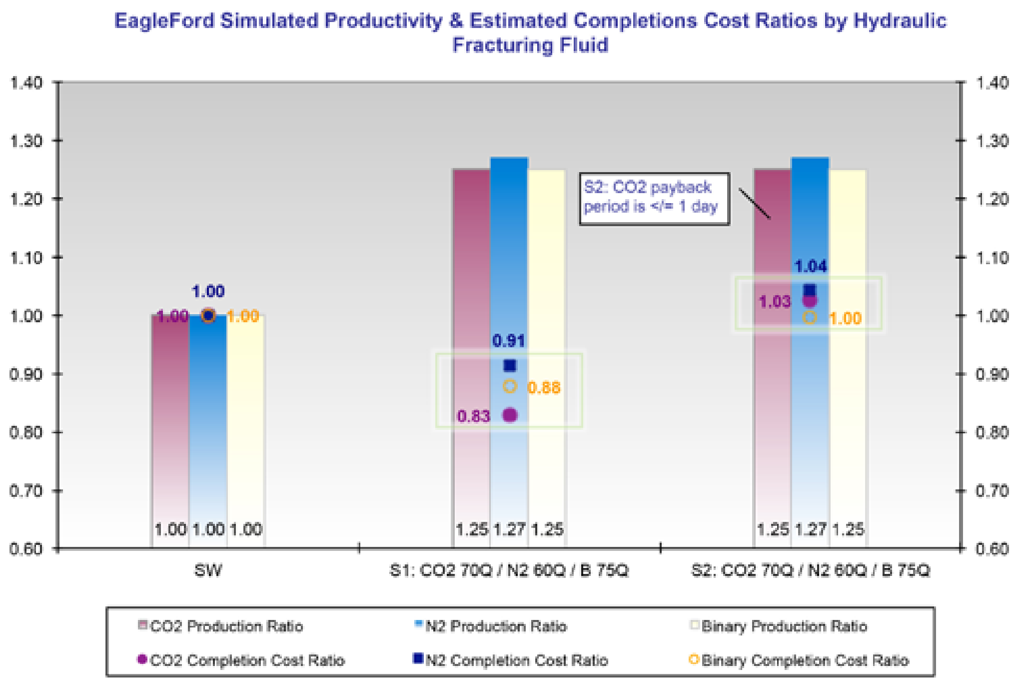
Fluid	bbls pumped	x(f)	Productivity Index	Improvement Ratio Over SW1	Over SW2	Over SW3
Slick Water (SW1) - same volume	2100	494	2.304	1.00	NA	NA
Slick Water (SW2) - 7% more	2240	484	2.448	NA	1.00	NA
Slick Water (SW3) - 52% more	3200	522	2.677	NA	NA	1.00
70 Quality CO2	2100	438	2.890	1.25	1.18	1.08
70 Quality N2	2100	360	2.926	1.27	1.20	1.09
Binary - CO2N2Only	2100	420	2.933	1.27	1.20	1.10
Binary - 70 Quality CO2N2Water	2100	416	2.881	1.25	1.18	1.08
CO2 Pad	2100	595	2.259	0.98	0.92	0.84

To initially evaluate costs of various fracturing fluid options, we start with a basis of $175,000/stage costs, adjusted for cost of fluid acquisition, management and disposal as well as fluid volume:

Table 8: EagleFord cost per stage of hydraulic fracturing treatment of energized fluids versus slick water. Scenarios indicate energized fluid costs comparable or less than slick water.

									cost/ stage $	175000			
EagleFord													
		$/bbl				$/bbl		$/bbl			Delta	$ Ratio	Ratio
		Water			Water				Treatment	Treatment	Treatment	Treatment	Productivity
	Fluid	A	M	D	Flowback	CO2/N2	Quality	Fluid	bbl/stage	$/stage	to SW	to SW	to SW
	SW	2.25	0.50	5.00	40%	0	0.00	4.45	5,000	197,250	0	1.00	1.00
		6.67	1.50	10.00	60%	0	0.00	13.57	5,000	242,850	0	1.00	1.00
$/ton													
150	S1: CO2 70Q / N2	2.25	0.50	5.00	40%	26.25	0.70	19.71	3,500	191,485	-5,765	0.97	1.25
		6.67	1.50	10.00	60%	26.25	0.70	22.45	3,500	201,061	-41,789	0.83	1.25
175	S2: CO2 70Q / N2	2.25	0.50	5.00	40%	30.63	0.70	22.77	3,500	202,204	4,954	1.03	1.25
		6.67	1.50	10.00	60%	30.63	0.70	25.51	3,500	211,780	-31,070	0.87	1.25
$/c-scf													
4.00	N2 70Q	2.25	0.50	10.00	40%	25.63	0.70	19.87	3,750	205,779	-37,071	1.04	1.27
4.50		6.67	1.50	10.00	60%	28.83	0.70	24.25	3,750	222,198	-20,652	0.91	1.27
	CO2/N2 Binary 70Q	2.25	0.50	10.00	40%	26.03	0.75	21.14	3,500	196,478	-772	1.00	1.25
		6.67	1.50	10.00	60%	30.00	0.75	25.89	3,500	213,116	-29,734	0.88	1.25
	CO2/N2 Binary	2.25	0.50	10.00	0%	25.78	1.00	25.78	3,500	212,741	15,491	1.08	1.27
		6.67	1.50	10.00	0%	29.28	1.00	29.28	3,500	224,979	-17,871	0.93	1.17

A graphical representation of the EagleFord pre-assessment of productivity and costs highlight the indicated value of energized fluids for hydraulic fracturing:



Graph 5: A pre-assessment for EagleFord indicates that energized fluids deliver improved productivity at a lower cost for hydraulic fracturing treatment.

Conclusion – hydraulic fracturing

The Programs of Tomorrow – Energized Solutions

The research shows that energized solutions provide a pathway to optimizing full field development – from fracturing of wells to scale up of well programs by delivering EOR & IOR benefits and bringing superior value at comparable costs to water. When the calculation includes the full view of fluid costs, factoring in expenses during both completion and production, and evaluates potential productivity gains, more accurate cost determinations and better decisions are made.

The bottom line: Better options exist when you evaluate the play from a reservoir, fieldwide development perspective so you can plan, develop, and invest to achieve optimal results.

To make the most of source development and economic delivery on a field-wide basis – the E-I-O-R of hydraulic fracturing, it is crucial to work with an experienced industrial gas and engineering firm like Linde. Linde can help calculate total costs and simulate the effects of energized solutions on performance in order to enable you to better evaluate the resources available and realize the greatest value. The key characteristics of a quality firm include:

—Full range of leading technologies

—Extensive project execution experience including mega projects

—Global presence with mature operations and supply chains

—Focus on partnering and joint solution development

—Flexible ownership, investment and business models

—Reliable long term partner with strong reputation

World leading supplier, services, and builder of Energized Solutions for EOR/IOR and well stimulation.

Diagram 4: Critical attributes of an industrial gas and engineering firm which can help to develop successful field-wide development program.

Getting ahead through innovation.

With its innovative solutions, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Driven by our tradition of entrepreneurship, we are working steadily on developing new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages and greater profitability. Each solution is tailored specifically to meet our customers' requirements – offering standardized as well as customized solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a leader in industry technology by your side for which top quality, process optimization, and enhanced productivity are part of daily business. Linde will not only be there for you ... but with you.

After all, working together to solve problems forms the core of commercial success.

Linde – Ideas become solutions.

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