THE LINDE GROUP

# Maximize well productivity with Linde Oil and Gas Services. Energized solutions, engineering, expertise and services.

## Energized fracturing

Choosing carbon dioxide ($CO_2$) or nitrogen ($N_2$) to energize fracturing treatments becomes an easy decision when you know that energized solutions:

- Maximize lifetime well performance
- Minimize formation damage and reduce water usage
- Minimize overall production costs

Partnering with Linde for energized solutions, engineering, expertise and services is also an easy choice.

- Linde is the market leading provider of $CO_2$ and $N_2$ in North America
- Linde was first to supply $CO_2$ and $N_2$ to the energy sector
- Linde is a global, $18 billion gases and engineering leader, with more than 50,000 employees in 100 countries.

## Maximum well performance

Studies show significantly higher gas production from unconventional reservoirs in wells fractured with energized fluids[1]. Using $CO_2$ and $N_2$ in hydraulic fracturing:

- allows for maximum fracture surface area to increase the flow of hydrocarbons
- delivers flexibility in solution viscosity for more uniform proppant placement, avoiding blockages and keeping fractures open

## Unique to $CO_2$

$CO_2$ vaporizes at reservoir conditions, leaving a liquid-free proppant pack. Additionally, the solubility and miscibility of $CO_2$ generates greater conductivity to energize hydrocarbon flow.

## Non-damaging

Energized solutions are non-damaging and can be beneficial in liquid-sensitive reservoirs that are damaged by conventional water-based hydraulic fracturing. In some instances, water is retained within the reservoir. The resulting damage can become permanent, creating long-term problems from clay swelling to reduced conductivity. Also, the majority of water used in fracturing can become trapped because the reservoir pressure is insufficient to push the liquid back to the well bore. Fracturing fluids that remain in the formation can impede the flow of oil and gas, diminishing the economic potential of the well.

[1] Motney study: Improved Hydraulic Fracture Performance with Energized Fluids: A Motney Example, Lyle H. Burke, Grant W. Nelson (same footnote too for "Minimal cost" reference below)


## Less water

Energized fluids leave no residue, like gels or cross-gels, and may eliminate the need for flushing. Flushing can cause the migration of fines – superfine particles that can create blockages. Even if mixed with water, $CO_2$ and $N_2$ (foam or emulsified) can reduce capillary forces, offering a lower leak-off coefficient and significantly reduce water usage, recovery, and disposal.

## Reduced overall cost

Generally speaking, $CO_2$ is more expensive than water. However, the overall economics of energized solutions are significantly improved through a faster payback and reduced well maintenance cost. In most studies, economics are improved through an increase in net present value (NPV). As proof, a study[1] of the Montney Formation in Canada demonstrates that the benefits of energized solutions within an efficient treatment program "can far outweigh the incremental costs." Energized solutions were proven not only to significantly increase well productivity, but to present opportunities to reduce fracturing resources such as water consumption and proppant required, as well as injection rates and injection pressures.

## Reliable, safe delivery of $CO_2$ and $N_2$

When you choose Linde for $CO_2$ and $N_2$, you get the safest, most reliable delivery from the leader in industrial gases. A service-oriented company, Linde works closely with customers to safely deliver and transfer a reliable supply of cryogenic liquids for a sustainable well program.

## Talk to Linde

To maximize your Expected Ultimate Recovery, talk to Linde about the advantages of using energized solutions for long-term effective well stimulation. We're ready to help you extract the full potential of your wells using $CO_2$ and $N_2$.

Learn more at www.lindeoilandgas.com.

Linde LLC
Oil and Gas Services, 575 Mountain Ave., Murray Hill, NJ 07974 USA
Phone 1-888 964-5642, www.lindeoilandgas.com

1736- 01.26.12