nanoActiv®
by Nissan Chemical

THE LINDE GROUP
Linde

RECHARGE HNP™.

Introducing the new generation of well production enhancement solutions.

RECHARGE HNP™.

Energize, activate and enhance hydrocarbon recovery.

RECHARGE HNP™ is a multi-spectrum treatment for vertical and horizontal wells experiencing a decline in production with restrictions to fluid flowing into the wellbore. This treatment enables the recovery of hydrocarbons to be accomplished faster, more completely, and with longer efficacy than existing options on the market today.

A productive partnership.

Linde and Nissan Chemical have joined forces to enhance downhole performance by combining nanoActiv® HRT (Hydrocarbon Recovery Technology) with the application of carbon dioxide (CO_2) or nitrogen (N_2) application method.

Nissan Chemical's excellence in nanotechnology and Linde's global reach and expertise in job design and technical services in oil and gas well remediation and restimulation, combine to provide maximum techno-economic production results in today's market.

A powerful combination.

Combining the properties of gas and nanoparticles creates a unique, synergistic treatment that addresses several potential production issues simultaneously. The gas helps remove debris, fines and other matter and stimulates the well with pressure, while driving the effective distribution of the nanoActiv® HRT particles to deeper parts of the formation. In cases where the gas is miscible, it also helps to mobilise crude oil by causing it to swell and reducing its viscosity.

nanoActiv® HRT's nano-sized particles penetrate further and more thoroughly permeate the natural fracture network than traditional remediation or restimulation technologies. These particles produce a Brownian-motion, diffusion-driven mechanism, known as disjoining pressure, resulting in longer and more complete production efficacy. Field application data validates that particles pushed with Linde's gases produce significant and sustained improved hydrocarbon recovery.

Application.

Our solution is a prescribed well remediation treatment (Huff'n Puff) consisting of three phases: injection, soaking and production. Because of the synergies between the nanoActiv® HRT and the gas, the soak times can be dramatically reduced compared with traditional HnP treatments. Depending on the type of formation, well history and identified issues, a specific treatment plan is prescribed.

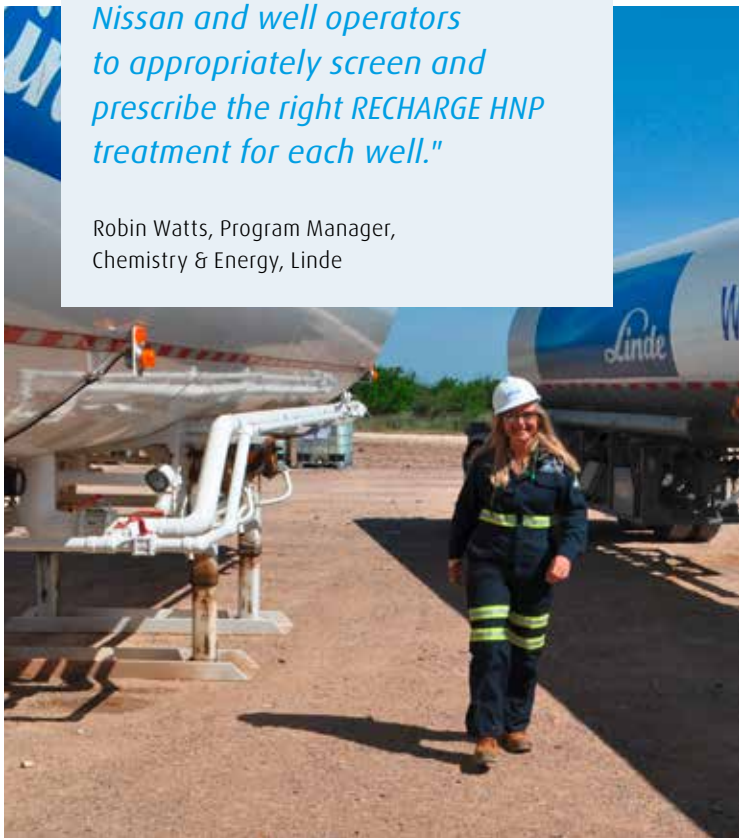
Well Treatment Screening.

For a successful treatment, appropriate screening of candidate wells is the first step. Linde and Nissan will work with operators on candidate identification before prescribing a recommended treatment plan.

Production	Good initial production (IP) with a decline curve that indicates wettability issues. Current production <20% of IP and >5–10 BOPD or 20 mscf.
Field data	Overall well performance should be on par with other wells in the field.
Treatments	Acid and other chemical treatments may negatively impact properties of nanoActiv® HRT.
Well equipment	To be in good mechanical condition. Pumps, linings, gaskets.
Water	Too high content of salts (e.g. KCl) and TDS may negatively impact nanoActiv® HRT.
Water cut	<80% (N_2), <90% (CO_2)
Net pay zone	<100 ft (30 m) to optimise for 60–90 -day payback.
Porosity	Conventional >8%, unconventional >4%.
Oil	Oil gravity <30 API it's recommended to use CO_2. Asphaltene precipitation may be caused by gas injection.

"Every well is different, so we tailor RECHARGE HNP to individual requirements. We work with Nissan and well operators to appropriately screen and prescribe the right RECHARGE HNP treatment for each well."

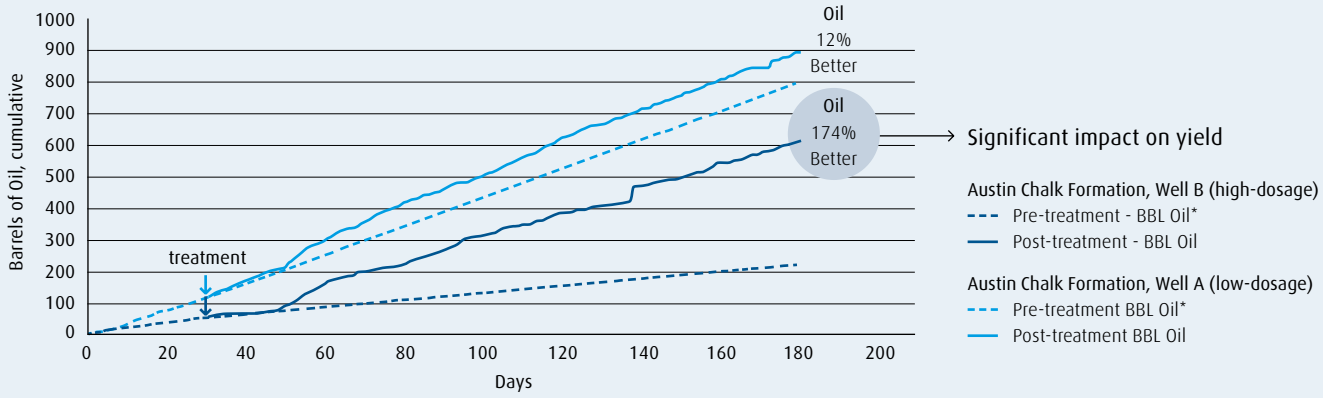
Robin Watts, Program Manager,
Chemistry & Energy, Linde



Oil production.

Austin Chalk Wells A&B – FRIO County

RECHARGE HNP (nanoActiv® HRT and Nitrogen) pre- and post-treatment comparison after 180 days of cumulative production.



*Post-treatment projection based upon the trajectory from the 30-day pre-treatment actuals.

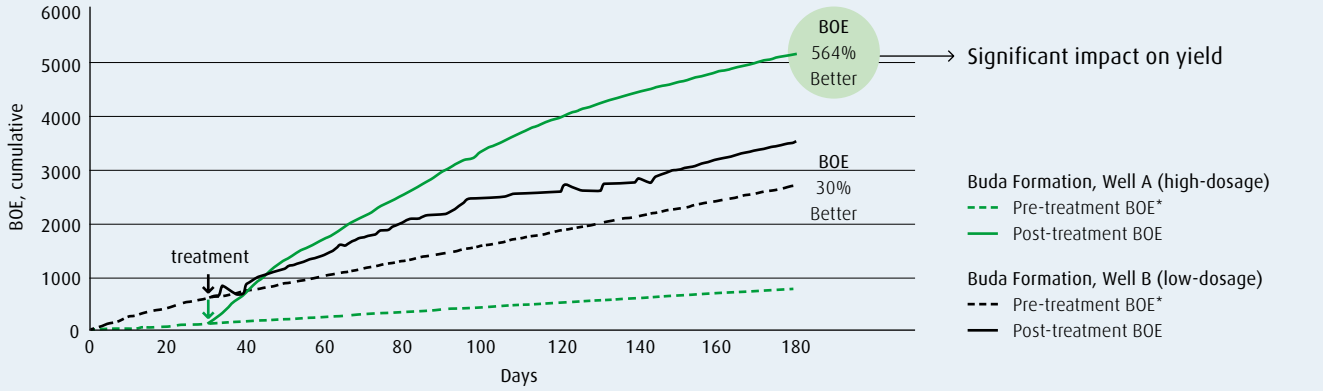
Austin Chalk Formation, Well A (low dosage).
RECHARGE HNP pre- and post-treatment comparison after 180 days of cumulative production. Cumulative oil production increased 12%.

Austin Chalk Formation, Well B (high dosage).
RECHARGE HNP pre- and post-treatment comparison after 180 days of cumulative production. Cumulative oil production increased 174%.

Gas production.

Buda Well A&B – FRIO County

RECHARGE HNP (nanoActiv® HRT and Nitrogen) pre- and post-treatment comparison after 180 days of cumulative production.



*Post-treatment projection based upon the trajectory from the 30-day pre-treatment actuals.

Buda Formation, Well A (high dosage).
RECHARGE HNP pre- and post-treatment comparison after 180 days of cumulative production. Cumulative gas production increased 564%.

Buda Formation, Well B (low dosage).
RECHARGE HNP pre- and post-treatment comparison after 180 days of cumulative production. Cumulative gas production increased 30%.

Numerous factors affect the performance of an oil well — the geology, the number and size of treatment stages, the choice of additives, etc. Wells treated with RECHARGE HNP have shown meaningful performance improvement versus comparative wells from the same operators. While no single technology or treatment can account for the entire performance of an oil well, the effects of RECHARGE HNP are significant and compelling.

Getting ahead through innovation.

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

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised 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 partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.

A history of success.

Nissan Chemical America Corporation is a division of Nissan Chemical Corporation, founded in 1887 as the first chemical fertilizer manufacturer in Japan. A forerunner in chemical innovations for nearly 130 years, Nissan Chemical currently manufactures products for the chemical, agrochemical, and pharmaceutical industries and is a market leader in the production of nanoparticles for the automotive, coatings, electronics, and oil and gas industries.

Nissan Chemical has been perfecting nanoparticles since 1951, making it one of the first companies in the world to produce highly surface-modified particles for industrial applications. Our years of experience, proprietary materials, and patented technologies have helped us become a worldwide leading provider of refined nanoparticle solutions.

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