Nano Pro MT™ Lubricant & Coolant Additive Testing

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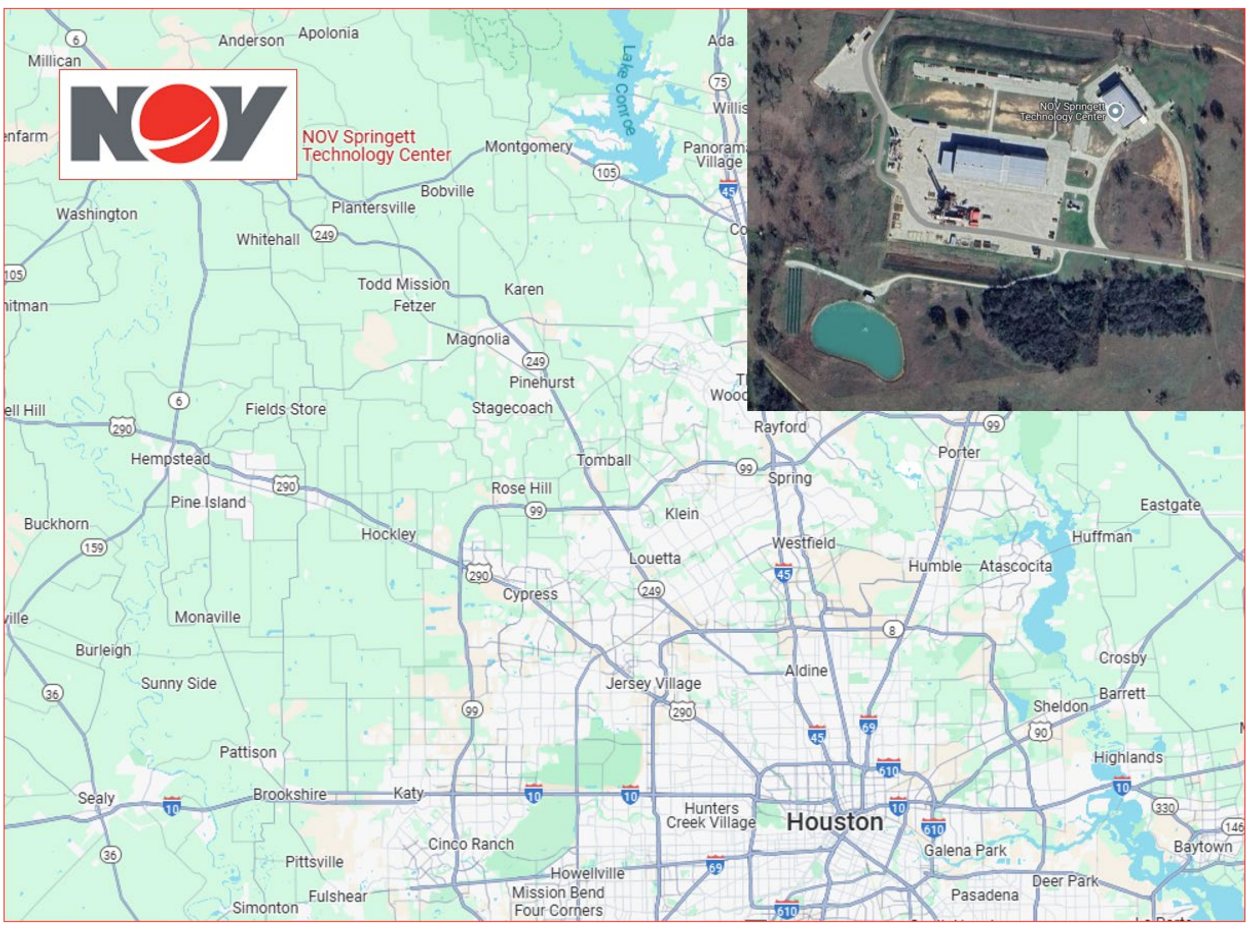
19-Dec-2024

NOV R&D has conducted extensive internal testing and is confident that a definitive reduction in emissions is achievable with the use of the Nano modified lubricant. When used in conjunction with the Nano Cooling additive, additional benefits in machine performance are observed, particularly under higher ambient temperature operating conditions. This paper presents the findings from these tests and explores the combined impact of these advanced technologies on both emissions and overall equipment efficiency.

Fig-1 Site Test Location | Navasota Texas in Grimes County

The Nano Pro MT testing is an on-going test located at the NOV – Springett Technology Center. This facility is nestled off of Highway 105 near Navasota, Texas in Grimes County.

The NOV-Springett Technology Center is designed to test a variety of technologies for both internal and customer facing applications.



NOV Springett Technology Center

The products specifically tested were an oil and a coolant additive manufactured by Nano Pro MT® (www.nanopromt.com)

From the manufacturer: **Nano Pro MT ®Oil Stabilizer:**

Nano Pro MT Oil Stabilizer features nanomaterials that enhance both lubricity and heat transfer. The nanoparticles embed into the metal's microscopic pores, creating a smoother surface for the oil to flow over, reducing friction without altering dimensional tolerances, unlike PTFE coatings.

These nanoparticles do not disrupt the flow or shear properties of the lubrication system, ensuring normal oil circulation.

The stabilizer also boosts the thermal efficiency of engine oil, improving heat transfer and reducing engine temperatures more effectively than competing products. In turbocharged engines or systems with oil coolers, it dissipates heat, extending the life of both the oil and its additives. By removing excess heat, it prevents heat-related failures and supports higher engine loads.

Nano Pro MT has received an API rating for its performance in finished engine oil, Gulf + Nano.

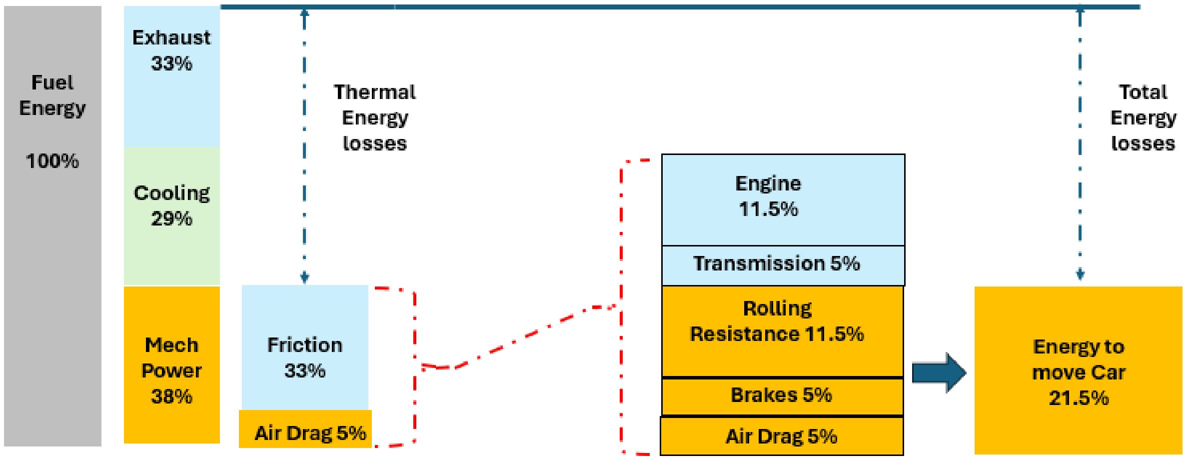
From the manufacturer: **Nano Pro MT® Nano Cool™:**

Nano Pro MT™ Nano Cool™ is a deionized water-based product that features a proprietary blend of suspended nanomaterials. Unlike other cooling products that rely on chemical surfactants to manage heat, Nano Cool offers superior long-term performance without degradation over time. It works throughout the life of the antifreeze, effectively improving heat transfer and maintaining more consistent coolant temperatures, which helps to reduce peak operating temperatures.
Nano Cool is not a chemical surfactant; it uses a mechanical process and surface area to lower water temperatures more efficiently than chemical-based products with similar claims. Its effectiveness has been demonstrated in a wide range of engines, from 1.0 liters to over 100 liters, proving its reliability and superior performance.

Academic Research Support

Academic research, independent commercial products, and internal testing at NOV have all demonstrated performance improvements with advanced lubricants. While various factors influence fuel economy, including operator behavior and equipment usage, a direct correlation exists based on fundamental engineering principles. The engine operates as a system characterized by gains and losses, and reducing friction within the engine results in a finite decrease in the input work (fuel) required to achieve comparable output (input minus losses). While this statement is general, it aligns with established engineering concepts. Academic literature consistently supports the idea that small, incremental changes can lead to efficiency improvements in machines, whether through material or fluid enhancements. Over the years, engine oil lubricants have continuously evolved to enhance engine performance and durability, with nano additives representing the latest advancement in these engineering efforts.

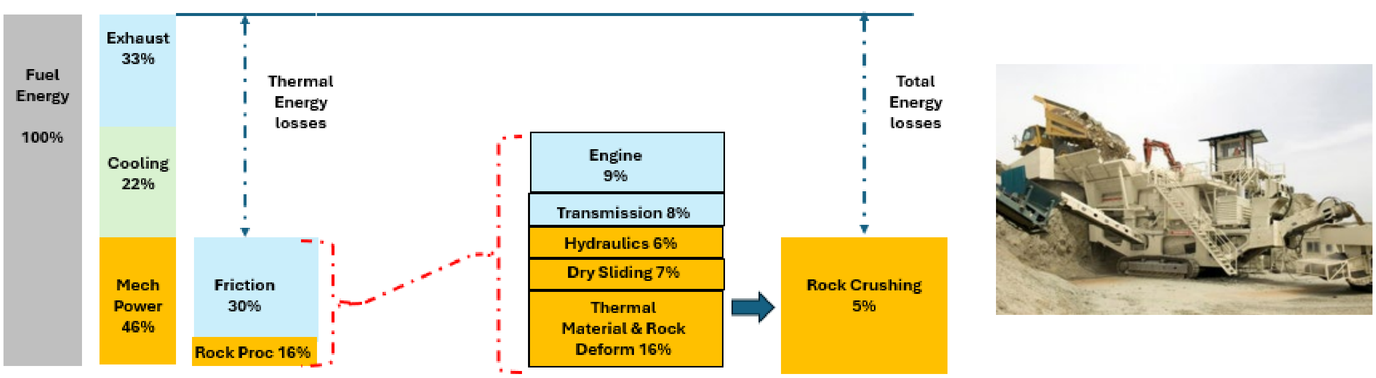
Fig-2 Car Energy Usage Simplified Breakdown



Source: Excerpt sketch from Reference [9]

Figure-2 illustrates a typical car's energy consumption, mapped out in percentages. Figure-3 is a large diesel-powered mining rock crusher that also illustrates the same concept. A reduction in friction directly impacts mechanical power, which in turn affects the energy required to provide work. By utilizing additives, lubricants, and coolants together, efficiency is improved in two key areas that influence both fuel economy and performance. In hot climate environments, particularly with gensets, performance losses are common, requiring the specification of larger generators to meet electrical demand requirements. However, if a genset can achieve greater cooling efficiency, it may be possible to select a more appropriately sized genset that operates more efficiently than a larger unit. Reference [6] provides one such academic example.

Fig-3 Mobile Powered Rock Crusher Energy Usage Simplified Breakdown



Source: Excerpt sketch from Reference [4]

The academic references cited in these papers are by no means exhaustive; they are intended to highlight key concepts discussed herein. Readers are encouraged to pursue further research on this topic. What is indisputable, however, is the significant impact that nanoparticles have already had, and will continue to have, on improving internal combustion engine performance.

Reference Major Conclusion Summary

Reference [1]
-Engine oil reduces friction between machine parts as a statement of fact
-One key element of nanoparticles is their ability to widely disperse in oils and throughout oil system

Reference [2]
-Lab-engine correlation studies possible through extensive build of testing capabilities
-Significant difference in structures observed and correlated to frictional performance enhancements (significant reduction boundary friction and as result less wear)

Reference [3]
-Contribution of engine lubricant oil to diesel engine particulate emissions is evident
-Mineral engine oil produces higher PM & NOx emissions than synthetic oil
-There are GOOD correlations between lubricant oil density and emission, the latter increasing with the former

Reference [4]
-Using nano-additives in lubricants can reduce friction and wear in large industrial equipment providing for increased wear protection and reduced emissions.

Reference [5]
-Advance tribology will play a crucial role in reducing wear and increasing efficiency.
-Emission reductions can be achieved through advanced lubrication and friction reduction

Reference [6]
-It has been found that addition of nanoparticles at optimal condition results in high viscosity, high-pressure distribution, high load carrying capacity, low coefficient of friction, and low wear scar diameter.

Reference [7]
-Marked improvement of the coolant's thermophysical properties leading to an improved cooling performance and a higher energy efficiency of the radiators.
-Nanoparticles could be used to reduce the size of radiator design for the same size/capacity machine.
-Overall, the use of nano-coolant has been shown to significantly improve heat transfer as well as create more uniform distribution of temperatures within the radiator assembly.

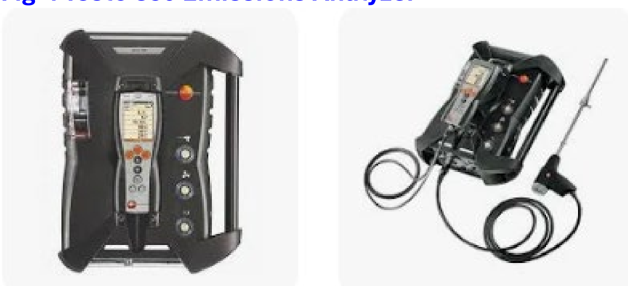
Reference [8]
-Fuel consumption reduction up to 4%
-Enhanced: Frictional properties, thermal/oxidation stability, wear protection
-Advanced oils, in this case Synthetic, do affect engine performance

Reference [9]
-Using nano-additives in lubricants is one of the most effective ways to control friction and wear.
-Nanomaterials as lubricant additives, because of their small size, are easy to enter friction contact areas and can form a protection 'tribofilm', preventing surface of friction pairs from being worn

Test Emissions Analyzer

The emissions analyzer for testing is a Testo 350 measuring: O2, CO, CO_2, NOx, SOx and shown in Figure-2. The Carbon Dioxide measurement is an added IR sensor rather than by calculation. The analyzer is connected to a laptop, servicing as the DAQ and is in 1sec intervals for the testing intervals when measuring.

Fig-4 Testo 350 Emissions Analyzer



The emissions analyzer is owned and maintained by the NOV research department.

The analyzer measures: CO, NOx, SOx, O2, and CO2 by IR measurement (versus calculated).

Test Engine

NOV-STC Office Building Stand-by Genset:
Cummins Model: QSM11-G4 NR3
6-Cylinder in-line 4 stroke
Displacement: 10.8L
Engine S/N: 35321343
Family: ACEXL019.AAD
Date Manu: 01/2014
Ref #: 02470327972

Idle Speed: 700-900rpm
Typical Load Speed: 1800rpm

ECM P/N: 4963807 S/N: 4001490 P/C: 01162014

Oil Type:	Chevron Delo 400 LE SAW 15W-40
Oil Additive:	Nano Pro MT NDTOS128GSCTM
Oil Capacity:	9.8 gallon (engine mounted filter)
Coolant Spec:	CES14603
Coolant Additive:	Nano Pro MT NDT128NC
Coolant Capacity:	2.5gallons Primus ELC 50/50%

Test Objectives

- Identify an easily implementable emission reduction technology
- Reduce overall equipment maintenance requirements
- Prevent power derating and heat-related failures during peak summer temperatures

The primary objective of this testing was to identify an easily implementable emission reduction technology suitable for all NOV assets utilizing diesel-powered equipment. This nanotechnology is specifically designed for seamless integration and maintenance during standard, scheduled preventive maintenance (PM) services throughout the equipment's lifecycle. It offers both immediate emissions reductions and long-term maintenance advantages, with the potential to lower NOV's operational costs while contributing to lasting global environmental improvements.

The goals of the extended test cycle include reducing overall equipment maintenance intervals and extending the lifespan of lubricants. However, as of the publication date, the total monitored runtime of the test asset has not yet accumulated sufficient hours to produce measurable long-term results. Ideally, the equipment would be monitored across multiple engine overhaul cycles, with findings to be detailed in this report or in subsequent studies. While the extended test cycle data remains pending, both academic and commercial literature support the premise that the product is likely to enhance engine longevity.

An additional goal is to improve the base performance of the units during peak summer months, when temperatures are highest, thereby mitigating the reduction in maximum available power capacity of the standby gensets. It should be noted that during periods of high heat, diesel gensets typically derate their available power to prevent unit damage if coolant temperatures exceed 203°F (95°C). These power reductions may necessitate scaling back operations or bringing additional gensets online to compensate for the reduced output.

There is another benefit to nano lubricants that over time the author believes will show that there is an extension of seal life within the engine components. While additional literature suggests it this has also not been currently validated with this testing but is part of the on-going evaluation. This testing is also time dependent and is better suited to fleet wide testing versus single-engine.

Test Data

Testing consistently demonstrated an approximate 23% reduction in nitrogen oxides (NOx) and an 17% reduction in carbon monoxide (CO) under identical operating Loaded conditions. (Figure 3) The net effect of improving efficiency should contribute to emission reductions, even with modest gains in fuel economy. Additionally, a slight decrease in carbon dioxide (CO_2), as measured by infrared (IR) analysis, was observed at 12.6% (however, the CO_2 % was already a small value), when comparing baseline to additive conditions. SOx readings were taken but these readings were very low both pre-additive and post additive and are not included in this report.

Fig-5

Pre-Additive **Post Additive**

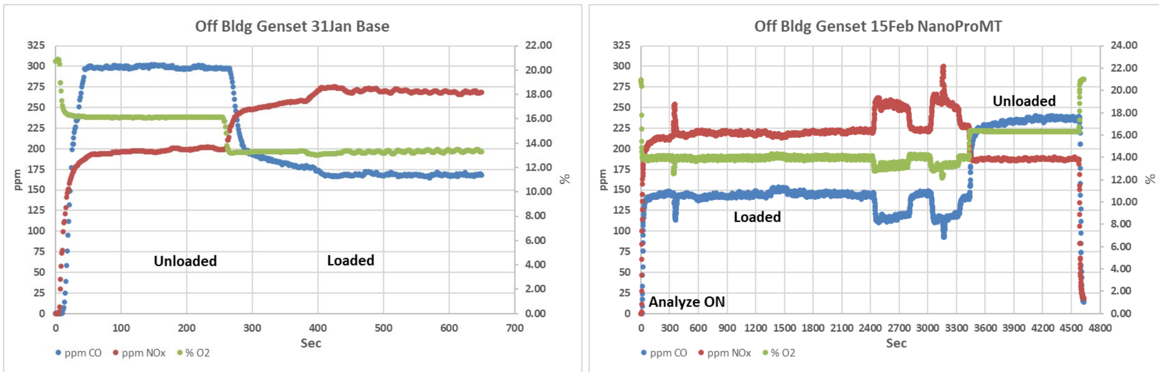
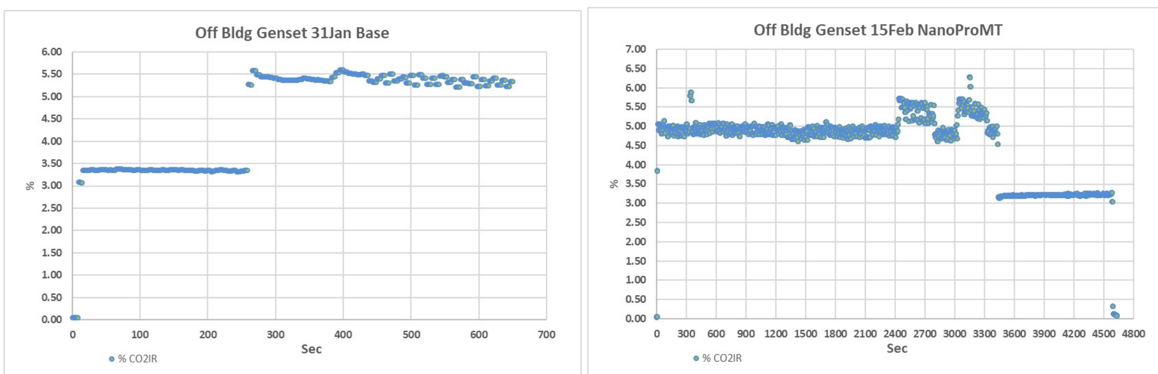


Fig-6



A reduction in engine coolant temperatures was also observed; however, the necessary equipment to measure performance under hot weather conditions was not installed in time for the current round of testing. Hot weather testing will resume when the required instrumentation becomes available in 2025, coinciding with the return of higher ambient temperatures. During the current testing, coolant temperature was monitored via the control panel and data extracted from the Engine Control Module (ECM). The intention is to continue testing under elevated temperature conditions. Both academic and commercial research indicate that, with the additive, the engine may achieve higher output compared to baseline conditions, as the upper operating temperature limits are either reached more slowly or entirely avoided.

Fuel measurement, although challenging to accurately quantify at this stage, has indicated a greater than 5% increase in fuel economy, which aligns with existing background research. It is desirable to continue long-term testing of these gensets across various operating conditions, such as within a rental fleet, and subsequently compare the operational costs of the fleet against itself. A larger pool of test units will help normalize variations in engine maintenance, operational conditions, and other factors that may be encountered in the field or at the STC facility. Sufficient academic evidence supports the notion that fuel consumption reductions are achievable. The installation of direct fuel measurement sensors—rather than relying on calculated fuel consumption values from many ECMs—represents an ongoing area of research that will provide a more accurate assessment of fuel savings. For the purposes of this testing, however, the primary focus was on emissions reductions.

Conclusion

The completed testing demonstrates a reduction in emissions compared to pre-additive emission levels, achieved with minimal effort as the technology involves the use of a simple additive applied during standard PM intervals. Although an external fuel flow measurement was not available during this round of testing, data extracted from the ECM in early testing phases indicates a reduction in fuel consumption under similar operating conditions. The results are conclusive enough to meet the initial objectives of this test, successfully identifying low-cost, high-impact emission reduction technologies for facility management and equipment fleet operations.

Independent research conducted by Nano Pro MT outside of NOV Corporate R&D efforts has also indicated and highlighted the advancement of nano lubricant applications and was the effort that prompted the on-going research by NOV. (++)

NOV Corporate R&D intends to continue to build upon these initial findings by conducting additional warm/hot weather monitoring and implementing long-term studies to measure peak power output and reliability results. These ongoing efforts will provide further insights into the full potential and effectiveness of this technology over a longer period of time. Additional research into nanomodified lubricants for plunger pumps and gear boxes is being considered for the 2025-2026 fiscal years.

(++)
NanoProMT has case studies on both a 1750KW Genset lowering coolant temperatures for running at higher load with same environmental conditions and Qty (8) Volvo gensets extending oil operating life from 250hrs to 400hrs (test objective was 350hrs) as well as operating temperature impact. Both of these studies illustrate tribology property improvements that directly impact engine operation.

References

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