Bridging Viscosity and Performance

Utilization of Heavy Base Stocks in Manufcaturing

October 2025

AGENDA

- ❑ Ergon Introduction
- ❑ Base Oil Overview
- ❑ Base Oil Selection & Basic Tribology for Formulators.
- ❑ Tips for Industrial Oil & Greases Fromulation.

Ergon - LATAM

Who We Are? - LATAM

- Sales Offices
- Headquarters

2 Sales Offices
Mexico City & Sao Paulo

+30 Employees

13 Sales Team

1 Regional Technical Manager

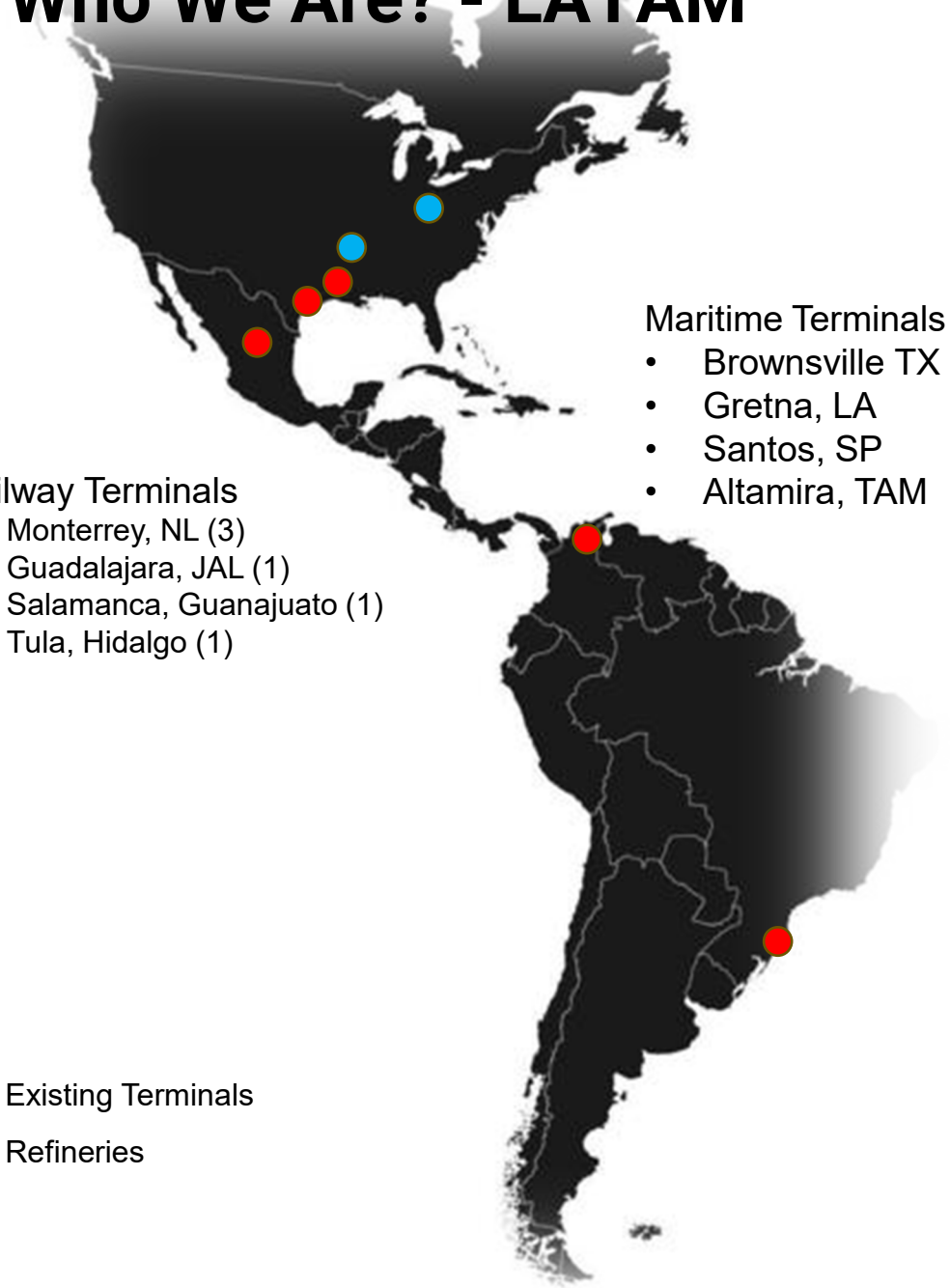
8 Distribution Channel Partners

+170 Customers

+45 Products

1954 USA
2014 MEX
2014 BRA

Who We Are? - LATAM

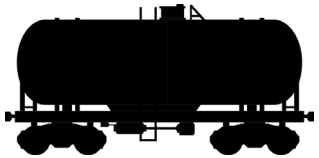


Railway Terminals
- Monterrey, NL (3)
- Guadalajara, JAL (1)
- Salamanca, Guanajuato (1)
- Tula, Hidalgo (1)

Maritime Terminals
- Brownsville TX (3)
- Gretna, LA
- Santos, SP
- Altamira, TAM

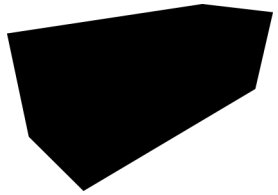
Existing Terminals

Refineries



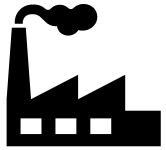
+105 Rail Cars
Loads per month

+50 Trucks
Loads per month



57 Isos and Flexis
Loads per month

12 Terminals
6 Mexico
4 USA
1 Brazil
1Colombia



2 Refineries
Legacy Volume

Who We Are? - LATAM

Total Customers +170

HyVolt / Dielectric Fluids

OEM Leader Supplier
+20 Customers

HyPrene / Process Oils

BO - PO Leader
+ 70 Customers

HyGold / Base Oils

BS Leader
+80 Customers

Industries Served around the region

- Adhesives
- Brake Oils
- Break-Resistant Goggles
- Building Construction Materials
- Candles
- Car Batteries
- Carpet Underlay
- Commercial Roofing
- Concrete Curing Products
- Corrosion Resistant Lining Systems
- Engine Oils
- Fire Logs
- Foam Mattresses
- Garden Hoses
- Gear Oils
- Glass Bottles
- Golf Grips
- Greases
- Hydraulic Fluids
- Inks
- Latex Gloves
- Metalworking Fluids
- Neoprene
- Petroleum Jelly
- Pothole Repair Products
- Primers
- PVC Pipes
- Sport Court Surfaces
- Tennis Shoe Soles
- Textiles
- Tires
- Traffic Paints
- Transformer Oils

Bridging Viscosity and Performance

Relevance of Heavy Base Stocks in a Post-Group I Scenario

Massive closure of Group I refineries: More than **7.5 million tons** per year of Group I capacity have been closed in the last 2 decades, severely reducing the global supply of bright stocks.

Persistent demand for industrial greases and lubricants: Applications such as gears, TPEO, and heavy-duty greases continue to require high-viscosity oils.

Supply gap and critical formulation: The gap between demand and supply of heavy stocks is forcing formulators to use alternatives such as HV PAOs or naphthenic base stocks with specific solvency and polarity properties.

Trend toward hybrid formulations: Intelligent combinations of Group III, naphthenic, and PAO base stocks allow for balancing critical properties without compromising tribological performance.

Global Base Oil Landscape

Properties and Market Transition from Group I to Group II/III/IV

- **Group I: Declining supply, moderate solvency:** Though solvency remains superior for additive compatibility, sulfur content (>0.03%) and lower saturates (<90%) limit its future use.
- **Group II/III: Cleaner, lower solvency:** Group II and III base oils are highly saturated and low in sulfur but show poor solvency (higher aniline point). This impacts their ability to dissolve polar additives.
- **Group IV (PAO): Excellent thermal performance:** PAOs exhibit VI > 130 and near-zero volatility, making them ideal for high-performance oils. However, their aniline point >149° C (> 300° F signals weak solvency for thickener systems.
- **Blending for performance retention:** Strategic blends of Group III/PAO with naphthenics restore solvency and maintain film strength—key in grease and industrial formulations.

Global Shift in Base Oils & Bright Stock Shortage

Strategic context behind the rise of naphthenic and Group V alternatives

Group I refinery rationalization
Decommissioning of Group I plants has led to global shortages of bright stocks, essential for high-viscosity grease applications.

Limitations of Group II & III oils
While more stable, these paraffinic oils lack the solvency and viscosity required for complex industrial grease systems.

Need for cost-effective alternatives
High cost and limited availability of synthetic esters and PAOs create demand for viable Group V substitutes like heavy naphthenics.

Role of heavy naphthenic oils
Balance viscosity and solvency, helping grease formulators replace bright stocks without compromising performance.

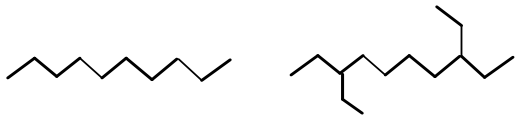
Base Oil Selection Guide for Grease & Industrial Oils

Framework for optimizing performance, cost, and formulation compatibility

IDENTIIFY	• Base oil group to performance needs
DETERMINE	• Viscosity & temperature requirements.
EVALUATE	• Additive compatibility & solvency.
PURSUE	• Cost-performance tradeoff.

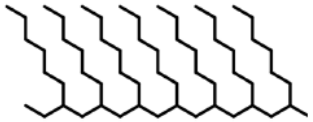
Molecular Architecture of Base Oils

How Structure Drives Solvency, Polarity and Lubricant Performance



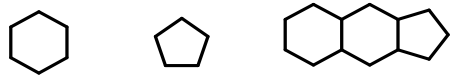
Paraffinic oils: High VI, low solvency

- Straight and branched paraffins
- ↑↑ (VI > 120)
- Excellent thermal properties.
- Low polarity
- High aniline point (>248°F
- Reduce additive compatibility.



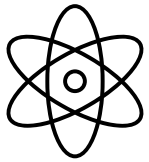
PAO: Engineered performance, inert polarity

- (PAO) are synthesized olefins
- ↑↑↑ VI (>140)
- Excellent oxidative stability
- Low polarity
- Limits thickener interaction in greases unless modified or blended.



Naphthenic oils: Medium VI, high solvency

- Cyclic saturated molecules
- ↑ VI (aprox 40 – 80)
- Superior interaction with thickeners and polar additives.



Polarity vs. solvency: balancing act

- Viscosity Gravity Constant (VGC) and aniline poin
- Allow formulators to optimize blends that maintain additive solubility without sacrificing oxidative or thermal performance.

Viscosity-Temperature Behavior

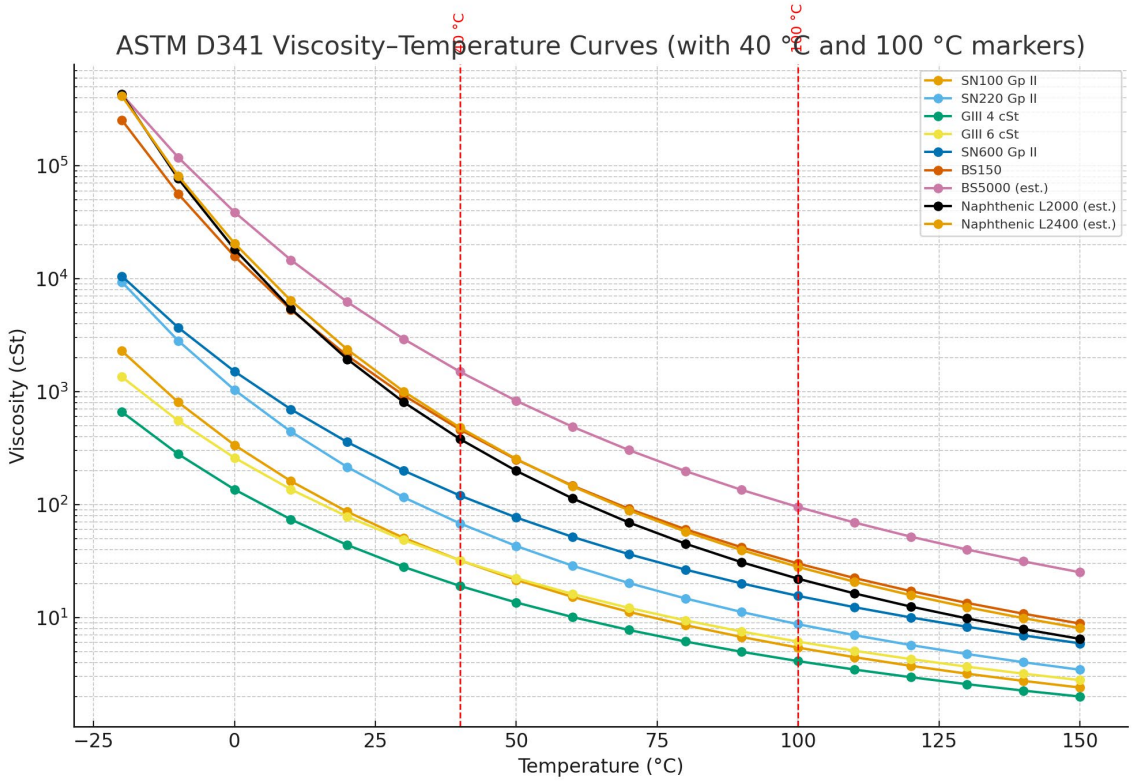
Log-Log Analysis Using ASTM D341 in Heavy Base Oils

- **ASTM D341: Log-Log Viscosity Model:** This standard allows predicting viscosity over a range of temperatures using Walther's equation. It's essential for designing lubricants operating across wide thermal conditions.

- **Heavy base oils: Higher shear stability:** flatter log-log curves, indicating stable viscosity at elevated temperatures—crucial for industrial use.

- **Impact on pour point and startup torque:** While providing excellent high-temp film strength, heavy stocks can compromise low-temperature flowability, requiring balance with lighter or synthetic stocks.

- **Formulation tool: Curve tailoring:** Blenders use ASTM D341 plots to design base oil packages that balance startup behavior with thermal protection—essential in marine, gear, and grease applications.



Tribological Performance of Heavy Base Oils

Friction, Film Formation and Micropitting Control

EHL Film Thickness: Hamrock-Dowson

Film thickness increases with viscosity and speed; high-viscosity base oils help maintain separation in loaded contacts. Key for anti-wear and surface fatigue protection.

Stribeck Curve: Mixed/Hydrodynamic Regimes

Heavy base oils shift the Stribeck curve, offering lower friction at higher loads due to stable film formation in the mixed regime.

Micropitting Resistance

Thicker films reduce metal-to-metal contact, minimizing rolling contact fatigue. FZG A/8.3/90 testing confirms improved protection with BS5000-like stocks.

Formulation Insight: Friction Control

Using high-VI or naphthenic-heavy blends can tune coefficient of friction in real-use conditions like gears, compressors, and bearings.

Linking Base Oil Properties to Field Performance

Critical formulation parameters and their operational impact

Viscosity Index & Shear Stability
Influences film strength and load-carrying capacity under dynamic conditions—key for bearings, gears, and hydraulics.

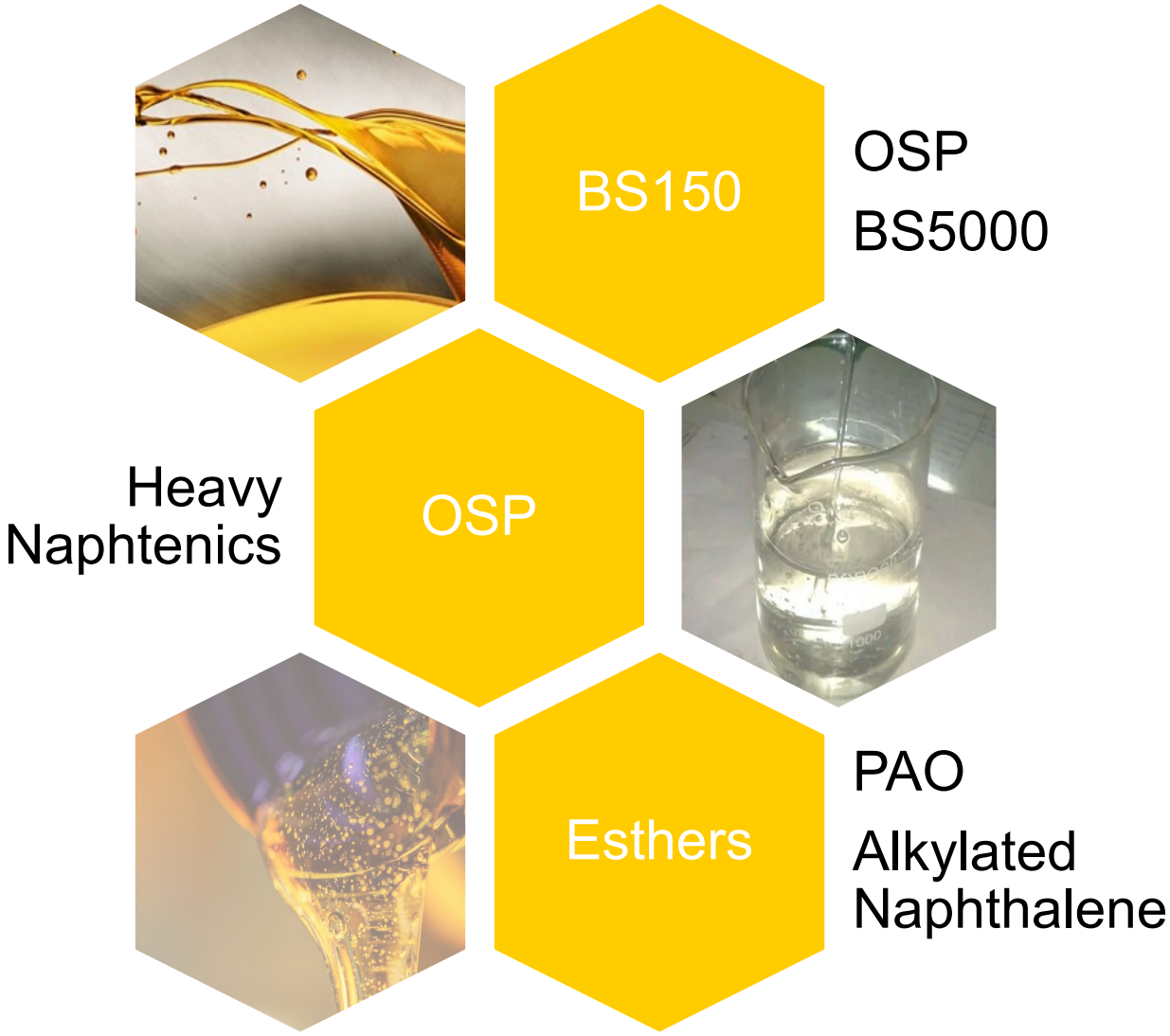
Polarity and Aniline Point
Affects solvency power for additives and thickener dispersion—critical in grease homogeneity and oil bleed control.

Volatility & Oxidation Stability
Low volatility and high oxidative resistance enhance lifespan and reduce varnish/sludge—important in high-temp and extended-drain applications.

Hydrolytic & Water Resistance
Essential for applications with water ingress; esters and OSPs vary significantly here and must be matched to seal and material compatibility.

Formulating Industrial Oils with Heavy Base Stocks

Performance implications and formulation tradeoffs vs Bright Stock



Challenges in Industrial Oil Formulation

Balancing performance, cost, and compatibility with heavy base oils

Viscosity targets vs pumpability

- High-viscosity oils can impair flow at low temps—impacting startup, filtration, and circulation in hydraulics and turbines.

Additive solubility management

- Polarity differences influence the solubility of dispersants, detergents, and friction modifiers—requiring careful balance.

Oxidation control under thermal cycles

- Heavy naphthenics and bright stock alternatives need tailored antioxidant packages to withstand repeated heating/cooling.

Seal material interactions

- Formulations must be tested with seals and elastomers, as naphthenic-heavy blends may alter swell or degradation rates.

Strategic Formulation Approaches

Tailoring industrial oils for durability, cleanliness, and efficiency

Hybrid base oil blends
Mixing Group I/II/III with naphthenics or esters balances performance, solvency, and cost.

Additive-system tuning
Adjust AW, EP, and dispersant levels based on base oil polarity and application demands.

Temperature profiling and VI control
Ensure thermal stability and fluidity across operating range via VI improvers or base oil choice.

Application-specific tailoring
Design around load, speed, seal type, and cleanliness targets to optimize field durability.

Advantages of Heavy Base Oils in Industrial Lubricants

Unlocking functional value beyond viscosity

Superior film strength under load
High-viscosity base oils ensure stable EHL films—crucial in gears, compressors, and sliding contacts.

Additive efficiency and dispersion
Naphthenic solvency enhances dispersant and AW additive availability, reducing deposits and wear.

Blending flexibility with Group II/III
Heavy oils complement paraffinic bases, enabling ISO VG tuning and formulation cost control.

Thermal management support
Naphthenics promote faster heat transfer and system cooling in high-duty operations.

Heavy Base Oils in Grease Manufacturing

Oil Retention, Thickener Interactions and ASTM Performance

Formulation Takeaways for Heavy Base Oils

A summary of key impacts from high-viscosity base stocks in grease and oil systems

↑ **NLGI Grade at equal thickener**
Higher viscosity base oils (VG1000–1500) increase grease firmness without raising soap concentration.

↑ **EHL film thickness**
Improves wear protection under high load and slow speed—especially in industrial gear and bearing systems.

↑ **Shear and mechanical stability**
Longer-lasting consistency in applications with mechanical agitation or thermal stress.

↓ **Oxidation resistance (unless fortified)**
Heavy naphthenics require antioxidant support; performance varies based on formulation and additive system.

Strategic Outlook

Key takeaways for grease formulators using heavy base oils

Heavy naphthenic oils are viable bright stock alternatives

They offer high solvency, moderate cost, and excellent compatibility with thickeners and additives, making them ideal for industrial grease applications.

Enhanced tribological and rheological performance

Compared to polymers, oils like BS5000 reduce friction, improve film formation, and provide more stable viscosity-temperature behavior.

Alkylated naphthalenes and OSPs expand synthetic options

These advanced Group V fluids enable superior oxidative stability, lower thickener demand, and compatibility with both polar and nonpolar systems.

Strategic adaptability amid raw material shifts

Formulators should leverage these fluids to mitigate bright stock shortages, lithium cost spikes, and increasingly strict performance demands.

Summary

Heavy Base Stocks as a Bridge to Performance and Formulation Resilience

- **Non-substitutable in high-load lubrication:** Despite supply constraints, heavy base oils remain essential in formulations requiring film strength, solvency, and thickener integration—especially in greases and gears.

- **Bridge between legacy and innovation:** Heavy base stocks enable a blendable interface between traditional Group I characteristics and modern Group II/III or PAO demands.

- **Smart blending is the future:** Customized blends using naphthenics, re-refined stocks and synthetics allow precise tuning of solvency, VI, and oxidative stability while managing costs.

- **Sustainability aligned performance:** Circular use of heavy base oils via re-refining reduces carbon footprint without compromising tribological performance.

Activation Threshold of EP Additives

How film thickness affects extreme pressure protection

EP additives require heat and contact
Sulfur, phosphorus, and chlorinated compounds activate under boundary conditions—pressure and localized heat trigger tribochemical reactions.

Thick EHL films may prevent activation
If the base oil film fully separates metal surfaces, EP additives may remain dormant unless film collapse or peak load occurs.

Risk during transient overloads
Sudden load spikes can exceed film capacity before EP additives react—potential wear if formulation isn't balanced.

Solution: balance film and reactivity
Use EP systems that activate gently (e.g., ZDDP) and ensure viscosity doesn’t fully mask contact in high-risk applications.

Heavy Base Oils in Grease Manufacturing

Oil Retention, Thickener Interactions and ASTM Performance

Oil-thickener interaction defines grease structure

High solvency of naphthenic oils enhances thickener incorporation and reduces oil bleed. Ca-sulfonate and Li-complex systems show better mechanical stability with high-VG stocks.

Saponification kinetics affected by oil polarity

Base oil polarity directly affects saponification rate and fiber formation. High VGC oils lead to denser network structures under identical cooking cycles.

ASTM D217/D6184: Consistency and oil separation

Greases formulated with heavy stocks maintain NLGI grade under mechanical shear and resist oil separation per D6184 oven test—critical in high-load applications.

Improved retention, reduced syneresis

Formulations using BS5000 or VG1500 naphthenics show 25–40% less oil bleed than Group II blends, preserving structure over long cycles.

