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ROSEFIELD INSIGHTS

LUBRICANTS & FUELS INDUSTRY - INDIA AT CROSSROADS

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Editorial

Shailendra Gokhale

It gives me an immense pleasure — and a deep sense of responsibility — to pen the editorial for the inaugural edition of **"Rosefield Insights."** This publication is the outcome of a vision that has guided Rosefield since its inception: **to bring together all stakeholders in the global lubricants and fuels industry through the power of shared knowledge.**

Over the years, as I've interacted with professionals across continents, one thought has consistently resonated — while our technologies, markets, and customer expectations evolve rapidly, what truly binds us as an industry is our collective pursuit of **understanding and improvement.** From refiners to additive companies, from OEMs to end users, every participant in this ecosystem contributes to shaping the future of lubricants and fuels. And that future, more than ever before, depends on **informed decision-making.**

> "Knowledge is Power Only When Shared"

At Rosefield, we have always believed that "knowledge is power only when shared."

This belief forms the cornerstone of all our initiatives — whether it's our **webinars, masterclasses, conference on Lubricants and Fuels or on Circular Economy in Used Oil**, or our **fortnightly newsletters** on global trends in lubricants, base oils, and fuels. These platforms have allowed experts and practitioners to come together, exchange insights, and collectively address the challenges of our dynamic industry.

Why "Rosefield Insights"?

Over the past few years, our newsletters have been widely appreciated by industry professionals for their quality, depth, and relevance. We've covered everything from mergers and acquisitions, policy shifts, and sustainability transitions to technology updates and market outlooks.

The consistent feedback we received from our readers — "Can you please make this into a magazine?" — was both humbling and inspiring. And that's how Rosefield Insights was born: as a natural extension of our mission to curate and share high-quality, actionable knowledge.

This inaugural edition brings together a diverse mix of content: **a high-level interview with the President of a Lubrizol** Corporation, USA, articles from senior industry professionals, and perspectives that span technology, market trends, and sustainability. We've consciously designed it not as another news digest, but as a thought-leadership platform — one that stimulates reflection, discussion, and collaboration among professionals who are shaping the industry's future.

A Time of Transformation

The lubricants and fuels sectors are undergoing profound transformation. OEM specifications are tightening, emission norms are evolving, and customers are increasingly demanding performance that goes beyond just price — emphasizing **sustainability, circularity, Fuel Economy and total value.**

Simultaneously, the shift toward **energy transition** and **carbon neutrality** is redefining how we think about mobility, industrial efficiency,
and resource utilization.

In such times of change, access to relevant, unbiased, and expert knowledge becomes indispensable. The goal of Rosefield Insights is precisely that — to serve as a **bridge between information and intelligence**, **between data and direction.** We aim to bring together viewpoints that help industry leaders make better strategic decisions, anticipate disruptions, and identify opportunities in an ever-changing landscape.

A Journey Built on Collaboration

If there's one thing I've learned in my three decades across the global lubricants, base oils, and additives industry, it's that **no one succeeds in isolation.**

The industry thrives when we collaborate — across companies, geographies, and disciplines. The very evolution of lubricant chemistry, formulation science, and fuel technology has been driven by shared learning and partnerships between refiners, additive suppliers, OEMs, and regulatory bodies.

Through Rosefield Insights, we hope to continue this spirit of collaboration. Each article, interview, or commentary here represents not just an individual's expertise but a collective commitment to the industry's growth. I am deeply thankful to all the contributors who generously shared their time and insights to make this first edition possible.

Your Feedback Shapes Our Future

As this is our inaugural issue, we have not yet finalized the publication frequency. Instead, we'd like **you — our readers — to guide us.**

Your feedback will help us understand what topics resonate most, what formats you prefer, and how frequently you'd like to receive Rosefield Insights.

After all, this magazine belongs as much to the community as it does to Rosefield.

We envisage Rosefield Insights as an evolving platform — one that stays current, inclusive, and valuable. Whether you are a lubricant formulator, base oil supplier, additive technologist, or sustainability professional, we hope you will find in these pages ideas that inform, inspire, and empower you.

In Closing

As I reflect on the journey that brought us here, I'm reminded of how far the industry has come — from conventional formulations to high-performance synthetics, from linear consumption models to circular economies. The next chapter will undoubtedly bring new challenges — and with them, new opportunities. I believe Rosefield Insights can play a small yet meaningful role in helping us navigate that future — together.

On behalf of the entire Rosefield team, I thank you for your continued trust and engagement.

Here's to new beginnings — and to the shared pursuit of knowledge that drives us all forward.

Warm regards,
Shailendra Gokhale

Shailendra Gokhale

Founder & Director, Rosefield Energy Tech

Mr. Shailendra Gokhale, Founder and Director of Rosefield Energy Tech, brings over 30 years of industry experience with a strong commercial focus and international exposure. A sought-after speaker at international conferences, Shailendra has over 18 years of senior leadership experience in India and UK. He has served as an external advisor to BCG, is a member of The Energy Institute in London, and has been consulting various major energy players worldwide including Petronas, ENOC, Infineum, BP/Castrol, Brenntag, HPCL and Morris for Lubricants value chain. He has been working closely with NITI Aayog and RECEIC in the field of Circular Economy in Used Oil.

Foreword

Lighting the Path Forward in a World of Uncertainty

We are living through a defining moment in the history of global supply chains. The past few years have shown us that disruption is not a passing phase—it is the new normal. From pandemics and geopolitical tensions to climate imperatives and digital revolutions, the forces reshaping our industry are profound and unrelenting. Yet, within this turbulence lies a powerful truth: the greatest transformations are born from the greatest challenges.

> "The launch of Rosefield Insights is a bold and timely response to this era of complexity. It is more than a magazine—it is a movement."

The launch of **Rosefield Insights** is a bold and timely response to this era of complexity. It is more than a magazine—it is a movement. A platform that dares to ask the hard questions, connect the brightest minds, and illuminate the path forward. In a world flooded with information, **Rosefield Insights** offers something rare: clarity, context, and courage.

This publication stands apart because it does not merely observe change—it catalyses it. It brings together voices from across the value chain—engineers, entrepreneurs, academics, policymakers, and sustainability champions—to spark dialogue, share breakthroughs, and challenge conventions. Whether exploring the future of lubricants in green energy, the promise of circular economies, or the digital reinvention of supply chains, Rosefield Insight offers a lens that is both wide and deep.

At a time when **"Uncertainty Is the New Normal"**, resilience is no longer a luxury—it is a necessity. The just-in-time model, once a symbol of precision, has given way to a new paradigm: one built on agility, redundancy, and foresight. And at the heart of this shift lies digital transformation. Technologies like AI, blockchain, and real-time analytics are not just tools—they are enablers of a smarter, faster, and more responsive supply chain.

> "At a time when "Uncertainty Is the New Normal", resilience is no longer a luxury—it is a necessity."

But technology alone cannot lead us. It is people—visionary leaders, bold thinkers, and collaborative teams—who will shape the future. It is our shared commitment to adaptability, transparency, and innovation that will define the next chapter of global commerce.

As Peter Drucker once said, "The greatest danger in times of turbulence is not the turbulence—it is to act with yesterday's logic." This quote resonates deeply with the mission of Rosefield Insight. It reminds us that progress demands new thinking, fresh perspectives, and the courage to challenge the status quo.
Rosefield Insight is a tribute to that spirit. It reflects the journey of Rosefield Energy Tech—from a knowledge-driven consultancy to a catalyst for industry evolution. It is a testament to what is possible when purpose meets perseverance.

> **"As Peter Drucker once said, The greatest danger in times of turbulence is not the turbulence—it is to act with yesterday's logic."**

As we look ahead, let us embrace uncertainty not as a threat, but as a call to lead. Let us build supply chains that are not only efficient, but resilient. Not only reactive, but predictive. Not only connected, but united by a common vision for a sustainable and inclusive future.

I extend my heartfelt congratulations to the team behind Rosefield Insight. May this publication continue to inspire, inform, and ignite progress across our industry—and beyond.

Jayanta Chatterjee
Global Supply Chain Director – Industrial and Global Marine & Energy, Castrol.

Jayanta Chatterjee

GLOBAL SUPPLY CHAIN DIRECTOR – INDUSTRIAL AND GLOBAL MARINE & ENERGY, CASTROL.

Jayanta Chatterjee is a distinguished supply chain leader with over three decades of global experience spanning Planning, Procurement, Manufacturing, Fulfilment, and Transformation. His career has taken him across Asia Pacific, India, the Middle East, and the UK, where he currently serves as Global Supply Chain Director for Castrol's Industrial, Marine, and Energy business. Jayanta's career includes pivotal roles such as Wholetime Director on the Board of Castrol India and leadership of Castrol's global Base Oil procurement. He is widely respected for his strategic vision, operational excellence, and ability to build high-performing teams that drive end-to-end transformation and deliver lasting value.

Lubricants Manufacturing – Challenges to Opportunities – 2030 and beyond

Demystifying Challenges faced in the coming decade - transform them to opportunities

When I began my career, Sales and Marketing were the most coveted roles, while operations—especially in petroleum—meant managing terminals and installations. Lubricants production wasn't a preferred domain, largely due to its primitive infrastructure and limited visibility. Over the last 3–4 decades, however, lubricants manufacturing has undergone a remarkable transformation. From manual tower blending to advanced ILB, SMB, and BBV systems, and packaging inspired by FMCG automation, the industry now boasts high-performance, efficiency-driven plants.

This evolution has been propelled by rising customer expectations and stringent engine oil standards like API CK4-SQ. Raw materials have shifted from mineral to synthetic base oils, with complex additive packages becoming the norm. While automation and supply chain integration have improved operations, the surge in SKUs and formulations has added complexity. Having designed and operated plants across regions, I now turn my attention to three future opportunities—born from today's challenges and shaped by both technological and conceptual aspirations.

Opportunity # 1 : Challenge # 1 : AI driven Blending of lubricants – Simplify design and set up on a continuous basis

From Manual Mastery to Intelligent Automation: The Evolution of Lubricants Blending

Lubricants blending has come a long way. Decades ago, I witnessed blenders manually keying in raw material quantities using local flowmeters, carefully adjusting flows to match batch requirements. It was a hands-on, skill-intensive process. Today, ILB, SMB, and BBV-based blending systems have revolutionized operations. Fully automatic blending is now the norm, managed from centralized control rooms by just a few operators—even in the most complex plants.

Production planning has also evolved. Planners interface directly with manufacturing modules, feeding in production needs. Blenders now accept or amend these plans to suit real-time production contexts. The system is streamlined, integrated, and efficient. But with all this progress, one might ask: what's the next opportunity?

The Hidden Manual Layer

Despite automation, several background tasks still require manual intervention. Raw material specifications and performance can vary batch to batch, and blend optimization often happens offline. These adjustments—critical for cost and quality—are not yet fully integrated into the automated system.

PLC and DCS setups demand multiple recipe steps, which must be configured frequently. Unfortunately, many of these are hard-coded by DCS vendors. Any hardware change typically requires vendor intervention, adding time and complexity. Moreover, blending must adapt to downstream performance—filling lines, tank availability, etc.—but current systems still rely on manual tweaks to respond to these variables.

Even new-generation plants are being commissioned with these limitations. The constraints are accepted as part of the design. This is where I see a transformative opportunity: AI-enabled blending.

The Case for AI in Blending

AI can redefine how lubricant plants operate. It's a wake-up call for all of us involved in designing the plants of tomorrow. The question is no longer "Can we automate blending?" but "How can we make blending intelligent?"

Here's what I envision:

Soft-Coded Flexibility: AI should enable soft coding of blending resources—no more rigid, hard-coded configurations. Operators, and eventually AI itself, should be able to:

- Automatically generate updated, optimized recipes using the best available raw materials.
- Select the most efficient routing of resources.
- Minimize idle time and maximize throughput.

The system should intrinsically handle recipe building, formulation optimization, and routing. Exceptional authorizations can be built in, but they should be rare.

Real-Time Cost Intelligence: AI's impact will extend beyond blending into the entire lubricants supply chain. Cost pressures are mounting, and AI can help manage them proactively.

Imagine a system that:

- Alerts planners in real time when blending costs exceed thresholds.
- Allows users to set cost limits and receive early warnings.
- Shifts performance management from lag indicators to lead indicators.

This kind of intelligence can empower decision-makers to act before issues escalate.

Conversational Intelligence: AI can also transform how teams interact with the system. Think of chatbots—not just for customer service, but for internal operations. Blenders, planners, and production managers could:

- Ask how long a raw material will last before stock-out.
- Get guidance during product changeovers.
- Explore alternate formulations in response to market disruptions.

Today's chatbots already handle unconstrained queries with realistic responses. Tomorrow's AI blending systems should do the same—building a vast library of techno-commercial knowledge accessible through natural language.

A Vision for the Future

AI-based blending is not just a technical upgrade—it's a paradigm shift. I dream of a future where blending becomes intuitive, engaging, and even enjoyable. Imagine a plant tour where business leaders can interact with the blending process, understanding it without needing deep technical expertise. The complexity will still exist, but it will be managed behind the scenes by a few experts and a powerful AI backbone.

Blending will become a plug-and-play experience. The fun will return—not because it's simple, but because it's smart. This is the opportunity I see: to make lubricants blending not just automated, but intelligent, adaptive, and delightful.

Opportunity # 2 : Challenge # 2 : Packaging of lubricants – Simplify design and set up on a continuous basis

Just as blending has evolved, so too has the packaging of lubricants. Today's high-speed filling lines can handle up to 400 small bottles per minute and over 100 drums per hour. These lines integrate multiple operations—depalletizing, bottle unscrambling, capping, sealing, labeling, cartonizing, and palletizing—into fully automated, synchronized systems. It's a remarkable technological leap for the lubricants industry.

Yet, as automation has advanced, so have

customer expectations. The proliferation of SKUs, pack sizes, and labeling variations—especially for global markets—has added complexity. Customers now demand flexibility, speed, and customization. In such a dynamic, competitive environment, ignoring these expectations is not an option.

This creates a paradox: while high-speed lines offer efficiency, they struggle with agility. Manufacturers prefer long, uninterrupted runs, but market demands require frequent changeovers. And here lies the bottleneck—changeover times. Switching from one product pack to another can take 45 minutes to an hour, especially when flushing and cleaning are involved. Even though equipment suppliers target 15-minute changeovers, real-world conditions often stretch this timeline.

The challenge is clear: how can we achieve F1-style changeovers in lubricant packaging? Just as pit crews reset a race car in seconds, we need fast or even universal change parts across the filling line. The goal is to minimize downtime and maximize responsiveness.

Artificial intelligence offers a promising path. AI-enabled filling systems can learn from past runs, automate setup changes, and optimize performance. By eliminating repetitive inefficiencies—what TIMWOOD defines as waste—AI can transform filling operations into lean, responsive systems.

Looking ahead, the next decade must see the rise of hybrid lines: high-speed, AI-driven, and capable of rapid, seamless changeovers. This vision isn't just about operational excellence—it's about customer delight. The brand that leads this transformation will not only meet expectations but set new benchmarks. For forward-thinking lubricant manufacturers, this is a golden opportunity to lead the pack.

Opportunity # 3 : Challenge # 3 : Multiple Additives Handling – Simplify Material Handling – Automation vs Manual Paradox

Reflecting on my first plant tour when I entered the lubricants industry decades ago, I vividly recall the tower blending plant setup. It was a classic gravity-flow system with numerous blenders, but what stood out most were the "on-floor sunken additive pits." These pits were used to dump various additives, which were then pumped—alongside base oils—into the blending system. Operators took pride in the process, swiftly emptying multiple drums and completing batches with impressive speed and efficiency.

Fast forward a few years, and the industry had transitioned to modern ILB and SMB-type blending plants. This evolution introduced automatic drum decanting units (DDUs) into the system. At first glance, these units seemed revolutionary—integrating automatic pump-out, measurement, data logging, rinsing, cleaning, and pigging. It was a comprehensive automation package that promised consistency and hygiene. I was intrigued and excited when I first implemented this system in one of my Middle East setups.

However, reality soon tempered that excitement. Despite its technological sophistication, the DDU posed several operational challenges. User-friendliness was a major concern. Operators found the system cumbersome, and its complexity often hindered productivity. The intuitive ease of manual drum handling was lost in translation. Even today, with improved pumping mechanisms designed to handle higher viscosities, DDUs continue to present hurdles. Most operators I've worked with echo my sentiment: "I'm not a big fan of DDU." Yet, we continue to incorporate it into our plant designs—not because it's perfect, but because the older manual systems no longer align with the visual and emotional expectations of state-of-the-art facilities.

This brings me to a critical inflection point: transforming a persistent challenge into a strategic opportunity. Drum-based additive handling remains a significant part of lubricant manufacturing, with over 50–60% of additive demand processed this way. That makes the DDU process a vital link in the supply chain. Its optimization is not just a tactical fix—it's a strategic imperative.

Looking ahead, I envision a hybrid solution that blends the operational simplicity of manual additive handling with the hygiene and automation of DDUs. The future system should be touch-free, minimize manual intervention, and simplify product changeovers. It should be intuitive for operators, not intimidating. While I don't yet have a concrete equipment blueprint, I'm confident that the industry's collective expertise can turn this vision into a proof-of-concept and eventually a scalable model.

This may sound tactical, but it's a deeply invigorating strategic opportunity. Given the volume of additives processed in drums and the operational pain points we've lived through, reimagining this process could unlock significant gains in efficiency, safety, and operator satisfaction. It's time we rethink the DDU—not just as a machine, but as a cornerstone of future-ready lubricant manufacturing.

Landscape for the future – EV fluids and impact – Is it a Boon or Bane?

Automotive engine oils currently dominate our product portfolio, but the rise of electric vehicles signals a transformative shift. Internal combustion engines may phase out within our generation, reshaping the industry's landscape. Manufacturing will face new challenges as future formulations diverge from traditional hydrocarbon-based blends. While core technologies may remain familiar, the supply chain and production processes will evolve—offering both disruption and opportunity. The coexistence of legacy and emerging product lines will hinge on demand-supply dynamics and may require innovative sourcing strategies. As the market redefines itself, questions arise: will engine oils and hydraulic fluids become obsolete or merely minimized? The coming decade will be pivotal. Our preparedness and agility will determine how well we adapt—and capitalize—on this transition.

Concluding Remarks and Key takeaways

1. As I conclude the article, while there could be many more opportunities presented in the future, I have framed some of the top tips from my experiential point of view. These are some long-term wins from my perspective, as well as my dream of truly transforming the lube plant into a "state of the art" facility, so to speak! The Key takeaways:
2. The article focused on a combination of strategic and tactical opportunities alike.
3. AI based blending as well as AI based end to end manufacturing is the way to go in future.
1. Much talked about OEE (Overall Equipment Effectiveness) is directly proportional to the changeover dynamics and the nerve centre of this is the high tech packaging lines. A great sense of opportunity lies here and now!!
2. Additive drums handling continues to be tactical pain point, and the industry needs to find a practical and user-friendly answer to the problem. Showcasing technology alone is not what the operator enjoys!!
3. Lubricants Product Portfolio is indeed changing in the next decade and here lies one of the upcoming challenges. Fortunately, the industry is well preparing

I am sure these will surely kindle your creative juices, as you may also discover different perspectives to my tabled positions on various situations. However, I strongly believe that by 2030 and beyond, I envision a new next-generation lube plant—AI-enabled, AI-operated, and AI-maintained. What the dimension and trick to this AI will be is what we need to figure out, and the quicker we do so, the greater the impact will be! That could become a trendsetter for many other industries, if we evolve here and now.

Ganesh Ganapathi

SUPPLY CHAIN & MANUFACTURING PROFESSIONAL

Ganesan Ganapathi has over 43 years of experience as a supply chain and manufacturing professional with leading oil companies such as BP, Shell, Total and Bharat Petroleum in India, Middle East and Southeast Asia. While leading operations, supply chain and plant management in these companies, Ganesan has noteworthy contributions in the space of Strategic and Master Planning of Supply Chain and Manufacturing. He believes in "sharing and caring" as his passionate mantra. Ganesan can be contacted via LinkedIn (www.linkedin.com/in/ganesan25)

Next-Generation Fuels in India

India is moving rapidly toward green/low-carbon fuels in several sectors
(transport, shipping, power).
Key trends include:

- Push for **green hydrogen**, green ammonia, green methanol & sustainable aviation fuel (SAF) especially for heavy-duty transport, coastal shipping, aviation. (IH2A - IH2A)
- Increased use of **bio-fuels** (ethanol blending, eventually perhaps biodiesel / HVO, etc.) in road transport. (NGS India)
- Growth in **LNG / dual fuel engines** (road, maritime, stationary), and pilot/experimental use of ammonia/hydrogen/mixed fuel ICE or fuel-cells. (Shell)

These changes imply both opportunities (emissions drop, fuel cost reductions, energy security) and **technical challenges**, especially for lubrication systems.

What Makes Next-Gen Fuels Harder for Lubrication

Different fuels bring different issues from the lubrication perspective.
Some key challenges:

Fuel / Fuel-blend Key Lubrication Challenges

Fuel/ Fuel Blend: Hydrogen / Ammonia
Key Lubrication Challenges: High combustion temperatures; corrosion risks (e.g., ammonia is caustic, tends to form corrosive compounds, high auto-ignition temperature, flame speed issues). (MDPI)
Fuel/ Fuel Blend: Methanol / Bio-fuels / Ethanol / HVO, etc.
Key Lubrication Challenges: Lower lubricity; potential solvent effects (washing away oil films or additives), increased water content or contaminants, different acid/base demands, and maybe more oxidative stress. Also, the compatibility of seals, gaskets, and other non-metal parts. (REPSOL)
Fuel/ Fuel Blend: LNG / Dual Fuel
Key Lubrication Challenges: Greatly variable operating conditions (compression ignition, high load cycles, switching between fuel types) mean a

wider operating range for lubricant; lower sulphur likely reduces neutralization demands; requirement for fuel-agnostic or multi-fuel validated lubes. (Riviera Maritime Media)

Fuel/ Fuel Blend: SAF / E-fuels (aviation, shipping)

Particularly high-temperature stresses, after-treatment systems (catalytic converters, particulate filters); risk of deposit formation; acid formation; need for stable base oils and additive systems. Also, regulatory and emission compliance adds pressure. (The Times of India)

In short: lubricants for next-gen fuels must do more (wider temperature/pressure range, more corrosion protection, maintain clean combustion chambers & after treatment systems, longer life under more varied stresses, compatibility with fuel blends, maybe even safety/toxicity constraints).

Strategies & Best Practices for Lubrication in India's Transition

Here are what might be or should be the "lubrication strategies" India should adopt, across R&D, regulation, industry, OEMs, and users:

- **Fuel-Agnostic / Multi-Fuel Lube Formulations**
  - Develop lubricants validated for a range of fuels (diesel, biofuels, LNG, methanol, ammonia, blends thereof).
  - Use additive chemistries that aren't just optimized for one fuel type but can handle varying acid formation, corrosiveness, ignition/combustion residues, etc.
  - OEMs & lubricant suppliers to work closely to co-develop and test in relevant real-world conditions. (Riviera Maritime Media)

- **Enhanced Corrosion & Wear Protection**
  - Because some fuels (e.g., ammonia, hydrogen blends) can be more corrosive or produce acid/oxidation byproducts, lubricants need higher quality additives (anti-oxidants, corrosion inhibitors) and base oils that resist oxidation.
    Possibly higher base numbers (BN) in lubricants for some engines (especially where sulphur or acid exposure remains). But with low sulphur fuels, the BN requirement may reduce; need to tailor.

- **Deposit Control & Clean Combustion Chambers**
  - Fuel changes (especially to biofuels, SAF, e-kerosene, etc.) may lead to different combustion residues, which can clog injectors, valves, and aftertreatment devices. Lubricants need to minimize deposits (so good detergency, dispersancy, ash control where relevant).
  - Engine design and lubrication intervals might need to be adjusted.

- **Monitoring, Diagnostics & Predictive Maintenance**
  - Oil condition monitoring becomes more critical: tracking additive depletion, wear metals, acid numbers, etc., to know early if a fuel change or operating regime is harming lubrication.
  - Data analytics, sensorization in field engines to adjust maintenance intervals, lubricant selection, etc.

- **Regulatory & Specification Frameworks**
  - Encourage development of Indian / regional standards for lubricants compatible with next-gen fuels: e.g., specify performance for fuels like methanol, ammonia, SAF blends.
  - Possibly mandate minimum performance levels (e.g., corrosion resistance, deposit control) in engines/fuel systems that are going to use these fuels.

- **Material Compatibility & Ancillary System**
  - Lubricant compatibility with seals, gaskets, hoses, etc., because new fuels (e.g., ammonia, hydrogen, methanol) may degrade certain polymers, rubbers, etc.
  - Use of synthetic base oils or ester base oils might offer better compatibility under certain fuel exposure.

- **Training & Industry Capability Building**
  - Training of OEM engineers and lubrication specialists on new requirements.
  - Strengthen labs for lubricant testing under alternate fuel conditions (combustion benches, corrosion/wear rigs).
  - R&D funding to study the effects of new fuels on lubrication, and to trial new lubricant formulations in India's diverse operating

climates (rural, high temperature, humidity, etc.).

- **EALs / Biolubricants & Circular Economy**
  - To align with decarbonization / environmental goals, encourage biodegradable/low-toxicity lubricants, especially for applications where leakage risk is high.
  - Developed biolubricants (from non-edible oils, etc.) may need to be assessed not just for environmental profile, but how they behave under fuels (oxidation, temperature resilience, etc.) as per comparative studies. (Frontiers)
- **Fuel Supply & Quality Control**
  - Ensuring that fuel blends / alternative fuels delivered to users meet consistent specs (purity, water content, contaminant levels) so that lubricant formulations don't suffer from fuel side variability.
  - Infrastructure for refueling/storage that minimizes contamination (e.g., moisture ingress, salt, metal particles, etc.).
- **Pilot Projects & Field Trials**
  - Running pilot programs (e.g., dual-fuel engines, ammonia/methanol fuelled vessels/trucks) to accumulate empirical data: in the Indian climate, Indian load cycles.
  - Use pilot insights to refine lubricant specification, maintenance schedules, and cost implications.

"Fuel standards, emission regulations, lubricant specifications, and subsidy programs may need to factor in lubricant impacts (indirect emissions, durability, maintenance costs)."

What India Needs to Decide/Plan For

To ensure a smooth transition, India (government + industry) needs to make choices now. Some decision points:

- **Which fuel mixes / transitions will dominate in each sector?** For example, will heavy trucks move to LNG first, then methanol, or directly to hydrogen/ammonia? That has big implications for lubricant R&D prioritization.
- **Regulatory incentives/mandate design:** Fuel standards, emission regulations, lubricant specifications, and subsidy programs may need to factor in lubricant impacts (indirect emissions, durability, maintenance costs).
- **Support for R&D / indigenous additive & base oil development:** To reduce dependence on imported speciality oils, additives—especially

since some needed for corrosion, high temp, deposit control, etc., may be high-cost or patented.

- **Trade-offs in cost vs performance:** Many lubricant innovations cost more (additives, synthetics, better tests). Need to consider lifecycle cost savings (longer engine life, lower emissions, less downtime) and whether fleet owners/OEMs will absorb costs, or need public sector support.
- **Standardization & OEM collaboration:** Having OEMs (automakers, engine manufacturers, marine, shipping) set clear guidelines/requirements for lubricant performance under next-gen fuels.

> "Safety, handling, toxicity: e.g., handling ammonia, hydrogen has additional risks; lubricant formulations/additives must not exacerbate these."

Key Risks / Pitfalls to Avoid

- Overlooking in real-field conditions: lab tests must be supplemented by field trials (durability, extreme climate, real duty cycles, etc.).
- Fuel quality variability: In India, fuel impurities, water content, and inconsistent blending may worsen lubrication issues if designs assume ideal fuel.
- Cost pushback: Suppliers/fleet operators unwilling to adopt more expensive lubes unless value (reduced maintenance/downtime/etc) is demonstrable.
- Material incompatibility: non-metal parts degrading under new fuels, seals, gaskets failing, etc., which can lead to leaks or safety risks.
- Safety, handling, toxicity: e.g., handling ammonia, hydrogen has additional risks; lubricant formulations/additives must not exacerbate these.

A Roadmap for Lubrication Strategy in India

Putting it together, here's a possible roadmap:

- **Assessment Phase (Next 1-2 years)**
  - Map out which fuels are likely in which sectors (heavy road, maritime, power, etc).
  - Audit current lubricant performance and failure modes in engines running on bio-fuel blends, dual fuels, etc.
  - Establish test labs/standards for new fuels (fuel quality, emissions, lubricant compatibility, etc.).
- **R&D & Standards Development**
  - Support R&D in additive chemistries tailored for corrosion resistance, high temperature stability, and deposit control under next-gen fuels.
  - Develop/modify Indian standards (e.g., BIS) for lubricant performance under alternative fuel environments.
- **Pilot Implementation & Feedback**
  - Run fleet trials (both marine & land) using alternative fuels + lubricants to collect empirical data.
  - Use feedback to refine lubricant specs, oil change intervals, and maintenance procedures.
- **Regulatory & Incentive Design**
  - Incentivize OEMs / fleet operators to adopt high-performance lubes (e.g., tax breaks, lower duties, subsidies).
  - Possibly regulate minimum lubricant grades for certain applications, especially safety-critical ones.
- **Capacity Building & Industry Collaboration**
  - Train engineers/maintenance staff in lubrication best practices, fuel/lube interactions.
  - Collaborate across OEMs, lubricant companies, and academia to share data, best practices.

- **Scale Up & Monitoring**
  - Once proven, scale up the use of next-gen fuel-compatible lubricants.
  - Use monitoring systems (IoT / sensors/oil analysis) to ensure performance remains acceptable and adjust as needed.
- **Environmental & Health Oversight**
  - Ensure lubricant additive chemicals are safe, non-toxic, and biodegradable where possible.
  - Manage the end-of-life of used lube oils (re-refining, safe disposal) so that the environmental gains from cleaner fuels aren't offset.

India stands at a cusp where fuel transitions on multiple fronts are gaining momentum. To ensure these transitions deliver their promised gains (emissions reduction, cost savings, energy security), the lubrication strategy must not be an afterthought. It needs to be baked into engine design, fuel regulation, maintenance practices, and R&D.

Shakti Prasad Mishra

GENERAL MANAGER-TECHNICAL SERVICES HINDUSTAN PETROLEUM CORPORATION LIMITED

Middle Level Manager: Proven record of thinking out of the box and delivering through innovations, novel approach & Leading Team.
Leverage knowledge and experience in Technical Services, Brand Management, Channel Management and Client Acquisition in the Industrial, Automotive, Lubricant and LPG Industry, in positions of General Manager/Dy. General Manager/Regional Manager/Product/Brand Manager in the service industry.

- A Graduate in B.E (Mechanical)
- Presently heading Technical Services in Lubes SBU at Hindustan petroleum Corporation Limited, Mumbai
- Possess more than 36 years of strong cross-functional experience in the petroleum and gas sector in diverse capacities spanning Operations, Technical services, Logistics and Marekting of LPG, Bulk Fuels and Lubricants
- Proven competencies in steering sales and marketing of Lubricants, Fuels Commercial LPG & Domestic LPG.
- Strengths in Technical Services, OEM Engagements, Brand Building, LPG sales, Retail Sales, Institutional Sales, Channel Management and product promotion
- Leading pivotal role in implementation of EPR for used oil by collaborating with Law makers & all stake holders
- Demonstrated consistency and focussed approach towards projects undertaken
- Exemplary Project management skills

Pilot Oils: The Unsung Fluids Powering Modern Industry

Walk into almost any factory, construction site, or packaging plant and you'll find machines humming, metals bending, sealants curing, and water being treated. What you won't see are the specialty fluids quietly enabling all these processes to function, fluids that never make the headlines but are indispensable to modern industry. Among these, low-viscosity base oils hold a particularly important role.

For nearly two centuries, We at Haltermann Carless have been a leading player in hydrocarbon chemistry. Today, our Pilot Oil portfolio represents one of the market's trusted portfolios of low-viscosity base oils, precisely engineered fluids that support industries ranging from aluminium rolling and metalworking to food packaging and water treatment.

Pilot oils are designed to meet these exacting demands. Each grade is tailored to specific viscosity ranges, boiling points, and purity requirements, giving companies confidence that their processes will run smoothly.

The Invisible Backbone of Industry

Base oils rarely capture attention outside technical circles, but they are the foundation of which countless applications are built on. Unlike heavier lubricants, low-viscosity base oils are water-thin, colourless, and odour-light. Their value lies in performance:

- They must flow effortlessly to lubricate delicate machinery.
- They must evaporate cleanly, leaving no residues on metals or films.
- They must be chemically stable, withstanding heat, UV, and oxidation.

  And increasingly, they must be safe, for workers, consumers and the environment.

A Heritage of Precision

At Haltermann Carless, we can trace our origins to the mid-1800s, making us one of Europe's oldest specialty chemical producers. Over time, our company has specialised in refining middle distillates, fractions of crude oil that sit between light fuels like gasoline and heavier oils.

The modern Pilot portfolio is the culmination of that expertise. Produced at our site in Germany (Speyer), these oils are created under stringent ISO-certified systems. This ensures both consistent product quality and compliance with global environmental and regulatory standards.

This ensures both consistent product quality and compliance with global environmental and regulatory standards.
A milestone came in 2022, when we commissioned a state-of-the-art hydrogenation unit in Speyer. This facility enabled production of Pilot H grades, oils with ultra-low aromatic content, enhanced stability, and an even cleaner performance. Hydrogenation represents a leap forward for industries facing stricter regulatory and safety requirements.

The Science Behind the Oils

At their core, Pilot oils are about molecular control. Through refining and hydrogenation, we can adjust key parameters:

- Viscosity: kept between ~1.9-8.5 mm2/s (at 40 °C).
- Boiling Range: carefully controlled, specialised cuts between ~220-360 °C.
- Flash Point: 88-160 °C, ensuring safe handling.
- Aromatics: Ultra-low levels across the portfolio.

Where Pilot Oils Make a Difference

One of the remarkable features of the Pilot range is its sheer versatility. Few industrial products find use in as many sectors. Let's explore some highlights.

- **Textile and Leather Industries**
  Textile spinning machines rely on spindle oils that prevent wear without staining fabrics. Pilot 400H and S00H excel here. Light, clean, and residue-free. Leather processing also benefits from their mild odour and chemical neutrality.

- **Aluminium Rolling**
  Producing aluminium foil, the thin sheets require rolling oils that evaporate completely. Pilot 200R is a trusted choice for foil, while Pilot 250H and 275H suit thicker sheet and ingot rolling. These oils ensure smooth surfaces and reduce cleaning costs. suit thicker sheet and ingot rolling. These oils ensure smooth surfaces and reduce cleaning costs.

- **Metalworking and Spark Erosion**
  From grinding gears to cutting aerospace alloys, metalworking demands fluids that cool, lubricate, and protect. Pilot grades 140, 250H, 275H, 400H, S00H, and 900 meet these needs. For spark erosion (EDM), where electricity shapes metals with micrometre precision, Pilot 400H and 900 are particularly valued.

- **Silicone Sealants**
  Modern construction relies heavily on silicone sealants for windows, fa9ades, and joints. Pilot oils serve as extender oils, improving workability without compromising curing. Grades like 250H, 275H, 300H+ and newer hydrogenated versions (400H, S00H) offer UV stability, low odour, and compatibility with both acetoxy and alkoxy systems.

- **Water Treatment**
  Municipal and industrial water treatment plants often use polyacrylamide flocculants to clump together impurities. Pilot oils act as carrier fluids, ensuring these flocculants disperse effectively. Their inertness and solvency power make them particularly attractive.

- **Construction and Infrastructure**
  From shuttering oils that prevent concrete from sticking to moulds, to bitumen emulsion plasticizers in road building, Pilot oils play diverse roles. They also function as dust binders on construction sites and even as accelerants in controlled explosives.

- **Plasticisers**
  Phthalates, once common in PVC and plastics, face growing restrictions. Pilot grades like 140 and 150H offer safer alternatives, allowing manufacturers to meet regulatory and consumer expectations.

- **Food and Beverage**
  Here, safety is paramount. Several Pilot oils: 200R, 261 R, 400H, 500H, 900 carry NSF H1 and FDA B certification, meaning they can be used in lubricants that may come into incidental contact with food. Aluminium foil rolling, food machinery, and cleaning fluids all benefit from these approvals.

Meeting the Challenges of Today

The story of Pilot oils is also the story of adaptation. Industry faces rising challenges:

- Regulatory pressure: EU REACH legislation and global chemical safety standards demand lower aromatic content and safer formulations.
- Sustainability: Customers seek biodegradable, VOC-free solutions.
- Globalisation: Markets from Asia to North America expect consistent supply and certification.

Haltermann Carless's response has been threefold:

- Technology Investment: The hydrogenation plant in Speyer positions the company to deliver ultrapure, future-proof oils.
- Certification Leadership: Expanding NSF and FDA approvals gives customers confidence in sensitive sectors.
- Customer Collaboration: Tailored formulations and technical support ensure Pilot oils integrate seamlessly into complex production lines. We work with you to solve your requirements.

Looking Ahead: The Future of Low-Viscosity Base Oils

As industries evolve, so too will their reliance on specialty oils. Several trends are shaping the horizon:

- **Sustainable Chemistry**
  Bio-based hydrocarbons and circular economy models are entering the spotlight. While petroleum-derived Pilot oils remain dominant, Haltermann Carless is exploring pathways to blend traditional expertise with renewable feedstocks with our Ecobase portfolio.

- **Growing Demand in Food Safety**
  With consumers demanding greater transparency, the market for NSF H1-certified base oils will expand, particularly in Asia, where industrial food production is accelerating.

- **Infrastructure Boom**
  Urbanisation and green construction initiatives will sustain demand for sealants, shuttering oils, and bitumen modifiers, all niches where Pilot oils already excel.

A Quiet but Crucial Role

It's easy to overlook base oils. They don't appear on store shelves or feature in trendy ads. Yet without them, countless industries would grind to a halt.

Pilot oils, with their blend of precision engineering, regulatory compliance, and adaptability, exemplify the quiet strength of specialty chemistry. They keep machines turning, buildings sealed, water purified, and food safely packaged.

For Haltermann Carless, the mission is clear: to refine not just oils, but the trust and reliability that industries depend on.

Sam King
TECHNICAL SERVICE & DEVELOPMENT MANAGER
Sam.King@haltermann-carless.com

Sam is the Technical Services and Development Manager at Haltermann Carless. A Chemistry graduate from The University of Sheffield, he has a strong background in R&D, technical sales, and service within the chemical industry. Sam is passionate about developing sustainable solutions that help advance industrial performance.


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From Textiles to Tribology : The Evolution of Pratap Tex-Chem Pvt Ltd

Driving Innovation and Excellence in Metalworking Fluids, Industrial Lubricants and Specialty Greases Since 1999-The Pratap Tex-Chem Pvt Ltd story!

In the dynamic landscape of the Indian industry, few stories reflect resilience, innovation, and forward-thinking as compellingly as Pratap Tex-Chem Pvt. Ltd. (PTCPL). The journey began in 1979, with the foundation of its textile manufacturing business. Through a legacy marked by adaptability and a relentless pursuit of quality, the company evolved, laying the groundwork for a broader, multi-sectoral enterprise.

The formal incorporation as a private limited company in 1999 marked a pivotal expansion and development in a new era for Pratap Tex-Chem, from a regional textile manufacturer to a trusted supplier of Metalworking Fluids, Industrial Lubricants and Specialty Greases for domestic as well as export customers.

Headquarters and Infrastructure

Based in Pune, Maharashtra, PTCPL operates a state-of-the-art manufacturing complex with an annual installed production capacity of 6000 KL, and usable capacity of 4800 KL. The advanced facility features automated batch reactors, integrated in-line quality control, and scalable packaging lines that support everything from high-volume industrial orders to tailored specialty batches.

Innovation and Quality Assurance

PTCPL's in-house laboratory is a hub for research and development in Chemistry and tribology. Equipped with pilot reactors and precision analytical instruments, the lab drives a continuous cycle of innovation and quality assurance, enabling robust prototyping and rapid market response.

Team and Reach

A dedicated team of over 100 skilled professionals—spanning chemical engineering, R&D, technical sales, operations, and customer service—fuels the company's progress. PTCPL's products are delivered through a pan-India dealer network, with growing exports to Asia, Africa, the Middle East, and Eurasia. Its warehousing and logistics system ensures efficiency, compliance, and on-time deliveries across diverse environments.

Over more than 26 years of excellence in this field, Pratap Tex-Chem has solidified its position among the most reliable partners for those seeking performance, sustainability, and technical edge in specialty chemicals and lubricants.

LUBECO: The Future of Metalworking and Industrial Lubrication

Under its flagship LUBECO Green Fluids brand, PTCPL offers a diverse and advanced product portfolio addressing the comprehensive needs of machining, corrosion protection, lubrication, and surface cleanliness in modern manufacturing.

Metalworking Fluids

- **Water Soluble Cutting Oils:** High lubricity, cooling, and sump stability for CNC machining, grinding, and turning.
- **Neat Cutting Oils:** Mineral, semi-synthetic, synthetic, and vegetable base variants for general purpose operations like honing, broaching, gear hobbing, deep hole drilling, thread rolling, tapping to special purpose applications like sliding head machines, carbide grinding, etc.
- **EDM & Wire EDM Oils:** Offers precise dielectric stability, rapid cooling, and excellent debris flushing—ensuring burr-free components and superior tool life in spark erosion and wire cutting operations.
- **Specialty Lubricants:** Solutions for quenching, MPI inspection, and specific forming, punching, and drawing operations tailored to meet intricate metallurgy demands.

Rust Remover, Rust Preventives & VCI Packaging

- **General and White Rust Removers:** Fast-acting, surface-safe rust elimination.
- **Rust Preventives:** Solvent, water, and oil-based coatings are effective under various climates and storage durations.
- **VCI (Volatile Corrosion Inhibitor) Packaging:** Advanced PE-polymer and biodegradable biopolymer bags and sheets—guarding components during storage and export.

Industrial Lubricants

- **Hydraulic Oils:** Anti-wear and HLP grades designed to sustain high loads and temperature fluctuations.
- **Gear and Spindle Oils:** For enclosed gears, open drives, and high-speed spindles, offering extreme pressure protection and optimized viscosity index.
- **General Plant Lubricants:** Ensuring seamless industrial processes from assembly lines to maintenance workshops.

Industrial Cleaners

- **Aqueous Cleaners:** Water-soluble, low-foam formulations for pressure, ultrasonic, and multi-stage cleaning.
- **Solvent Cleaners:** Fast-evaporating, residue-free solvents for critical degreasing and pre-coating operations.

Other Solutions

- **Paint Strippers and Specialty Surface Chemicals:** Designed for rapid cleaning, surface preparation, maintenance, and component restoration.

With over 150+ product variants, the LUBECO Green Fluids brand embodies Pratap Tex-Chem Pvt Ltd's commitment to total metalworking and maintenance reliability.

FLUIDMATE: Smart Oil Management and Machine Care Evolved

Driven by the goal of maximizing process health and productivity, FLUIDMATE represents PTCPL's expertise in oil and fluid management systems.

Key Offerings:

- **Oil Skimmers:** Automated removal of tramp oils in cutting fluid and washing tanks. Deployed in over 200 installations across India, reducing coolant spoilage and extending system service life.
- **Sump Cleaner & Filtration:** Fluidmate SC 200 advanced sump cleaner and filtration systems, along with portable sucker pumps, utilize efficient coalescence, gravity separation, and multi-stage filtration to remove used oils, coolants, and sludge—delivering cleaner process fluids and fast, mess-free maintenance for maximum equipment life.
- **Mixers:** Automated mixers ensure homogeneous oil-in-water emulsions in metalworking fluids and cleaners, delivering consistent solution quality and improved performance for all water-soluble applications.

Benefits

FLUIDMATE products reduce waste, lower fluid operating costs, and maintain the optimum environment for modern machining—proving essential for industries looking to combine productivity with eco-friendly compliance.

LUBECO Futuristic Greases: Nano-Technology Driven Performance

Anticipating the emerging demands of industrial machinery, PTCPL introduced LUBECO Futuristic Greases in 2023, pioneering a range of nano-technology enhanced lubricants.

Portfolio Highlights:

- **High Temperature & Synthetic Greases:** Withstand extreme thermal loads, minimize wear, and prevent build-up across bearings, kilns, and ovens.
- **Wire Rope, Pin & Bush, Conveyor Greases:** Formulated to combat high-load, oscillating motion, moisture ingress, and environmental degradation.
- **Open Gear and EP Greases:** Nano-particle reinforced for boundary lubrication, impact, and shock absorption in heavy slow-moving gears (mining, steel, cement industries).
- **Synthetic Chain Oils & Centralized Greases:** Designed for lubrication pumps, high-speed chain drives, and exposed mechanisms.
- **Environmental Stewardship:** Biodegradable, non-toxic solutions available for sensitive and food-grade applications.

By leveraging nano-additives and advanced base stocks, LUBECO Futuristic Greases enhance efficiency, safety, and reliability—servicing critical equipment in sectors including steel, power, mining, and infrastructure.

"FLUIDMATE products reduce waste, lower fluid operating costs, and maintain the optimum environment for modern machining—proving essential for industries looking to combine productivity with eco-friendly compliance."

SUPERGEN: Automotive Lubricants for Indian Roads / Engineered Excellence in Automotive Lubrication

Supergen defines PTCPL's reputation in the automotive segment from 2020, catering to OEMs, fleet operators, and dealers nationwide through over 10+ active channel partners.

Core Offerings:

- **Engine Oils:** Mineral and synthetic blends for gasoline, diesel, and CNG vehicles; compliant with the latest BS-VI, ACEA, and API specifications.
- **Transmission and Gear Oils:** For manual and automatic transmissions, hypoid gears, and synchromesh boxes, ensuring smooth operation and protection against wear.
- **Coolants and Brake Fluids:** High-stability, long-life formulations for optimum thermal management and braking reliability.
- **Special Lubricants:** High-speed chain lubes and chain cleaners, and greases remove low splash multipurpose products, supporting performance even under India's toughest driving conditions.

SUPERGEN's technical team works closely with automotive R&D, ensuring all lubricants deliver cleaner engines, reduced maintenance, and enhanced longevity for new-generation vehicles.

KRUSHAGRA: Science-Driven Agriculture & Dairy Solutions

Recognizing India's agricultural transformation, PTCPL's Krushagra brand (launched in 2022) provides farmers with modern tools for yield and efficiency.

Product Spectrum:

- **Biofertilizers & Biopesticides:** Eco-safe, microorganism-rich solutions for soil enrichment and pest control.
- **Dairy Cleaners:** High-purity alkali cleaners and sanitizers, maintaining milk safety and plant hygiene.
- **Water Soluble Fertilizers & Micronutrients:** Precision nutrition for horticulture crops and open farming crops.
- **Adjuvants & Spray Aids:** Enhancing chemical uptake, coverage, and rain-fastness.
- **On-Field Consulting:** Technical guidance and crop management support, benefiting 100s of farmers and cooperatives nationwide.

Conclusion: Partnerships, Customization, and Future-Ready Service

Pratap Tex-Chem Pvt Ltd is defined not just by its products but by its unwavering commitment to customer partnership.

Services include:

White Labelling & Private Branding: Supporting partners with customized formulations and packaging.

Bespoke Product Development: Agile R&D delivering solutions tailored to client processes and regulatory frameworks.

Sustainable Packaging & Logistics: Flexible configurations, eco-friendly materials, and best-in-class
supply chain support.

Technical Support: On-site troubleshooting, process audits, and lab assistance to ensure customer goals
are always met.

Compliance & Quality Assurance: Dedicated to continuous improvement, PTCPL complies with global standards for safety, ethics, and environment—defining trust and transparency across the value chain.

More than 45 years after its founding and 26 years after its birth into the lubricants industry, Pratap Tex-Chem Pvt. Ltd. remains India's reliable partner for sustainable, innovative chemical and lubricant solutions—empowering progress today and tomorrow.

For product details, technical partnership, or to explore collaboration, contact:

info@pratapchem.com
www.pratapchem.com

Kunal Marathe

CHIEF EXECUTIVE OFFICER & EXECUTIVE DIRECTOR PRATAP TEX-CHEM PVT. LTD

Mr. Kunal Pratap Marathe, born in Mumbai and raised in Pune since 1991, is the Chief Executive Officer and Executive Director of Pratap Tex-Chem Pvt. Ltd. A commerce graduate from BMCC, Pune, he also boasts an impressive cricketing career, having represented Maharashtra across all junior levels and scoring a century on his Ranji Trophy debut in 2004.

His professional journey began in 2006 when he joined the family business, gaining hands-on experience across departments including Accounts, Manufacturing, Sales & Marketing, and R&D. Today, he leads the company as a dynamic CEO and shareholder, blending strategic insight with a legacy of excellence both on and off the field.

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Value Is Perception, Cost Is Reality: The Technology Behind Sustainable Leadership

Technology, procurement, and sustainability are no longer separate disciplines—they are the new trinity of leadership. Balancing cost efficiency with value creation defines the next frontier of competitive advantage.

In an era where technology, procurement, and sustainability converge, leadership depends on balancing hard cost realities with perceived value. This article explores how organizations can redefine competitiveness by integrating innovation, foresight, and financial discipline. Drawing lessons from across industries—with examples including Veedol's Engine Power Retention (EPR) technology—it highlights how the future belongs to those who can harmonize techno-commercial balance with sustainable innovation.

The Paradox of Modern Procurement

Every business leader understands the weight of cost. It is real, measurable, and unforgiving—appearing in every balance sheet, tender, and operating ratio. Yet, what truly drives competitive advantage is often invisible: value.

Value lives in perception. It resides in how customers experience performance, reliability, and sustainability. In procurement and technology, this paradox defines leadership: cost is reality, value is perception.

In today's business environment—where competition is global, innovation cycles are shorter, and sustainability is a shared mandate—true leadership lies in balancing both. The ability to manage cost while creating differentiated value determines who thrives and who fades.

> "Managing cost is discipline; creating value is leadership."
> — Mr. Arijit Basu.

Cost: The Reality That Cannot Be Ignored

Cost remains the foundation of business discipline. In industries dependent on raw materials—such as lubricants—input costs for base oils, additives, packaging, logistics, and energy are unavoidable. Global price volatility, currency fluctuations, and freight challenges only amplify this reality.

Over the last decade, many sectors, including lubricants, have faced intense price-based competition. The instinctive response is often to rationalize costs, optimize operations, and improve efficiencies—and rightly so. Across the industry, sourcing of Group II base oils within India has reduced logistical burdens, while the continued import of Group III base oils ensures international quality benchmarks for high-performance products.

Beyond this, the emergence of bio-derived Group V base oils marks a step toward sustainability and self-reliance. These advanced molecules, increasingly produced in India, represent a new generation of base stocks that combine performance with environmental responsibility—embodying the philosophy of "Made in India, for India, and for the World."

Yet, cost optimization alone ensures only survival. It keeps an organization solvent, not significant. Long-term leadership demands value creation.

Value: The Perception That Shapes Markets

Value is never a number—it's a perception. It reflects what customers believe they are gaining, not merely what they are paying for. In engineered products like lubricants, value manifests through performance, sustainability, trust, and user experience.

A fleet operator, for instance, might see two engine oils priced differently by 10%. The lower-priced option may seem cost-effective until the higher-priced oil extends drain intervals by 15,000 km and delivers measurable fuel savings. In that moment, the equation shifts—the total cost of ownership defines the true value.

The same logic applies in aviation, where operators pay a premium for lubricants that guarantee reliability under extreme conditions, or in the smartphone industry, where two similar devices command vastly different prices based on ecosystem trust and perceived performance. Even in electric mobility, advanced battery coolants that prevent thermal runaway and extend battery life offer disproportionate value relative to their cost.

These examples illustrate a universal truth: markets reward perceived value more than absolute cost.

> "Innovation today is not about what goes into the oil, but about what the customer gets out of it—performance, trust, and responsibility."
> — Dr. Kalpendra Rajurkar.

A Strategic Leap Toward Sustainability

The global push toward sustainability and efficiency is redefining leadership across industries. In the lubricant sector, this transformation has been driven by stricter emission norms, evolving OEM demands, and a growing focus on total cost of ownership. These shifts have challenged technology leaders to look beyond short-term performance and create long-term, sustainable value—a vision that led to the development of Engine Power Retention (EPR) technology.

> "Leadership is not about chasing the market—it's about anticipating it."

Engine Power Retention: Innovation with Purpose

EPR technology is based on a promise—that engine power, from 0 km to 20,000 km, should remain stable. Delivering this outcome required integrating cross-disciplinary innovation, not merely refining existing chemistry.

Through the development of bio-derived molecular blends such as EstoBioLide™, synthetic and sustainable performance were combined to achieve superior durability and cleanliness. This innovation, inspired by biomimicry, mirrors nature's resilience. Field trials demonstrated tangible results: improved acceleration even after long intervals, cleaner pistons, lower deposits, and measurable fuel efficiency gains across diverse Indian driving conditions—from the high-altitude cold of Leh to the heat and dust of national highways.

Such advances demonstrate how innovation can balance cost, performance, and environmental stewardship—turning sustainability into a competitive advantage.

These technological advancements form the foundation of Veedol's NextGen Synthetic Lubricants range, which includes the SwiftPower series for motorcycles (MCO) and the SynthGlide

series for passenger cars (PCMO). Both embody the principles of Engine Power Retention—ensuring consistent performance, cleaner engines, and superior efficiency across India's diverse driving conditions.

> "EPR is not just a lubricant technology—it is a philosophy of resilience, designed in India and benchmarked for the world."
> — Dr. Kalpendra Rajurkar.

The Techno-Commercial Balance: A Framework for Future Leadership

In modern procurement and technology management, balancing cost and value is not an option—it's a necessity. Cost efficiency ensures sustainability, but technology and innovation create relevance. True progress lies in harmonizing the two.

Extended drain intervals reduce maintenance and waste, improve fuel economy, add direct financial value, and bio-derived formulations strengthen both ESG compliance and brand trust. When local sourcing meets global benchmarking, supply chains become not just resilient but intelligent.

Leadership today is defined not merely by product performance, but by the ability to integrate technology, sustainability, and customer experience into one coherent value proposition. The science inside a product matters—but so does the story around it: reliability, performance, savings, and responsibility.

Looking ahead, the future of industrial leadership will rest on three pillars: co-engineering with OEMs, where lubricants and components are designed as performance partners; sustainability integration, where every product is measured by its carbon footprint; and digital transparency, where traceability and predictive insights redefine trust.

Cost Is Reality, Value Is Perception

The future will not favor those who compete on cost alone. It will reward those who balance financial prudence with innovation, performance, and purpose.

From the pioneering spirit that defined early industrial breakthroughs to the new generation of sustainable, high-performance solutions, the message remains the same: leadership is not about spending less—it's about delivering more value for every cost incurred.

In the evolving world of procurement and technology, that balance—between cost as reality and value as perception—is where the next generation of leadership will be found.

> "Cost is reality, value is perception. True leadership lies in balancing both."

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Arijit Basu

MANAGING DIRECTOR, VEEDOL CORPORATION LIMITED

Arijit Basu, Managing Director of Veedol (Tide Water Oil Company India Limited), leads the company towards profitable growth. With over 25 years in construction chemicals and lubricants, he is an influential leader known for his strategic investment, team building, and digitalization efforts. He holds a Chemistry degree and has completed executive courses at IIM Calcutta and IMD Business School.

Dr. Kalpendra Rajurkar

HEAD – TECHNOLOGY & SERVICES, VEEDOL CORPORATION LIMITED

Dr. Kalpendra Rajurkar is experienced 'Lubricants' Technology and Sustainability expert with a broad global experience and with major strengths in Cutting Edge Technology Development across Automotive, Industrial-Metalworking, Greases and Catalysis. A PhD in Chemical Engineering from National Chemical Laboratory, Pune, India in the area of catalysis and reaction engineering focused on Fine chemicals and oil & gas sector.

Lubricants Towards Sustainability

How Fuel Efficiency, Re-Refining, and Bio-Innovations are Redefining the Future of the Lubricant Industry

Introduction

Sustainability today is not just a global imperative-it is a decisive factor that will shape the future of industries, economies, and societies. The lubricant industry, often regarded as a background enabler of machines, is stepping into the spotlight as a powerful force in advancing this transformation. Far beyond their traditional role in reducing friction, lubricants are now at the heart of sustainability strategies-helping reduce emissions, conserve resources, and build resilience across automotive, industrial, and energy ecosystems.

This article brings together the multifaceted dimensions of how lubricants can redefine sustainability, weaving through energy efficiency, fuel economy, re-refining, bio-lubricants, synthetic innovations, and cost localization. Together, these levers show how lubricants are becoming more than just performance enablers-they are critical drivers of a greener, more sustainable tomorrow.

Governance Models for Sustainable Growth

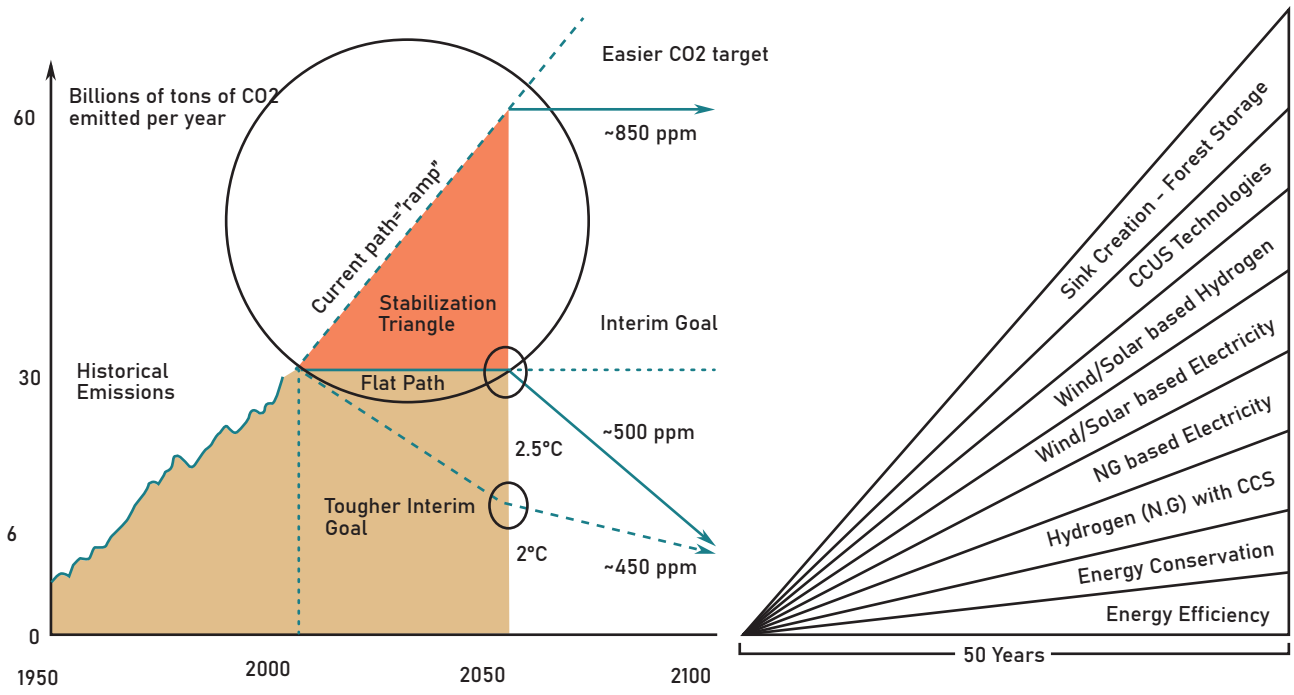
Sustainability cannot be achieved in silos; it requires strong governance models that integrate purpose-led strategies with stakeholder engagement. A sustainable growth framework emphasizes transparency in reporting, leadership-driven commitment, and a culture rooted in long-term value creation. Companies must go beyond compliance, aligning with societal expectations to deliver benefits not only for shareholders but for the larger community of stakeholders.

Fuel and Energy Efficiency: Prime Levers of Sustainability

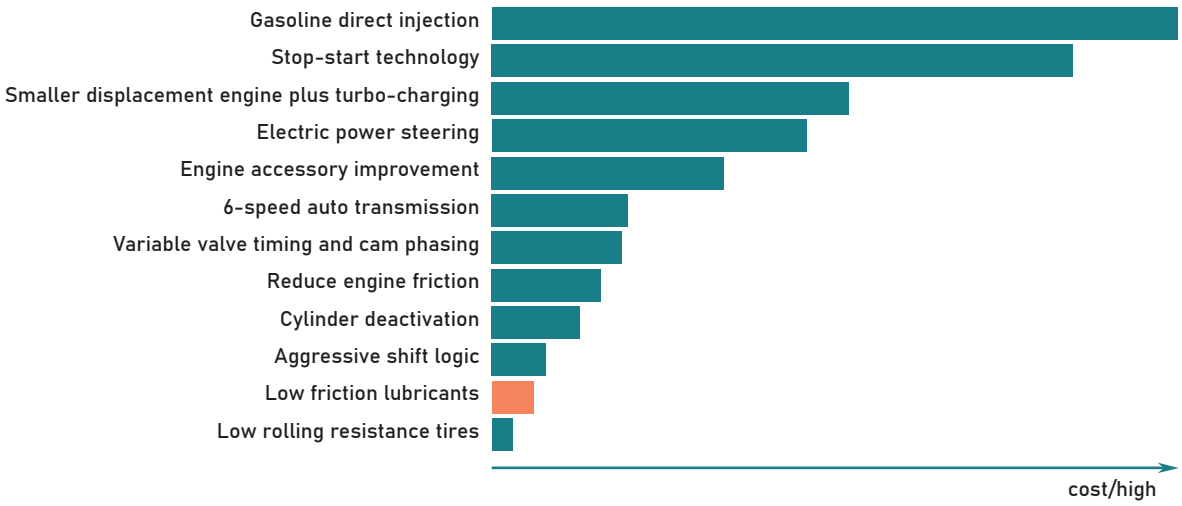
Fuel and energy efficiency remain the most impactful levers in sustainability. The "Princeton Wedges" approach illustrates how incremental measures collectively create significant reductions in carbon footprint. Among these wedges, fuel-efficient lubricants stand out as one of the most practical and immediate routes to reducing CO2 emissions.

Fuel economy is often described as the "lowest hanging fruit" in sustainability. Low-friction lubricants deliver measurable improvements at relatively low costs compared to alternatives such as cylinder deactivation or advanced transmission technologies. Lubricants thus emerge as a cost-effective and scalable way to balance fuel economy and durability.

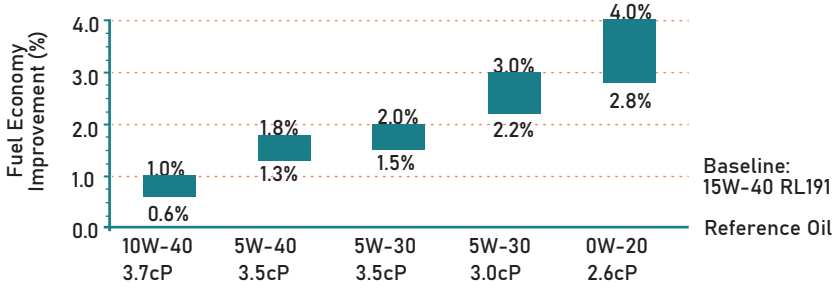
Laboratory testing, such as the European M111 fuel economy trials, confirms these benefits. By optimizing base oil viscosity, polymer selection, and shear stability, gains of up to 4% can be achieved simply by transitioning from a 15W-40 reference oil to a 0W-20 grade lubricant.



Relative cost of technology to achieve 1% Fuel Economy

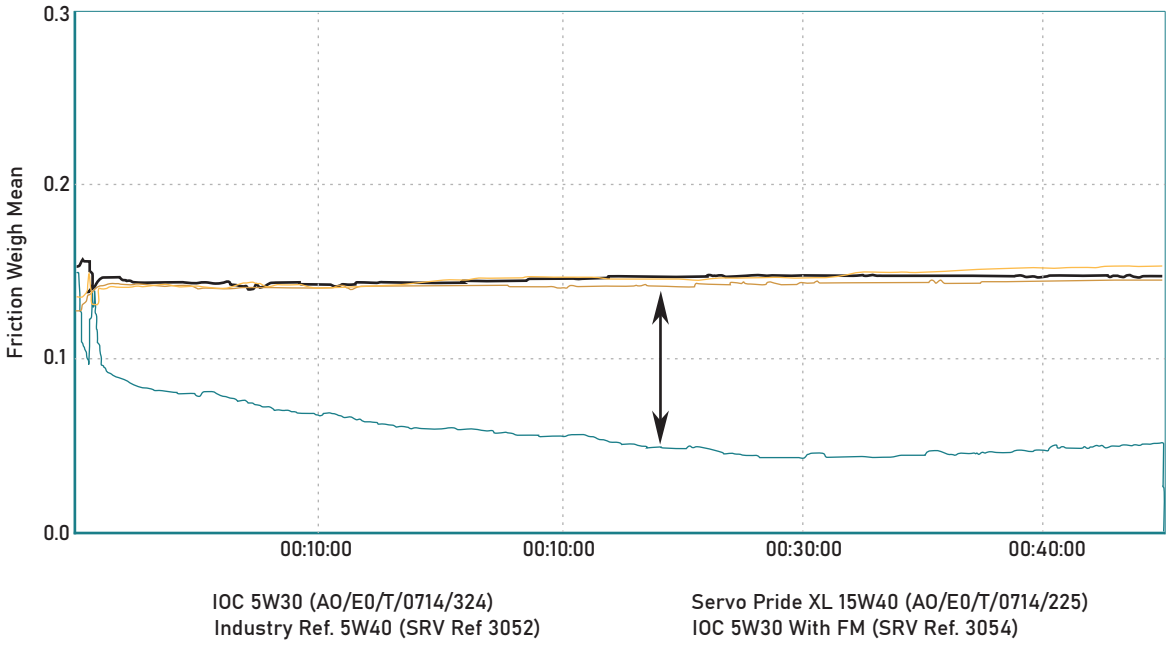


Typical ranges for M111E fuel economy* improvement

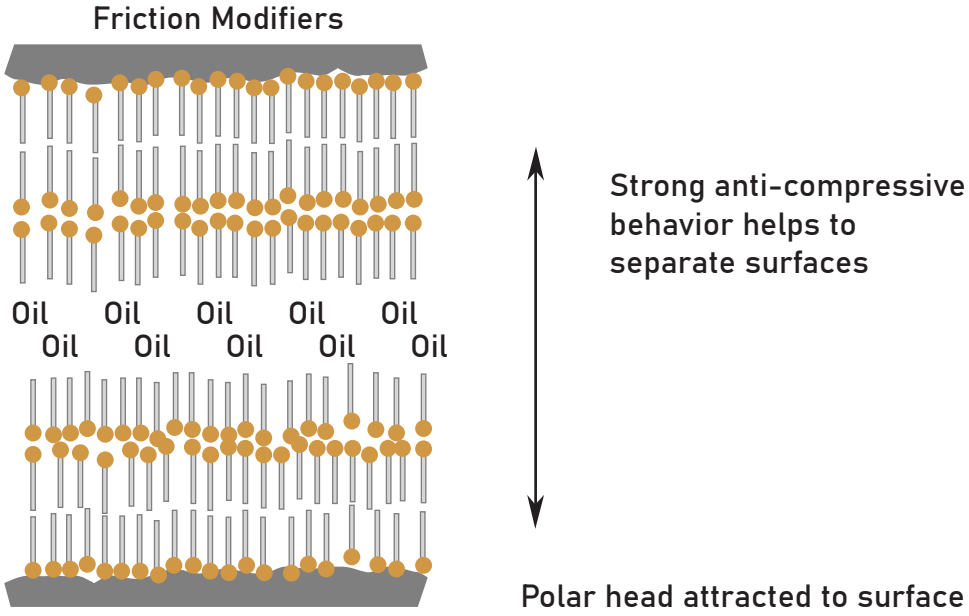


*M111 FE is a European FE Test

Source: Lubrizol



Source: Indian Oil R&D



Reducing Friction and Improving Fleet Efficiency

The ability of lubricants to minimize both viscous and boundary friction is a cornerstone of sustainability. With the use of advanced friction modifiers, lubricants reduce wear and energy losses, thereby extending component life and boosting efficiency. Platforms such as SRV, MTM, and HFFM validate these performance improvements.

IndianOil's field evaluations further demonstrate tangible benefits. Fuel economy-grade lubricants across engines, transmissions, and axles delivered 3.5-4. 7% efficiency gains in OEM fleets. These improvements translate into reduced fuel costs and extended oil drain intervals, driving both environmental
and economic impact.

Automotive Oils	Viscosity grade	ODI
Engine Oil	CI4 Plus 1 0W-30	1.5 Lac kms
Transmission Oil	75W-80	2.4 Lac kms
Axle Oil	80W-110	2.0 Lac kms

Details	Existing Grade	FE Grade
No of vehicles	4000	4000
Average km/Lt	3.5	3.62
ODI	1 lac	2 lacs
Annual cost saving due to fuel saving	——	1.3 crore
Annual cost saving due to increased ODI	——	3.84 lacs
3.5-4.7% improvement in FE in OEM fleet		

The Green Combo Solution showcases the combined potential of differentiated fuels and lubricants. Trials across trucks, buses, fishing vessels, and heavy-duty machinery recorded fuel economy gains of 5--9%. Alongside these gains, reductions in carbon monoxide, oxides of nitrogen, and CO2 emissions were observed, with added benefits of injector longevity, smoother drivability, and lower noise.

IndianOil's "Green Combo Solution"

Average fuel economy benefits with Differentiated Diesel Only

- (+) 5.78 % on BS4 HDV Truck (Ashok Leyland 1618/4 Model) - IS:11921
- (+) 7.01 % on Fishing Vessel with Actual Fishing Activities

Differentiated Diesel and Green Combo

- (+) 9.26 % on BS4 Truck (Ashok Leyland 1618/4 Model)
- (+) 9.01 % on BS4 Bus (Haryana Roadways Ashok Leyland Viking)
- (+) 5.82 % on Cummins Engine DG Set - On derived ISO:8178-3 Indigenous Test Cycle
- (+) 5.81 % on JCB Backhoe Loader 3DX - On Working Cycle, Idling & Low speed
- (+) 4.30 % on Komatsu Dumper HD 785-7 - Varied RPMs Indigenous Test Cycle

Reduction in emissions

- 5.29% - Carbon Monoxide (CO)
- 4.99% - Oxides of Nitrogen (NOx)
- 0.13 - 0.15 MT of CO2 per KL of diesel
- Environmentally greener fuel with low carbon footprint

Superior Injector Cleanliness & Lubricity

- Longer injector life

Smoother drivability

- Reduction in noise by~ 5%

Product is Commercially Available

Courtesy: JOG R&D

National and Industrial Savings Potential

When scaled to the national level, the impact of fuel-efficient lubricants is monumental. India's fleet of nearly 97 lakh heavy-duty vehicles offers the potential to save around 900 crore litres of fuel annually if the Green Combo Solution were universally adopted. This translates into a staggering ₹81,000 crore in savings. Even partial adoption scenarios-ranging from 10% to 50%-would yield substantial environment and financial advantages.

The industrial sector offers similar opportunities. In coal-fired thermal power plants, energy-efficient gear oils can save ₹86 lakhs annually in a single facility. Compressor oils deliver over 3.5% energy savings, while hydraulic oils reduce fuel consumption by 6.4% and increase productivity by 6.5%. These examples highlight how lubricants can drive sustainable savings across industrial operations. Recognition of such innovations has already arrived, with IndianOil's Green Combo Solution receiving the **National Energy Efficiency Innovation Award in 2022.**

S. No.	Parameters	Details
1	No. of Trucks in India*	80.00 Lakh
2	No. of Buses in India*	17.00 Lakh
3	Total HD Vehicle in India (1+2) *SIAM Data (2020-21)	97.00 Lakh
4	Total Distance Travelled in a year (200 km/day for 330 days in a year)	97 * 200 * 330 = 64,02,000 lakh km
5	Typical Mileage of HD Vehicle	5 KM/Litre
6	Qty. of fuel required in a year	64,02,000/5 = 12,80,400 Lakh Litre
7	Qty of fuel Saved with Green Combo - FE benefit @7%	12,80,400*0.07 = 89,628 Lakh Litre
	Total Fuel Saving ~	900 crore Litre
8	Diesel Cost	Rs 90/Litre
	Amount of Fuel Saved	900*90 = Rs 81000 crore

% Fleet (HDV) on Green Combo Solution	Amount Saved
100% fleet (HDV) on Green Combo Solution	Rs. 81000 Crore
50% fleet (HDV) on Green Combo Solution	Rs. 40500 Crore
30% fleet (HDV) on Green Combo Solution	Rs. 24300 Crore
20% fleet (HDV) on Green Combo Solution	Rs. 16200 Crore
10% fleet (HDV) on Green Combo Solution	Rs. 8100 Crore

Re-Refining Used Lubricants: Closing the Loop

Improper disposal of used lubricants poses serious environmental risks-a single litre can contaminate one million litres of fresh water. Re-refining, however, converts this hazard into a sustainable opportunity. Producing re-refined base oil requires only one-third of the energy needed to produce virgin base oil, and from 100 litres of used oil, around 70 litres of re-refined oil can be recovered-compared to the 7,000 litres of crude needed for the same amount of virgin base oil.

India's regulatory landscape is evolving rapidly in this area. From 2024-25, **Extended Producer Responsibility (EPR)** for used lubricating oil will be enforced. The CPCB will administer traceability through an online portal, generate tradable EPR certificates, and mandate compliance audits. Meanwhile, the Bureau of Indian Standards (BIS) will set specifications for re-refined lubricants and base oils. Together, these measures will accelerate the shift to circularity in lubricant management.

For producers of base oil or lubrication oil, the target prescribed in the following table -

S. No.	Year	Used Oil Recycling Target
1	Extended Producer Responsibility obligation of the Year 2024-2025 (the year in which this Chapter comes into force)	5% of the base oil or lubrication oil sold or imported in the Year 2022-2023.
2	Extended Producer Responsibility obligation of the Year 2025-2026.	10% of the base oil or lubrication oil sold or imported in the year 2023-2024.
3	Extended Producer Responsibility obligation of the Year 2026-2027.	20% of the base oil or lubrication oil sold or imported in the year 2024-2025.
4	Extended Producer Responsibility obligation of the Year 2027-2028.	20% of the base oil or lubrication oil sold or imported in the year 2025-2026.
5	Extended Producer Responsibility obligation of the Year 2028-2029.	40% of the base oil or lubrication oil sold or imported in the year 2026-2027.
6	Extended Producer Responsibility obligation of the Year 2029-2030.	40% of the base oil or lubrication oil sold or imported in the year 2027-2028.
7	Extended Producer Responsibility obligation for the year 2030-2031 (Y) onwards	50% of the base oil or lubrication oil sold or imported in the year (Y-2).
8	For units established after 1st April, 2024	The extended producer responsibility obligation will start after two years from the end of the financial year in which the unit was established and will be as per the target prescribed above.

Globally, advanced re-refining technologies such as Avista Oil's ECO HUILE, HyLube, and other hydroprocessing-based configurations are paving the way for higher-quality Group III re-refined base oils. India, too, is poised to adopt these technologies as demand for sustainable alternatives grows.

Bio-Lubricants and the Alternate Fuels Conundrum

Sustainability and bio-lubricants are often conflated, yet the two are not interchangeable. While bio-lubricants accounted for less than 1 % of global consumption in 2019, they hold significant promise. Challenges such as higher additive requirements, solubility, and oxidation stability remain, but innovation is expanding the bio-lubricant arsenal.

Estolides, farnesene-based base oils, nanocellulose oleogels, lignin-derived additives, proteins, vitamins, and lecithin are among the emerging solutions. Each offers specific advantages, from biodegradability and rheology to oxidation stability and anti-wear performance.

At the same time, alternate fuels such as ethanol blends, biodiesels, CNG, LNG, hydrogen, and ammonia present new challenges. Lubricants must evolve to provide enhanced corrosion resistance, optimized dispersants, and better thermal stability. Specialized coolants for fuel cells will be critical as the energy mix diversifies.

Synthetic Lubricants: Superlative Sustainability

Synthetic lubricants are widely recognized as the pinnacle of performance and sustainability. With superior viscosity-temperature relationships, oxidation stability, biodegradability, and low volatility, synthetics extend drain intervals and reduce total lifecycle costs.

The global synthetic lubricants market stands at 6.5 million tonnes annually, with Asia-Pacific driving demand. In India, the market is around 64,000 kilotonnes, growing at a CAGR of 4%. For the country to realize the full benefits, however, indigenous production of PAOs and synthetic esters is vital. Localization will not only reduce costs but also secure supply chains, enabling widespread adoption.

Cost Efficiency and Localization in Grease Production

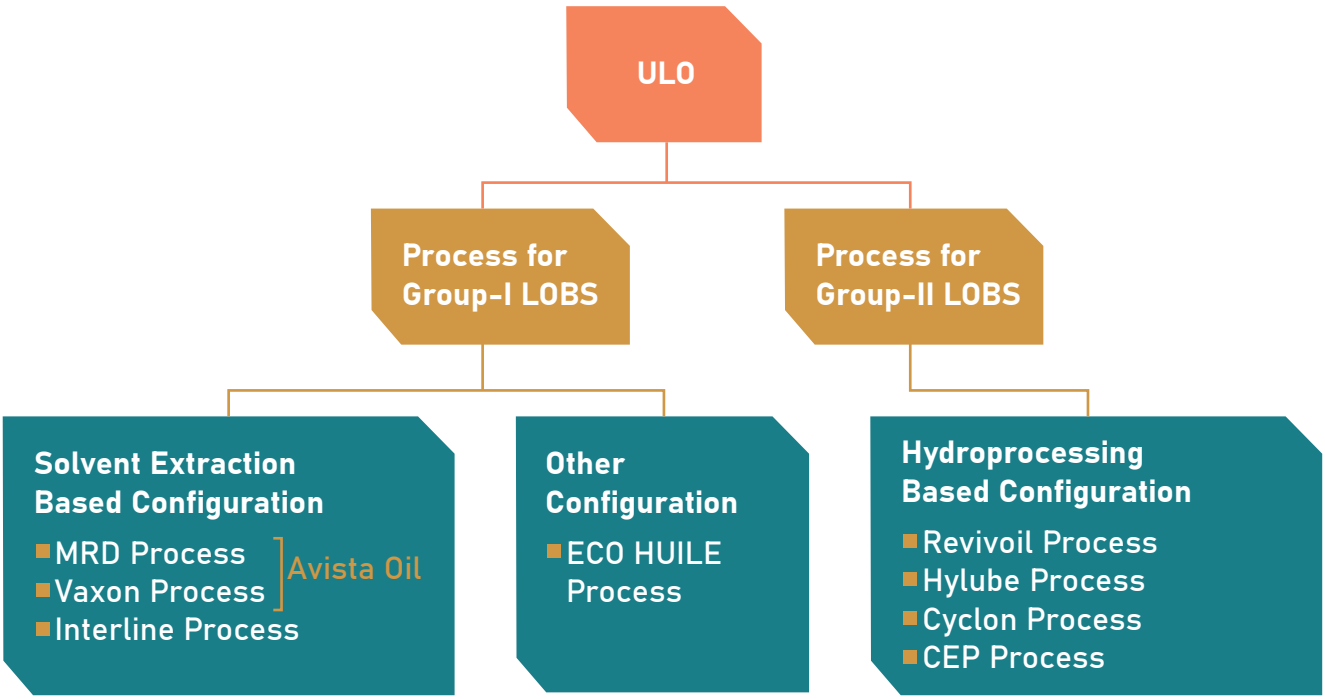
Cost efficiency and localization are equally important sustainability levers. Lithium-based greases dominate the market but are expensive and vulnerable to global price fluctuations. India-centric alternatives are proving highly effective. Research into transitional metal and alkaline earth-based thickeners, as well as hydroxy stearate blends, has shown they can match performance benchmarks at less than half the cost of lithium soaps. This makes grease production more affordable while supporting the broader sustainability agenda.

Conclusion

The lubricant industry is no longer confined to ensuring smooth operations-it is an essential pillar of global sustainability. By advancing fuel and energy efficiency, enabling massive national savings, re-refining used oil, pioneering bio-innovations, adopting synthetics, and localizing grease technologies, lubricants are directly shaping a cleaner and more resilient industrial future.

The roadmap is clear: efficiency, circularity, innovation, and localization are the imperatives that will define the lubricant industry's role in sustainability. If embraced fully, these measures can unlock not only environmental gains but also vast economic opportunities.

Lubricants, once viewed as supporting actors in industrial systems, are now emerging as catalysts of transformation. Their role in the global pursuit of sustainability is not optional-it is indispensable. The future of sustainable development quite literally runs on smarter, greener, and more innovative lubricants.



RRBO to API Group III - The Need of the Hour

Soap	% of Soap	Drop Point, C	NLGI Grade	Cost Rs/kg
Lithium Soap	10-12	180	2	175
Lithium Complex	13-16	260	2	223
M- stearate	40-50	120	2	128
M-12 hydroxy stearate	40-50	150	2	130
M- 12 hydroxy stearate + Complex	30-35	260	2	120
M-12 hydroxy stearate + Complex+ M1-soap M-India centric transitional metal M1-Alkaline earth metal	18-22	260	2	107

Dr SSV Ramakumar

CHIEF TECHNOLOGY OFFICER - AM GREEN

Dr. SSV Ramakumar has over three decades of expertise in downstream hydrocarbons, focusing on lubricant technology, refinery processes, and catalyst development. He pioneered India's OEM-approved marine lubricant technology and Indian Oil's INDMAX process while driving alternative energy initiatives, including hydrogen and bio-energy. As MNRE hydrogen mission advisor and Chairman of BIS PCD-3, he shapes national fuel standards. With 150+ publications, numerous patents, and multiple innovation awards, Dr. Ramakumar is a distinguished IIT-Roorkee alumnus.

Circular Economy for Used Oil: India's Status and Global Best Practices

Introduction

Used oil, a hazardous waste generated from industrial and automotive activities, presents both a challenge and an opportunity. When improperly handled, it contaminates soil, water, and air. But when re-refined, it becomes a valuable resource—Re-refined Base Oil (RRBO)—that can reduce India's import dependency, save foreign exchange, and support climate goals. As India prepares to implement Extended Producer Responsibility (EPR) for used oil starting FY25, the country stands at a critical inflection point to formalize and scale its circular economy for lubricants.

This article explores the current status of used oil management in India, the regulatory framework, operational challenges, and global best practices that can guide a transformative roadmap.

India's Current Landscape

Regulatory Momentum

India's climate commitments under COP26 ('Panchamrit') and the Hazardous Waste Management Rules (2016) provide a strong foundation for sustainable used oil management. The draft EPR framework for used oil, expected to be notified in FY25, mandates producers to meet progressive recycling targets:

Fiscal Year	Recycling Target
FY25	5%
FY26	10%
FY27-28	20%
FY29-30	40%
FY31	50%

All stakeholders—producers, bulk generators, collectors, and recyclers—must register on a centralized portal. This digital backbone will enable traceability, compliance monitoring, and certificate issuance, aligning India's lubricant sector with its Net Zero ambitions.

Fragmented Ecosystem

Despite regulatory intent, India's used oil ecosystem remains largely informal and inefficient:

- **Informal Collection Dominance:** Scrap dealers ('kabadi walas') dominate the collection process, often operating outside the tax net. Transactions are undocumented, and used oil is frequently diverted for fuel adulteration or sold to unauthorized recyclers.
- **Unorganised Automotive Sector:** Small garages and roadside mechanics contribute 35–45% of used oil generation. However, they lack awareness, infrastructure, and incentives to segregate and store used oil properly.

Logistical Bottlenecks: State-specific No Objection Certificates (NOCs), manual Form 10 manifests, and restrictions on interstate transport complicate operations for recyclers and collectors.

- **Quality Degradation:** Improper storage, mixing with other fluids (e.g., brake fluid, coolants), and lack of segregation reduce the quality of used oil, making it unsuitable for high-grade re-refining.

Re-refining Capacity Constraints

India has approximately 565 authorized recycling facilities with a combined capacity of ~2,600 KT. However, fewer than 25% can produce RRBO that meets BIS standards. Most facilities are MSMEs with limited access to advanced technology, testing labs, and quality assurance systems. As a result, RRBO output is inconsistent, and lubricant producers hesitate to incorporate it into their formulations.

Untapped Potential of Used Oil

Used oil is one of the most recyclable hazardous wastes. Its circularity offers compelling environmental and economic benefits:

- **High Recovery Efficiency:** Re-refining 100 litres of used oil yields ~70 litres of RRBO. In contrast, producing the same quantity of virgin base oil (VBO) from crude requires ~7,000 litres of feedstock.
- **Energy Savings:** RRBO production consumes one-third the energy required for VBO refining, reducing operational costs and carbon footprint.
- **Carbon Emission Reduction:** Each litre of RRBO saves approximately 2 kg of CO_2 equivalent emissions, contributing to India's climate goals.
- **Foreign Exchange Savings:** India imports over 85% of its crude oil and more than 75% of its base oil, amounting to ~$1.2 billion annually. Scaling RRBO production can significantly reduce this dependency.

Market Outlook and Demand Forecast

India's lubricant demand is projected to grow from ~3 MMT (FY22) to 5–6 MMT by FY31. Consequently, recoverable used oil will increase from ~1.5 MMT to ~2.2 MMT. The EPR framework will create a robust market for recycling certificates, with demand rising from ~0.09 MMT in FY25 to ~1.0 MMT by FY31.

To meet these targets, India will require:

- **Minimum Re-refining Capacity:** 600–700 KT
- **RRBO Output:** 400–500 KT
- **G2 RRBO Demand:** 100–200 KT (for high-performance lubricants)

Formalizing the unorganised sector, which holds ~0.6–0.7 MMT of untapped potential, is essential to avoid certificate shortages and ensure compliance.

Strategic Roadmap for India

Institutional Reform

India must establish a dedicated National Used Oil Management Association, modeled on successful global entities like:

- **Italy's CONOU**
- **Canada's UOMA**
- **France's CYCLEVIA**

This body should be responsible for:

- Building a nationwide collector network
- Incentivizing stakeholders across the value chain
- Monitoring oil movement and ensuring traceability
- Driving awareness and training programs

Such an institution can serve as the backbone of India's used oil circular economy, ensuring coordination, compliance, and continuous improvement.

Formalisation & Digitalisation

A phased approach is essential to bring both organised and unorganised sectors into the formal fold.

Phase 1: Organised Sector (FY25–26)

- **Mandatory Portal Registration:** Lower the bulk generator threshold from 100 MT to 10 MT to include more entities.
- **Track-and-Trace System:** Use AI and analytics to link lubricant input to used oil output (~70% yield), flagging anomalies.
- **Digital Manifest:** Replace manual Form 10 with real-time tracking and QR-coded documentation.
- **Structured Collection Agents:**
  - CA1: Collect from generators and deliver to recyclers or CA2
  - CA2: Aggregate, store, and transfer to recyclers
- **Re-refiner Audit:** Conduct technical and environmental audits of all authorized facilities to assess RRBO capability.

Phase 2: Unorganised Sector (FY27 onwards)

- **Self-Registration App:** Enable garages and mechanics to register via mobile apps and receive ID cards.
- **Training & Awareness:** Launch government-led campaigns on safe handling, storage, and environmental impact.
- **Collector Integration:** Onboard informal collectors into CA1/CA2 networks with incentives and training.
- **Financial Inclusion:** Provide access to banking, insurance, and digital payments to formalize transactions.

Infrastructure & Technology

- **Grants & Soft Loans:** Support MSMEs in upgrading to G1 and G2 re-refining technologies (e.g., hydro-processing).
- **Pilot Plants:**
  - Solvent extraction (50 KTPA): ₹400–500 crore investment
  - Hydrogenation: ₹700–900 crore investment
- **Testing Labs:** Establish regional labs to reduce reliance on metro cities and ensure faster certification.
- **Bottom Residue Utilisation:** Promote use in bitumen, rubber oils, and cement kilns to minimize waste.

Policy & Compliance Enhancements

- **EPR Incentives:**
  - Allocate a portion of EPR credits to collectors
  - Offer premium certificates for high-grade RRBO
- **Segregation Mandates:** Enforce separation of brake fluids, coolants, and other contaminants at source.
- **Transport Simplification:** Harmonize interstate regulations and eliminate redundant NOCs.
- **Pricing Index:** Develop a benchmark for used oil prices to prevent manipulation and ensure fair compensation.
- **RRBO Inclusion:** Encourage lubricant producers to voluntarily incorporate RRBO in formulations.
- **BIS Enforcement:** Mandate certification, periodic audits, and develop specs for G2 RRBO.
- **Tax Incentives:**
  - Lower GST on lubricants with ≥5% RRBO content
  - Apply Reverse Charge Mechanism under GST to simplify compliance
- **Stakeholder Sensitisation:** Conduct workshops, webinars, and campaigns to build ecosystem awareness.
- **Penalties for Non-Compliance:** Implicit in EPR; Chile's model includes legal obligations for generators and fines for violations.

Global Best Practices

India can draw inspiration from mature markets that have successfully implemented circular models for used oil.

- **Advanced Technologies & High Re-refining Rates**
  - **Italy (CONOU):** 98% re-refining rate; collects from 103,000 sites
  - **Greece, Spain:** 80–98% re-refining rates
  - **US & Canada:** ~30–45% re-refining rates; investments in G2/G3 technologies are rising
- **Digital Traceability Systems**
  - **Spain's SIGAUS:** End-to-end IT system automating ~160,000 operations annually
  - **France's CYCLEVIA:** Monthly declarations and annual RRBO reporting
  - **South Korea & Italy:** Centralised legislation enforcing producer responsibility
- **Public Awareness & Education**
  - **US (California):** 2,600+ drop-off sites promoted via utility bills and public ads
  - **Portugal's SOGILUB

Conclusion

India's journey toward a circular economy for used oil is both urgent and promising. With the lubricant market poised for significant growth and the environmental stakes higher than ever, the implementation of the Extended Producer Responsibility (EPR) framework marks a watershed moment. However, policy alone is not enough.

To truly unlock the potential of used oil recycling, India must adopt a multi-pronged strategy: formalizing the informal sector, upgrading re-refining infrastructure, incentivizing stakeholders, and embracing digital traceability. The creation of a national coordinating body—akin to CONOU, UOMA, or CYCLEVIA—can serve as the institutional anchor for this transformation.

Global best practices offer a rich repository of models and technologies that India can adapt to its unique context. From Italy's near-perfect re-refining rates to Spain's digital logistics and California's public outreach, the blueprint is clear: success lies in integration, innovation, and inclusion.

"The road ahead demands collaboration, commitment, and courage—but the rewards are well worth the effort."

By aligning environmental stewardship with economic opportunity, India can not only reduce its import dependency and carbon footprint but also emerge as a global leader in sustainable lubricant management. The road ahead demands collaboration, commitment, and courage—but the rewards are well worth the effort.

Let's turn WASTE into WEALTH, and POLICY into PROGRESS.

Bhaskaran Nagarajan

COO OF ROSEFIELD ENERGY TECH

With extensive experience in business operations, project delivery, and consulting across the lubricants sector, Mr. Bhaskaran has been instrumental in enabling practical sustainability initiatives across value chains. At Rosefield, he leads strategy and execution with a focus on driving measurable impact.

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Typical Properties of Pilot® Oils

Properties	Low Aromatic Grades							
	Method	Pilot® 200H	Pilot® 250H	Pilot® 275H	Pilot® 300H	Pilot® 400H	Pilot® 500H	Pilot® 900H
Appearance	Visual	Clear & colourless						
Colour (Saybolt)	ASTM D 156	30						
Boiling Range – IBP	ASTM D86	220 °C	235 °C	250 °C	260 °C	280 °C	280 °C	300 °C
Boiling Range – FBP	ASTM D86	243 °C	275 °C	295 °C	320 °C	320 °C	360 °C	350 °C
Density at 15 °C	EN ISO 12185	820 kg/m³	820 kg/m³	820 kg/m³	820 kg/m³	820 kg/m³	820 kg/m³	840 - 860 kg/m³
Flash Point (PM)	EN ISO 2719	min. 88 °C	min. 100 °C	min. 110 °C	min. 110 °C	min. 130 °C	min. 130 °C	min. 160 °C
Kin. Viscosity at 40 °C	DIN 53015	1.9 mm²/s	2.5 mm²/s	3.0 mm²/s	4.0 mm²/s	4.5 mm²/s	5.5 mm²/s	8.5 mm²/s
Aromatics (UV)	HM-14-Labor	max. 1000 ppm						
Pour Point	DIN ISO 3016	–	-30 °C	-20 °C	-20 °C	-10 °C	-5 °C	-35 °C
CAS. No.	–	64742-47-8	64741-91-9 64742-46-7 64742-47-8	64741-91-9 64742-46-7 64742-47-8	64741-91-9 64742-46-7	64741-91-9 64742-46-7	64741-91-9 64742-46-7	1174522-19-0
EC Number	–	926-141-6	927-632-8	927-632-8	919-029-3	919-029-3	919-029-3	919-029-3

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Proposed portfolio overview

	Halpasol® 190/240G	Halpasol® 240/270G	Halpasol® 270/310G HP	Halpasol® 270/310G	Halpasol® 310/340 G
Density @15°C	760 kg/m3	775 kg/m3	785 kg/m3	785 kg/m3	800 kg/m3
Color Saybolt	30	30	30	30	30
I.B.P.	190 °C	235 °C	265 °C	265 °C	295 °C
F.B.P.	245 °C	275 °C	295 °C	315 °C	360 °C
Flash Point	> 65 °C	> 100 °C	> 120 °C	> 125 °C	> 150 °C
Pour Point	< -50 °C	< -25 °C	< -15 °C	< -15 °C	< -10 °C
Aromatics (UV)	< 50 mg/kg	< 50 mg/kg	< 50 mg/kg	< 250 mg/kg	< 100 mg/kg
Viscosity @40°C	ca. 1,5 mm²/s	ca. 2,5 mm²/s	ca. 3,2 mm²/s	ca. 3,6 mm²/s	ca. 5,9 mm²/s
Paraffinic Content	> 95 %				
Isoparaffins	typically > 80% isoparaffinic structures				
Biodegradability	readily biodegradable				
EC N°	940-726-3	940-728-4	940-730-5	940-730-5	940-734-7
CAS N°	848301-67-7 928771-01-1	848301-67-7 928771-01-1	848301-67-7 928771-01-1	848301-67-7 928771-01-1	848301-67-7
Chain length	C10 - C13	C14 - C16	C15 - C19	C15 - C19	C18 - C24
Article number	380693	380763	380850	380792	380793

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PRODUCT		APPLICATION
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F-21X	F-54X	ANTIOXIDANT ADDITIVES

ROSEFIELD Interview WITH Keith Corkwell

Global Market Outlook & Strategic Vision

Q How do you see the global lubricants and additives industry evolving over the next 5–10 years?

Over the next decade, the lubricants and additives market will be characterized by its capacity for flexibility in response to the evolution of mobility. The rapidly emerging trend toward electrification and alternative fuels is transforming market imperatives. At Lubrizol, we are strongly dedicated to enabling future mobility with an extensive range of solutions for next-generation vehicles. One prime example is our EVOGEN™ range of additives, fluids, and specialized greases, designed to optimize the efficiency, longevity, and performance of electric vehicles.

Equally important in the next 5-10 years will be collaboration throughout the value chain. Advances in EVs and the rapid adoption of alternative fuels require close collaboration between OEMs, Tier 1 suppliers, and fuel marketers to create the chemistry, standards, and market improvements that will shape tomorrow's transportation infrastructure. Behind it all is the increasing role of sustainability. The sector is becoming more interested in facilitating cleaner mobility and energy efficiency, and Lubrizol is shifting its innovation strategy to provide solutions that reduce emissions and drive a cleaner future for all transportation sectors and industrial markets.

Q What are the biggest challenges facing the industry today, especially in light of global trade uncertainties and geopolitical shifts?

One of the biggest challenges for the lubricants and additives sector today is how to manage the volatility of international trade and the consequent supply chain vulnerabilities. As a very interconnected sector, even slight disruptions have a ripple effect on availability, price, and customer commitments. We are taking a forward-thinking approach to this at Lubrizol with a "local-for-local" approach, which localizes production and innovation near growing markets. By growing our manufacturing presence in India, we are improving supply chain resilience, shortening lead times, and diminishing the carbon impact of long-haul transportation. This strategy not only makes us

resilient in the face of trade volatility and also allows us to better serve to the specific needs of local clients.

Another compelling concern is competitive pressure from foreign markets, more so from areas that supply finished goods at prices equivalent to raw materials. Such a situation can have the ability to displace local manufacturing efforts and discourage investment if not backed by good trade policies. The sector acknowledges this problem, with most constituents supporting steps to limit import dependence and promote homegrown manufacturing. For Lubrizol, further investment in localized manufacturing and collaborations with regional players continues to be key to establishing a stronger, more independent ecosystem that can best weather global risks. Lubrizol is able to combine a global network of R&D and manufacturing capabilities with in-region expertise and reliability.

Q How is your company adapting its global strategy to navigate supply chain disruptions and regulatory changes?

At Lubrizol, we have responded to these challenges with a strong "local-for-local" approach, which brings manufacturing, warehousing, and distribution closer to our customers with the backing of a global company with global capabilities. By building up our regional production network, we can reduce exposure to external trade changes, improve lead times, increase reliability, and operate more sustainably. A prime example of this strategy is our US$200 million investment to build a new facility in Aurangabad, India. This will be our largest facility in the country and second-largest manufacturing facility globally.

Our localized model also strongly connects with our sustainability goals. Shorter transportation distances help reduce our carbon footprint, while innovations like pipeline delivery of key raw materials boost safety and efficiency. On the regulatory side, we work closely with government initiatives such as "Make-in-India" to secure the local supply of vital materials for fast-growing markets. India presents an inviting business environment with skilled talent and progressive state policies that encourage R&D investment; these conditions support our ongoing growth.

Impact of EVs & Alternate Fuels

Q With the rise of electric vehicles and alternate propulsion technologies, how do you see the role of additives changing?

The growth of electric vehicles and other emerging technologies is, in essence, remaking the role of additives, extending their historical role of enabling internal combustion engines to one that enables a wide array of mobility platforms. Additives are emerging as key enablers of performance, efficiency, and durability in a much wider range of mobility platforms.

This development is spurring substantial innovation in chemistry. Our EVOGEN™ e-axle portfolio is designed to solve electric drivetrain-specific challenges from thermal management to gear and bearing protection so that these vehicles run efficiently throughout their entire service life. Outside of battery electrics, we are also creating solutions that maximize the performance of vehicles powered by hydrogen, ammonia, and other alternative powertrains to expand the future mobility ecosystem.

Q What innovations are being pursued to cater to hybrid powertrains, hydrogen fuel cells, and biofuels?

Our contribution extends far beyond electrification. We are hard at work developing solutions that allow the safe, efficient running of hydrogen, ammonia, and other alternative fuel-powered vehicles. These solutions are designed to maximize system performance while facilitating the industry's shift toward lower-carbon fuels. By blending technical depth with a look-ahead mindset, we are helping our products become a key driver in bringing these new fuel technologies to market around the globe.

Our R&D teams are also exploring compatibility solutions for engines running on higher biofuel blends, addressing challenges such as water separation, microbial growth, and material degradation. These efforts are part of our broader commitment to sustainable mobility and energy diversification.

Q Do you believe the shift to EVs will shrink the market for traditional lubricants, or will it open new opportunities for specialized fluids and additives?

We see this shift as a massive opportunity. EVs and hybrids open entirely new categories of specialized fluids. EVOGEN™ driveline e-fluids address copper corrosion and heat transfer issues, while Lubrizol® AT9311 is purpose-built for hybrid transmissions.

Importantly, this shift positions India as both a domestic demand hub and an export base. With our new Aurangabad facility and local-for-local strategy, we are positioning our company to meet India's needs and supply EV-ready fluids and additives to the region beyond India.

The possibility also goes beyond the vehicle itself. With expanding EV infrastructure, we are providing high-tech ESTANE® EV TPUs for charging cable materials that can resist harsh weather, mechanical stress, and strict global safety standards. By doing so, we are supporting the vehicles of the future and the infrastructure that will facilitate their adoption.

Q How is your R&D strategy evolving to stay ahead of these transitions?

Our R&D approach is evolving to keep pace with the changes transforming mobility and materials, built around a global-local model of innovation. We are establishing a cutting-edge Global Technology and Innovation Center in Maharashtra that will be a center of excellence for creating next-generation solutions for India and the world. This center will introduce advanced analytical capabilities, automation, and data-driven decision-making into our innovation process. Our new Customer Experience Center will facilitate close co-development with OEMs, Tier 1 suppliers, and other industry partners to drive speed-to-market and market relevance.

We are also addressing complex technical issues like copper corrosion prevention, thermal property management with low-viscosity fluids, and material compatibility with new polymers and alloys used in new drivetrains. Concurrently, we continue to enhance our Centers of Excellence in India, such as our Navi Mumbai grease lab and Two-Wheeler CoE, which enable us to develop solutions that address both regional and global requirements. By integrating world-class science, local market understanding, Lubrizol is poised to lead the next generation of mobility and materials development

Emerging Markets Focus — India & Beyond

Q India is one of the fastest-growing automotive and industrial markets. What is your assessment of the Indian lubricants and additives landscape?

India is one of the most dynamic markets in the world for lubricants, additives, and specialty chemicals, fueled by its fast-growing economy, expanding middle class, and growing transportation and industrial base. As the world's third-largest automotive market, India is experiencing steady growth in passenger car and commercial vehicle sales, complemented by a two-wheeler market that dominates mobility for millions. This is creating a broad range of demand from sophisticated engine oils for modern downsized and turbocharged engines to solutions specifically designed for motorcycles and scooters.

The market is also experiencing a deep technological shift. While electrification and alternative fuels are on the rise, internal combustion engines are still improving, with OEMs demanding greater efficiency, lower emissions, and longer durability. This is opening opportunities for high-performance additives such as Lubrizol® PV1710 for LSPI protection and fuel economy improvement, and Lubrizol® AT9311 for hybrid-ready transmission systems.

> "India is one of the most dynamic markets in the world for lubricants, additives, and specialty chemicals, fueled by its fast-growing economy, expanding middle class, and growing transportation and industrial base."

Q How does India compare with other emerging markets in terms of demand, innovation, and regulatory environment?

From a demand standpoint, India presents unparalleled growth potential. It is already one of Lubrizol's largest markets globally and the company aims to double business here in the next five years. This growth is supported by a diverse and growing consumer base.

In terms of innovation, India has been selected as the site of a new Technology and Innovation Center, a strong vote of confidence in its strategic significance. This center will address both local and global needs, establishing India as a hub for groundbreaking R&D and enabling co-creation with OEMs and industry partners. The choice was also influenced by access to a rich pool of engineers and scientists, with plans to triple technical talent in the region to drive innovation. Few other emerging markets are being entrusted with this level of global responsibility and investment in future-proof technologies.

Regulation is also a positive differentiator. Initiatives like "Make in India" and progressive state policies align well with our local-for-local approach to R&D and manufacturing.

Q What are the key growth drivers in India — and what barriers still exist for global players?

Growth is being driven by a rising middle class that is transforming consumption habits, creating strong demand for passenger cars, two-wheelers, and premium lubricants. Infrastructure and industrial development are also accelerating, with India representing nearly half of Lubrizol's global CPVC volume, while the healthcare sector is expanding rapidly with an ambition to quadruple by 2030. These drivers create an unmatched opportunity for advanced chemistry and specialty solutions.

At the same time, barriers remain. Fierce price competition, particularly from lower-cost imports, can undermine local investment. Regulatory complexity requires companies to be agile, and resilient supply chains are essential to cope with volatility. Perhaps most importantly, success in India depends on localized innovation that reflects the country's unique mobility patterns, consumer behavior, and infrastructure needs.

Q Is your company investing in local partnerships, manufacturing, or R&D in India?

Yes, India is a critically important region for Lubrizol and we are backing that position with significant investment in manufacturing, partnerships, and innovation. Our $200 million Aurangabad facility will be our largest in India.. In Gujarat, we are constructing the world's largest single-site CPVC resin plant at Vilayat and have already doubled CPVC compound capacity at Dahej with almost no increase in energy consumption.

In Maharashtra, we are establishing our first Global Technology and Innovation Center, which will triple our technical talent pool and serve as a global R&D hub for next-generation mobility solutions. Alongside these investments, we continue to expand local partnerships, from our joint venture with Indian Oil Corporation to collaborations in MedTech and academia. Together, these efforts ensure that India is not only a growth market but also a vital platform for global supply, innovation, and sustainable development.

Sustainability & Innovation

Q How is your company addressing the growing demand for environmentally friendly and sustainable additives?

Sustainability is core to our innovation decisions—it is who we are and what we do. We maximize the positive impact our products enable (our handprint) to exceed our customers' and consumers' performance and sustainability goals. At the same time, we minimize our environmental footprint by operating our business in a safe, efficient and responsible manner, continually identifying ways to reduce our carbon emissions. We develop sustainable solutions that help to advance mobility, lowering lifecycle emissions, improving energy efficiency and extending equipment life. Operationally, we are cutting transport emissions through local-for-local manufacturing and investing in renewable energy. By embedding sustainability into both our products and processes, we aim to lead the industry's transition to cleaner mobility.

Q Are there any breakthrough technologies or formulations you're particularly

At the core of our innovation agenda are technologies that enable both high performance and cleaner mobility. Our EVOGEN™ portfolio tackles challenges unique to EVs, from copper corrosion to thermal management. On the materials side, ESTANE® ECO TPUs and halogen-free recyclable polymers are redefining durability and circularity in EV infrastructure. What excites us most is how these solutions converge: advanced additives that cut emissions, polymers that enable recycling, and chemistries that extend equipment life — together setting new benchmarks for performance and sustainability.

Leadership & Industry Perspective

Q What leadership principles guide your decision-making in such a dynamic global environment?

Customer focus has always been central to our leadership approach. We work closely with OEMs and Tier 1 suppliers to co-develop relevant, market-ready solutions. Long-term investment is another guiding principle. In the past few years, we have committed more than $350 million in India, from Aurangabad and Vilayat to our Global Capability Center in Pune, laying a foundation for sustained growth. Empowering local talent is equally important. We are tripling our employee base and investing in training and collaboration with academia to build a skilled workforce for global projects. Finally, digital transformation underpins how we operate, with AI, IoT, and automation at our new Innovation Center in Maharashtra accelerating product development and decision-making

Q How do you envision the role of industry collaboration in shaping the future of lubricants and additives?

OEMs, additives companies and partners all through the value chain must come together to understand the changes ahead and develop innovative solutions. As we see the rapid adoption of alternative fuels and the wide variety of new platforms gaining adoption, the future is simply too complex to face alone. Together, we can share perspectives and speed to market. With manufacturing and R&C anchored in India, we can secure supply, control costs, and build resilience while developing expertise in areas like two-wheelers, hybrids, and new mobility technologies that can stand out internationally. Innovation should be customer-centric, co-created with OEMs and validated under real-world conditions. Finally, people and digital capabilities are the true differentiators. A skilled workforce empowered by automation, AI, and data-driven R&D will define the next generation of globally competitive companies.

Keith Corkwell

President, Lubrizol Additives

Keith Corkwell serves as Senior Vice President and President of Lubrizol Additives at The Lubrizol Corporation, a Berkshire Hathaway company. With over 25 years at Lubrizol and prior experience at Texaco and BP, Keith brings deep industry expertise in fluid engineering and additives solutions across transportation and industrial sectors. His leadership spans global commercial and product teams, covering fuel additives, heavy-duty engine oils, driveline technologies, and e-mobility. Academically, he holds dual bachelor's degrees in Physics and Mechanical Engineering, a master's in Mechanical Engineering from Rensselaer Polytechnic Institute, and an MBA in Marketing from Case Western Reserve University. Outside of work, Keith actively contributes to nonprofit initiatives, including the Foundation for Geauga Parks, Learning About Business (LAB), and the Boy Scouts of America.

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Used Oil Management in Greece

Greece is a small European country, but it can still demonstrate remarkable achievements regarding used lubricant management. Since 1981, LPC has been one of the first companies worldwide to apply catalytic hydrotreatment to produce high-quality and fully competitive Re-Refined Base Oils, thus preserving valuable resources and energy. Moreover, the knowledge stemming from the need to support the Re-refining process has been put in place, developing a state-of-the-art waste management framework, based on the Extended Producer's Responsibility. The latter has been instrumental in boosting used oil management across the country, years before Europe adopted similar practices, along with the support of Greek legislation enforcing that Re-Refining is the only permitted treatment route for used oils, over the energy recovery option.
Today, worldwide, a new era is rising as the necessity for decarbonization and circularity is changing the business environment.

LPC Re-refining process

Since 1981, LPC SA has operated a re-refining facility in the vicinity of Athens in Greece, treating annually 43,000 tn of used lube oil (ULO) to produce high-quality Base Oils. The applied technology is based on the KTI process combined with the IFP propane extraction process. Re-refining process includes (a) vacuum distillation with a thin film evaporator and selective propane extraction for maximum recovery yield and (b) catalytic hydro-treatment for advanced quality of produced Base Oils.

Catalytic hydro-treatment is the core of LPC's technology. Its purpose is the overall upgrade of produced Base Oils, providing improved lubricating characteristics, chemical stability and safety. Catalytic hydro-treatment is so important because the process drives de-sulphurisation, de-nitrification, de-metallization, de-chlorination, other heteroatoms removal, reduction of unsaturated fraction (reduction of olefins and of carcinogenic poly-aromatic compounds), improvement of oxidation stability, and alteration of VI (Viscosity Index) leading to
high quality output.
Another important aspect of catalytic hydro-treatment is the safety of re-refined Base Oils. ULOs contain high levels of poly-aromatic hydrocarbons, which are carcinogenic at concentrations above 3%. These hazardous substances are eliminated by catalytic hydro-treatment.
The facility of LPC also includes blending and packaging of more than 250 lubricant products, as well as a grease production plant by the technology of ABB.

LPC has the opportunity to produce finished lubricants using Re-refined Base oils, significantly improving the carbon footprint of the products, which hold all the necessary approvals by international bodies (ASEA E sequences, API approvals, part of MIL-L-2104, DIN, and OEM). Activity of LPC is registered to EMAS Registry (EL00051) and is certified according to management systems, ISO 9001:2018 for quality, ISO 14001:2018 for environment, ISO 45001:2018 for health & safety, and ISO 50001:2015 for energy.

History of Greek EPR

In '90s, LPC launched its ULO collection activity, introducing Greece in the used lubricants re-refining process. The collection of ULO in Greece was a very demanding task. The Greek landscape, consisting of high mountains in combination with the absence of highway infrastructure, the limited reach of railways, the high number of scattered remote islands, the lack of adequate legislation and controls to restrict the illegal burning of ULO, were barriers that had to be overcome.

On an operational level, to achieve efficient ULO collection, LPC invested in infrastructure with collection centers strategically positioned around the country, adopting technological tools such as reverse MRP, GIS, and database for predictive and rooting algorithms, and setting up from scratch a state-of-the-art call center.

Although the process of ULO collection was becoming much more efficient for Lubricant users, the operational improvements were not enough to move the needle. The next instrumental steps forward were legislation update, Authorities training and support as well as dissemination actions to be taken. As a result, in 2001, the Greek national legislation introduced the Extended Producers' Responsibility scheme. Organizations selling finished lubricants in the Greek market became obliged to collectively contribute to the management of used lubricant oils. Furthermore, the energy recovery of used oils became banned, and the only acceptable option is the production of RRBOs. Process-wise, producers of ULO, collectors, and re-refining facilities are obliged to report to the digital Waste Registry the sales volumes of finished lubricants, and competent authorities need to validate the process and the figures, acting wherever deviations are spotted. Today, 70% of collectable used oil is collected, and 100% of collected oil goes to re-refining. Greek ULO Collection and Re-Refining yields are among the highest in Europe.

Life Cycle of Lubricants

The life of lubricants begins with crude oil drilling and can go on indefinitely:

To meet these targets, India will require:

1. Drilling of crude oil and transportation to crude oil refineries
2. Production of virgin Base Lube Oil (VBO, among other products)
3. Mixing Base Oil with additives, packaging, and marketing of lubricant products
4. Use of lubricants until the loss of their lubricating characteristics
5. Replacement of lubricants with fresh products and Collection of Used Oils from workshops
6. Collection and transportation of Used Lube Oils (ULO) from Official Collectors to be dispatched to re-refining facilities
7. Production of Re-Refined Base Lube Oil
8. Loop from step [3]

Used lube oil is not the end of lubricant life rather the beginning of its recycling life circle, which can take place forever. ULO becomes a valuable resource supporting the environment and the local economies, while it can be reclaimed repeatedly. This is the circular way of thinking.

ULOs are dangerous waste in sizable quantities. They are dangerous because they contain hazardous compounds that were added or produced during their use (heavy metals, chlorine, polyaromatic hydrocarbons). Other possible options are the disposal of ULO (sewer, surface, and underground waste, landfill) or energy recovery. These choices cause a serious environmental impact due to the emission of all the hazardous compounds into the environment. Moreover, energy recovery implies a single use of the ULO, thus reducing significantly the usage cycles to just 1, in contrast Re-refining, which has an indefinite number of cycles. Re-refining is the obvious way to move forward. Today's technology can recover 100% of useful material and produce high-quality Re-Refined Base Oils (RRBO), fully compatible with the latest OEM needs. Furthermore, re-refining keeps the value in the market as ULO is a valuable local raw material that may be reclaimed repeatedly. This is the circular way of thinking. On the other hand, energy recovery removes this value permanently.

Re-refining: the clever way

Worldwide, a great number of Life Cycle Assessments (LCA) have been conducted.
These studies evaluate and compare the different options of lubricant life and management of ULO. The outcome of the studies consistently proves that re-refining, has a lower environmental impact (global warming, etc.), does not emit dangerous substances, and finally, saves natural resources compared to the other options. As discussed earlier, disposal and even well-controlled combustion emit heavy metals, dioxins, fine particulates, etc. to the environment.
Moreover, we need to note that it takes 10 liters of crude oil to produce 1 liter of virgin Base Lube Oil (VBO), while it takes only 1.35 liters of ULO and 70% less energy to produce the same amount of Re-Refined Base Oil.
It is also well justified that Re-Refining promotes the national/local economy (ULO is a valuable raw material) and creates a great number of jobs (for each employee in the re-refining sector, 10 additional jobs are created).
In 2022, the group of European Re-refining Industry updated the LCAs from 2005 and 2018. This study covered more than 50% of European re-refining capacity, underlying the results of 2005 and 2018 and enhancing previous conclusions, stating that advanced Regeneration technology shall be the favored way to keep used oil as long as possible as high-grade material within the circular economy. In brief, this LCA supports the higher ranking of Regeneration versus energy recovery according to the waste hierarchy required by EU policies.
In 2024, LPC conducted an LCA for its own Re-Refined Base Oils. As expected, RRBOs produced by LPC have significantly lower environmental impact compared to Virgin Oils (VBO). This study states that for LPC's RRBOs compared to equivalent VBOs, there is a reduction in CO2eq of more than 66%. In other words, for each kg of RRBO used instead of VBO, the impact is reduced by more than 1,2 kg of CO2eq.

Legislation and emerging obligations

In line with the above studies, the European Waste Framework Directive (2008/98/EC) provides explicit instructions for waste oil management, prioritizing options for the best environmental outcome according to the waste hierarchy:

- Prevention: the first choice
- Preparing for re-use
- Recycling: to produce products for initial use
- Other recovery (for example, energy recovery)
- Disposal: the least preferred option

Given that ULO cannot be used for lubrication and that it is a dangerous waste, the first two steps cannot be implemented. So, according to legislation, recycling (re-refining) is the preferred management option.
Europe is committed to being carbon neutral by the end of the next decade. This means that product carbon footprint (PCF) is changing the industry. The ability to provide PCF affects the whole supply chain, both suppliers and customers: suppliers should provide data for evaluation, and customers require data for their own reporting. So, PCF is not just an environmental issue but rather a business "must".
These days, the EU focuses on the circular economy as a key to boosting economic security, resilience, competitiveness, and decarbonization. There are several actions under consultation and development for waste management, mandatory targets for collection, simplification of EPR schemes, and other administration burdens, mandatory use of RRBOs, etc. European companies prepare for emerging lifecycle regulations such as Carbon Border Adjustment Mechanisms (CBAM), Corporate Sustainability Reporting Directive (CSRD), Eco-design for

Sustainable Product Regulation (ESPR), Green Claims etc.
Of course, this new business environment affects the lubricant market and used lubricant management. The demand for modern high-quality Re-Refined Base Oils is increasing as they provide significantly lower PCF compared to virgin equals and help lubricant manufacturers and consumers to improve their carbon impact.

Facts

1	Lube oil does not wear. It only gets contaminated. It is scientifically proven that by Re-Refining, oil can be used repeatedly without losing its lubricating ability
2	Today's re-refining technology can recover 100% of useful material and produce high-quality Re-Refined Base Lube Oil, fully compatible to the contemporary OEMs specifications
3	Re-Refining of ULO takes 70 % less energy and raw material than refining crude oil.
4	Re-refining creates new jobs and promotes the national economy
5	Re-refining industry can drive the way to the circular economy
6	RRBO is a key product for carbon-neutral economy

Dr Christos Karavasilis

Dr Christos Karavasilis' background is chemical engineering coupled with a PhD on catalysis and fuel cells. For more than 25 years, he works on waste oil management and his involvement in the development of the Greek Extended Producer Responsibility (EPR) system gave him great experience for effective waste management strategies. As a technical supervisor at LPC's re-refinery facilities, Dr. Karavasilis likely plays a crucial role in ensuring the efficiency of the re-refining process. He is an active member of GEIR and ATIEL/UEIL working groups, regarding sustainability, circular economy and carbon footprint of lubricants industry.

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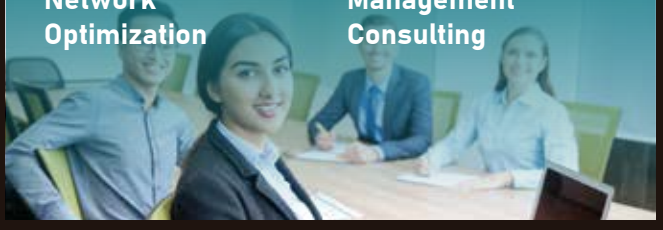

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