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QUALITY DRIVES.

Additin® RC 3502

New Organic Friction Modifier Additive

STLE Nashville May 2019

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LANXESS is committed to the long term growth of the global lubricants industry

Objective: To help lubricant formulators extend oil life, protect equipment, conserve energy and resources and grow in their markets

Approach: To be the leading integrated[1], full value chain collaborator for industrial applications and a trusted, specialized component provider for automotive applications

	Synthetic Basestocks	Additive Components	Industrial Additive Packages	Industrial Finished Fluids
Products	▪ High viscosity PAO ▪ Synthetic esters ▪ Phosphate esters ▪ Ester-functionalized PAO	▪ Antioxidants ▪ Detergents ▪ Anti-wear, Extreme pressure ▪ Corrosion inhibitors ▪ Friction modifiers	▪ Hydraulic fluids ▪ Greases ▪ Neat oil and water-based metalworking fluids ▪ Gear and turbine oils	▪ Aviation turbine oils ▪ Refrigeration fluids ▪ Fire resistant hydraulic oils ▪ Calcium sulfonate complex greases
Key applications	▪ Automotive & industrial finished fluids ▪ Automotive & industrial additive packages	▪ Automotive & industrial finished fluids ▪ Automotive & industrial additive packages	▪ Hydraulics ▪ Greases ▪ Metal working fluids ▪ Select other industrial	▪ Aviation ▪ Refrigeration ▪ Hydraulics ▪ Select other industrial
				

1. Backward integrated into sulfur-, phosphate-, thiophosphate-, diphenyl amine- and sulfonate- chemistries

Automotive Additives – Future Trends and Drivers

- Energy efficiency remains a key driver in Automotive
- E-mobility is changing the nature of the industry and lubricant demand
- Automotive lubricants and Automotive additives will continue to play an important role in the near future

- **Metal, Sulfur and Phosphorus free additives** provide the freedom to formulate new lubricants without impacting limits
- **Durable additives** support longer efficiency and lubricant life
- **Highly compatible and synergistic additives** enable formulation flexibility and optimization

*source: Kline Global Lubricant Additives: Market Analysis and Opportunities 2017

New Additive Development and Focus – reducing friction and improving efficiency

- Our aim is to focus Additive innovation around **key needs and unique technology** to deliver effective simple solutions..

- **Additive technology can help to reduce friction** to improve fuel economy
- **Friction modifiers**, although a relatively small percentage of the market, are predicted to grow ~6%pa over the next 5 years*
- A number of organic friction modifier solutions exist today, but are not optimized for performance, durability and compatibility

- With this in mind our goal was to develop a **new organic friction modifier technology with multi-functionality** for the development of next generation lubricants

Introducing… ADDITIN® RC 3502

Organic Friction Modifier Additive

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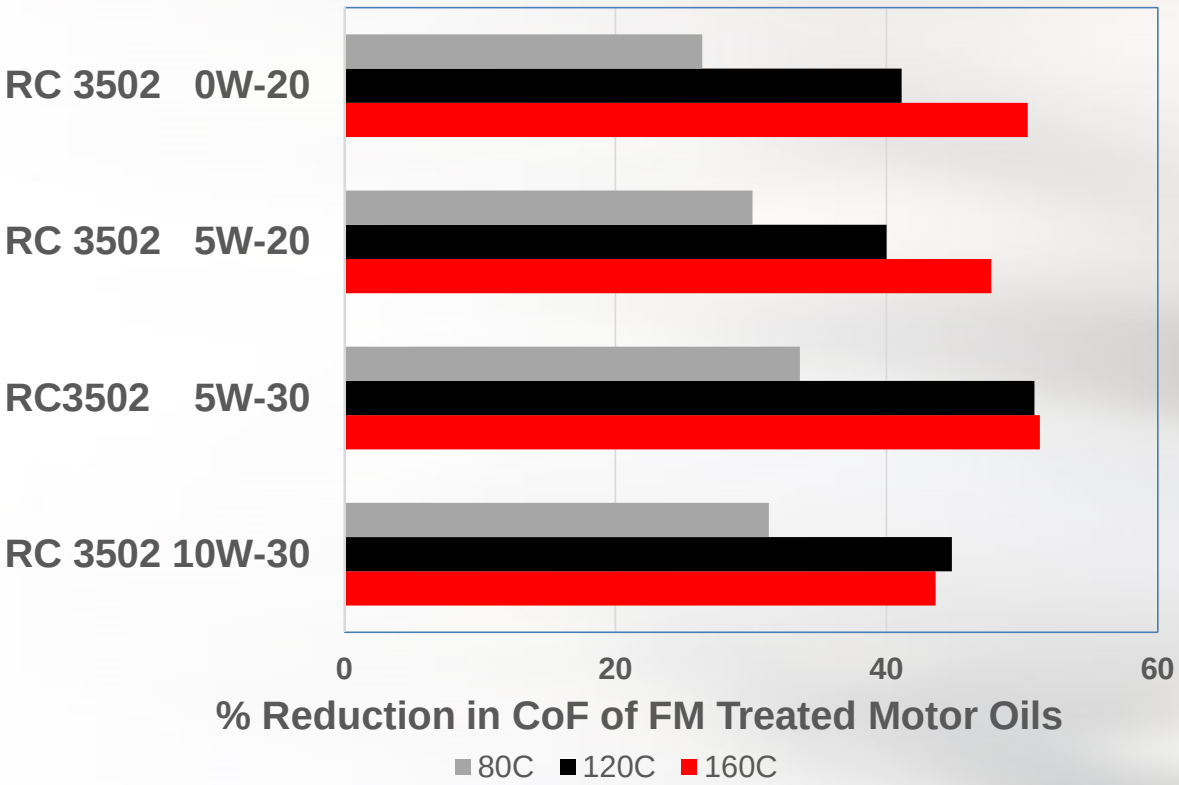
- New patented organic technology
- ZERO Metals, Sulfated Ash, Phosphorus or Sulfur
- Clear, non corrosive liquid additive
- Fully compatible with Group I-V based engine oils

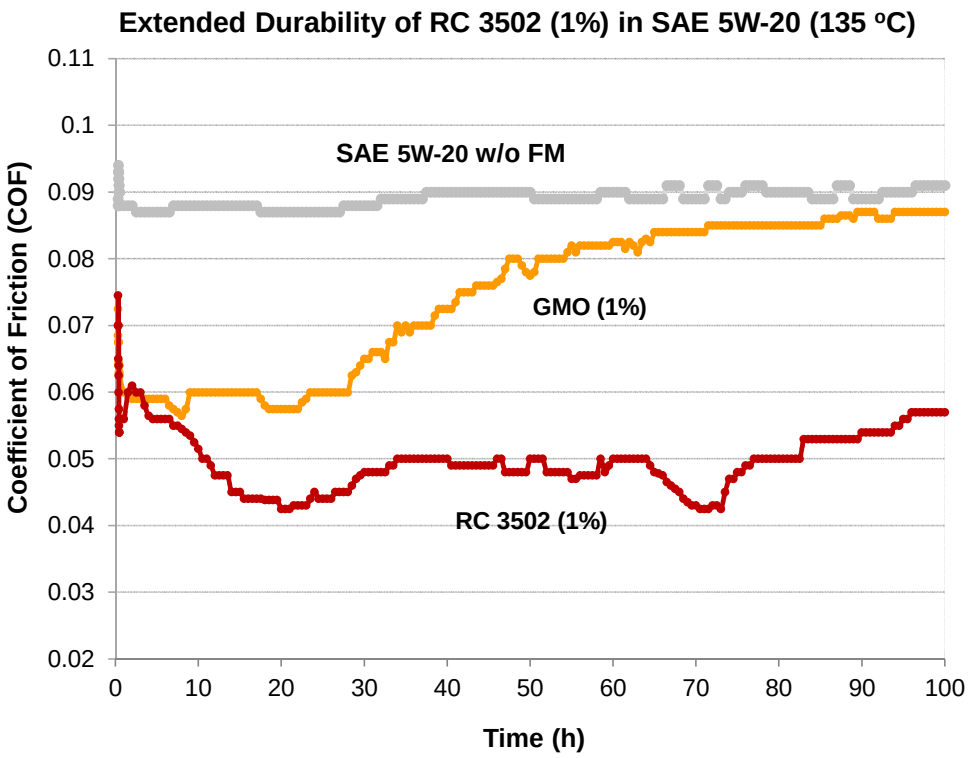
- **Greater friction reduction** than glycerol monooleate (GMO), or other amide/amine and ester based chemistries
- **Sustained performance durability** compared to GMO and MoDTC friction modifiers
- **Excellent compatibility and synergy** benefits with other additives, including Magnesium sulfonate detergents

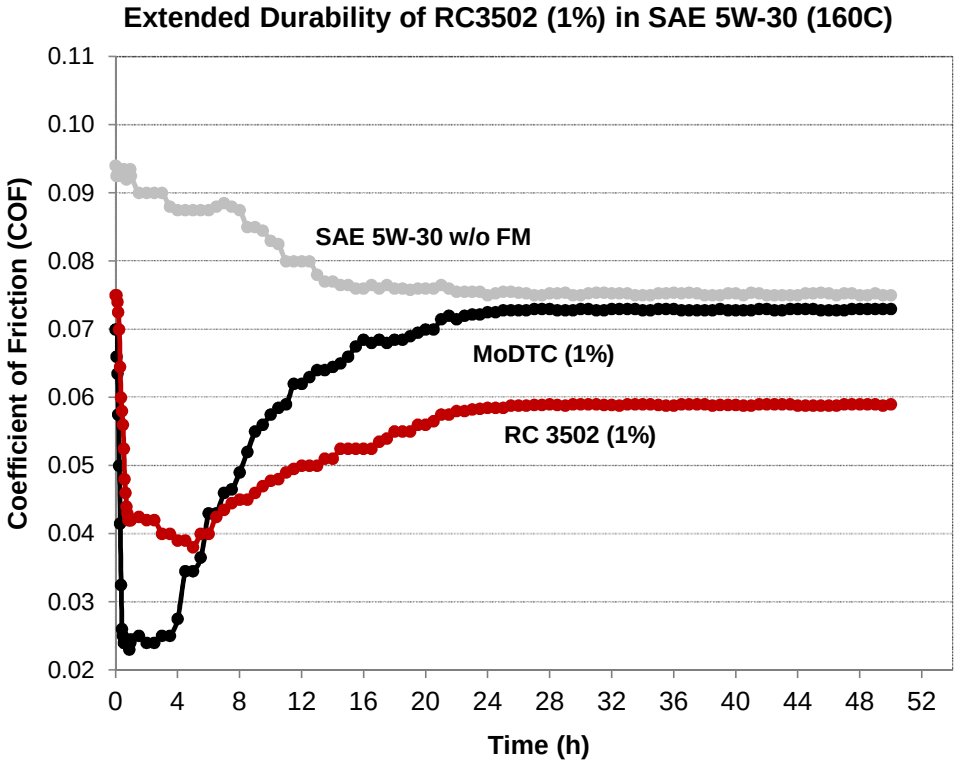
CoF Reduction of Additin® RC 3502 in different viscosity oils



- 1% addition of Additin® RC 3502 to a range of motor oil viscosities without a friction modifier
- % reduction in CoF calculated compared to the oil without a friction modifier
- Even at lower temperatures (80°C) Additin® RC 3502 shows greater than 20% reduction in CoF

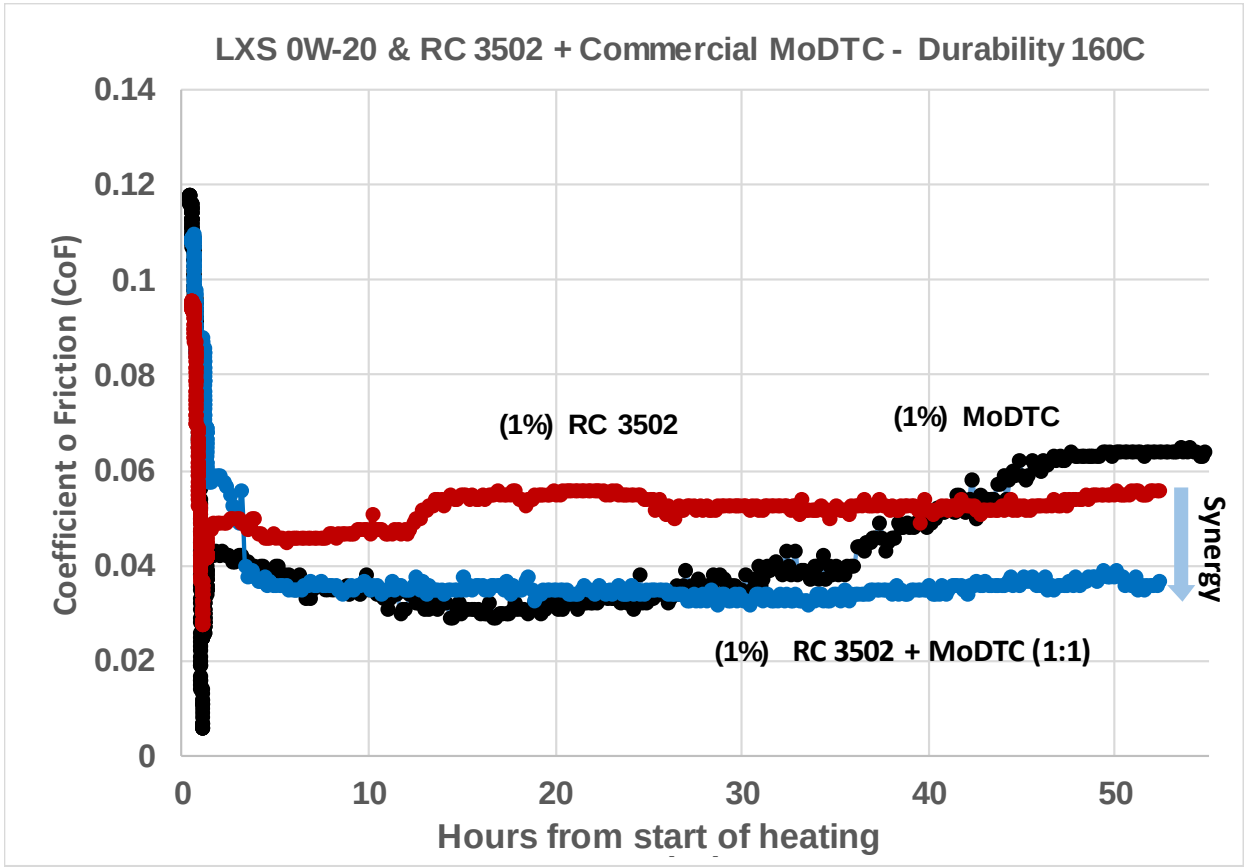
Excellent durability performance over time





Plint TE-77 pin-on-plate line contact 100 N Load

Strong compatibility with MoDTC Friction Modifiers



Plint TE-77 pin-on-plate line contact 100 N Load

Excellent solubility in mineral and synthetic motor oils

- 2% in SAE 5W-30 (-20C) remains clear after 6 weeks
- Enhanced solubility acts as a co-solvent to increase additive treat flexibility
- Additin® RC 3502 neat, can be stored for 5 years if kept cool, dry, heat and moisture free

(***Additive gel globule***)

> 0.5% in SAE 5W-30 insoluble additive gel globule after 8 hrs mixing both room temp and -20C

(***Additive insoluble haze***)

1.0% in SAE 5W-30 insoluble when stored at -20C for 24 hrs: Additive suspension-haze formed

Additional Antiwear Benefit

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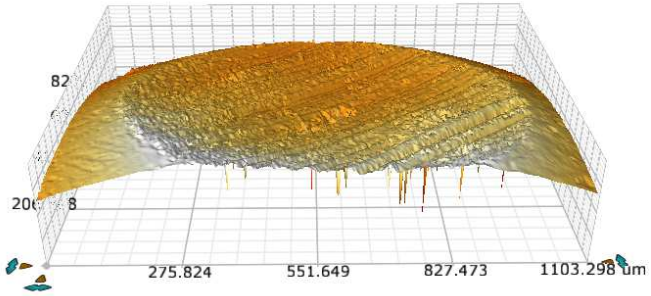
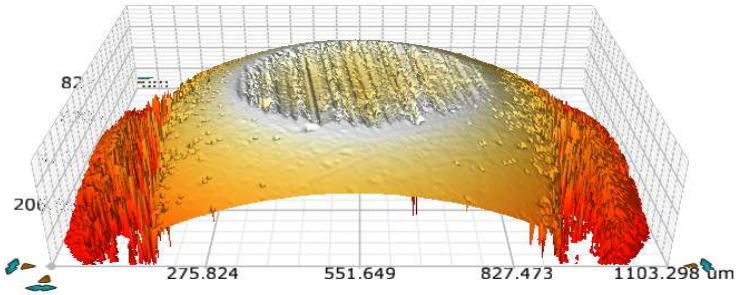
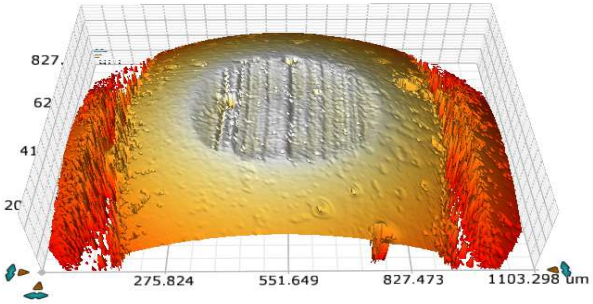
ASTM 4172 Four Ball Wear Scar Optical Profilometry Analysis



SAE 5W30 no AW
D4172 AWS = 895 microns

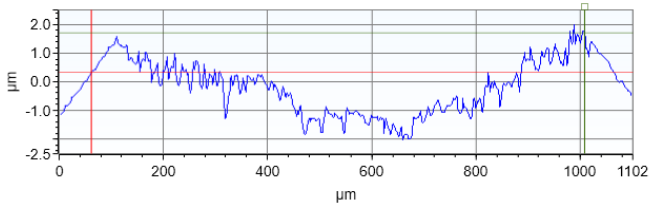


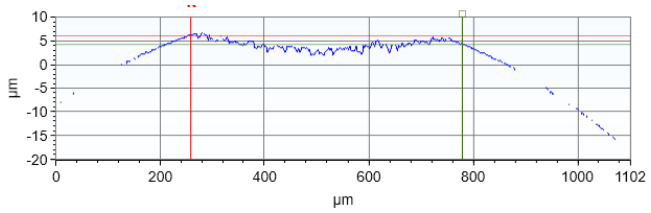
SAE 5W30 0.06% (P) ZDDP
ASTM D4172 AWS = 505 microns

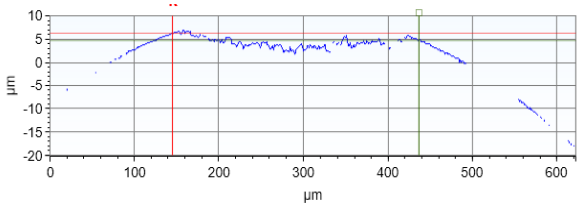


SAE 5W30 0.06% (P) ZDDP **+1% RC 3502**
ASTM D4172 AWS = 414 microns

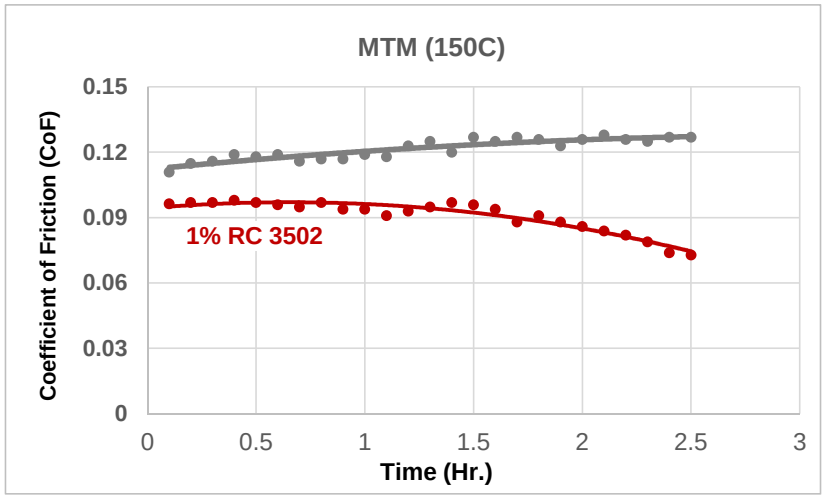
lowest scar 0.414 (mm) and lowest shallow volume

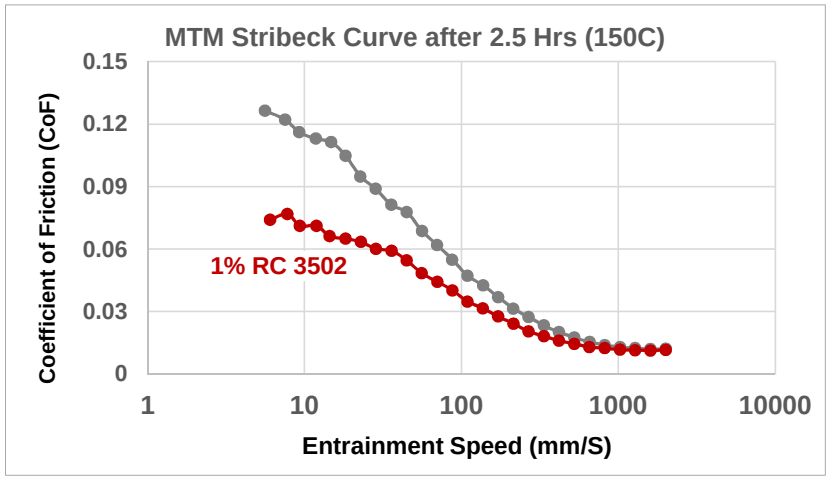






Friction reduction benefit in Automotive Gear Oil

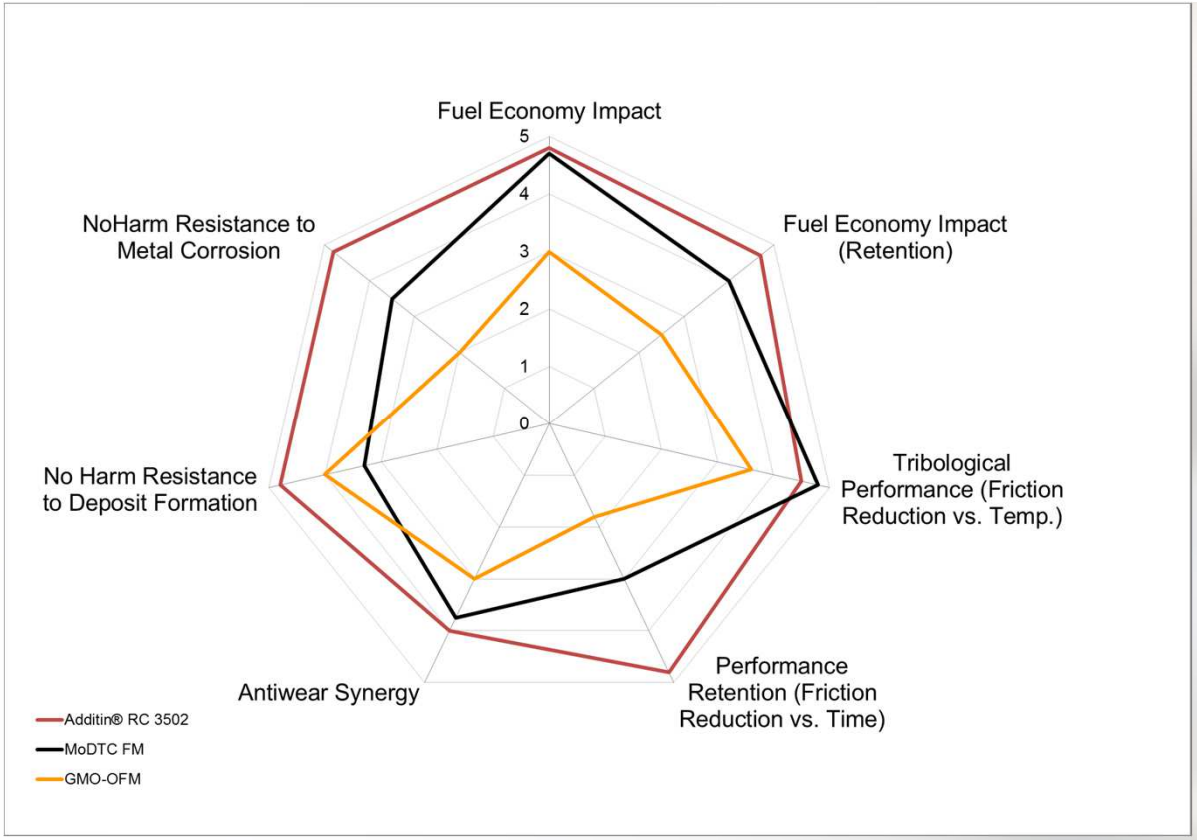




Automotive Gear Oil 75W-140 plus Additin® RC 3502

- Friction reduction impact benefit observed
- Stronger performance benefit observed on continued Stribeck testing after 2.5 hours

Key attributes of Additin® RC 3502



- Demonstrates up to **5% Fuel Economy improvement*** and retention in Industry Sequence VI E test (ASTM D8114-17)
- Provides a **synergistic boost in antiwear** performance with ZDDP
- **Excellent resistance to deposit formation** at high temperatures (TEOST 33C test)
- **Excellent low Cu, Sn, and Pb corrosion** resistance (ASTM D6594)
- Full no harm tested - **Corrosion, oxidation, thermal & material compatibility**

*fuel economy benefit calculated from sequence VIE engine test FEI sum over SAE 20W-30 baseline

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Additin® RC 3502 - Freedom to formulate…

- Zero metals, Sulfated Ash, Phosphorus and Sulfur
- Clear light amber liquid, compatible in a range of Group I-V formulations
- Excellent additive compatibility
- Full no harm testing: excellent low Cu, Sn, and Pb corrosion resistance


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Unless specified to the contrary, the values given have been established on standardized test specimens. The figures should be regarded as guide values only and not as binding minimum values. Kindly note that the results refer exclusively to the specimens tested. Under certain conditions, the test results established can be affected to a considerable extent by the processing conditions and manufacturing process.