

QUALITY PROCESS AND EXTENDER OILS
WITH A UNIQUE IDENTITY





HOLLYFRONTIER
SPECIALTY PRODUCTS & SERVICES

**EVERY GRADE OF HOLLYFRONTIER SPECIALTY PRODUCTS PROCESS
OIL CARRIES THE IMPRINT OF SUNPAR™ AND SUNDEX™ LEADERSHIP,
PROVIDING OUTSTANDING CHARACTERISTICS FOR THE
MANUFACTURE OF QUALITY RUBBER GOODS.**

OILS WITH A UNIQUE IMPRINT

Just as every fingerprint is unique, HollyFrontier Specialty Products' oils for polymer manufacturing and rubber compounding carry the unique imprint of our long and close association with the rubber industry. Our incomparable experience includes pioneering the use of oils in rubber as well as developing products with outstandingly unique characteristics for the rubber industry. Using only West Texas and light sweet crude (low sulfur) as our feed stock, HollyFrontier Specialty Products assures you a consistency of quality that's as individual as a fingerprint. We are proud to continue offering the rubber industry the performance and cost advantages that our legendary oils can provide. They become the "Oils of Choice"™ to help position your products for market leadership.



ABOUT HF SINCLAIR

HF Sinclair, the parent company of HollyFrontier Specialty Products, is principally an independent petroleum refiner headquartered in Dallas, Texas. Through its subsidiaries, HF Sinclair owns and operates five complex refineries in Oklahoma, New Mexico, Wyoming, Kansas and Utah, while having a global imprint in producing process oils and other specialty products in the U.S., Canada, and the Netherlands. Its 678,000 gallons per day crude refining capacity produces high-value light products such as gasoline, diesel fuel, jet fuel, lubricants, specialty products and modified asphalt. Through its subsidiaries, HF Sinclair exports to more than 80 countries for applications including automotive, agriculture, adhesives, construction, health and beauty, manufacturing, mining, marine, pharmaceutical, plastics, railroad, rubber, and sporting goods.





SUNPAR™ Paraffinic Oils

SUNPAR™ PARAFFINIC OILS EXHIBIT EXCELLENT COLOR STABILITY AND LOW VOLATILITY. THEIR LOW AROMATIC CONTENT MAKES THEM EXCELLENT CHOICES IN PEROXIDE CURES WHERE AROMATICS INTERFERE WITH THE CURING PROCESS.

Compared to inferior oils, you can:

1. Obtain less oxidative and color degradation
2. Lower emissions during mixing and cures
3. Obtain better heat aging
4. Reduce peroxide consumption
5. Obtain longer service life with Sunpar™ oils

COLOR STABILITY

In applications that would allow both paraffinic and naphthenic oils, the Sunpar™ paraffinic oils are generally characterized by much lower aromatic contents. Therefore, they are more typically resistant to oxidation and color degradation. The comparison in [Figure 1](#) illustrates the higher level of color stability.

The better initial color and color stability are also indicators of better resistance to contact migration stain and ultraviolet discoloration. The lower aromatic content and volatility characteristics of the Sunpar™ oils relative to lesser refined competitive paraffinic oils are illustrated in [Figure 2](#) for Sunpar™ 2280.

The combination of low aromatic content and volatility is intended to provide better performance in membrane roofing and under-hood automotive hose applications where the low aromatic content minimizes oxidative degradation and the low volatility helps prevent heat age shrinkage. Both of these features are important in assuring long service life.

VOLATILITY

Controlling volatile losses has become increasingly important in maintaining a safer work environment and complying with the Clean Air Act. An example of how Sunpar™ oils can help is the comparison between the volatile weight loss of an EPDM extrusion compound made with Sunpar™ 2280 and compounds made with competitive paraffinic oils after hot-air curing at 535°F (280°C) for 30 minutes. In this application, the volatiles emitted to the atmosphere may represent a potential source of non-compliance and greater exposure to workers.

FIGURE 1: TYPICAL COMPARISON OF COLOR STABILITY

Color (D1500)	100 SUS/100°F		500 SUS/100°F	
	NAPHTHENIC OIL	SUNPAR™ 110	NAPHTHENIC OIL	SUNPAR™ 150
Initial	L0.5	L0.5	L1.0	L1.5
UV Aged	2.5	1.5	4.5	L2.5
Heat Aged	L4.0	1.5	L4.5	2.0

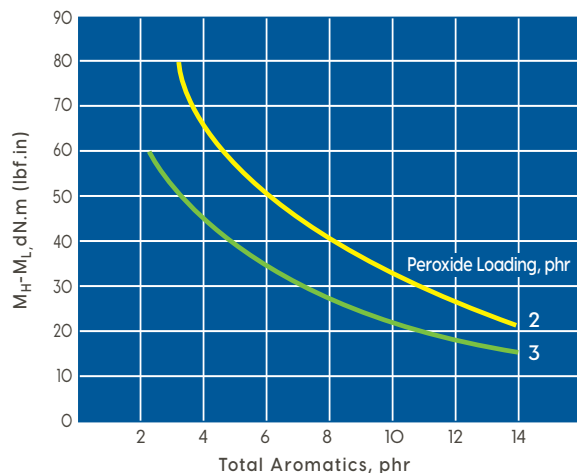
FIGURE 2: TYPICAL COMPARISON OF TOTAL AROMATICS & VOLATILITY

Product	TOTAL AROMATICS MASS% (D2007)	VOLATILITY MASS% (D972)
Sunpar™ 2280	24.0	0.03
Competitor A	33.3	0.07
Competitor B	29.8	0.35
Competitor C	35.9	0.08

FIGURE 3: COMPARATIVE VOLATILE WEIGHT LOSS

Product	WEIGHT LOSS MASS% 30 MIN. @ 535°F	% INCREASE RELATIVE TO SUNPAR™ 2280
Sunpar™ 2280	1.2607	—
Competitor A	1.6173	+28
Competitor B	1.7397	+38
Competitor C	1.8647	+48

FIGURE 4: PEROXIDE LOADING VS. TOTAL AROMATICS



The results are listed in **Figure 3** and show that Sunpar™ 2280 generated the lowest amount of volatiles. Relative to Sunpar™ 2280, the competitive offerings produced from 28% to 48% more volatiles. Accordingly, Sunpar™ 2280 may offer a more cost-effective way to comply with the Clean Air Act and reduce employee exposure.

AROMATIC CONTENT

The lower aromatic content of Sunpar™ 2280 is particularly significant in peroxide-cured applications where it can reduce the curative loading and, therefore, the cost of the expensive peroxide curative. The accompanying **Figure 4** illustrates how the lower aromatic content of Sunpar™ 2280 can reduce peroxide loading by 1 phr (parts per hundred). The benefits of lower aromatic content in paraffinic oils are discussed in detail in our publication, “Petroleum Extender Oils for Reduced Peroxide Consumption in Compounded EPDM.” Using Sunpar™ 2280 at nominally 24% aromatics in a selected recipe provides an effective level of aromatics of 6% when all the compounding ingredients are considered. Using a competitive oil containing a higher percentage of aromatics imparts an effective level of 10% aromatics. Achieving the same net torque would require increasing the peroxide loading by 1 phr, from 2 to 3 phr.

THE SUNPAR™ SERIES

Paraffinic Oils

The Sunpar™ oils are highly refined, premium quality oils designed for a wide variety of rubber applications. Most of these oils are ASTM Type 104 oils. Structurally, they have a predominance of saturated rings and long paraffinic side chains containing a minimum of 55% paraffinic carbon atoms (Cp) and thus are highly saturated. Compared to naphthenic and aromatic oils, they are generally more resistant to oxidation and color degradation from ultraviolet light and heat. The Sunpar™ paraffinic oils find applications in both thermoset and thermoplastic rubbers.

THERMOSET

The Sunpar™ grades are excellent choices for use with thermoset elastomers such as IIR, EPM, EPDM, IR, NR in either sulfur or peroxide cures. They are highly recommended for applications requiring low odor, good initial color, and color stability to heat and light.

Because they are designed for the rubber industry, they are intended to offer rubber compounders a balance of compatibility, processability, color stability, reduced peroxide consumption and low sulfur content.

THERMOPLASTIC

The Sunpar™ grades are also excellent choices for use with thermoplastic elastomers such as SBS, SEBS or TPVs. They offer the thermoplastic producer a balance of compatibility, improved processability, colorability and low volatiles.

SUNPAR™

The Sunpar™ series is produced at HollyFrontier Specialty Products' refinery in Tulsa, Oklahoma, through a solvent refining process, which maintains the traditional properties and benefits for which HollyFrontier's paraffinic oils are noted among rubber compounders.

FDA STATUS

Because of the industry's need for mineral oils conforming to specific FDA regulations, all of HollyFrontier Specialty Products' process oils have been tested. All of the Sunpar™ oils described here meet the requirements of a "paragraph c" or "third grade mineral oil" per 21 CFR 178.3620(c). Oils complying with 21 CFR 178.3620(c) may be used as a component of non-food articles in accordance with the regulations found on [Chart A](#).

CHART A

176.210

Defoaming agents used in the manufacture of paper and paper board

175.105

Adhesives

178.3910

Surface lubricants used in the manufacture of metallic articles (rolling of metallic foil and sheet stock only)

178.3120

Defoamer, animal glue (Ref: 176.210)

177.2800

Textiles, resin bonded

176.200

Defoaming agents used in coatings



OSHA STATUS

Sunpar™ oils do not require labeling as potential dermal carcinogens under the OSHA Hazard Communication Standard.

DERMAL BIOASSAY STATUS

For over 30 years, a representative number of severely refined paraffinic process oils have been submitted for lifetime Dermal Bioassay testing to assess the carcinogenic potential of our base and process oils. All have successfully passed, showing no evidence of carcinogenicity.

IP 346 STATUS

Sunpar™ grades described here comply with IP 346, producing less than 3 wt% DMSO extractables. This criterion is based upon European Commission Directives 94/69 EC, 21st Adaptation for coal and oil derived products. It stipulates that the classification as a carcinogen need not apply if it can be shown that the substance contains less than 3 wt% DMSO extractables as measured by IP 346.

PARAFFINIC OILS

SUNPAR™ GRADES – TYPICAL PROPERTIES

[illegible]

A close-up, black and white photograph of a tire tread. The surface is covered with numerous small, glistening water droplets, highlighting the texture of the rubber and the grooves of the tread pattern. The lighting creates strong highlights and shadows, emphasizing the three-dimensional nature of the droplets and the tread.

SUNDEX™ Aromatic Oils

SUNDEX™ AROMATIC OILS EXHIBIT
A HIGH AROMATIC CONTENT, HIGH
EXTENDER INDEX AND LOW WAX
CONTENT.

Compared to inferior oils, benefits include:

1. Higher oil loadings
2. Lower pound/volume cost
3. Faster mixing times, higher yields
4. Better carbon black dispersion

AROMATIC CONTENT

Higher aromatic content may offer both the polymer manufacturer and the rubber compounder more reliability and latitude to increase oil loading without unacceptable oil bleed out. Since there is generally nothing less expensive in most rubber recipes than process oil for both polymer and rubber compounders alike, the higher aromatic content helps reduce the pound/volume cost.

For the rubber compounder, the higher aromatic content also helps promote faster mixing by improving take-up time and therefore helps to increase more Banbury batches per eight-hour shift and, accordingly, productivity. Faster mixing times also translate into lower power consumption per batch.

The effect of high aromatic content is also shown in [Figure 5](#) where oil take-up time is shown as a function of viscosity-gravity constant (VGC) and molecular weight. VGC typically increases as aromaticity increases. As shown, mixing time is reduced with increasing VGC.

For many polymer systems an oil with higher aromatic content imparts better carbon black dispersion and, therefore, helps to achieve better product consistency for statistical process control. Our publication, "Effect of Rubber Processing Oils on the Dispersion of Carbon Black in SBR," discusses this in detail. It concludes that carbon black dispersion increases as the aromatic content of the oil increases, and that, in general, physical properties improve as the degree of dispersion increases.

WAX CONTENT

In tire building operations, where rubber is being layered, the lower wax content helps maintain building tack. Controlled wax content helps to prevent loss of building tack.

EXTENDER INDEX

Extender index is the amount of oil added to the polymer which will produce a Mooney viscosity of 53, a point midway between the 45–60 traditional specification range for many polymers. It is an indicator of the benefit of a higher aromatic oil, particularly in the manufacture of oil extended SBR.

To illustrate the concept of extender index, listed in **Figure 6** is the extender index for paraffinic and naphthenic oils compared with those of Sundex[™] aromatic oils.

Even relatively narrow differences in extender index or total aromatic content between aromatic extracts are important. In one case, Sundex[™] 8125TN, whose total aromatic content is in the 80s, was able to reduce the latex Mooney viscosity from 112 to 106, a nominal reduction of 5% compared to a competitive extract whose total aromatic content was in the low 80s. This reduction was considered significant in terms of reducing polymer yield loss.

OIL EMULSION STABILITY

Emulsion SBR refers to oil extended SBR, which is manufactured by adding emulsified extender oil to latex SBR rubber polymer. Since oil emulsion stability is important in this operation, we compared the emulsion stability of Sundex[™] 8125TN with a competitive offering by measuring the rate of water separation after emulsifying the extracts in distilled water with sodium oleate soap between 120°F and 130°F. The results are shown in **Figure 7**. The competitive product has poorer emulsion stability than Sundex[™] 8125TN. This may be due in part to its higher neutralization value of 0.63 mg KOH/g compared to 0.23 for the Sundex[™] 8125TN used in the evaluation. Poor emulsion stability can result in “spotty” rubber polymer in which there are pockets of high and low oil concentrations.

FIGURE 5: EFFECT OF HIGH AROMATIC CONTENT

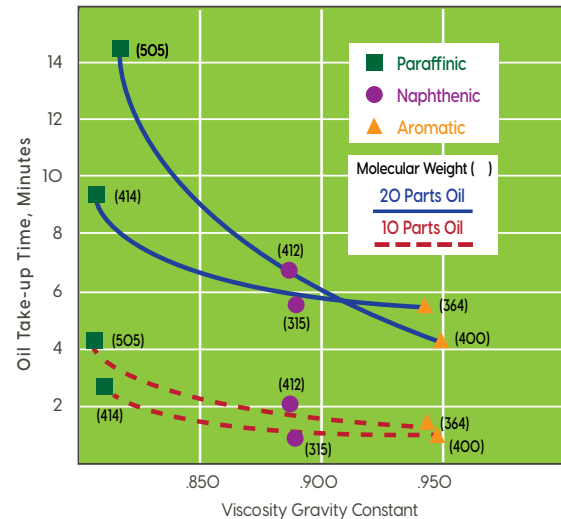
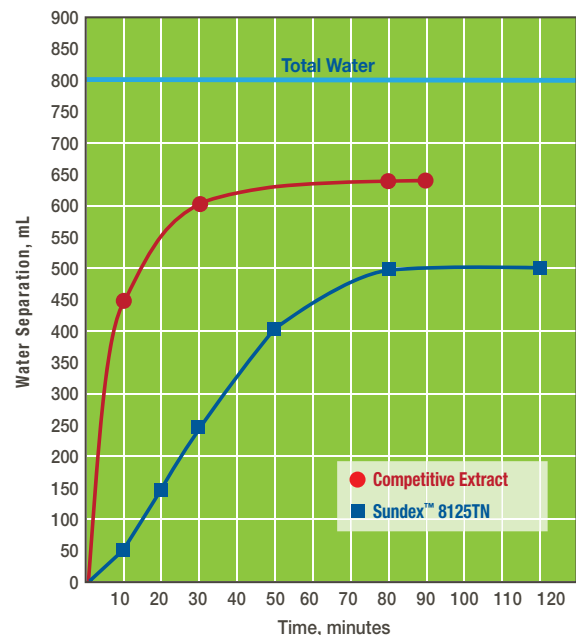


FIGURE 6: TYPICAL COMPARISON OF EXTENDER INDEX

OIL	EXTENDER INDEX
Paraffinic	38.5
Naphthenic	42.0
Sundex [™] 8125TN (Aromatic)	47.5

FIGURE 7: TYPICAL COMPARISON OF WATER SEPARATION RATE*



*Internal publication

THE SUNDEX™ SERIES

Aromatic Oils

HollyFrontier Specialty Products' aromatic rubber process oils, most of which are ASTM Type 101 or Type 102 oils, provide outstanding performance and potentially greater profits through their consistently high-quality and unique properties. HollyFrontier Specialty Products is more selective in its manufacturing procedure than many other producers of extract oils who consider their aromatic oils residual asphaltic products or by-products. HollyFrontier Specialty Products uses a solvent treating process and additional proprietary steps to extract the aromatics rather than distillation alone. The Sundex™ oils have distinctly better properties than inferior competitive extracts and thereby offer the rubber industry several compounding advantages. The higher aromatic levels (low aniline

points) of Sundex™ oils yield maximum loading potential and reduced mixing times through increased polymer compatibility. The low wax levels reduce "blooming" and "building tack" problems in tire assembly. Additionally, a cleaner work environment can be maintained when using Sundex™ oils because of their low volatility, which reduces smoking and volatile losses in the curing and mixing processes.

While the Sundex™ aromatic oils in the table below are not manufactured to be low PAH oils for use in European tire manufacturing, Sundex™ 8000 EU is. For information on this low PAH oil in compliance with EU Directive 2005/69/EC, contact your rubber process oil representative at 1-800-395-2786.

CHOOSE THE SERIES FROM SECTION A. CHOOSE THE GRADE FROM SECTION B

SECTION A	BUTYL - NATURAL POLYISOPRENE	SBR - NEOPRENE POLYISOPRENE	EPDM
Maximum Compatibility	Sunpar™	Sundex™	Sunpar™
Minimum Mixing Time	Sunpar™	Sundex™	Sunpar™
General Purpose	Sunpar™	Sundex™	Sunpar™

COLOR REQUIREMENTS

Good Natural Color	Sunpar™	Sunpar™	Sunpar™
U.V. Resistance	Sunpar™	Sunpar™	Sunpar™

SECTION B	SUNPAR™	SUNDEX™
Maximum Compatibility	110	8125TN, 7110T, 790T, 750T
Minimum Mixing Time	110	8125TN, 7110T, 790, 750T
General Purpose	110–150	8125TN, 7110T, 790TN, 790T, 750T
Good Initial Color	2280	–
U.V. Resistance	110	–
Low Volatility	2280	8125TN, 8600T
Maximum Contact Stain	150	790TN, 790T
Minimum Migration Stain	110	8600T
Low-Temperature Properties	110	750T

AROMATIC OILS
SUNDEX™ GRADES – TYPICAL PROPERTIES

VISCOSITY RANGE		LOW		MEDIUM	HIGH			LOW PAH	
TYPICAL PROPERTIES	ASTM Method	SUNDEX™ 840	SUNDEX™ 750T	SUNDEX™ 790TN	SUNDEX™ 8125TN	SUNDEX™ 7110T	SUNDEX™ 7120T	SUNDEX™ 165	SUNDEX™ 8000 EU
Viscosity, cSt @ 40°C		<p align="center">PLEASE CONTACT YOUR HOLLYFRONTIER SPECIALTY PRODUCTS REPRESENTATIVE FOR THE TYPICAL PROPERTIES CHART.</p>							
Viscosity, cSt @ 100°C									
Viscosity, SUS @ 100°F									
Viscosity, SUS @ 210°F									
Flash, COC, °C (°F)									
Pour Point, °C (°F)									
Gravity, API									
Density @ 15°C, kg/dm3									
Pounds/Gallons									
Total Acid No. mg KOH/g									
Total Sulfur, mass%									
Aniline Point, °C (°F)									
VGC									
Molecular Weight, g/mole									
Volatility, 22hr @ 225°F, mass%									
Carbon Type Analysis, %									
Aromatic (Ca)									
Naphthenic (Cn)									
Paraffinic (Cp)									
Clay-gel Analysis, mass%									
Asphaltenes									
Polar Compounds									
Aromatics									
Saturates									

HOLLYFRONTIER SPECIALTY OILS FOR RUBBER PROCESSING AND EXTENDING

ASTM D-2226 TYPE	PARAFFINIC	AROMATIC
	Light colored, low aromatic oils Good thermal and light stability with low volatility and odor	Highly unsaturated. High aromaticity provides excellent processing with low volatility
	SUNPAR™ GRADES 110 115 120 125 130 160 2170 2280	SUNDEX™ GRADES 840 750T 790T 7110T 7120T 8600T 790TN 8125TN
POLYMER COMPATIBILITY AND PROCESSING GUIDE		
SBR (Styrene Butadiene)	GOOD	EXCELLENT
Cis-polybutadiene	GOOD	EXCELLENT
Neoprene	NOT RECOMMENDED	EXCELLENT
EPR (Ethylene Propylene)	EXCELLENT	NOT RECOMMENDED
EPDM (Ethylene Propylene Diene)	EXCELLENT	DEPENDS ON POLYMER
Butyl	EXCELLENT	NOT RECOMMENDED
Polyisoprene	EXCELLENT	EXCELLENT
Natural	EXCELLENT	EXCELLENT
Thermoplastic	EXCELLENT	NOT RECOMMENDED
	GENERAL PROPERTIES	
Resistance To Discoloration By UV Light	EXCELLENT	GOOD
Volatility Losses	SLIGHT	NIL
Good Initial Color	GOOD	FAIR
		NOT RECOMMENDED

Quality, Safety and Efficiency with **WORLD-CLASS SUPPORT**

THE HOLLYFRONTIER SPECIALTY PRODUCTS RUBBER LAB

*Dedicated to ensuring customers receive
the finest products and greatest value.*

It is rare for an oil company to have a rubber chemist on staff, and even more rare to put a complete rubber lab at their disposal. But, that's only natural for HollyFrontier Specialty Products. Our Tulsa Refinery helped pioneer the use of oil in rubber over 70 years ago, and has remained in the forefront of the development of effective extender oils ever since. Its Sunpar™, Sundex™ and Circosol™ brands are world-renowned, and its Sundex™ 8000 EU was the first RAE available in North America.

The HollyFrontier Specialty Products Rubber Lab is fully equipped with state-of-the-art rubber compounding and testing equipment. Fully functional, it enables our experienced professionals to experiment with, and recommend, the most effective combinations of oil and rubber characteristics to meet performance requirements. Whether compounding, testing or analyzing, our chemists will work closely with Holly Frontier Specialty Products' customers in troubleshooting

existing compounds for improvements, or developing new products entirely. HollyFrontier Specialty Products views our Rubber Lab as the latest reinforcement of its role as more than a vendor, but as a responsible partner to the rubber industry.

CERTIFIED ISO 9001

Our oils are produced in strict compliance with statistical process control managed through the latest version of the ISO 9001 Quality Management System to ensure consistent quality.

REACH REGISTRATION

In accordance with the European Union (EU) REACH legislation, HollyFrontier Specialty Products, as a "Non-EU Manufacturer," has designated The Acta Group EU, Ltd (Acta EU) as our Only Representative (OR). Acta EU will retain records of the annual volume of substances imported by customers of HollyFrontier Specialty Products into the EU, and will ensure, where applicable, that the latest hazard communication (i.e., Safety Data Sheet) on these substances is supplied.





TRANSPORTATION LOGISTICS

HollyFrontier Specialty Products is proud to offer one of the most efficient and reliable transportation systems in the industry. The core components of the program include safety, information availability, equipment and service. Our fleet of 1,200 rail cars operates out of our centrally located refinery and our strategically located terminals around the country, ensuring prompt bulk delivery supported by the following critical logistics:

1. Electronic Information System (EIS)

The technology at the heart of our transportation system enables accuracy, speed, current information and integration with your system.

2. Rail Tracking Service

Our performance measurement and management system provides daily reports on car location and forecasted arrival dates. Daily reports contain standard railroad CLM reporting.

3. Rate Tracking Service

Our freight rating system ensures freight cost accuracy on invoices and enables prompt return of rate requests.

4. Electronic Data Interchange (EDI)

HollyFrontier Specialty Products sends all bill of lading information to the railroads via EDI, ensuring accuracy and timeliness in processing.

5. Transportation Service

HollyFrontier Specialty Products' integrated system may offer an attractive economy of scale and best meets your needs because we combine our inbound and outbound requirements for greater negotiating power. All this translates into added reliability and convenience, as well as savings for you.

HollyFrontier Specialty Products also offers convenient access to international shipments by sea, as well as shipments using Flexibag and ISOTANK via Texas and Oklahoma terminals.



SUNDEX™ 8000 EU

Low PAH, non-labeled Sundex™
8000 EU provides the shortest
stopping distance compared to
Naphthenic Oils*

CRITICAL STOPPING STARTS WITH YOUR RUBBER PROCESS OIL

Sundex™ 8000 EU, The Clean Aromatic Oil™, helps you put more safety and marketability into every tire you build. It is classified as a residual aromatic extract (RAE) and does not require R-45 labeling. It not only provides shorter stopping distances, it meets the EU Directive for tires, and does so at a lower cost when used as a drop-in replacement, as compared to low aromatic and naphthenic type oils.

Sundex™ 8000 EU Key Features & Advantages

- Economical drop-in replacement for non-compliant oil
- No compound formulation changes required
- Full tire performance retained
- Low PAH, non-labeled high aromatic oil
- Meets the European Union standard for non-carcinogenic rubber extender oil for tires

Scan to review our Tech Report:
*Superior Vehicle Stopping Distance
in Tire Tread Formulation Containing
Sundex™ 8000 EU*



40%
Shorter
DRY
Stopping
Distance

25%
Shorter
WET
Stopping
Distance



**FOR IMMEDIATE AND HELPFUL ANSWERS
TO YOUR TECHNICAL QUESTIONS CALL:
1-800-TECH-REP (832-4737)**

**Compared to other oils tested by an independent testing facility.*

HOLLYFRONTIER SPECIALTY PRODUCTS' NOMENCLATURE SYSTEM

HollyFrontier Specialty Products' nomenclature system has been adopted to make the identification of any of HollyFrontier Specialty Products oils quick and easy. Two basic types of oils are produced under the trade names shown below.

SUNPAR™

SUNDEX™

Because the aromatic content and viscosity largely determine the performance of oils in rubber, HollyFrontier Specialty Products further identifies its process oils by a number code of three or four digits. Adding a zero to the first digit gives the decade in which the aromatic content lies.

For the Sunpar™ grades, adding a zero to the remaining digits yields the approximate viscosity at 100°F in Saybolt Universal Seconds. Thus, Sunpar™ 150 is a paraffinic-type oil having an aromatic content between 10% and 19.9% and a viscosity at 100°F of 500 SUS. For the Sundex™ grades, the second, third and fourth (if any) digits give directly the approximate viscosity of these oils at 210°F. Sundex™ 8125TN, for example, is an aromatic oil having an aromatic content between 80.0 and 89.9, and a nominal viscosity at 210°F of 125 SUS.

First Digit	% Aromatic Content
1	10–19.99
2	20–29.9
3	30–39.9
etc.	etc.

ASTM REFERENCE OILS*

SPECIFIED PROPERTIES	ASTM METHOD	IRM No. 1	ASTM Oil No. 5
Aniline Point, °C	D611	124.0 +/-1.0	115.0 +/-1.0
Kinematic Viscosity, mm ² /s (cSt)	D445	18.7–21.0	10.8–11.9
99°C (210°F) Flash Point, COC, °C, min	D92	243	243

**As specified in ASTM D471-98*

