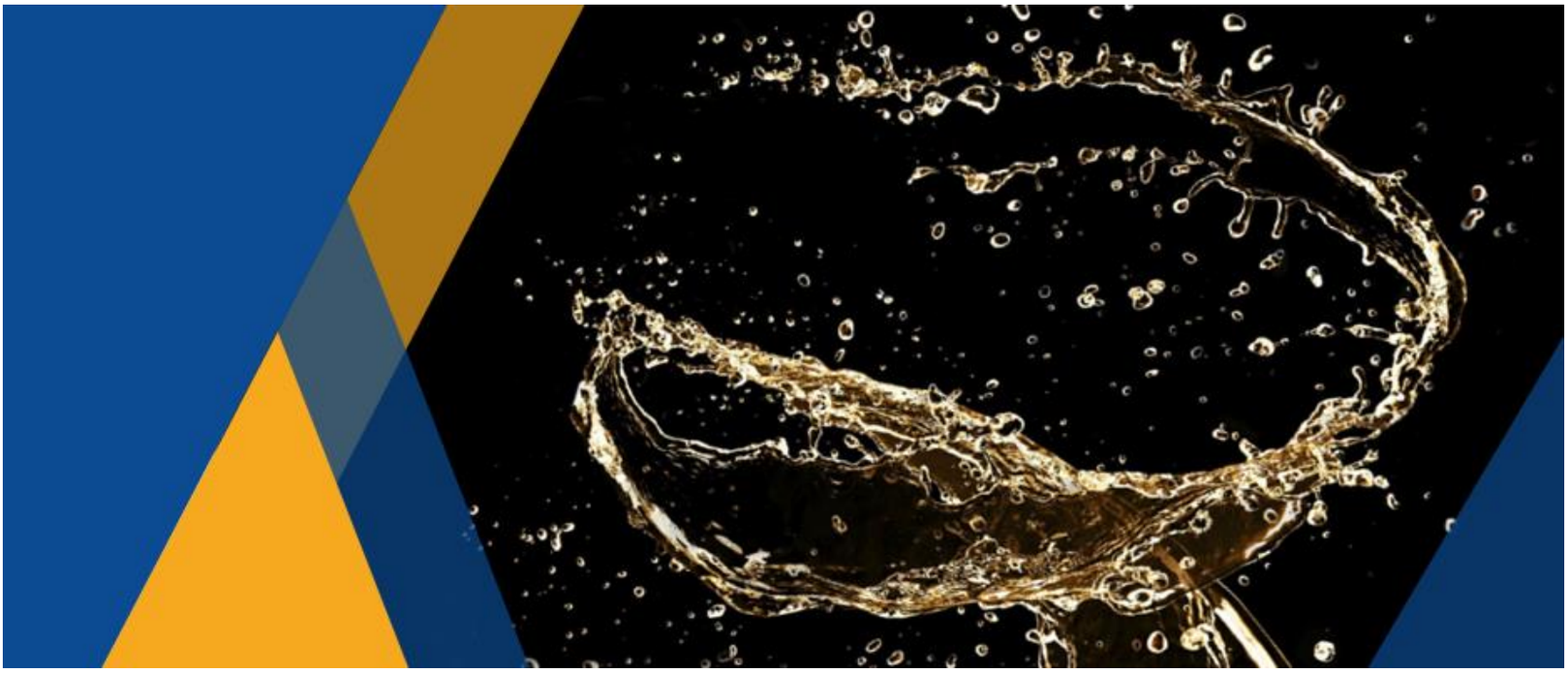
FUNCTIONAL PRODUCTS INC.

Innovative Chemistry for Lubricants

Tackifier Products



Industrial Lubricant Tackifiers 3
PARATAC 3
High Performance Synthetic Tackifiers 4
NSF HX-1 Tackifiers 4
Biobased Tackifiers 4
Tackifiers for Grease 5
Anti-misting Agents 5
Water-based and Silicone Specialty Tackifiers 6
Testing, Handling, and Blending Information 7
Quick Guide to Lubricant Tackifiers 8

QMS Certified to ISO 9001:2015 (With Design) REACH and GHS Compliant

8282 Bavaria Road | Macedonia, Ohio USA 44056 | 330-963-3060 | functionalproducts.com | March 2023

FUNCTIONAL PRODUCTS INC.

Since 1985, Functional Products Inc. has been a leading supplier of innovative polymer additives for lubricants and grease.

Functional Products Inc. manufactures market general components as well as unique, tailor-made additive solutions through development projects with clients. FPI produces over 300 standard or custom products from one drum to tanker batches.

All clients – from small blenders to multi-national corporations – receive world-class support on the necessary technologies, formulations, and regulations from experts on staff to succeed on their projects.

FPI's headquarters, offices, labs, and production are located in Macedonia, Ohio, USA. For global sales and warehousing, contact **sales@functionalproducts.com** or refer to page 2 of the **Applications Chart**.

Mission Statement

"Functional Products Inc. is committed to providing our customers with quality products and services that meet or exceed their expectations through the use of continuous improvement."

FPI is proud to maintain an ISO 9001:2015 (with design) quality management system and complies with all REACH and CLP regulations, including the Globally Harmonized System (GHS) for labeling.

Health and Safety

The product descriptions, labels, and datasheets (TDS) are not intended to take the place of a Safety Data Sheet (SDS).

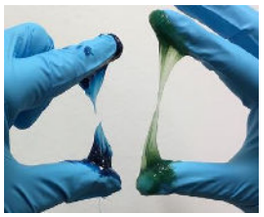
SDS are available online or requested at: sds@functionalproducts.com

Tackifier Products

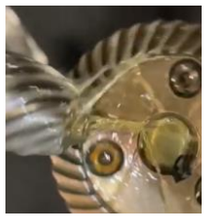
Lubricant tackifiers add an adhesive, string-like quality to lubricating oils, greases, and fluids. This viscoelastic behavior prevents fling-off, dripping, and misting on high speed equipment. Tackifiers also improve the surface wetting, sealing properties, and cohesion of lubes and greases. An efficient tackifier adds this effect at low treat levels with negligible effect on viscosity or other properties.

Tackifiers are used in wide range of applications, not limited to: Bar & chain oils, saw guide oil, open gear lubricants, antimist oil, cutting and metalworking fluids, rust preventatives, and grease.

Functional Products Inc. is the global leading manufacturer and researcher of tackifiers. This brochure highlights the key tackifiers for a wide range of petroleum, synthetic, and biobased base fluid types.





Scan to see the 'Tack in Action' ILMA Video

Excellence in Lubrication

Functional Products Inc. is an active member or participant in the following professional technical organizations:

STLE • ILMA • NLGI • ELGI • NLGI-IC • CLGI • K-STLE • AOCS •UEIL • Lube Expo

and supporter of university programs in lubrication and tribology.

Functional Products Inc. has received best technical paper awards at:

ELGI (Paris, 2011)
NLGI (Coeur d'Alene, 2018)
NLGI-IC (Amritsar, 2018)
CLGI (Wuyishan, 2011)

Functional Products Inc. was noted as an 'HPM Valuable Contributor' for the NLGI High Performance Multiuse Grease Specification (2020).

Scientists from FPI authored the chapter "Tackifiers and Antimisting Additives" in *Lubricant Additives: Chemistry and Applications*, 2nd ed. (2009) and 3rd ed. (2017), edited by Leslie R. Rudnick; and helped edit the *NLGI Lubricating Grease Guide*, 7th ed. (2022).

Industrial Lubricant Tackifiers

Functional Products Inc. offers further options to customize your selection to specific performance parameters or even different handling viscosities to suit different manufacturing sites. **FUNCTIONAL V-176** is an excellent start to any formulating project but see the last page of this brochure for a quick guide to tackifiers by application.

Tackifiers vary by the molecular weight of the active polymer, the concentration and viscosity, and by diluent oil.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length
V-172	Paraffinic	PIB	4000	Light Yellow	Better	48
V-175	Paraffinic	PIB	5900	Light Yellow	Fair	65 (0.25wt%)
V-176	Paraffinic	PIB	2900	Light Yellow	Good	55
V-177	Paraffinic	PIB	10500	Light Yellow	Good	98
V-178	Paraffinic	PIB	4000	Light Yellow	Good	90
V-178N	Naphthenic	PIB	4000	Orange	Good	90
V-188	Paraffinic	OCP	4000	Light Yellow	Best	28
V-298	Tech. White Oil	PIB	4000	Colorless	Good	53

Diluent Oil – FPI can offer over a dozen conventional and synthetic base stocks to prepare a custom-fit tackifier for your project.

Chemistry – Different active polymers have unique advantages that best complement an application.

PIB – polyisobutylene: best tackiness and lower handling viscosities

OCP – olefin copolymer: best thermal and mechanical stability

Proprietary – a unique polymer chemistry developed by FPI

Viscosity – In centistokes; products are available in lower viscosity cuts for better ease of handling or high viscosity cuts for better economics.

Color – Typical color of the product. Product color range is specified by ASTM D1500.

Shear Stability – Relative measure of ability to withstand shearing or crushing forces in application: Best > Better > Good > Fair > Poor

String Length – Measured at 0.5wt% in ISO 68 Group I; measure of tackiness with ductless siphon test method. See last page for more.

PARATAC® and PARATAC XT®

Functional Products Inc. is proud to offer legacy tackifiers PARATAC and PARATAC XT for all applications.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length
PARATAC	Paraffinic	PIB	2950	Light Yellow	Better	23
PARATAC XT	Paraffinic	PIB	750	Light Yellow	Good	41

PARATAC and **PARATAC XT** are high quality tackifiers with longstanding approvals in industrial and automotive applications.

PARATAC XT is recommended as an easy to handle and low viscosity option for facilities with limited heating or pumping capabilities.

Specialty Tackifiers for Lubrication

High Performance Synthetics

For Synthetic Oils or High Temperature Use

Prior work has found that additives based in Group I or II conventional oil can carry over sufficient impurities to full synthetic base oils to affect oxidative or color stability. The V-300 series is formulated in synthetic Group III base oil which adds greater oxidation stability over the colorless V-200 or V-400 products.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length
V-378	Group III	PIB	6250	Colorless	Good	75
V-388	Group III	OCP	4000	Colorless	Best	22

NSF HX-1 Incidental Food Contact

For Food Machinery Lubricants and Greases

Incidental food contact, or food machinery, lubricants require rigorous compliance to NSF standards. V-400 products are formulated in NSF H1 white oil and are registered on the NSF White List to ensure that formulations will pass NSF review.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length	HX-1?
V-422	H1 White Oil	PIB	3000	Colorless	Good	53	Yes
V-425	H1 White Oil	OCP	3000	Colorless	Best	15	Yes
V-475	H1 White Oil	PIB	1650	Colorless	Fair	82	Yes

Biobased or Biodegradable

For Environmentally Acceptable Lubricants (EAL)

Natural oils, synthetic esters, and other biodegradable or 'environmentally acceptable lubricants' require unique tackifiers to impart tack effectively. Functional Products Inc. has been a strong supporter of the European Ecolabel program and features a number of additives on the European Ecolabel Lubricant Substance Classification (LuSC) list. See the **Biobased Additive** brochure for more information.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length	Ecolabel?
V-188P2	PAO	OCP	9250	Colorless	Best	20	Yes
V-515	Triglyceride	Proprietary	8000	Yellow	Good	5	Yes
V-584	Triglyceride	Proprietary	1250, 40°C	Amber	Fair	10	Yes

Tackifiers for Grease

In addition to **FUNCTIONAL V-177** and other concentrated tackifiers, there are specialized tackifiers for imparting cohesion and adhesion to industrial lubricating grease.

Emulsion Form Grease Tackifier

FUNCTIONAL V-191 is a highly concentrated tackifier to add tack and consistency to calcium or particle based greases.

Product	Diluent Oil	Chemistry	Typical Color	pH
V-191	Water	Proprietary	White	10

Solid Grease Polymers

Solid polymers melted into a batch of grease provide high amounts of tackiness which will best survive the intense greasemaking and milling processes. See the **Grease Additive** brochure from Functional Products Inc. for more

Product	Suggested wt%	Form	Polymer Type	Recommended Use
V-207	0.5wt%	Flake	Temp. Sensitive	Calcium sulfonate, calcium sulfonate complex
V-211	0.5wt%	Flake	Temp. Sensitive	Aluminum complex; NSF HX-1 greases

Anti-misting Agents

Misting of metalworking fluids is an environmental and health concern in many metal-removal applications such as milling and grinding. Anti-misting agents are similar to tackifiers but provide mist suppression without contributing tackiness to the lubricant.

Anti-mist additives **FUNCTIONAL MW-612** and **V-162** greatly reduce the formation of mist and are especially in equipment that lacks mist-collecting systems. **FUNCTIONAL V-421** is available as an NSF HX-1 incidental food contact version of **FUNCTIONAL V-162**.

Product	Diluent Oil	Chemistry	Viscosity, 40°C	Typical Color	Shear Stability	Note
V-162	Paraffinic	PIB	850	Light Yellow	Excellent	Industrial oils
V-421	H1 White Oil	PIB	3000	Colorless	Excellent	Food grade, NSF HX-1
MW-612	Water/Oil	Proprietary	10	Colorless	Excellent	For emulsions

Unique Tackifiers for Specialty Fluids

Water-Based Tackifiers

FUNCTIONAL V-802P is an environmentally friendly, nonhazardous liquid additive that thickens and confers tack/stringiness to fluids made from water or emulsions of water and soluble oils. Other applications include: flocculating agents, home care/cleaning, and ceramic applications, including as a binder for powders and an anti-sag agent in paints.

Product	Diluent Oil	Chemistry	Typical Color	pH	NSF HX-1
V-801	Water	Proprietary	White	Neutral	No
V-802	Mixture	Proprietary	White	Neutral	Yes
V-802P	Mixture	Proprietary	Colorless	Basic	No

Silicone Tackifier and Anti-Mist

FUNCTIONAL V-870 is a tackifier for lubricants based in silicone or silicone/petroleum blends. **FUNCTIONAL V-870** is an effective anti-mist agent in low viscosity silicone sprays or lubricants to prevent unwanted aerosol formation.

Product	Diluent Oil	Chemistry	Viscosity, 100°C	Typical Color	Shear Stability	String Length
V-870	Proprietary	Proprietary	8500	Colorless	Good	22

Instructions for Testing, Handling, and Blending

String Length Testing using the Ductless Siphon Method:
The ductless siphon method quantifies the tackiness of fluids up to ISO 100. 100 mL of sample is placed in a 100 mL graduated cylinder and evacuated through capillary tube under vacuum. The capillary is positioned at the surface of the liquid level and as the fluid is evacuated the surface level will drop. This causes a string of oil to be pulled between the capillary tip and the receding liquid level. Tackier solutions will draw a longer string of oil than less tacky solutions; non-tacky solutions do not form an oil string. The maximum height of the filament supported by the vacuum is recorded as the string length in arbitrary units, i.e. “80 mL DS” or “ductless siphon string length of 80”.

A comprehensive discussion of this test method is available. The ductless siphon test is based upon a paper, *Evaluating Tackiness of Polymer Containing Lubricants by the Open Siphon Method: Experiments, Theory, and Observation*, which was authored by scientists from FUNCTIONAL PRODUCTS INC. and the University of Akron Department of Polymer Engineering.

Incompatibilities:
Like other polymers, tackifier polymers can drop out of solution if the polarity of the diluent is changed. Usually, this problem arises when a polymer is blended with another (more-polar) additive such as a motor oil detergent package, way oil package or a sulfonate emulsifier. In such cases the polymer may drop out of solution. Incompatibility can be avoided by attention to the blending sequence; when blending a polymeric additive and a polar additive, always completely dissolve one additive in the diluent oil before starting the addition of the other.

Blending:
Viscous additives like tackifiers can be difficult to mix into low-viscosity diluents. Poor mixing may cause incompatibility when other additives are added (as stated above). If the agitation is not sufficient for good blending, the easiest solution is to heat the tackifier before blending.

Thermal Breakdown:
Polyisobutylene-based tackifiers start to break down during prolonged storage above 100°C (212°F). Fortunately, most tackifier applications are at modest temperatures. Some greases, however, are made at higher temperatures and breakdown can occur. Be especially wary of the long cooling time of grease that is drummed hot.

Shear Breakdown:
The high molecular weight of polymers provides tack in solution. While some tackifiers are more shear-stable than others, shear will eventually break down any tackifier. The shear that occurs in agitating with air or with ordinary open propellers is typically not a serious problem.

Shear in pumping, however, frequently leads to loss of tackiness. Best practice is to use a diaphragm pump or centrifugal pump, without pump recirculation during blending. The number of transfer operations should be minimized. Be especially careful about devices that re-circulate through a by-pass to limit pressure. One solution is to replace the pump with an air-driven diaphragm pump, which will stop pumping when the discharge pressure reaches the limit.

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Quick Guide to Lubricant Tackifiers

Decades of R&D in lubrication suggest these eight key tackifiers for starting a new project:

FUNCTIONAL V-176

Versatile industrial tackifier; good balance in effectiveness, handling viscosity, and stability.

Key Areas: General purpose lubricants

PARATAC

Legacy tackifier with long-standing OEM approvals. Improved shear stability.

Key Areas: Industrial, auto, off-highway

FUNCTIONAL V-178

High strength, efficient tackifier for lubricants used at higher speed or lower viscosity.

Key Areas: Machine oils, slideway

FUNCTIONAL V-188

Unique mechanically and thermally stable chemistry for enclosed or open gears.

Key Areas: Gear oil, long service life

FUNCTIONAL V-177

Highly concentrated tackifier for thickening and tackifying industrial greases or coatings.

Key Areas: Grease, rust coatings, seals

FUNCTIONAL V-298

Clear and colorless in aromatic-free oil for the best color stability to prevent staining.

Key Areas: Textile, needle oil, paints

FUNCTIONAL V-422

NSF HX-1 tackifier for incidental food contact. Clean burn off and low varnish at high temperatures.

Key Areas: NSF H1, oven, chain

FUNCTIONAL V-584

Biodegradable and biobased tackifier for natural vegetable oils and fatty synthetic esters. NSF HX-1 listed.

Key Areas: Environmental, esters

Suggested treat levels to start:

Light Tack	Medium Tack	Heavy Tack
0.3 – 0.5wt% Tackifier	**0.5 – 1.0wt% Tackifier**	**1.0 – 2.0wt% Tackifier**
Table and slideway lubes	Pneumatic / rock drill oils	Bar & chain and saw guide oils
Circulating oil	Non-drying corrosion preventatives	Open gear lubricants and greases
Textile machinery and needle oil	Wire rope lubricants	Neat cutting lubricants