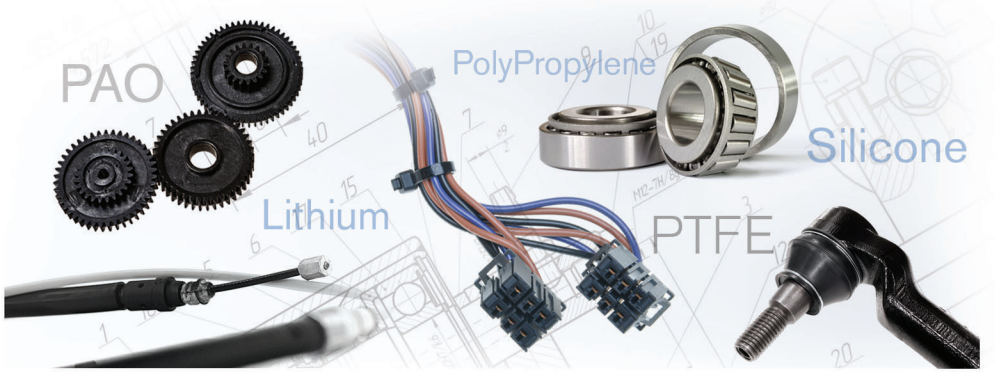
An Engineer's Guide to **Selecting a Grease**



Matching Oils with Plastics, Elastomers and Thickeners

		Mineral -30 to 100°C	PAO -60 to 150°C	Ester -70 to 150°C	PAG -40 to 180°C	Silicone -75 to 200°C	PFPE -90 to 250°C
Oil + Oil	Mineral Oil	↑	↑	↑	↓	↓	↓
	Synthetic Hydrocarbon Oil (PAO)	↑	↑	↑	↓	↓	↓
	Ester Oil	↑	↑	↑	↑	↓	↓
	Polyglycol Oil (PAG)	↓	↓	↑	↑	↓	↓
	Silicone Oil	↓	↓	↓	↓	↑	↓
	PerFluoroPolyEther Oil (PFPE)	↓	↓	↓	↓	↓	↑
Oil + Plastics	Acrylonitrile butadiene styrenes (ABS)	●	●	↓	↓	↑	↑
	Polyamides (nylons) (PA)	↑	↑	↑	●	↑	↑
	Polyamide-imides (PAI)	↑	↑	↑	↑	↑	↑
	Polybutylene Terephthalates (PBT)	↑	↑	●	●	↑	↑
	Polycarbonates (PC)	●	●	↓	↓	↑	↑
	Polyethylenes (PE)	●	●	●	●	↑	↑
	Polyetheretherketone (PEEK)	↑	↑	↑	↑	↑	↑
	Phenol-formaldehyde (phenolics) (PF)	↑	↑	↑	↑	↑	↑
	Polyimides (PI)	↑	↑	↑	↑	↑	↑
	Poly-oxymethylenes (acetals) (POM)	↑	↑	↑	●	↑	↑
	Polyphenylene oxides (PPO)	↑	↑	↓	↓	↑	↑
	Polyphenylene sulfides (PPS)	↑	↑	↓	↓	↑	↑
	Polysulfones (PSU)	↑	↑	↓	↓	↑	↑
	PolyPropylene (PP)	●	●	●	↑	↑	↑
	PolyTetraFluoroEthylene (PTFE)	↑	↑	↑	↑	↑	↑
	Polyvinyl chlorides (PVC)	●	●	↓	↓	↑	↑
	Thermoplastic Polyurethane (TPU)	↑	↑	●	●	↑	↑
Oil + Elastomers	Polyacrylate Rubber (ACM)	↑	↑	●	●	↑	↑
	Vamac (AEM)	↑	↑	●	●	↑	↑
	Polychloroprene (CR)	↑	↑	↓	↓	↑	↑
	Ethylene Propylene Diene Monomer (EPDM)	↓	↓	●	↑	↑	↑
	Fluoroelastomers (FKM)	↑	↑	↑	↑	↑	↑
	FluoroSilicone Rubber (FVMQ)	●	●	●	↑	↓	↑
	Hydrogenated NBR (HNBR)	↑	↑	●	●	↑	↑
	Butyl (IIR)	↓	↓	↓	↓	↑	↑
	Nitrile (Buna N) (NBR)	↑	↑	●	●	↑	↑
	Buna S (SBR)	↓	↓	↓	↓	↑	↑
	Silicone (VQM)	●	●	●	↑	↓	↑
	Natural Rubber	↓	↓	↓	↓	↑	↑
Oil + Thickeners	Aluminum (Al)	↑	↑	↑	↓	↓	↓
	Aluminum Complex (Al Comp)	↑	↑	↑	↓	↓	↓
	Amorphous Silica (Si)	↑	↑	↑	↑	↑	↑
	Barium Complex (Ba Comp)	↑	↑	↑	↓	↓	↓
	Bentonite Clay (Bentone)	↑	↑	↑	↓	↓	↓
	Calcium (Ca)	↑	↑	↑	↓	↓	↓
	Calcium Complex (Ca Comp)	↑	↑	↑	↓	↓	↓
	Calcium Sulfonate (Ca Sul)	↑	↑	↑	↓	↓	↓
	Lithium (Li)	↑	↑	↑	↑	↑	↓
	Lithium Complex (Li Comp)	↑	↑	↑	↑	↑	↓
	Polyurea (Urea)	↑	↑	↑	↓	↓	↓
	PolyTetraFluoroEthylene (PTFE)	↑	↑	↑	↑	↑	↑
	Sodium Complex (Na Comp)	↑	↑	↑	↓	↓	↓

How Thickeners Enhance Greases

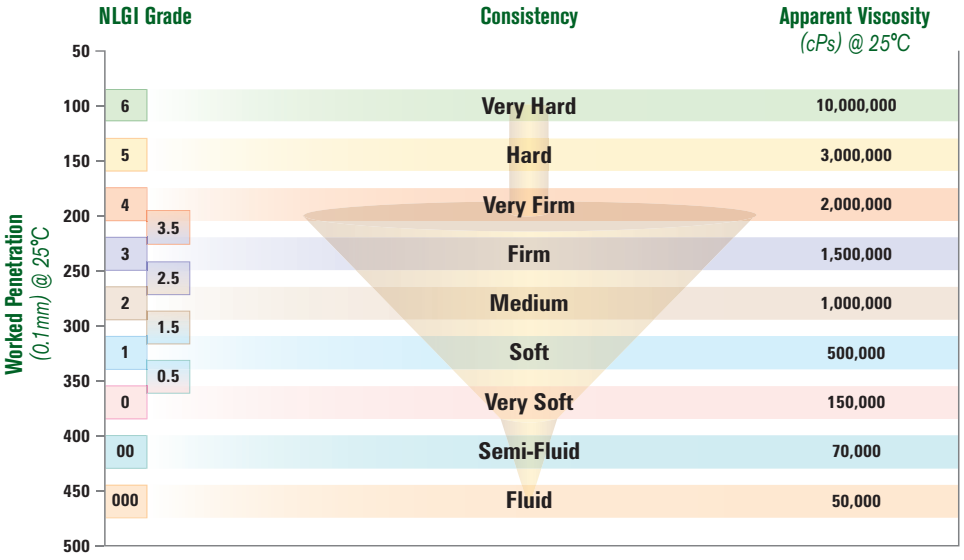
	Aluminum	Aluminum Complex	Amorphous Silica	Barium Complex	Bentonite	Calcium	Calcium Complex	Calcium Sulfonate	Lithium	Lithium Complex	Polyurea	PTFE	Sodium Complex
Adhesive	●	↑	↓	↑	●	●	↑	↑	●	↑	●	↓	↑
Autophoretic Paint Process	●	●	●	●	●	●	●	●	●	●	↑	↑	●
Corrosion	↑	↑	●	↑	●	●	↑	↑	●	●	↑	●	↑
Dropping Point	↓	↑	↑	↑	↑	↓	↑	↑	●	↑	↑	↑	●
Fretting	●	●	●	●	●	●	↑	↑	●	●	●	●	●
Low Friction	●	●	↓	●	↓	●	●	↓	●	●	●	↑	●
Salt Water	↓	●	↑	●	●	↓	●	↑	↓	●	●	↑	●
Water	↑	↑	↑	↑	↓	↑	↑	●	●	↑	↑	↑	↓
Wear	↑	↑	↓	↑	●	↑	↑	↑	↑	↑	↑	↑	↑
Worked Stability	↓	↑	●	↑	●	●	●	↑	↑	↑	●	↑	●

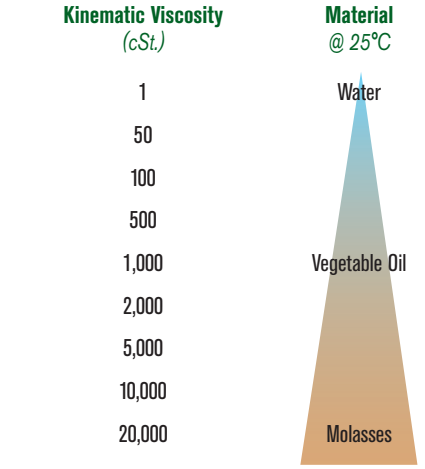
How Thickeners Mix with Thickeners

	Al <80°C	Al Comp <175°C	Si <300°C	Ba Comp <135°C	Bentone <200°C	Ca <110°C	Ca Comp <175°C	Ca Sul <175°C	Li <135°C	Li Comp <175°C	Urea <200°C	PTFE <275°C	Na Comp <125°C
Aluminum (Al)	↑	↑	↑	●	↑	●	↑	↓	↑	↑	↑	↑	●
Aluminum Complex (Al Comp)	↑	↑	↑	↑	●	↑	●	●	↑	↑	●	↑	●
Amorphous Silica (Si)	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Barium Complex (Ba Comp)	●	↑	↑	↑	↑	↑	●	●	↑	●	●	↑	↑
Bentonite Clay (Bentone)	↑	●	↑	↑	↑	↑	●	↓	●	↑	↑	↑	↓
Calcium (Ca)	●	↑	↑	↑	↑	↑	↑	↑	↑	↑	●	↑	↑
Calcium Complex (Ca Comp)	↑	●	↑	●	●	↑	↑	●	↑	↑	↑	↑	↑
Calcium Sulfonate (Ca Sul)	↓	●	↑	●	↓	↑	●	↑	●	●	●	↑	↓
Lithium (Li)	↑	↑	↑	↑	●	↑	↑	●	↑	↑	●	↑	↓
Lithium Complex (Li Comp)	↑	↑	↑	●	↑	●	↑	●	↑	↑	●	↑	●
Polyurea (Urea)	↑	●	↑	●	↑	↑	↑	●	●	●	↑	↑	↑
PolyTetraFluoroEthylene (PTFE)	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sodium Complex (Na Comp)	●	●	↑	↑	↓	↑	↑	↓	↓	●	↑	↑	↑

↑ Should be safe ● May or may not work ↓ Don't try it

Crib Notes: Understanding Our Lubricant Data Sheets





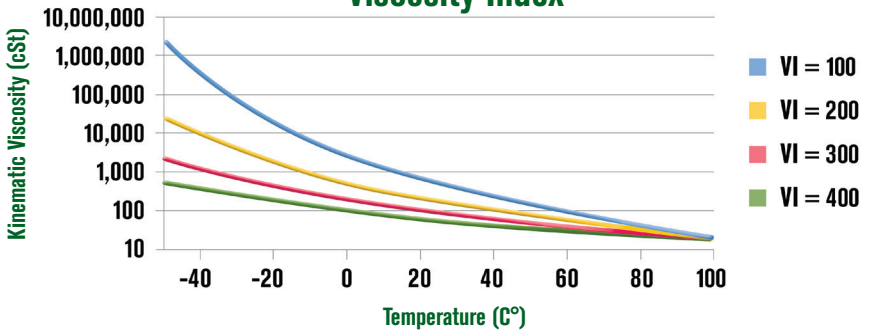
Grease Addtives

- Antioxidants
- Antiwear/Anti-scuffing
- Extreme pressure/Solid lubricant
- Color and UV dyes
- Electrical conductivity
- Friction reducers
- Rust and corrosion inhibitors
- Tackifiers/polymers
- Thermal conductivity
- VI improvers

Lubricant Properties	Test Methods		
Base Oil Visc cSt. (mm^2/s)	ASTM D-445	JIS K 2220 23	DIN 51562
Unworked Penetration, 1/10 mm (25°C)	ASTM D-217	JIS K 2220 7	DIN 51804-T1
Worked Penetration, 1/10 mm (25°C)	ASTM D-217	JIS K 2220 7	DIN 51804-T1
Density, g/cc (25°C)	ASTM D-1480	JIS K 2249	–
Dropping Point (°C)	ASTM D-2265	JIS K 2220 8	DIN ISO 2176
Evaporation (24 hrs @ 100°C)	ASTM D-972	JIS K 2220 10	–
Oil Separation (24 hrs @ 100°C)	ASTM D 6184	JIS K 2220 11	–
Four-Ball Wear 40kg, (60 min, 1200 rpm, 75°C)	ASTM D-2266	–	DIN 51350-T5
Four-Ball EP, Weld Load (1770 rpm, 100 – 800 kg)	ASTM D-2596	–	DIN 51350-T4
Copper Corrosion (24 hrs @ 100°C)	ASTM D-4048	JIS K 2220 9	DIN 51811
Low Temperature Torque (-40°C)	ASTM D-1478	JIS K 2220 18	–
Oxidative Stability, 100 hours (100°C)	ASTM D-942	JIS K 2220 12	DIN 51808
Water Washout (60 min @ 80°C)	ASTM D-1264	JIS K 2220 16	DIN 51807-T2

-40°C Torque (g-cm)	-40°C Torque (N-m)	4 Ball Wear (mm)	Ratings	Load Wear Index (kg)	Weld Load
>10,000	>1.00	>1.50	Not Good	< 25	< 200
5,000	0.50	1.25	Fair	25	250
2,500	0.25	1	Okay	40	315
1,000	0.10	0.75	Good	60	400
500	0.05	0.5	Very Good	80	500
100	0.01	0.4	Excellent	100	620
<100	<0.01	<0.4	Outstanding	>100	800

Viscosity Index



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