

**FUNCTIONAL PRODUCTS INC.**

**Innovative Chemistry for Lubricants**

## **High Viscosity Synthetic Base Stocks**



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

***8282 Bavaria Road – Macedonia, Ohio – 44056***

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## HIGH VISCOSITY SYNTHETIC BASE STOCK GRADES

**FUNCTIONAL** high viscosity synthetic base stocks are highly shear stable alternatives to viscosity modifiers to blend high performance lubricants that meet the most demanding shear stability and low temperature requirements. These base stocks provide reduced treat rates and better additive compatibility over polybutene, liquid ethylene-propylene, and mPAO stocks.

Product	Chemistry	20hr KRL SSI	KV @ 100°C	KV @ 40°C	Viscosity Index	Color D1500	lb/gal
<b>FUNCTIONAL V-705</b>	Olefin	4	6500	37,000	510	< 0.5	7.5
<b>FUNCTIONAL V-731</b>	EPO	8	1100	18900	270	< 0.5	7.1
<b>FUNCTIONAL V-732</b>	EPO	13	2000	37500	300	< 0.5	7.1
<b>FUNCTIONAL MB-1010</b>	Methacrylate	15	900	44,000	170	< 1.0	7.8

Formulation guides for gear oils, hydraulic fluids, and industrial or automotive lubricants can typically be found with technical datasheets for each product. Functional Products has a library of starting point formulations and can design new formulations based on your specifications and preferred raw materials or base oils.

## TYPICAL PHYSICAL PROPERTIES

	Test	V-705	V-731/732	MB-1010
API Gravity	D7777	26.37	36.95	19.53
Specific Gravity, g/mL @ 60F	D7777	0.90	0.84	0.94
Flashpoint, Open Cup, °C/°F	D92	>220C	>290C	>150C
Total Acid Number, mg KOH/g	D974	3.86	0.01	3.66
Water by Karl-Fischer, ppm	D6304	170	30	320
RPVOT, minutes	D2722	491	TBD	58
Aniline Point, Celsius	D611	N/A	>170°C	N/A
Elemental Analysis by ICP *	D5185	Nil	TBD	1360 ppm S

\* All other elements below detection limit of ASTM D5185 XRF method.

## SOLUBILITY GUIDE

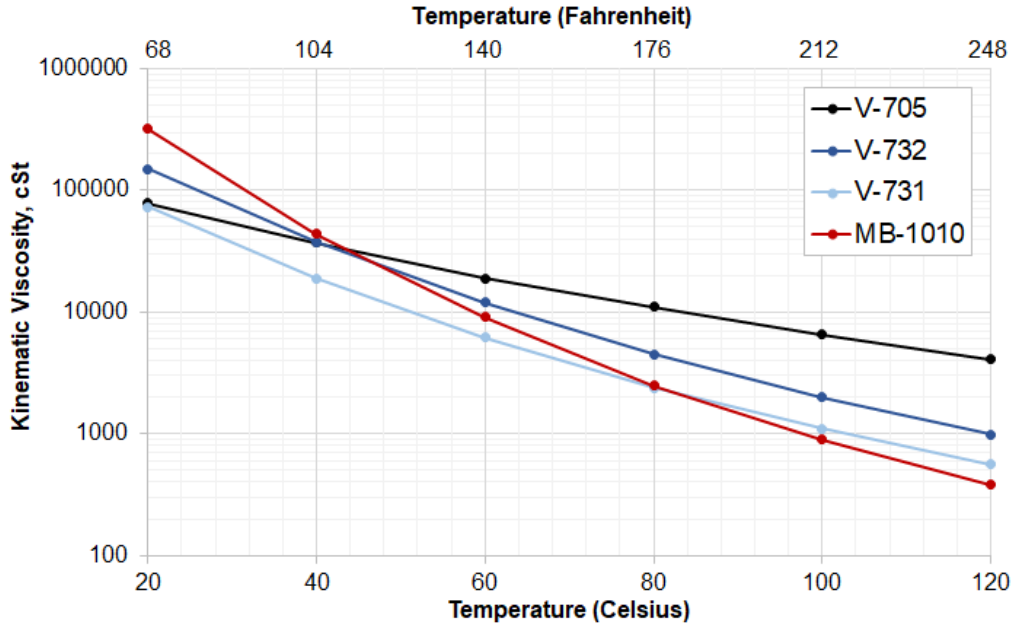
**FUNCTIONAL** synthetic base stocks compatibility in typical petroleum-based lubricating oils.

Product	Paraffinic Oil Gr. I-III	PAO Gr. IV	mPAO Gr. IV	Naphthenic Oil	White Oil	Bright Stock
<b>FUNCTIONAL V-705</b>	•	•		•	•	•
<b>FUNCTIONAL V-731/732</b>	•	•		•	•	•
<b>FUNCTIONAL MB-1010</b>	•	•		•	•	•

**FUNCTIONAL** synthetic base stocks compatibility in environmentally acceptable lubricant (EAL) base stocks.

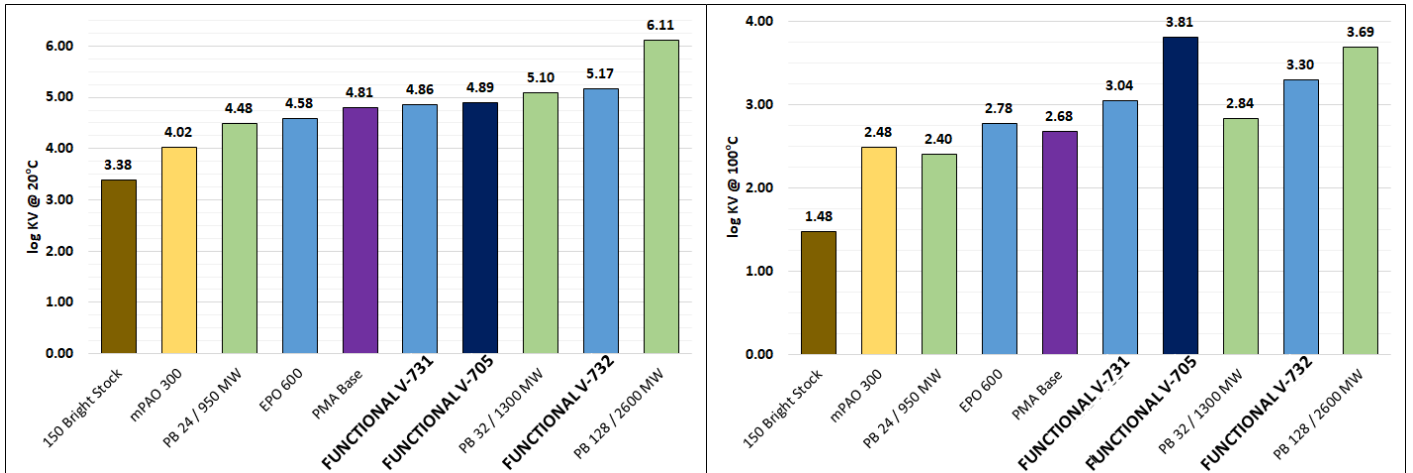
Product	Vegetable Oil	Blown Oil	Polyol Ester	TMP Ester	Complex Ester	PAG
<b>FUNCTIONAL V-705</b>	•		•	•	Some	OS
<b>FUNCTIONAL V-731/732</b>	•					
<b>FUNCTIONAL MB-1010</b>	•	•	•	•	•	WI / OS

# HANDLING VISCOSITY



T (°C)	T (°F)	V-705	V-732	V-731	MB-1010
20	68	78000	150000	73000	320000
40	104	37000	37500	18900	44000
60	140	19000	12000	6200	9100
80	176	11000	4500	2400	2500
100	212	6500	2000	1100	900
120	248	4100	990	560	380

## Handling Viscosity (T = 20°C) vs. High Temp. Viscosity (T = 100°C) by Chemistry vs. Others



## PACKAGING OPTIONS

Functional Products Inc. supports a wide range of packaging options.

Product	Net Product Weight in Container		
	Open Head Drum (48 gallons product)	Tote (230-260 gallons product)	Bulk Tanker (6000 gallons product)
<b>FUNCTIONAL V-705</b>	363 lb (165 kg)	1764 lb (800 kg)	45,000 lb (20412 kg)
<b>FUNCTIONAL V-731/732</b>	352 lb (160 kg)	TBD	TBD
<b>FUNCTIONAL MB-1010</b>	379 lb (172 kg)	1984 lb (900 kg)	46,800 lb (21228 kg)

## BATCH-TO-BATCH CONSISTENCY

### FUNCTIONAL V-705

	KV40, cSt	KV100, cSt
Lot #1	36997	6450
Lot #2	36721	6422
Lot #3	36862	6525
Average	36860 +/- 0.4%	6466 +/- 0.8%

### FUNCTIONAL MB-1010

	KV40, cSt	KV100, cSt
Lot #1	60872	1267
Lot #2	66722	1349
Lot #3	62736	1285
Average	63443 +/- 4.7%	1300 +/- 3.3%

### FUNCTIONAL V-731

	KV40, cSt	KV100, cSt
Lot #1	21000	1112
Lot #2	22003	1177
Lot #3	19400	1122
Average	20801 +/- 6.3%	1137 +/- 3.1%

### FUNCTIONAL V-732

	KV40, cSt	KV100, cSt
Lot #1	38300	2010
Lot #2	37500	1995
Lot #3	37000	1996
Average	37600 +/- 1.7%	2001 +/- 0.42%

## HANDLING GUIDE

**SAFETY** – Consult safety data sheet before any transferring operation and wear appropriate PPE for both the physical hazards of heating and pressurized fluids/equipment and any chemical hazards associated with the product. When working with heated surfaces or liquids, the ASTM C 1055 standard suggests temperatures of 100°F/40°C can cause immediate pain with skin damage after long-term exposure while temperatures of 140°F/60°C can cause immediate damage to skin upon contact.

**Drums and tote unloading** – Drums can be warmed to facilitate pouring or pumping with a hot room, drum oven, or individual heating jackets. Totes should be warmed in a hot room or drum oven but heating jackets should be avoided to prevent melting of the plastic container. Inspect containers for residual product before proper disposal. See the Handling Viscosity chart for guidance on reducing viscosity by applying heat.

**Bulk unloading** – Bulk shipments of high viscosity synthetic base stocks should be requested with ‘in transit heat’ to allow the product to be delivered at approximately 100-160°F (40-70°C). Purge all hoses and pumps before and after unloading. Due to the high shear stability of the product, most pump types will be suitable for transferring the product. Applying more steam on-site should be limited to steam pressures of 50 psi (150°C) or the steam pressure limit of the tanker, whichever is lower.

**Storage** – High viscosity synthetic base stocks may be transferred to large heated storage tanks for ease of use in production. Long-term storage is recommended at 100-160°F (40-70°C) under nitrogen. Use the lowest

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temperature possible to achieve acceptable pumpability to minimize product oxidation and discoloration. Avoid localized hot spots above 300°F (150°C) by restricting boiler and steam jacket pressure to 50 psi or less. Check storage tank regularly for discoloration or changes to viscosity. Circulate tank once per day.

## BLENDING GUIDE

**Lubricants** – Blending high viscosity synthetic base stocks should occur at 100-140°F (40-60°C). Add base oils in order from lowest to high viscosity followed by viscosity modifiers (or VI improvers), additives and packages, and finally tackifiers. Allow 30 minutes of continuous mixing between each different components to ensure equal mixing and avoid possible incompatibilities. Once all components have been added proceed with QC and oil adjustments to reach target viscosity. Mixing speed should be regulated to avoid aerating the product and ideally to minimize disturbances to the surface which will reduce oxidation and discoloration.

**Lubricants with solid polymer** – If dissolving solid polymers then it is recommended to add 0.1wt% of a process antioxidant such as BHT and heat the base oils to 176-212°F (80-100°C). Grind bales to ¼” pieces or chop into 1” slides and add to tank manually or through a conveyor or blower system. Allow 8-16 hours for polymers to dissolve with higher concentrations of higher MW polymers requiring the longest time. Adjust times and temperatures as needed but always confirm a process change at small scale in the lab first.

**Grease** – Add high viscosity base stocks after the soap making reaction once the temperature of the batch has been adjusted to 176-212°F (80-100°C) with cooling oil. Add the base stock and mix continuously for one hour to ensure even distribution of the base stock into the soap network. If solid polymers are used in the grease formulation then add the solid polymer per supplier instructions (typically mix at 176-212°F (80-100°C) for 1-3 hours) before adding the high viscosity base stock. This order of addition allows the solid polymer to dissolve faster in the lower viscosity base oil before adjusting with high viscosity base stock.

**Tank and Mixer Design** – Functional Products recommends an upright mixing tank equipped with external steam jacket, side baffles, top-mounted paddle mixer, and center drain to ensure the most thorough blending of high viscosity liquids into other base oils and additives. Various paddle/agitator designs are acceptable. Consult Functional Products Inc. for a generic tank schematic or how to adapt an existing tank.

High viscosity synthetic base stocks are typically compatible with ultrasonic homogenizers or disintegrators but blenders should observe for discoloration and accelerated oxidation during long blend times. Default manufacturer settings on homogenizers may not be optimal for lubricant blending.

Mixing by recirculating with a pump is not recommended and may produce areas of poorly mixed lubricant with higher or lower viscosity than expected. The use of heating, tank baffles, and a tank eductor nozzle may greatly improve recirculation mixing performance when mixing capabilities are limited.

## ECONOMICS AND ADVANTAGES WITH V-705 and MB-1010

High viscosity synthetic base stocks are an excellent way to reduce the total cost of a formulation and maintain exceptionally clear lubricants. **FUNCTIONAL** base stocks do not require the use of expensive synthetic esters to maintain compatibility as is common with mPAO, PB, and EPO chemistries.

**Comparison of Shear Stable Base Stocks and VMs**

	V-705	MB-1010	PMA	mPAO	PB	EPO
20hr KRL SSI, Typical	4	15	20	2	5	12
KV100, cSt	6700	900	450	150	4900	2000
wt% in 4 cSt for 16 cSt	9	30	32	42	23	13

The example below compares the treat rate and economics of **FUNCTIONAL V-705** and **MB-1010** against other shear stability chemistries in a simple 75W-90 formulation.

	V-705	MB-1010	PMA	mPAO	PB	EPO
<b>FUNCTIONAL V-705</b>	9					
<b>FUNCTIONAL MB-1010</b>		30				
PMA - Gear Oil			32			
mPAO 150				42		
PB 128					23	
EPO 2000 cSt						13
GL-5 Gear Package	4	4	4	4	4	4
Synthetic Ester				10	10	15
Pour Point Depressant	0.5			0.5	0.5	0.5
4 cSt Group III Base Oil	86.5	66	64	43.5	62.5	67.5

**Relative Competitive Costing for 16 cSt Group III 75W-90 Examples**

