

Shock Absorber

- High VI (200 – 300)
 - Low viscosity, ISO <32
 - Heating
 - Friction
 - Pressurization

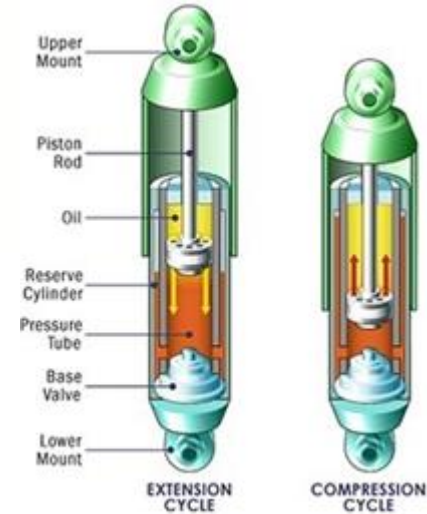


Photo: Dragzine.com, Mack Springs

Shock Challenges

- Low viscosity (< ISO 32), high VI (200+)
 - Little room for adding VI improver before out of grade
 - PMA for fastest VI per cSt
- Sliding friction on metals, dynamic seals
 - Need package with great stick-slip results plus AO/AW/CI/etc.



Formulation Approach

- Way oil packages – ad pak
- Low viscosity oils – base oil
 - Specific oils for very high VI
- Functional M Series PMA – thickener
 - MH-2000 / MH-4000 / MH-7000
 - With the right oil, VI 200/300/400 is possible with PMA

Way Oil Pack for Shock?

- Functional Products WA products
 - No stick-slip (“stiction”) in precision industrial machinery
 - Contains everything else - AO/AW/EP/CI/demuls.
- Merits
 - P-47 and GM LS-2 specifications
 - AW D4172: <0.4mm wear at 1200 rpm, 65°C
 - EP D2596: >200 kgf weld
 - 1a copper corrosion on “SF” packages

1.75%
WA-64



1.5%
WA-60SF



Very High VI Shock

- Do you need Asteric or Comb technologies for very high VI?
 - No.
- The potential for high VI is due in part to the base fluids
 - Certain base fluids have high ‘VI potential’
 - Which?



Very High VI Base Oil Selection

- Compare final VI of 15% MH-2000 in various base fluids:

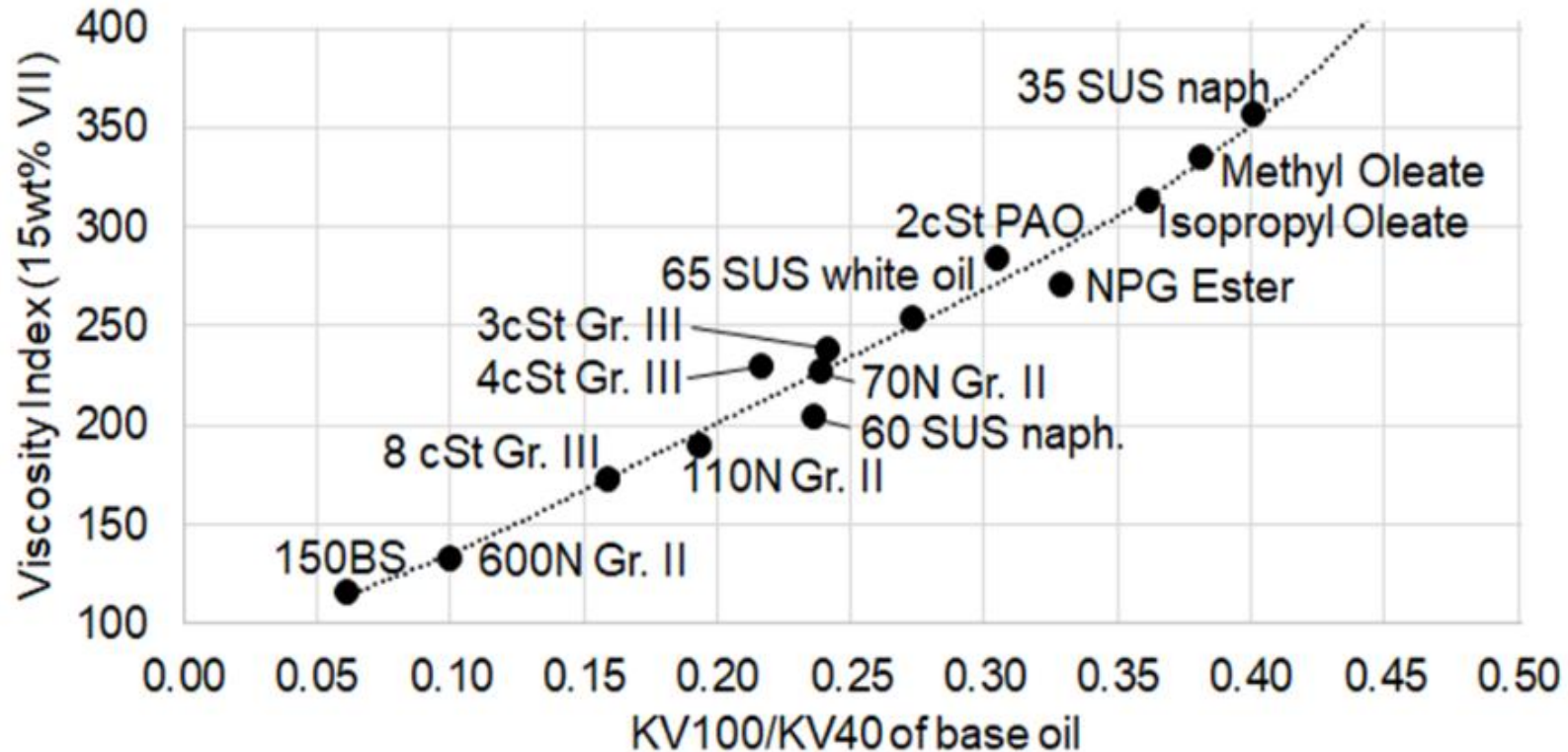
Base Fluid	VI w/ 15% MH-2000
D-Limonene	572
Cross C-35	357
Methyl Ester	335
Isopropyl Oleate	313
Synfluid PAO2	284
Lexoluble 2I-214	271
65 SUS White Oil	254
Ultra S3	238
Yubase 4	230
Phillips 70N	227
Cross L-60	204
Phillips 110N	190
Yubase 8	173
Phillips 600N	133
Ergon 150BS	116

**How do these
final VI's correlate
to the base fluid?**

**Initial VI?
Low KV?**

Base Fluids with High VI Potential

- KV100/KV40 ratio predicts potential for high VI*



Summary of Approach

- WA package for excellent stick-slip and performance
 - The right base fluid for very high VI at low viscosity
 - Low viscosity, high KV100/KV40
 - Functional PMA as the thickener of choice
-
- These three key points were used to implement a new tool



Shock Absorber Calculator

- Live demo w/ Gavin
 - Pick your base oil
 - Pick your VM
 - Pick a way oil package
- Base oils for high VI
 - Functional can toll

FUNCTIONAL PRODUCTS INC.
 SHOCK ABSORBER FORMULA DEMONSTRATION - VERSION 3 (10/26/2018)

Customer: Product:

1) Pick your base oil:

Oil	Cost	KV40	Flash Point	Pour Point	VI, 10% PMA	Color
<input type="radio"/> Naphthenic Oil	\$	9	140 °C	-65 °C	230	
<input checked="" type="radio"/> Paraffinic	\$\$	9	170 °C	-48 °C	280	
<input type="radio"/> Bio Ester	\$\$\$	5	170 °C	-10 °C	340	
<input type="radio"/> Poly Alpha Olefin (PAO)	\$\$\$	7	140 °C	-55 °C	290	
<input type="radio"/> Polyol Ester (POE)	\$\$\$\$	6	190 °C	-60 °C	283	

2) Pick your VI Improver:

Polymer	Cost	Typical wt%	Advantage
<input type="radio"/> Functional MH-4000	\$\$	10%	Versatile, high VI improvement
<input checked="" type="radio"/> Functional MH-7000	\$	7%	Higher VI possible, lower treat
<input type="radio"/> Functional MH-2000	\$\$\$	13%	Extra shear stability for longest use

3) Pick your performance package:

Package	Cost	Chemistry	Flash Point	Color
<input type="radio"/> Functional WA-64	\$	Sulfur	110 °C	
<input type="radio"/> Functional WA-65F	\$	Sulfur-free	180 °C	
<input checked="" type="radio"/> Functional WA-65F	\$\$	Sulfur-free	180 °C	

4) Dial in your viscosity and VI:

Limited to 1 - 20% PMA, up to ISO 46

SPECIFICATIONS:

KV40, cSt	25.6
KV100, cSt	7.8
Viscosity Index	304
Pour Point, C	-48
lb/gal	6.9

Note: KV40 and/or KV100 may vary by 1.0%.

ECONOMICS:

Shipping (\$/lb)

Your Delivered Price:

\$	1.203	\$/lb
\$	2.076	\$/qt
\$	8.303	\$/gal

VI Profile of MH-7000 in Paraffinic

KV40, CST	Viscosity Index	PMA %
10	140	5%
22	300	10%
38	350	15%