

# Shock Absorber

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

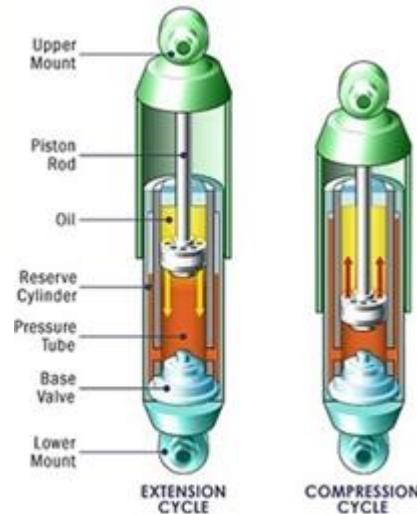


Photo: Dragzine.com, Mack Springs

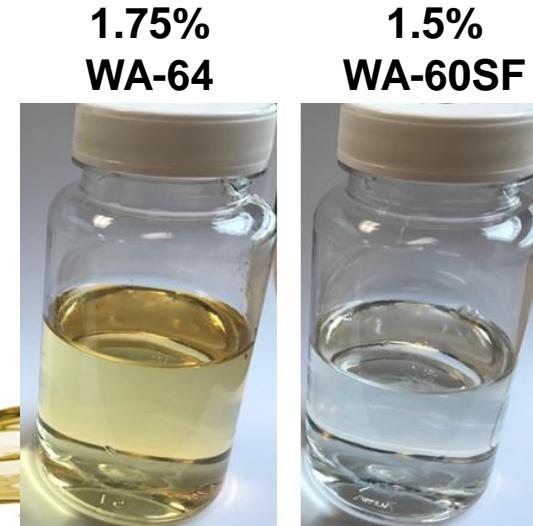
- Low viscosity (< ISO 32), high VI (200+)
  - Little room for adding VI improver before out of grade
    - PMA for fastest VI per cSt
- Sliding friction on metals, dynamic seals
  - Need package with great stick-slip results plus AO/AW/CI/etc.

# 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



# 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:

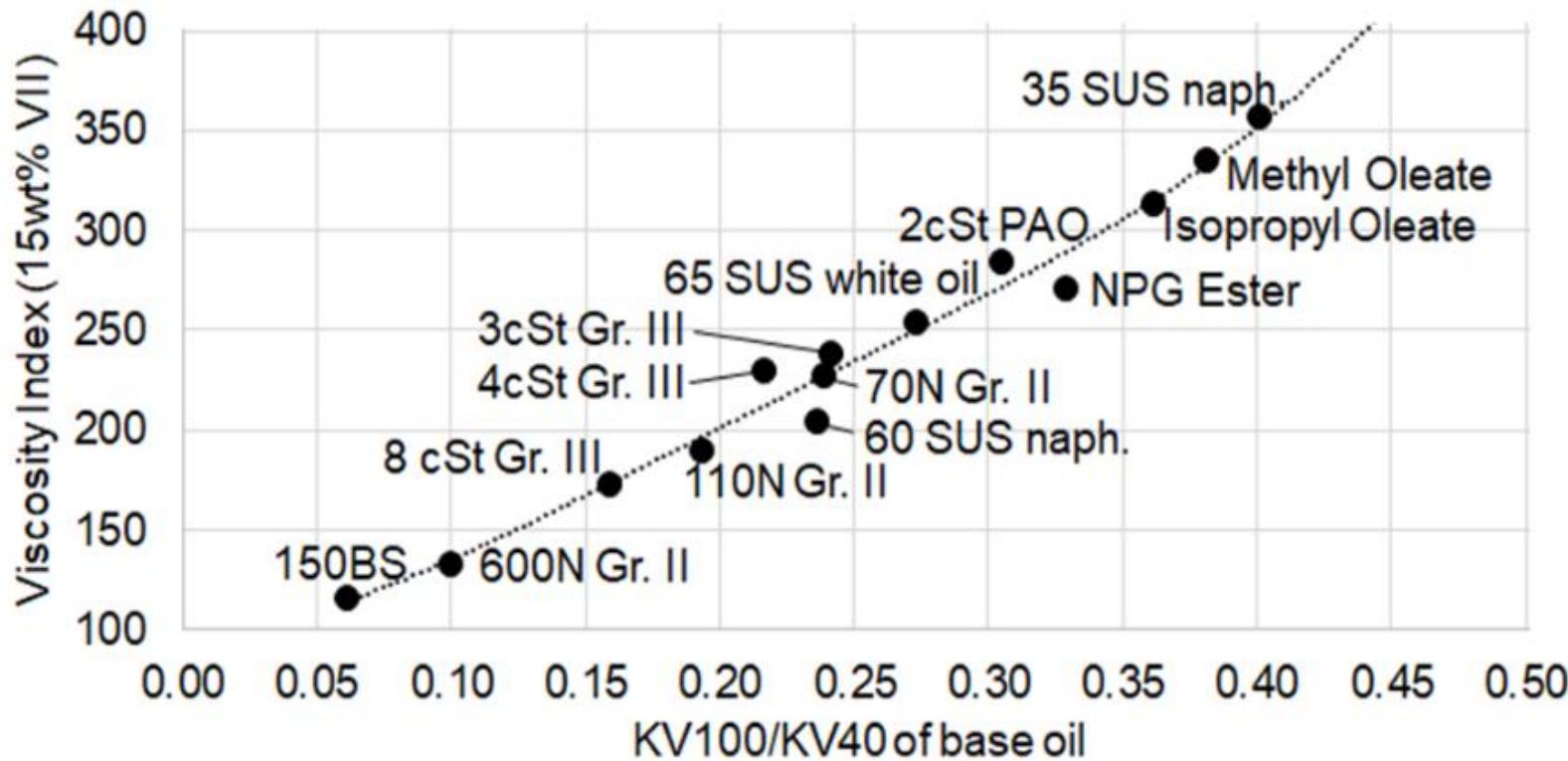
| Base Fluid       | VI w/ 15% MH-2000 |
|------------------|-------------------|
| D-Limonene       | 572               |
| Cross C-35       | 357               |
| Methyl Ester     | 335               |
| Isopropyl Oleate | 313               |
| Synfluid PAO2    | 284               |
| Lexoluble 2I-214 | 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



- Live demo w/ Gavin

- Pick your base oil
- Pick your VM
- Pick a way oil package

- Base oils for high VI
  - Functional can toll

# Shock Absorber Calculator

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

Customer: **Functional** Product: **25 cSt, VI 300**

1) Pick your base oil:

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

2) Pick your VI improver:

|   |        |             |                                 |
|---|--------|-------------|---------------------------------|
| <input type="radio"/> Functional MH-4000            | Cost   | Typical wt% | Advantage                       |
| <input checked="" type="radio"/> Functional MH-7000 | \$     | 7%          | Versatile, high VI improvement  |
| <input type="radio"/> Functional MH-2000            | \$\$\$ | 13%         | Higher VI possible, lower treat |

3) Pick your performance package:

|   |      |             |             |       |
|---|------|-------------|-------------|-------|
| <input type="radio"/> Package                       | Cost | Chemistry   | Flash Point | Color |
| <input type="radio"/> Functional WA-64              | \$   | Sulfur      | 110°C       |       |
| <input type="radio"/> Functional WA-66SF            | \$   | Sulfur-free | 180°C       |       |
| <input checked="" type="radio"/> Functional WA-66SF | \$\$ | Sulfur-free | 180°C       |       |

4) Dial in your viscosity and VI:

10.5% MH-7000

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 up to 10%.

ECONOMICS:

Shipping (\$/lb)

Your Delivered Price:

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

VI Profile of MH-7000 in Paraffinic

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