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MAXIMUM EFFICIENCY mehf HYDRAULIC FLUID

A Higher Performance Level for Hydraulic Fluid Technology

- Increased Hydraulic Power
- Enhanced Energy Efficiency
- Reduced Exhaust Emissions
- Improved Productivity

September 28, 2005

RohMax OIL ADDITIVES

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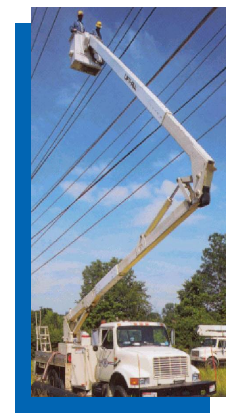
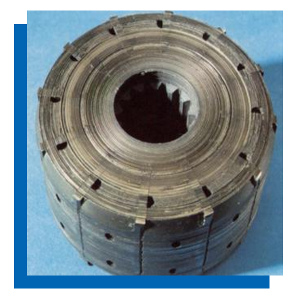
Viscosity Impact on Performance

Viscosity, mm^2/s

10000 – 5000	**Cavitation**
	Poor Flow to Lubricated Areas
1000 – 500	**Sluggish Operation**
	Low Mechanical Efficiency
100 – 50	
	Optimum Range
10	**Reduced productivity, Overheating**
5	**High wear, Reduced equipment life**
1	





Viscosity grade is a major selection criteria for a hydraulic oil

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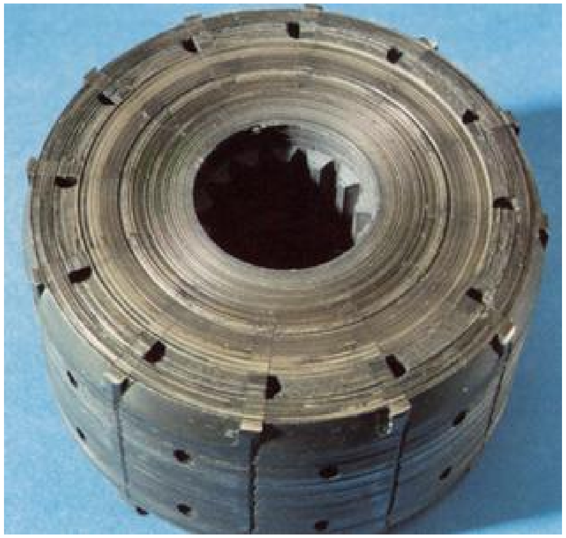
Viscosity Impact on Performance

Cavitation

Sluggish Operations

High Wear



Viscosity

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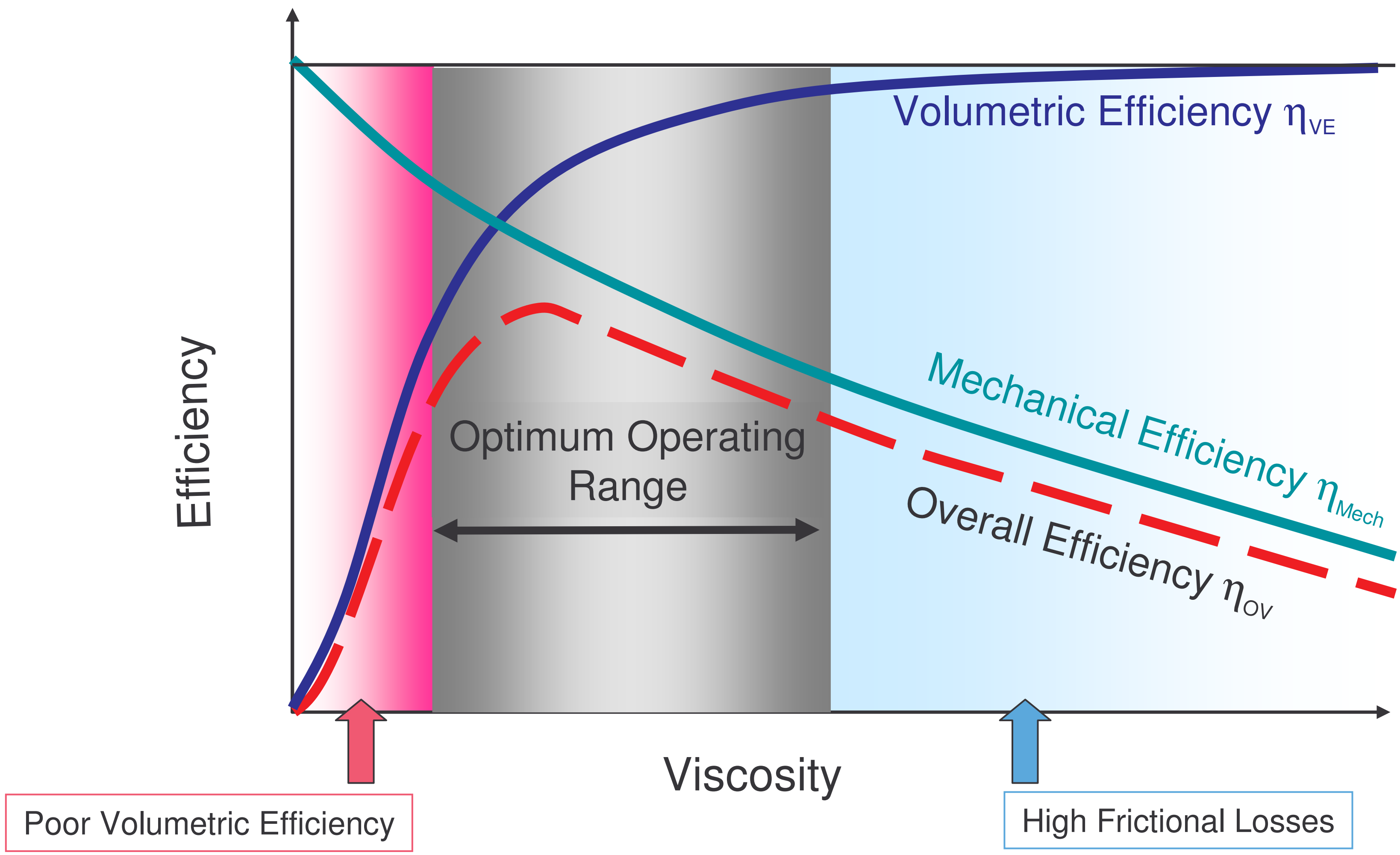
Performance Versus Viscosity
Hydraulic System Efficiency



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Major Viscosity Classifications for Hydraulic Oils

Several classifications or specifications are intended to provide a definition of the oil viscosity under different temperature conditions

- § ISO 3448 (ASTM D 2422) - ***ISO VG Classification***
- § ASTM D 6080-97 - ***Fresh & Sheared Oil Viscosities***
- § NFPA T2.13.13-2002 - ***Viscosity Grade Selection Criteria***
- § Denison HF-O - ***Fresh & Sheared Oil Viscosities***
- § Swedish Standard SS 15 54 34 - ***Full Formulation Specification***
- § JCMAS HK - ***Full Formulation Specification***

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Maximizing Pump Efficiency at High Temperature and High Pressure

- At high temperature and high pressure, low fluid viscosity will result in high internal pump leakage which :
  - Reduces the actual flow rate and thus the hydraulic power
    - Increases the amount of fuel/electricity required to achieve a desired amount of hydraulic work
    - Increases the amount of time needed to obtain a desired amount of hydraulic work
    - Increased fuel consumption means higher exhaust emissions
  - Increases the rate at which the temperature of the fluid increases, since the energy that is lost is converted into heat
  - Reduces pump life due to wear and potential damage
  - Increases the rate at which oxidation takes place reducing fluid life
    - Anti-oxidant additives are consumed faster
    - Formation of lacquers and varnishes

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Optimizing Pump Operation at Low Temperature

§ At low temperature if the oil viscosity is too high, this will result in:

- Ø Inadequate flow of oil to the pump inlet
  - Jerky or sluggish operations
  - Cavitation
- Ø Excessive loss of energy to overcome the frictional losses due to viscous drag in the circuit
- Ø Risk of pump failure due to lack of proper lubrication
- Ø Long idle time before the equipment becomes operational
- Ø Inability to work if the temperature falls below a certain level

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What Is MAXIMUM EFFICIENCY mehf HYDRAULIC FLUID Performance ?

§ MEHF delivers improved viscometric properties that provide:

Ø **High system efficiency over a wide range of temperature**
- MEHF oils minimize frictional losses at low temperature
- MEHF fluids reduce internal pump leakage and maximize Efficiency under high pressure and high temperature conditions

Ø **Benefits allowing fast pay-back on slightly higher oil costs**
- Lowers energy consumption for same amount of work
- Allows use of smaller pumps for same performance
- Reduced need for auxiliary cooling in mobile equipment
- Widens effective Temperature Operating Window (TOW)
- Reduced overheating and risk of equipment shut down
- Reduced costs for equipment builders and end users

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MEHF Performance Definition

Performance Requirement	Comments	Units	Method	Limit	Limit	Limit
Viscosity Grade	New Oil	ISO VG	ISO 3448 or ASTM D 2422	**32**	**46**	**68**
Viscosity Index	New Oil		ISO 2909 or ASTM D 2270	**>150**	**>150**	**>150**
Total Energy Savings* - Denison T6C Vane Pump	vs. HM fluid, same ISO VG, VI=100	%	80℃, 250 bar, 1500 rpm	**>3.5****	**>5**	**>3.5**
Low Temperature Viscosity	"L" grade must be at least one grade lower than the ISO VG	mPa·s (cP)	Brookfield viscosity requirements according to ASTM D 6080	**≤750** @ -15℃ **"L22"**	**≤ 750** @ -8℃ **"L32"**	**≤ 750** @ -2℃ **"L46"**
Shear Stability	Minimum KV100 after shear in bench tests, predicts operating viscosity in the pump	mm^2/s (cSt)	Kinematic Viscosity @ 100℃ (ASTM D 445) after 40 minute Sonic Shear (ASTM D 5621)	**>5.9**	**>7.5**	**>10.0**

*Relative difference in the amount of energy input to the pump to generate the same amount of hydraulic work.
**ISO 32 pump tests must be run at 70℃ to meet OEM minimum viscosity requirements.

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Additional MEHF 46 Performance Information

- Fluids that meet the MEHF Performance Definition will show similar advantages in all types of hydraulic pumps
  - Fluids have been compared at typical mobile equipment operating conditions
    - High pressure external gear pump at 207 bar and 80℃
    - High pressure vane pump at 250 bar and 80℃
    - Variable displacement piston pump at 350 bar and 100℃

Typical Performance Advantage	Comments	Conditions	% Energy Savings
Total Energy Savings* Eaton L2 Series, 25503 **Gear Pump**	vs. ISO 46 HM, VI=100 vs. 10W engine oil	80℃, 207 bar, 2750 rpm 80℃, 207 bar, 2750 rpm	**>4** **>7**
Total Energy Savings* Denison T6C **Vane Pump**	vs. ISO 46 HM, VI=100 vs. 10W engine oil	80℃, 250 bar, 1500 rpm 80℃, 250 bar, 1500 rpm	**>5** **>7**
Total Energy Savings* Komatsu HPV 35+35 **Piston Pump**	vs. ISO 46 HM, VI=100 vs. 10W engine oil	100℃, 350 bar, 2100 rpm 100℃, 350 bar, 2100 rpm	**>15** **>20**

*Relative difference in the amount of energy input to the pump to generate the same amount of hydraulic work

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Conclusions

§ **MEHF fluids offer Improved Performance and Energy Savings**

- Ø In all pump types (Gear, Vane, Piston)
- Ø At low temperature start-up (<0℃)
- Ø At high temperature operation (>60℃ oil temperature)
- Ø Allow the operator to meet the fluid viscosity requirements of multiple OEM’s
- Ø Can reduce peak oil operating temperatures
- Ø Reduced fuel consumption and exhaust emissions
- Ø Significant energy savings provide fast-pay-back of slightly higher oil cost.

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