A fluid solution to efficient power

David B Gray
NA OEM Manager
October 2017

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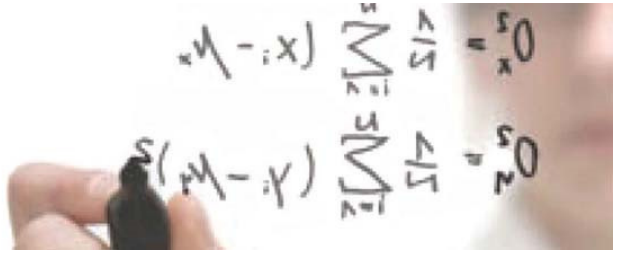
Overview

Can Hydraulic systems be made more efficient just by changing the fluid?

How are efficient fluids different?



How can we demonstrate productivity advantages of efficient fluids?

Who are Evonik?

- One of the World's leading specialty chemicals companies
- Global footprint
  - Sales Offices in over 35 countries
  - Sales in more 100 countries
  - Manufacturing Worldwide
- **34,350 employees**

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What does *Resource Efficiency* mean to you?

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“ *We all talk about fluid power but rarely talk about the fluid* ”

“ We all talk about fluid power but rarely talk about the fluid ”

Drivers for efficiency improvement in hydraulic applications

Economic Forces

Technology Changes

Social Trends

Environmental Issues

Political Influences

Demand for highly efficient hydraulic systems

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Drivers for efficiency improvement in hydraulic applications

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- Total cost of ownership
- High productivity and reliability

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Technology Changes

- Higher pressures
- Smaller volumes
- Higher power density
- Industry 4.0

Social Trends

Environmental Issues

Political Influences

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- Quality awareness
- Compliance

Environmental Issues

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Environmental Issues

- Reduced noise levels
- Emission reduction
- Lifecycle analysis

Political Influences

Demand for highly efficient hydraulic systems

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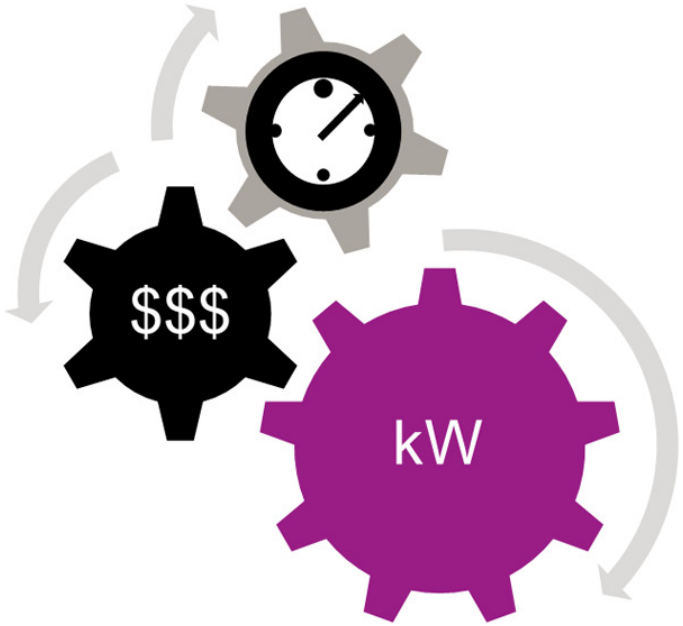
Political Influences

- Tax credits
- Political targets / Regulations e.g. EU Directive (2012/27/EU)

Demand for highly efficient hydraulic systems

How can “efficient fluids” help end users?

- Reduce energy consumption, fuel or electric power
- Maintain optimum power and productivity
- Provide long service life – reduced heat
- Ensure equipment protection and durability



Definitions of Energy Efficiency and Productivity

- **Energy Efficiency = work done/energy consumed**
- **Productivity = work done/time**

Most good IDEAS start with a question…

THE QUESTION
How can the efficiency of hydraulic equipment be improved?

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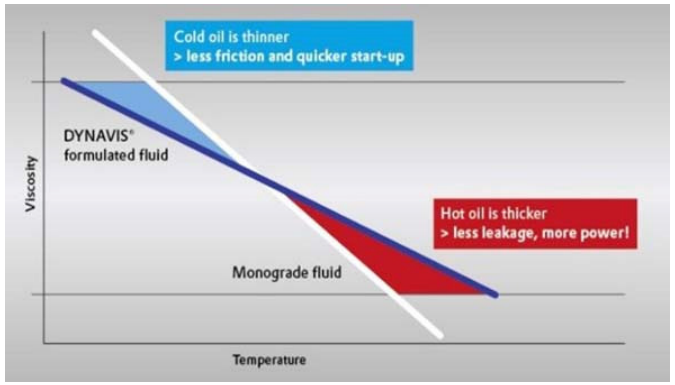
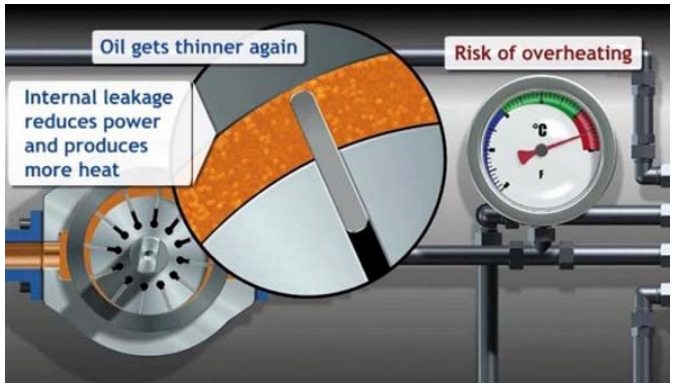
Improved efficiency with High VI multigrade hydraulic fluids

High VI fluids are a technology for improving the flow characteristics of hydraulic fluids

- Provide lower viscosity at colder temperatures
  - Especially at start up, less power required
- Resists internal leakage in the pump at higher temperatures
  - Avoids overheating
- Maintains pump efficiency
  - **Reduced fuel consumption**
  - **Increased service life**





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Where can High VI efficient fluids be applied?

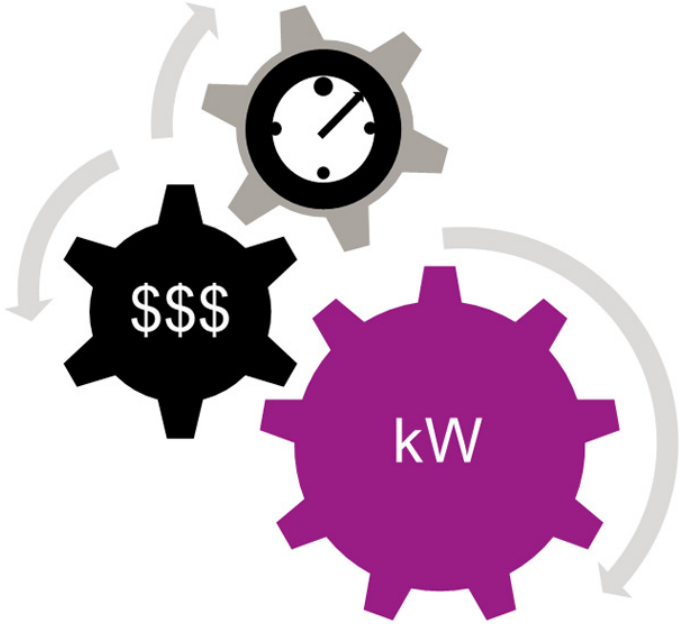
Hydraulic Fluids

Stationary, e.g. Injection Molding

- Plastic processing industry
- Simple hydraulic monograde fluids
- High potential to improve efficiency

Mobile, e.g. Excavators

- Developing markets
- Conventional multigrade fluids
- High potential to improve efficiency



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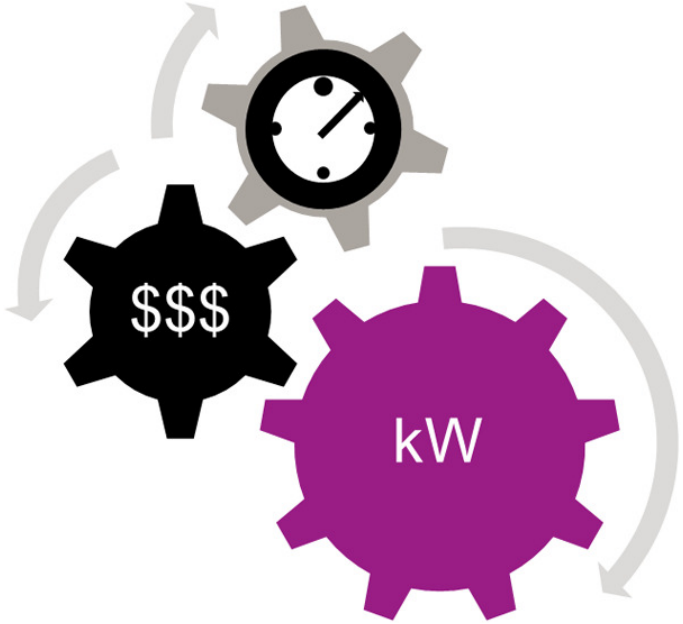

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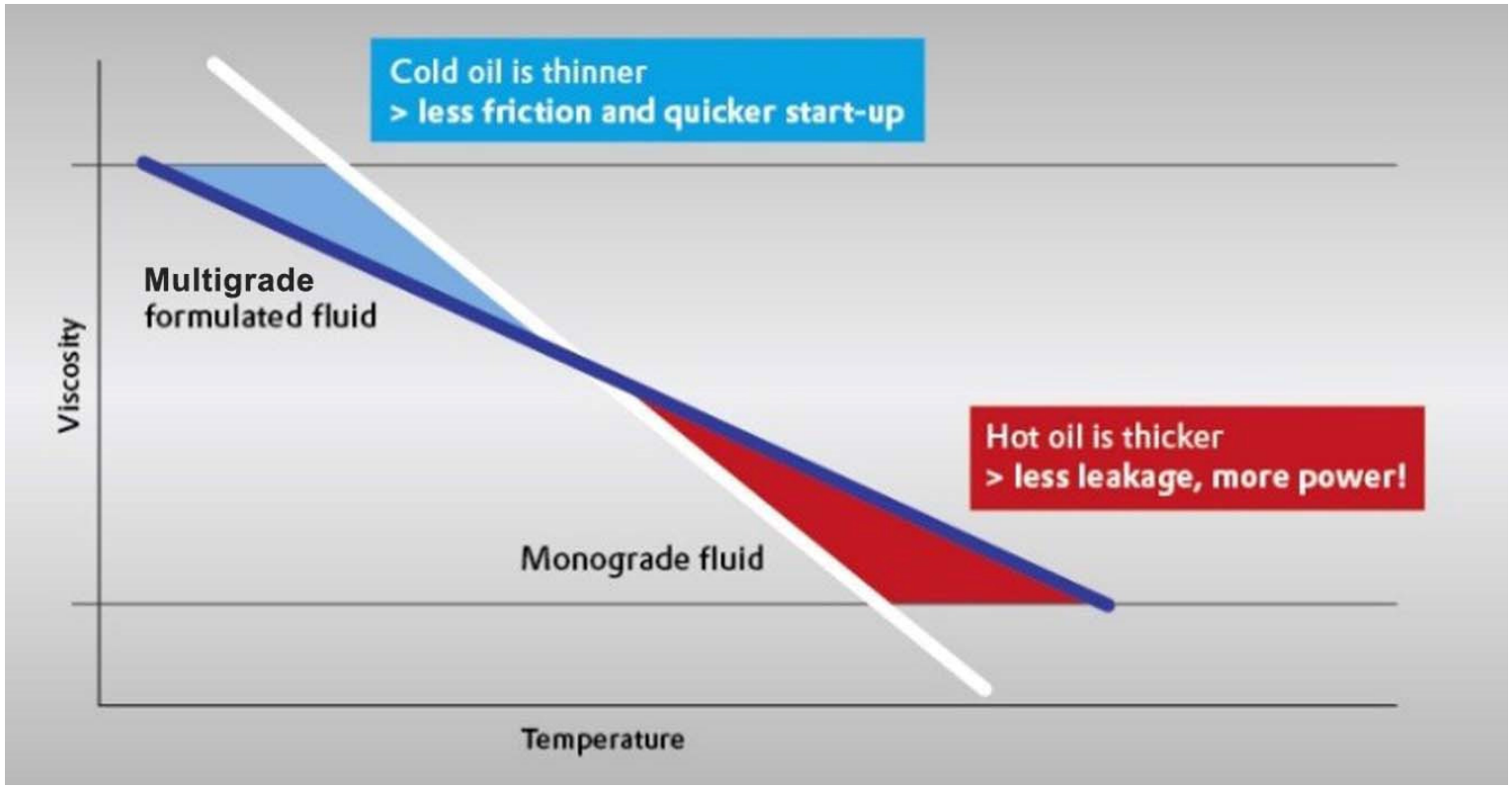
Multigrade vs Monograde Hydraulic fluids



The higher the *Viscosity Index* (VI) ….

… the *flatter* the curve !

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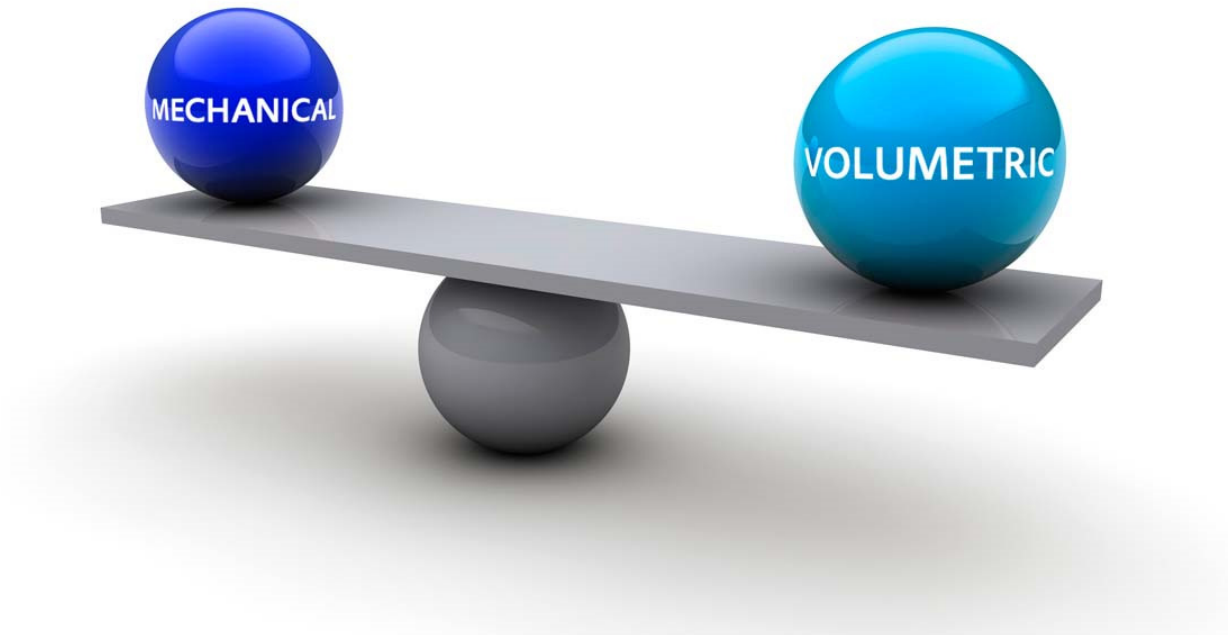
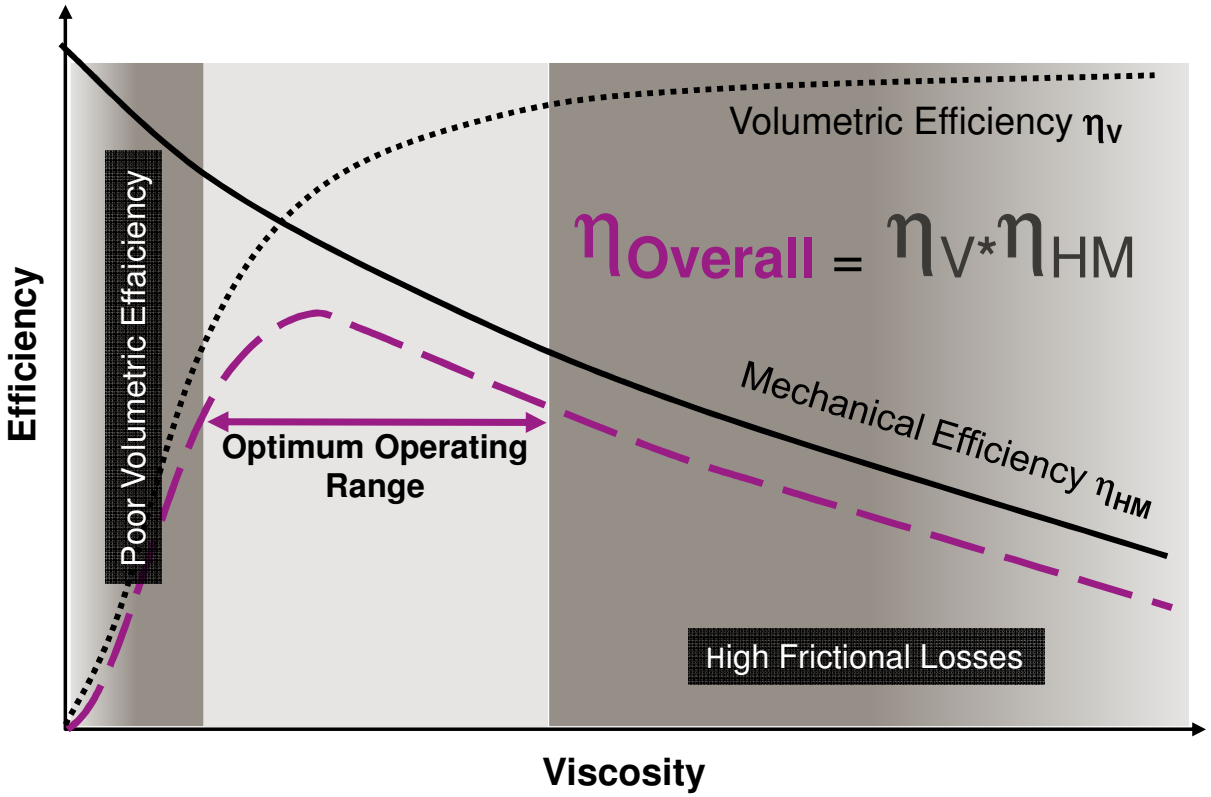
System efficiency depends on two loss mechanisms

- **Hydrodynamic friction**
- **Churning losses**
- **Poor lubrication**
- **Heat losses**



- **Internal leakage**
- **External leakage**

The influence of viscosity on the overall efficiency of a hydraulic pump



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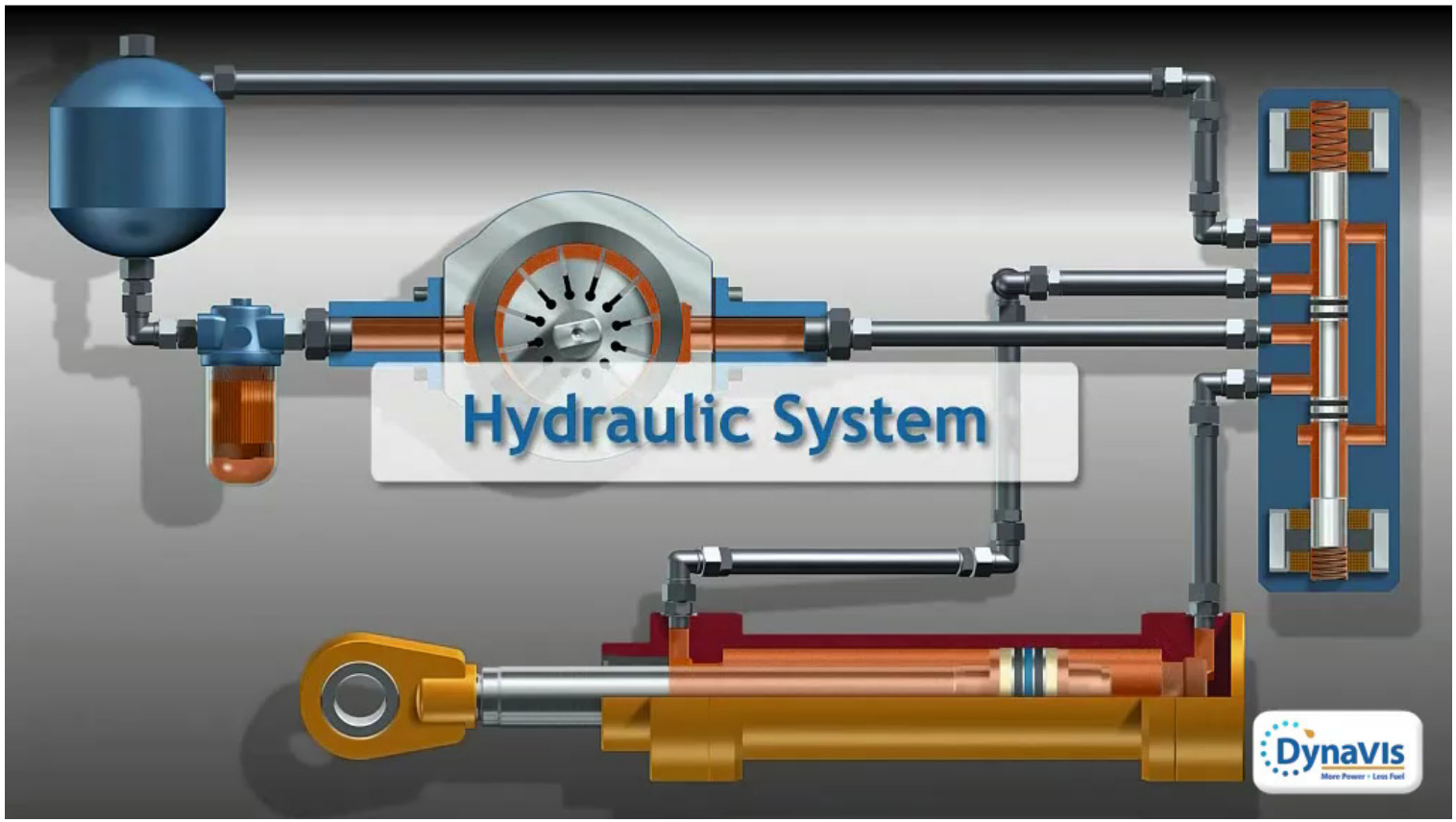
How does it work?



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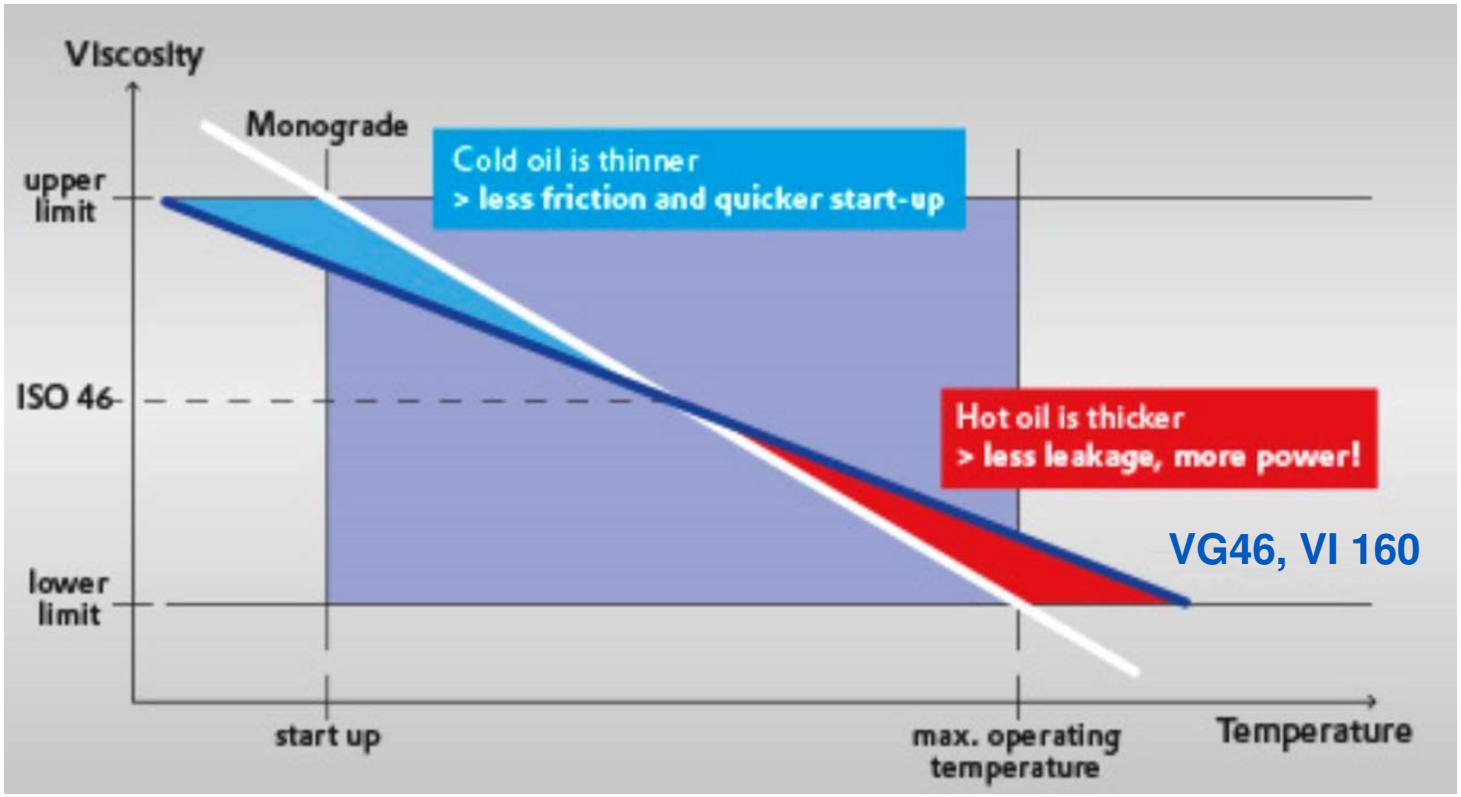
The Hydraulic fluid determines TOW and energy efficiency



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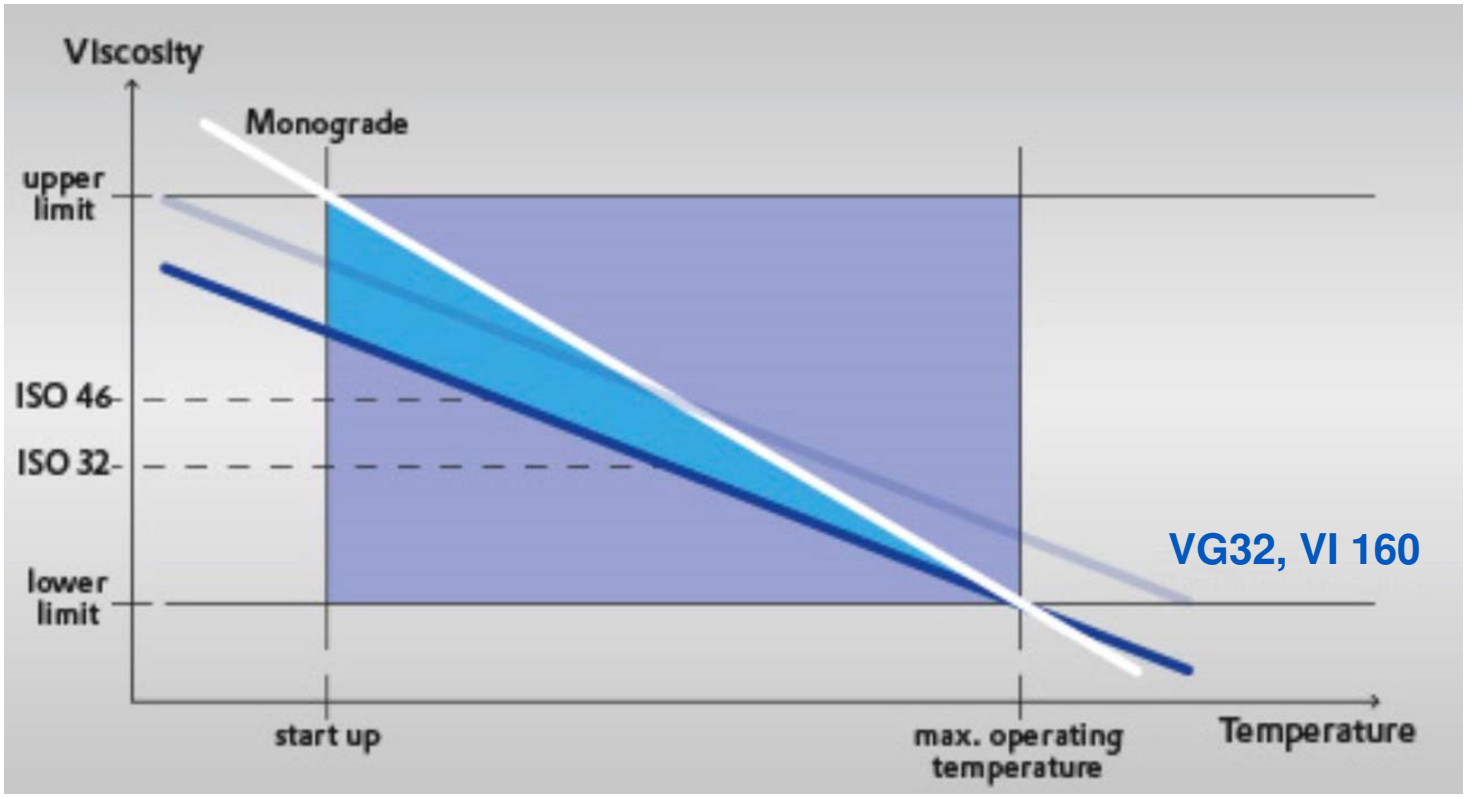

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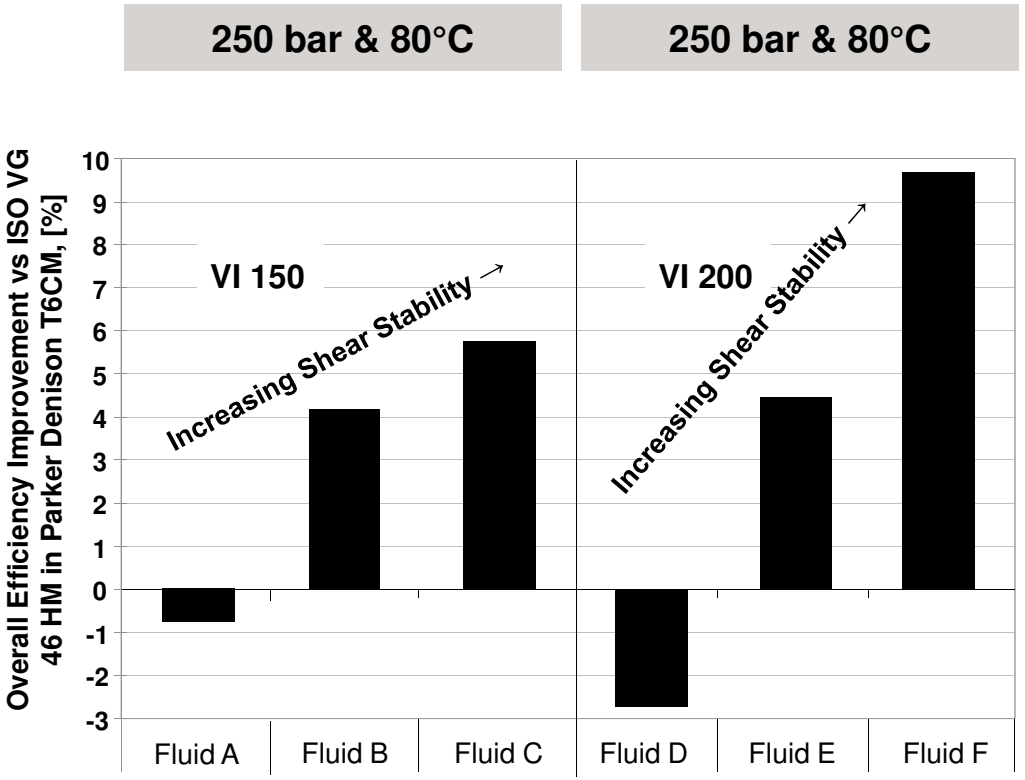
Not all high VI hydraulic fluids improve efficiency

- The fluids evaluated are **ISO VG 46 VI 150 & 200** based on Viscosity Index Improvers of different shear stability in mineral oils.
- The efficiency is a function of the dynamic viscosity within the pump

Only shear-stable, high VI fluids deliver significant efficiency improvements.



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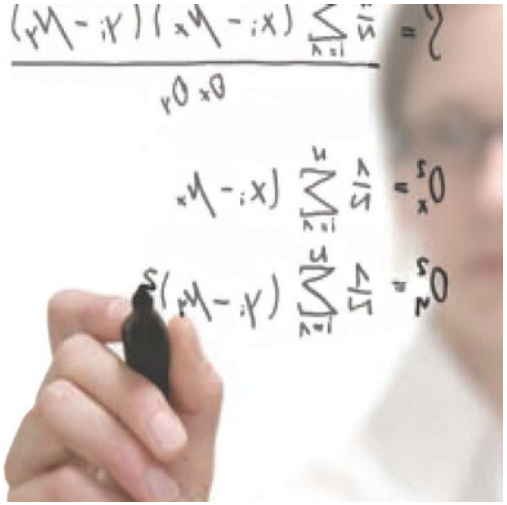
Lubricant product development and its path to market

Lubricant product development and its path to market



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Lubricant product development and its path to market

Theory

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Lubricant product development and its path to market

Theory

Development in laboratory

Lubricant product development and its path to market

Theory ✓

Development in laboratory ✓

Bench tests ✓

Performance Demonstrations

Performance Demonstrations

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Excavator Specifications and Field Test Activities – Test Protocol

Hitachi ZX290

Digging

Truck Loading

Hitachi ZX 290:

- Engine: Isuzu AL-4HKK1X 140 kW (188 HP) at 2 100 rpm
- Hydraulic pumps: 3 axial piston pumps and 1 pilot gear pump
- Hydraulic system: 290 L and hydraulic oil tank: 156 L

Field Test Daily Routine:

- Truck loading (32 times with 12 buckets / truck loading)
- Digging (8 times with 10 minutes / digging)
- Hydraulic fluid is tested for 4 days (oil temp: 50°C - 90°C)

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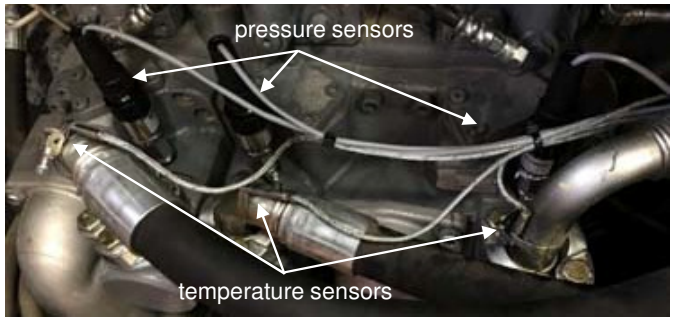
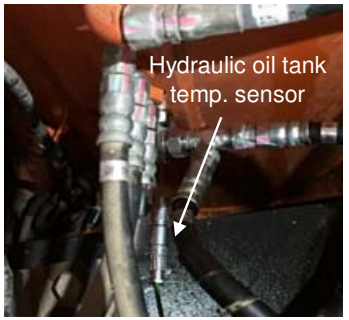
Measurements and Monitoring System – Data Capture

Temperature & pressure sensors

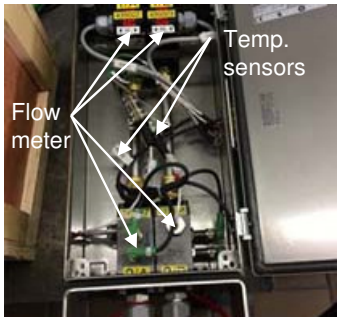


Ambient temp.sensor

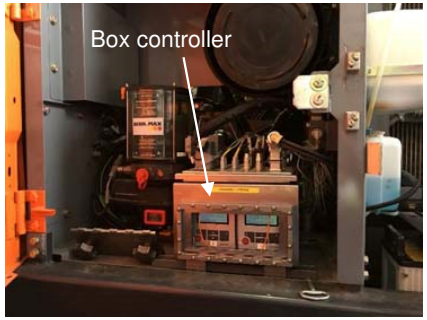
Hydraulic oil tank temp. sensor



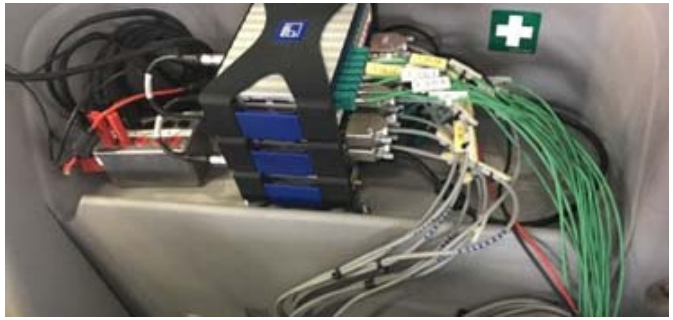
Flowmeter, temp.sensor



Engine fan speed sensor & box controller



Universal data acquisition system



Display shows live-measurement

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High VI Multigrade performance demonstrations
Construction Machines

- A range of instrumented excavators in comprehensive tests
- Accurate recording of the saving potential depending on the type of use
- Robust protocols ensure statistically valid data

	Fuel consumption per cycle	Efficiency increase (buckets per liter of fuel)	Productivity increase (buckets per cycle)
Leveling	–	Up to 4%	–
Drive mode (meters)	_	Up to 11 %	Up to 8 %
Digging (at full speed)	Up to 5%	Up to 15 %	Up to 15 %

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High VI Multigrade fluid DYNAVIS® performance demonstrations
Construction Industry

Schrode GmbH – Germany
New Holland crawler excavator
Application:
Earth moving and road construction

Effect:
10 to 15% during normal use
up to 25% during stone milling

Vakaru Verslo Projektai – Lithuania
Kleemann, mobile screening unit
Application:
Sand sieving

Effect:
Saves 3 liters fuel per operating hour, better cold start behavior

Screen-Renting BVBA – Belgium

Hitachi ZX210W mobile excavator,
Application:
Material handling

Effect:
Saves 2 liters fuel per operating hour, no more failures caused by overheating

Ghizzoni S.p.A. – Italy

New Holland E385B crawler excavator,
Application:
Restoring a pipeline route

Effect:
10% fuel saving,
improved machine handling

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Where can High VII efficient fluids be applied?

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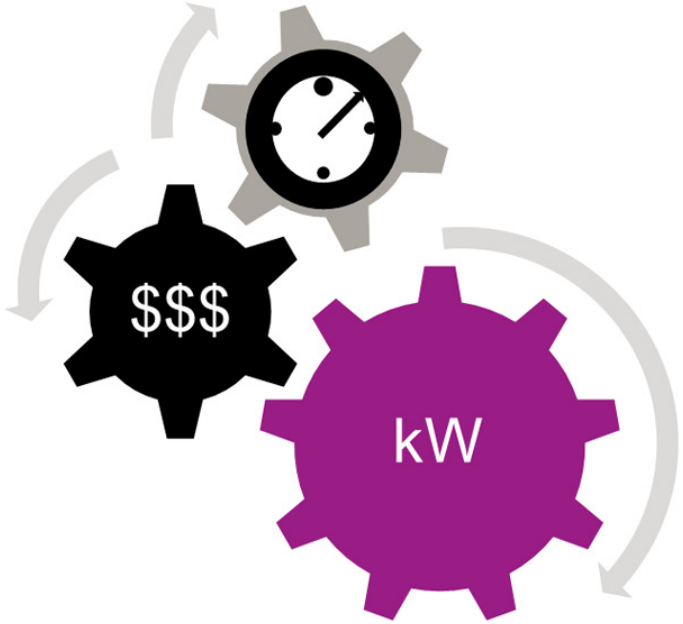

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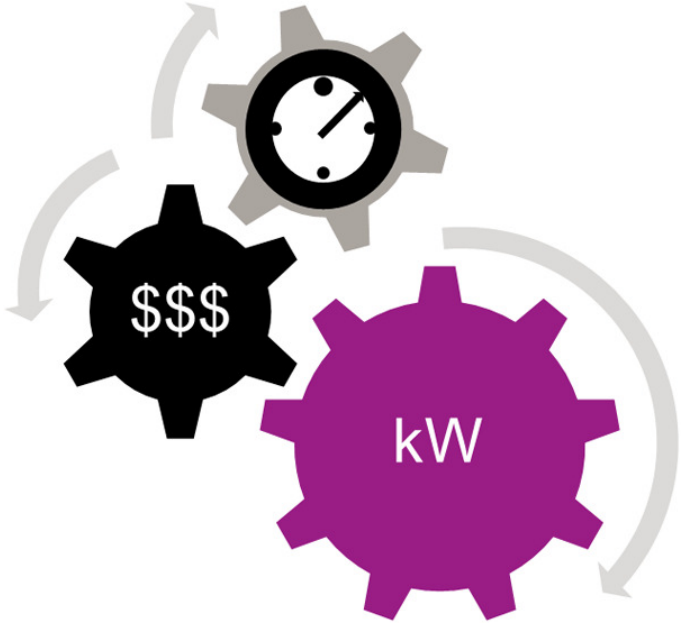

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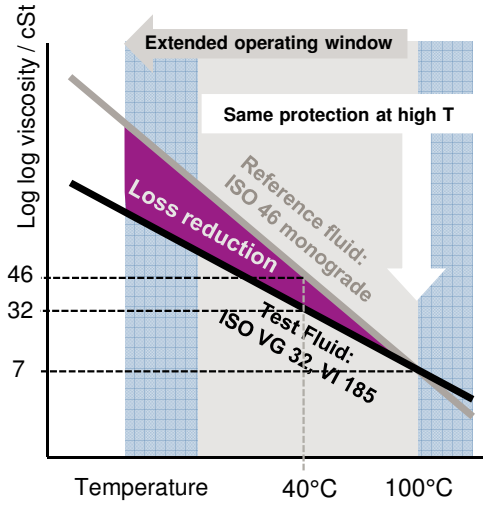
Performance demonstrations

Equipment		Energy savings	Hydraulic Fluid
	Husky XL300	4.2 %	
	Krauss Maffei KM 80 CX SP 380	up to 5 %	
	Engel Victory 330/120	6.2 %	
	Boy 35 E	up to 10 %	
	Haitian MA10000 II	11 %	



Theory ✓ → **Development in laboratory** ✓ → **Bench tests** ✓ → **Performance demonstrations** ✓

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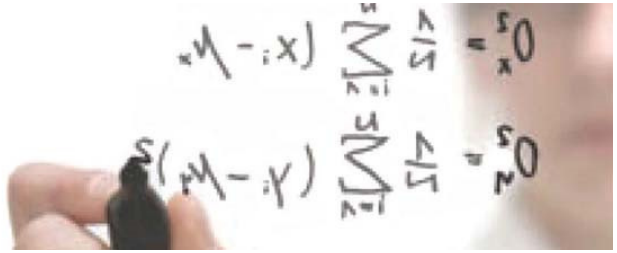
Conclusions

Gains in Productivity and Efficiency can be realized by switching to High VI Multigrade fluids.

Efficient fluids differ from conventional fluids by using shear stable, High VI components.



Productivity and Efficiency gains can be demonstrated by developing robust testing protocols and performing ‘real world’ testing.

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“ We all talk about fluid power but rarely talk about the fluid ”

Efficiency for end user

Work done within excavator

Work at gravel

$$\underbrace{\mu_{fuel} \cdot t \cdot Q_{HV} \cdot \eta_{ICE} \cdot \eta_{HS}}_{\text{Fuel consumed}} = m \cdot Q_{MG}$$

- μ_{fuel} - average fuel mass flow rate, kg/h
- Q_{HV} - heating value of fuel, J/kg
- η_{ICE} - average efficiency of the internal combustion engine
- η_{HS} - average efficiency of the entire hydraulic system
- t - time consumed to move gravel with mass m, h
- m - gravel mass to be moved, kg
- Q_{MG} - average specific work needed to move gravel, J/kg

Lubricant product development and its path to market