A fluid solution to efficient power

David B Gray
NA OEM Manager
October 2017
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
What does Resource Efficiency mean to you?
“We all talk about fluid power but rarely talk about the fluid”
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<th>Drivers for efficiency improvement in hydraulic applications</th>
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### Drivers for efficiency improvement in hydraulic applications

#### Economic Forces
- Total cost of ownership
- High productivity and reliability

#### Environmental Issues

#### Political Influences

#### Technology Changes

#### Social Trends

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**Demand for highly efficient hydraulic systems**
### Drivers for efficiency improvement in hydraulic applications

### Economic Forces

### Technology Changes
- Higher pressures
- Smaller volumes
- Higher power density
- Industry 4.0

### Social Trends

### Environmental Issues

### Political Influences

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### Drivers for efficiency improvement in hydraulic applications

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Demand for highly efficient hydraulic systems
Drivers for efficiency improvement in hydraulic applications

Economic Forces

Technology Changes

Social Trends

Environmental Issues

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?
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
Where can High VI efficient fluids be applied?

### Hydraulic Fluids

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

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

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Multigrade vs Monograde Hydraulic fluids

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

... the flatter the curve!
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

\[ \eta_{\text{Overall}} = \eta_V \cdot \eta_{HM} \]
How does it work?
The Hydraulic fluid determines TOW and energy efficiency
The Hydraulic fluid determines TOW and energy efficiency

![Viscosity chart showing Monograde, ISO 46, ISO 32, VG32, VI 160](image)

- VG32, VI 160
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.
Lubricant product development and its path to market
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Theory
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

✔️

✔️

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Performance Demonstrations
Performance Demonstrations
Excavator Specifications and Field Test Activities – Test Protocol

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

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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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<td>Ambient temp. sensor</td>
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<td>Hydraulic oil tank temp. sensor</td>
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<td>Flowmeter, temp. sensor</td>
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<td>Engine fan speed sensor &amp; box controller</td>
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<td>Universal data acquisition system</td>
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<td>Display shows live-measurement</td>
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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

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October 19 2017 | FPMC Industry Panel – A fluid solution to efficient power
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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<th>Equipment</th>
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<td>Husky XL300</td>
<td>4.2 %</td>
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<tr>
<td>Krauss Maffei KM 80 CX SP 380</td>
<td>up to 5 %</td>
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<tr>
<td>Engel Victory 330/120</td>
<td>6.2 %</td>
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<td>Boy 35 E</td>
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<td>Haitian MA10000 II</td>
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Theory

Development in laboratory

Bench tests

Performance demonstrations
**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.
“We all talk about fluid power but rarely talk about the fluid”
“We all talk about fluid power but rarely talk about the fluid”
Efficiency for end user

\[
\mu_{fuel} \cdot t \cdot Q_{HV} \cdot \eta_{ICE} \cdot \eta_{HS} = m \cdot Q_{MG}
\]

-  \( \mu_{fuel} \) - average fuel mass flow rate, kg/h
-  \( Q_{HV} \) - heating value of fuel, J/kg
-  \( \eta_{ICE} \) - average efficiency of the internal combustion engine
-  \( \eta_{HS} \) - 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