

Increased energy efficiency for plastics injection molding with DYNAVIS® Technology

Evonik Oil Additives GmbH

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Agenda

1. Background Oil Additives

2. Improved Viscometrics with DYNAVIS® technology

3. Market Overview Industrial Hydraulic Equipment

4. Performance Demonstrations

Evonik Oil Additives GmbH

Evonik Industries AG

**More than
BVB!**



Evonik.

One of the
world's leading
specialty
chemicals
companies.



Let it flow. Resource-efficient lubricant additive solutions



The Oil Additives Business Line

Evonik's oil additives products are designed for use in automotive and industrial lubricants, hydraulic fluids, fuels and in refinery processing. Evonik's extensive knowledge and experience comes from its valuable partnerships with formulators, OEMs and end users around the world, collaborating to deliver solutions that enable improved fuel consumption and reduced carbon emissions.

Collaborating for the future – **Let it flow.**

Focus on fluids for industrial applications

Hydraulic Fluids

Stationary, e.g. Injection Molding



- Increasing demand for energy efficiency in plastics processing industry.
- Simple monograde hydraulic fluids are predominantly used.
- High potential to improve efficiency via process control and changes to the hydraulic fluid

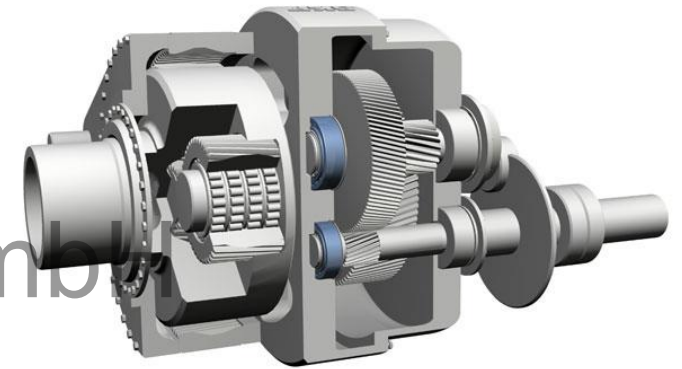
Mobile, e.g. Excavators



- Growth in developing markets for construction and mining equipment
- Conventional hydraulic fluids without efficiency claims most common
- Very high potential to improve efficiency via changes to the hydraulic fluid

Industrial Gear Oils

e.g. Wind Turbine Gearboxes



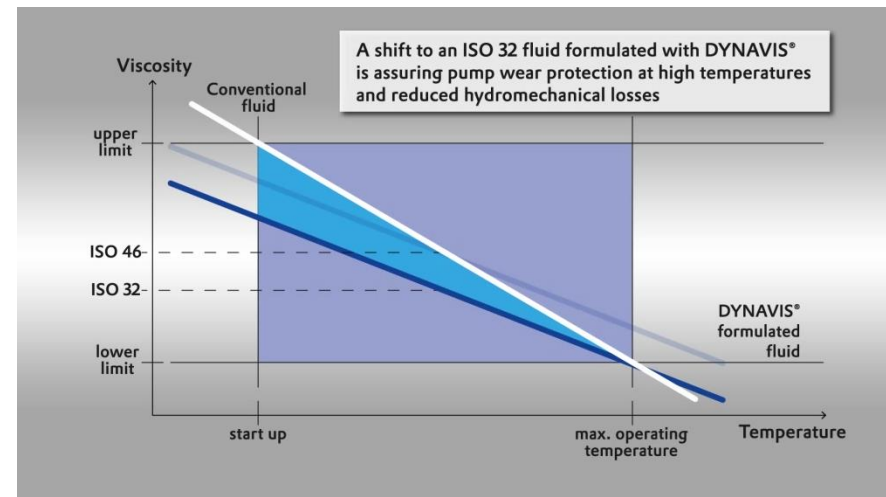
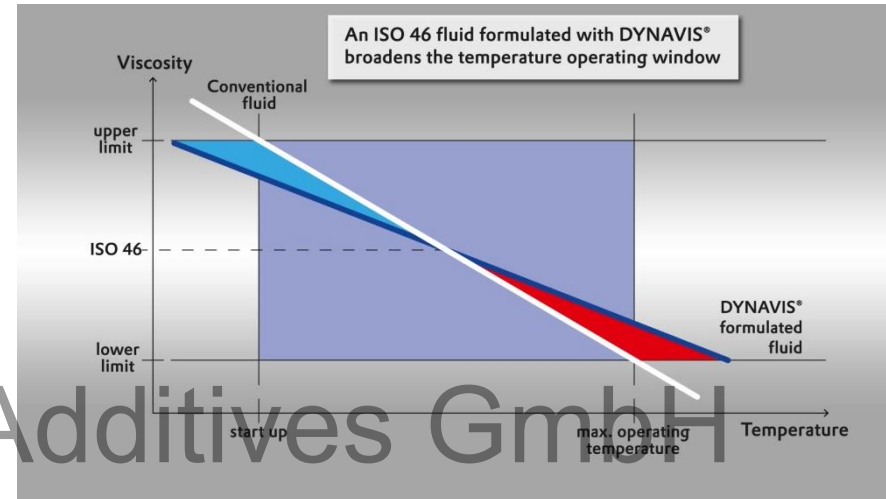
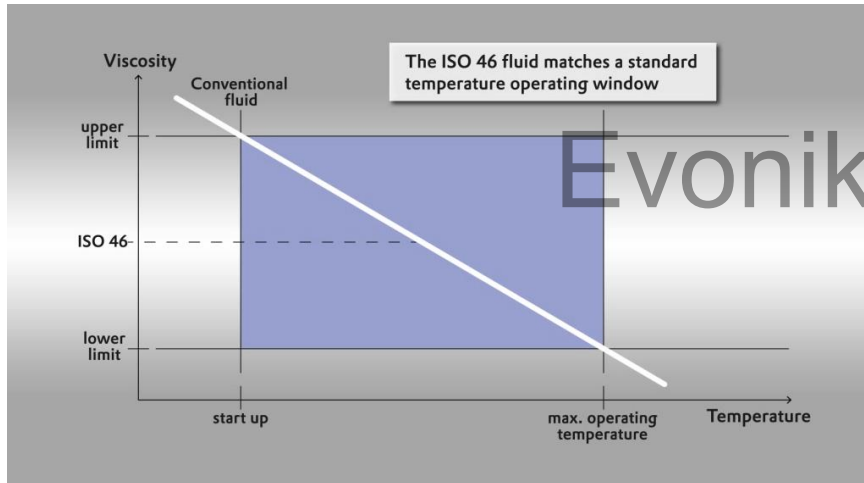
- Growth in the wind power market has triggered the demand for high performance fluids
- Equipment protection and extended oil drain intervals are prevailing requirements
- Package technologies improve efficiency

Agenda

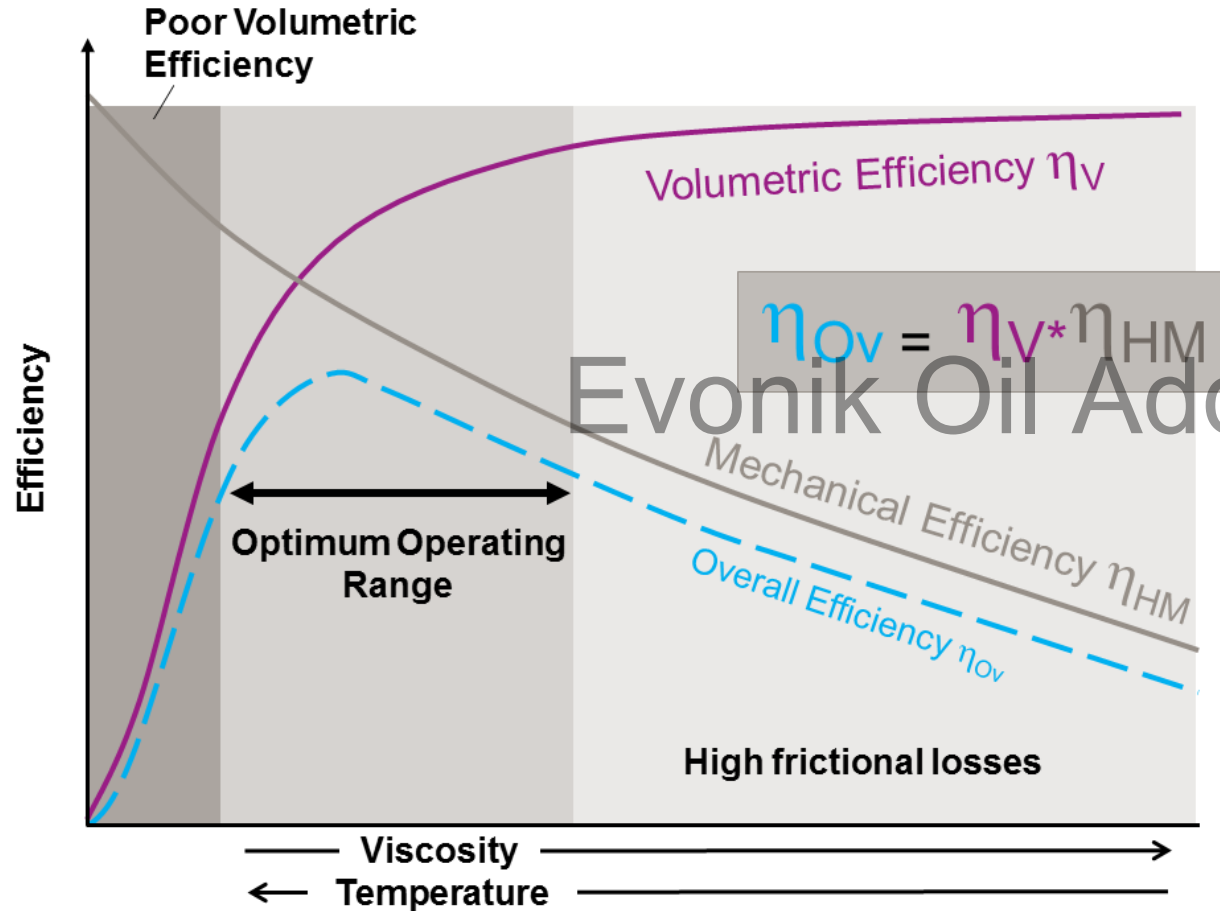
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Hydraulic fluids formulated with DYNAVIS®-technology broaden the temperature window

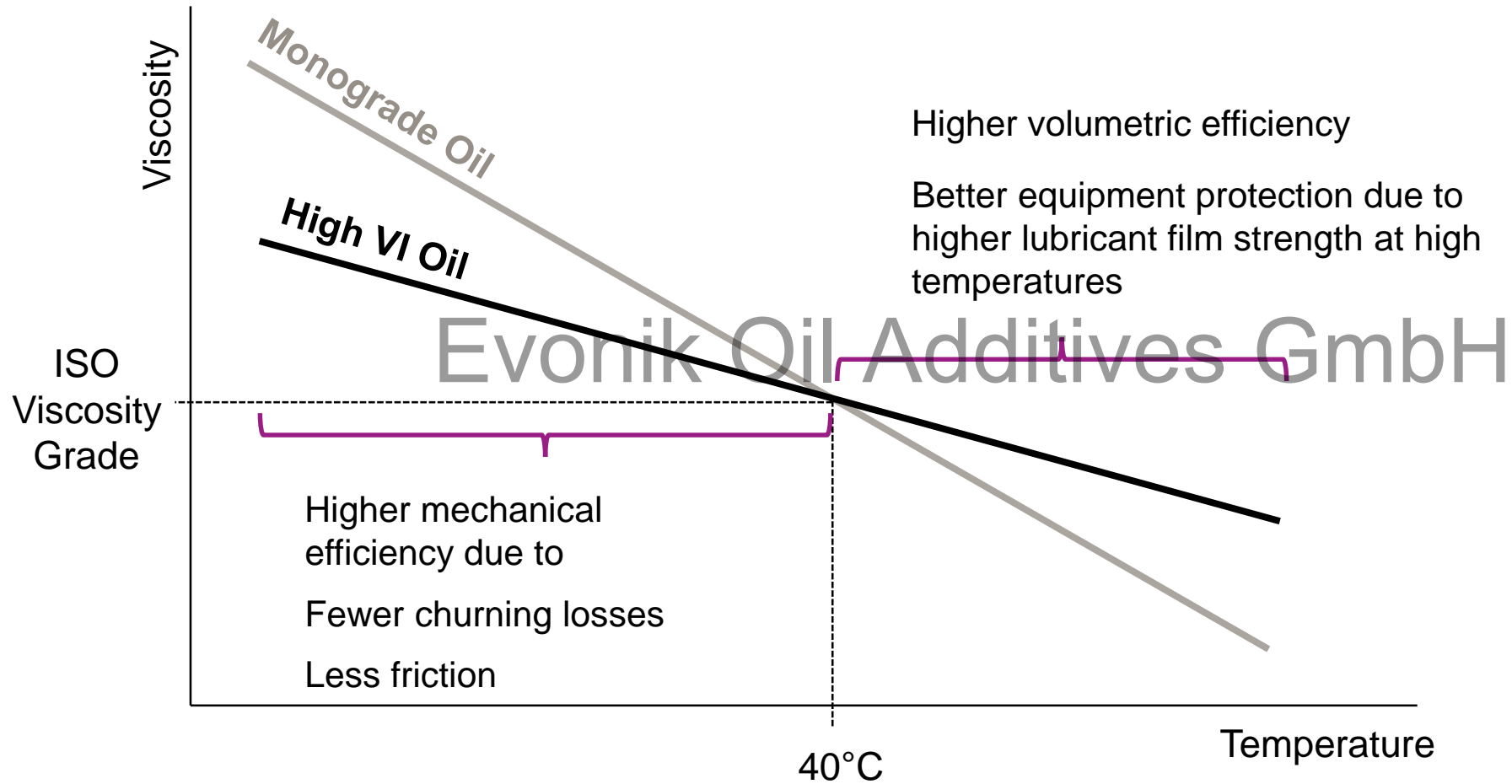


Looking for the best balance of hydro-mechanical and volumetric efficiency



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Viscometric view on monograde vs. high VI industrial oils



**More for
less...**

Hydraulic fluids formulated with DYNAVIS® technology provide:

Sustainable increases in productivity and reductions in energy consumption

Widened temperature operating window

Increased protection and extension of oil drain intervals

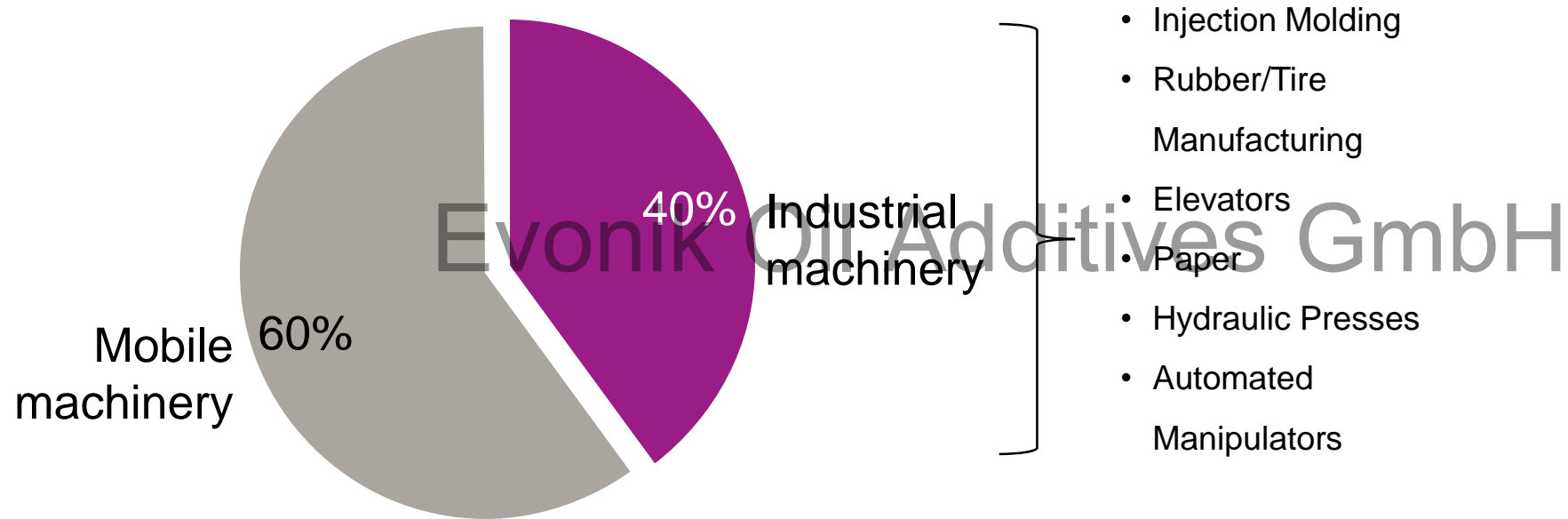
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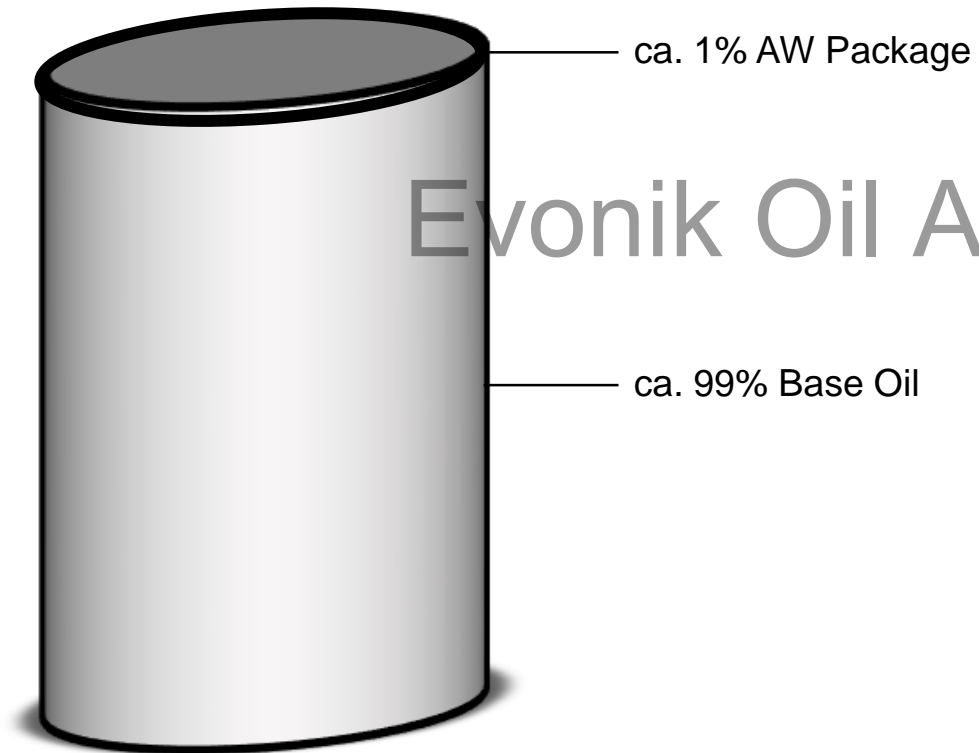
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Versified applications for industrial lubricants

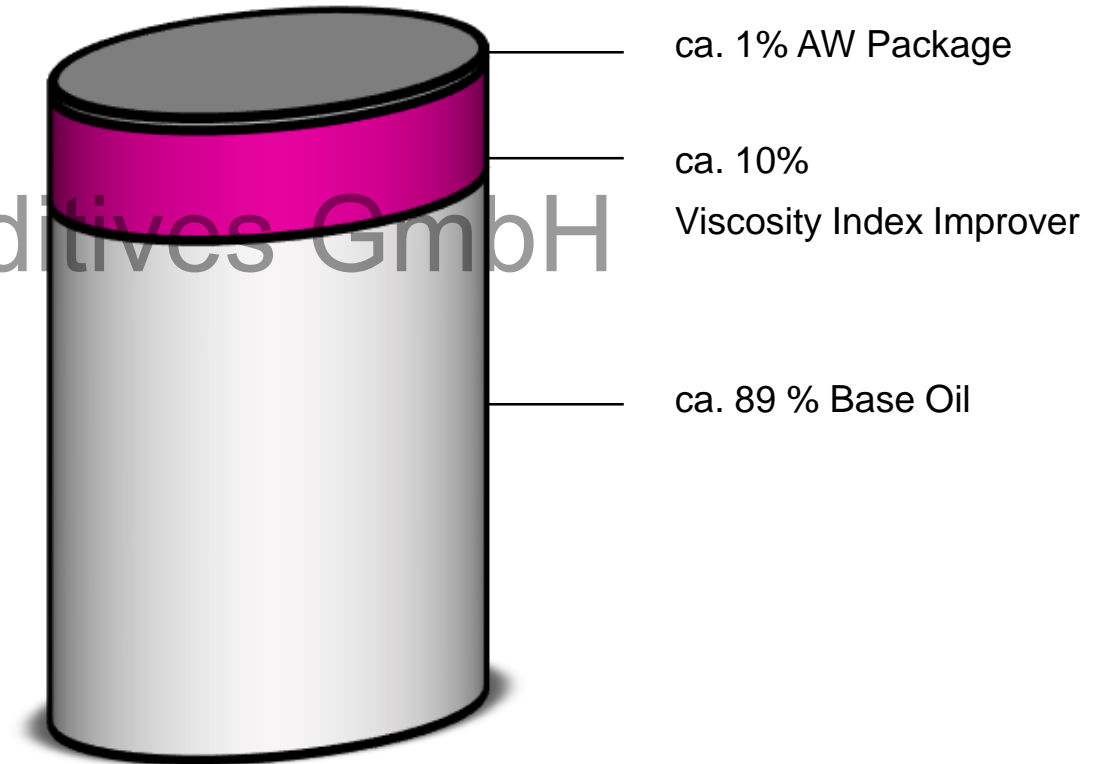


A closer look into Hydraulic fluids

Monograde



Multigrade



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The facts and figures of success

Practical tests have been carried out in the following fields:



- Construction machines and mining
- Up to 30% lower energy consumption to complete the same amount of work

In-house tests at Evonik and at OEMs



- Stationary industrial equipment
- Up to 10% energy savings in Injection Molding machines

DYNAVIS® in the In-House Test Injection Molding Machine

Performed by the Evonik R&D Department using a Krauss-Maffei injection molding machine

	VI optimized fluid	Reference fluid
3 temperatures were tested for each fluid	Low	
	Mid	
	High	
Two test cycles for each temperature	Slow test cycle	
	Fast test cycle	

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Performance demonstration – Engel



CASE STUDY: ENGEL INJECTION MOLDING EQUIPMENT / AUSTRIA

DYNAVIS® technology amplifies efficiency in injection molding equipment

In today's injection molding equipment marketplace, energy efficiency has become almost as important as high levels of technical sophistication. With over 60,000 sold over the past quarter century, the "Victory" series of injection molding machines manufactured by Engel is an industry "workhorse". But even with its smart design and energy efficient concept, there's still room for improvement. Where, you ask. Is energy consumption!

The technical highlights of many Engel machines is the "die-barless technology", a barrier-free mold area design that provides a host of benefits, including a smaller machine footprint, faster tool changing times, greater flexibility and an overall improved accessibility, which facilitates the addition of other functional elements, such as robotics. As if these features weren't enough, Engel's Victory series delivers low energy consumption via low-friction, clamping pressure lock-in and an electro-hydraulic control pump.

Engel Victory. Designed for Energy Efficiency
Firstly Engel states that its Victory series saves up to 70 % of the drive energy consumed with conventional hydraulic equipment. Secondly, the Victory design renders oil cooling practically obsolete, which means that Engel equipment can operate without an energy-consuming component upon which the majority of competitive equipment relies. With its "Engel eco-drive", the company optimizes equipment efficiency. The fact

that 80 % of Engel machines are ordered with "Engel Eco-drive" speaks for itself.

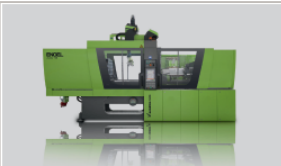
Not surprisingly, the Engel Team was only too eager to meet with the DYNAVIS® Efficiency Team to learn what a difference a more efficient hydraulic fluid could make in its already highly efficient injection molding equipment.

An Initiative by Total and Engel: Multiple Hydraulic Fluid Tests
The hydraulic oil specialists from the Total energy company learned about the testing underway by the DYNAVIS® Efficiency Team using Viscosity Index (VI)-optimized hydraulic fluid on other injection molding equipment.

They decided to analyze the potential of TOTAL EQUIVIS HE hydraulic fluid featuring DYNAVIS® technology. Thanks to an already well-established relationship with Engel, the tests were arranged in no time.



JUST BY CHANGING YOUR HYDRAULIC FLUID
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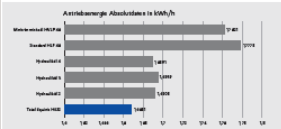
A total of six different hydraulic fluids were evaluated in the testing. As previously noted, the Total fluid featured DYNAVIS® technology.

In the chart below, two distinct groups are identifiable in terms of their viscosity. The first four fluids demonstrated at 40 °C values around the average of 33 mm²/s and the last two, values of approximately 48 mm²/s. The drive energy of the hydraulic pump was the basis for measurement of each fluid's efficiency.

Test oil	Viscosity in mm ² /s at 40 °C
Total Equivis HE32	33.41
Hydraulic oil 2	33.67
Hydraulic oil 3	35.10
Hydraulic oil 4	32.75
Standard HLP 46	48.02
Multi-purpose oil HV LP 46	48.28

The Test Subject: Engel Victory 330/120 Tech
The Engel Victory was used to produce a polypropylene panel within a cycle time of 24.35 seconds at a shot of 38 grams. To create identical test conditions, the oil temperature was a controlled 32 °C.

Significant Differences in Drive Energy
Measurements were conducted over a period of two hours to obtain realistic average values. It became clear that the fluids with lower viscosity consumed less drive energy than the two VG 46 oils tested. Among all the lower-viscosity oils, one oil stood out – the oil featuring DYNAVIS® technology, achieving an impressive 6.17 percent in energy savings. Of the remaining low-viscosity fluids, the best-performing could only achieve a savings of just under five percent.



Where to find hydraulic fluids formulated with DYNAVIS® technology? Visit dynavis.com



FACTS AND FIGURES

Machine	ENGEL VICTORY 330/120 TECH		
Clamping force	1.200 kN		
Pump drive	Constant pump and ENGEL ecodrive servomotor		
	HLP 46	TOTAL EQUIVIS HE32 with DYNAVIS® Technology	
Drive energy consumption	1.7778 kWh/h	1.6681 kWh/h	
Drive energy savings effect at a constant 32 °C	0	6,17%	

The DYNAVIS® technology Advantage: Over 6% in Drive Energy Savings
It comes as no surprise that fluids, which are easier to pump require less drive energy than fluids that are more viscous. However, it is very impressive that the DYNAVIS®-formulated fluid performs significantly better compared with fluids in the same viscosity category. It saves the most energy.



The Best Formula Wins: The Secret Behind DYNAVIS®
As a result of a higher viscosity index, DYNAVIS® fluids retain more viscosity when they heat up compared to other fluids. Consequently, they are classified as one, or possibly two ISO VG classifications below the fluids specified by the machine manufacturer. In addition, fluids formulated with DYNAVIS® technology do not heat up as much as conventional fluids.

DYNAVIS®-formulated fluids also exhibit excellent shear stability characteristics, even after long periods of continuous operation. The hydraulic fluid formulated with DYNAVIS® technology reliably maintained equipment durability, with no evidence whatsoever of abnormal wear.

FACTS AND FIGURES

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Performance demonstration, BOY Injection Molding Machines



Hydraulic fluid formulated with DYNAVIS® technology makes injection molding machines more efficient!

The plastics industry is particularly competitive. BOY injection molding machines offer a genuine competitive edge in this context. They operate with high degrees of accuracy, reliability and are also extraordinarily cost-efficient. This is in large part due to the outstanding energy efficiency of BOY machines. However, the search for additional savings potential continues. One highly promising new area of inquiry that had previously not been taken into account is the replacement of the standard hydraulic fluid used in BOY machines with a fluid formulated with DYNAVIS® technology.

Up to now, the hydraulic fluids used in BOY injection molding equipment met all demands in terms of functionality and compatibility. The fact that more suitable, customized fluids could generate significant energy-savings had previously not been known, and, of course, had not been verified with testing on BOY equipment.

The DYNAVIS® Efficiency Team contacted Boy, and soon after, an inaugural test was launched.

The viscosity of a hydraulic fluid can be a crucial factor in determining machine hydraulics efficiency. Fluids formulated with DYNAVIS® technology optimize viscosity in two ways: at low temperatures, they are more fluid, and at high temperatures, they remain more viscous than comparable standard fluids. And it raises the question, "What, if anything, does this optimized viscosity bring about in terms of the energy consumption of injection molding equipment?" BOY injection molding equipment already enjoys a reputation for being highly optimized in terms of energy consumption. Could additional savings be in the cards?



JUST BY CHANGING
YOUR HYDRAULIC FLUID

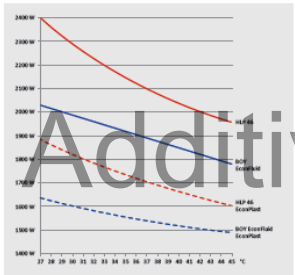
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FACTS AND FIGURES

Machine	Boy 35 E	
Clamping force	350 kN	
Pump drive	servomotor	
	HLP 46	BOY EconFluid
Energy consumption/operating cycle (depending on the temperature)	1.96 – 2.22 kW	1.78 – 2.01 kW
Energy consumption/operating cycle (depending on the temperature) with EconPlast equipment	1.60 – 1.81 kW	1.55 – 1.3 kW

Savings in percent: 7 – 10.3 % (depending on the temperature)
At 8,000 operating hours, the result is an annual savings of approximately € 400, –



DYNAVIS® Technology Fluid also Scored High in Tamed Injection Molding Machines

As mentioned above, the test machine featured EconPlast equipment. A host of measures were integrated to boost the efficiency, such as the installation of larger hoses affixed to the hydraulic motor.

As a result, in this case, the energy-saving DYNAVIS® technology effect was not as impressive as with conventional injection molding equipment. Nevertheless, the energy-saving contribution of DYNAVIS® technology was still noticeable. And, as yet to be quantified, are extended length of fluid replacement intervals. The replacement intervals are expected to be 1.5 times longer for the EconFluid formulated with DYNAVIS® technology than for monograde hydraulic fluids.

Where to find hydraulic fluids formulated with DYNAVIS® technology? Visit dynavis.com



FACTS AND FIGURES

Machine	Boy 35 E	
Clamping force	350 kN	
Pump drive	servomotor	

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Performance demonstrations summary

Equipment



Husky XL300
Clamp force: 3000 kN
T = 44 °C

4,2 %



Krauss Maffei KM 80 CX SP 380
Clamp force: 800 kN
T = 32 – 45 °C

4-5 %



Engel Victory 330/120
Clamp force: 1200 kN
T = 32 °C

6,2 %



Boy 35 E
Clamp force: 350 kN
T = 27 – 44 °C

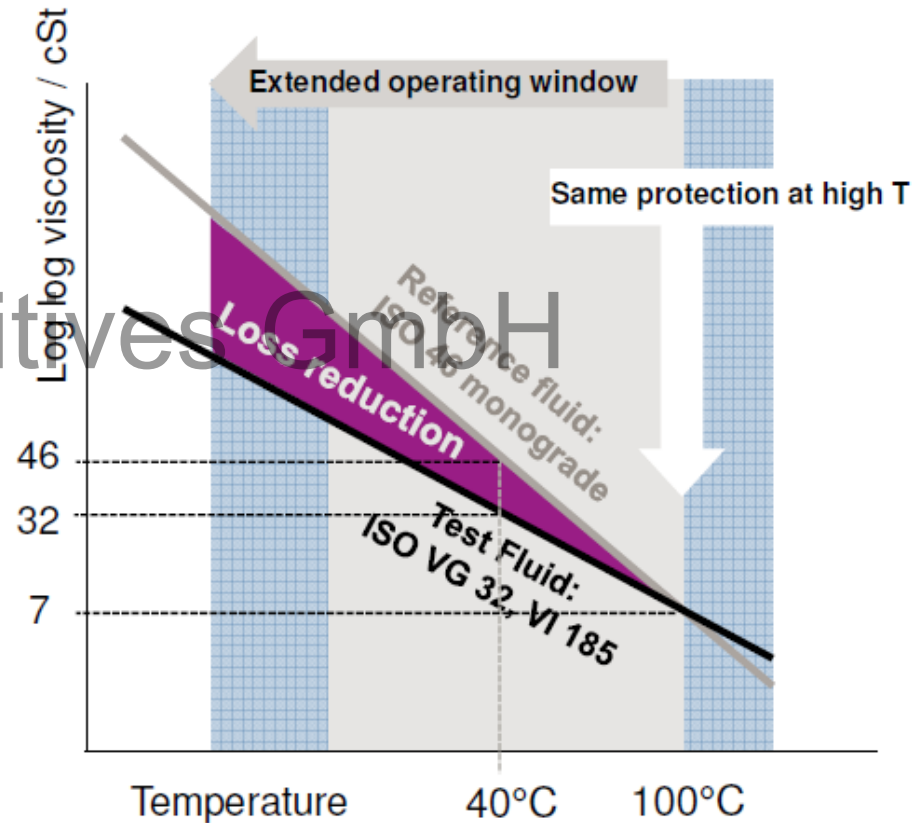
7-10 %



Haitian MA10000 II
Clamp force: 10000 kN
T = 49 +2 °C

11 %

Hydraulic Fluid



DYNAVIS® Performance Standard

Test results led to the idea to create a performance standard which helps the equipment owner to identify energy efficient hydraulic fluids formulated with the DYNAVIS® technology

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Extract of the DYNAVIS® performance standard

Performance Requirement	Comments	Units	Limit	Limit	Limit
ISO Viscosity Grade	New Oil HVLP	ISO VG	32	46	68
Viscosity Index	New Oil HVLP	-	> 160		
Shear Stability	Minimum KV100 after shear in bench tests, predicts operating viscosity in the pump	mm ² /s (cSt)	>5.9	>7.5	>10.0
Guaranteed Energy Savings - Denison T6C Vane Pump	vs. Hydraulic monograde fluid, same ISO VG, VI=100	%	>3.5 *		

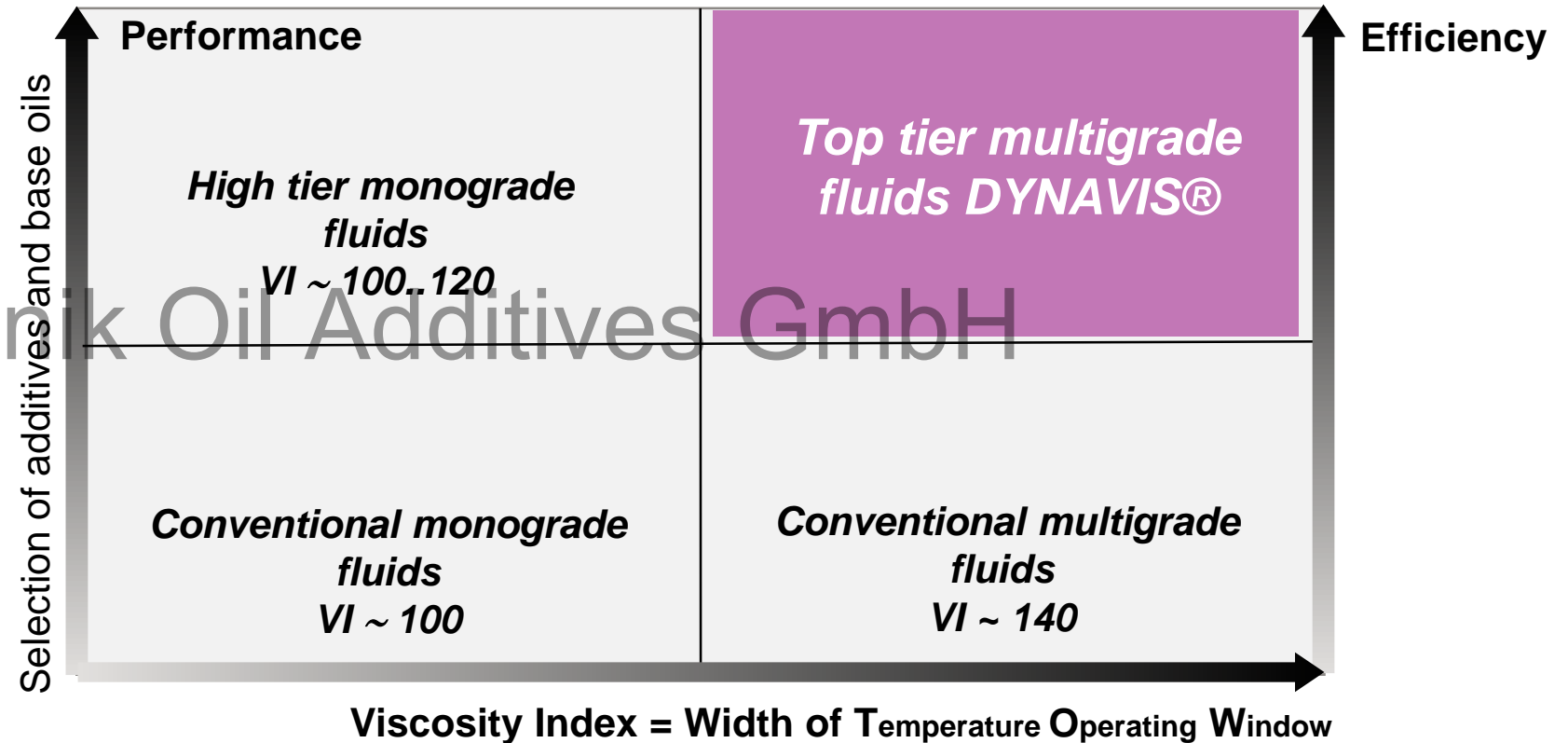
* Guaranteed energy savings with ISO VG 46 > 5%

Summary

More for less...

Hydraulic fluids formulated with DYNAVIS® technology provide:

- Sustainable increases in productivity and reductions in energy consumption
- Extended temperature operating window
- Improved protection and extension of oil drain intervals



What's next?

- Extend focus of plastic injection molding to other industrial hydraulic applications, e.g. hydraulic presses, elevators etc.
- Projects with Oil formulators and OEMs in the area of industrial hydraulic equipment

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- Work with end users to quantify the reduction of total cost of ownership

