ExxonMobil

October 2017 Bucharest

Energy Efficiency with Industrial Lubricants

G. Gagliardi / O. Maréchal – Field Engineering Support

Energy lives here™

Our objective : Advancing Productivity

Technology Leadership

By helping to improve productivity

Application Expertise

Extend Equipment Life

- Enhanced reliability
- Reduced labour
- Availability
- Increased ROC

Reduced Energy Consumption

- Lower operating costs

1 2 3 4

Extended Oil Life

- Reduced waste
- Reduced labour
- Reduced transportation

Environment, Health, Safety

- Reduced intervention in machines

Energy Efficiency with Industrial Lubricants

- **Industrial Gears: Mobil SHC 600 / Mobil SHC Gear**
- **Hydraulic machinery: Mobil DTE 10 Excel**
- **Gas Engines : Mobil SHC Pegasus 30**

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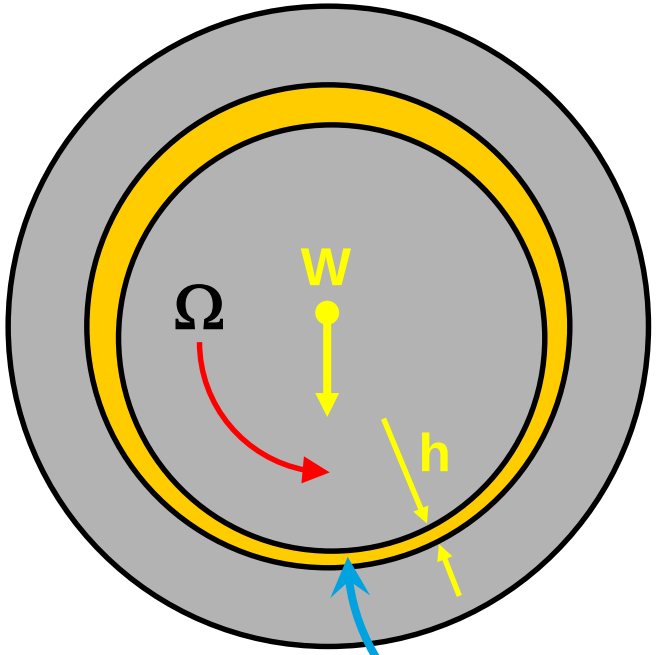
Energy Efficiency in Gearboxes with

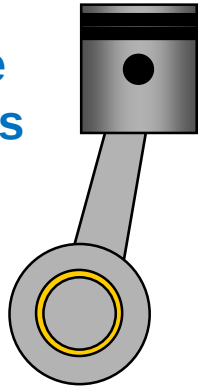
Mobil SHC 600 / SHC Gear

Hydrodynamic Lubrication - Theory



Journal and thrust bearings for industrial equipment

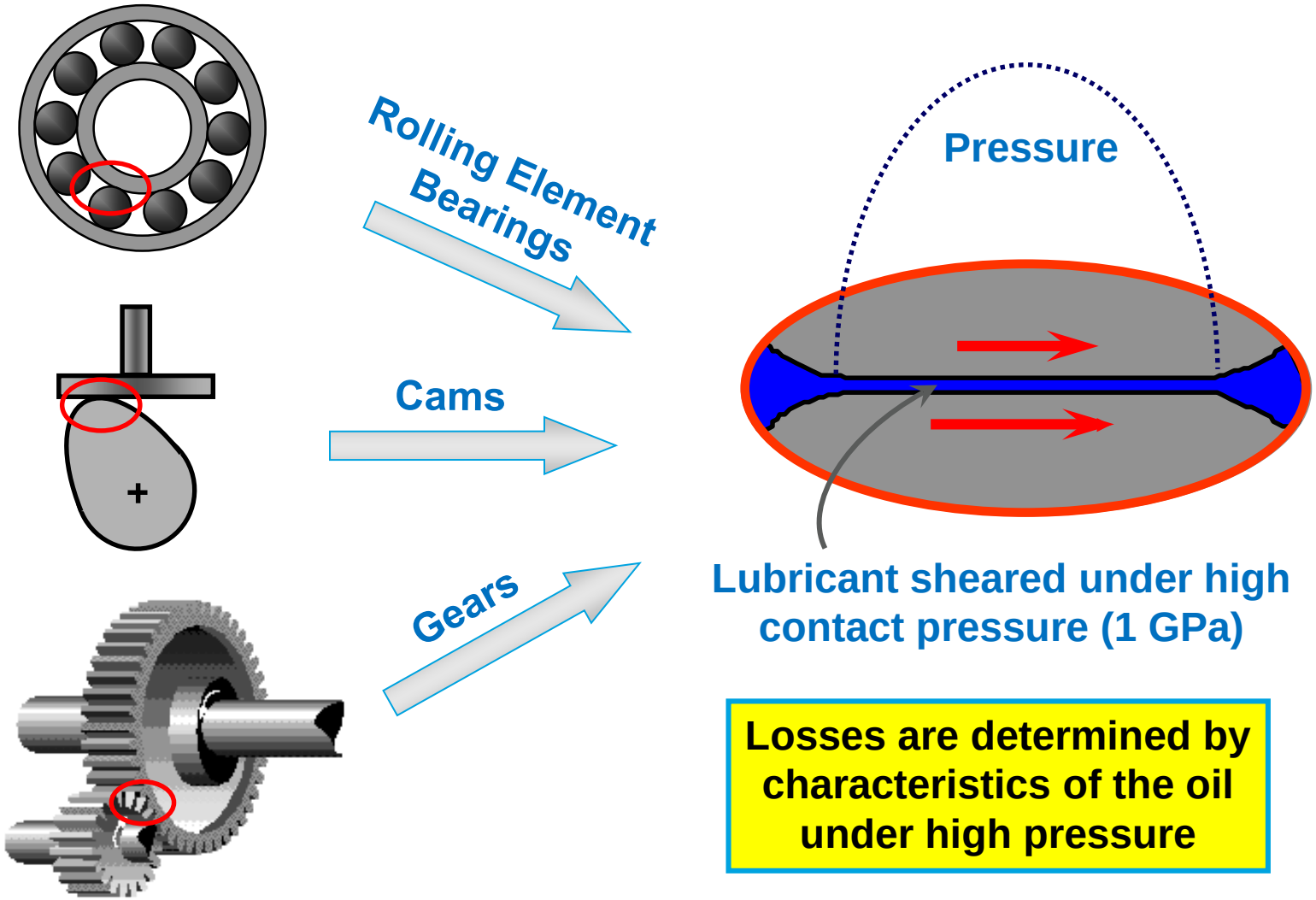
Automobile engine crankshaft bearings



Lubricant sheared under moderate pressure (0.01 GPa)

Losses are determined by oil viscosity

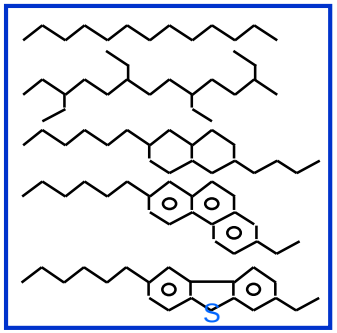
Elastohydrodynamic Lubrication (EHL) Theory



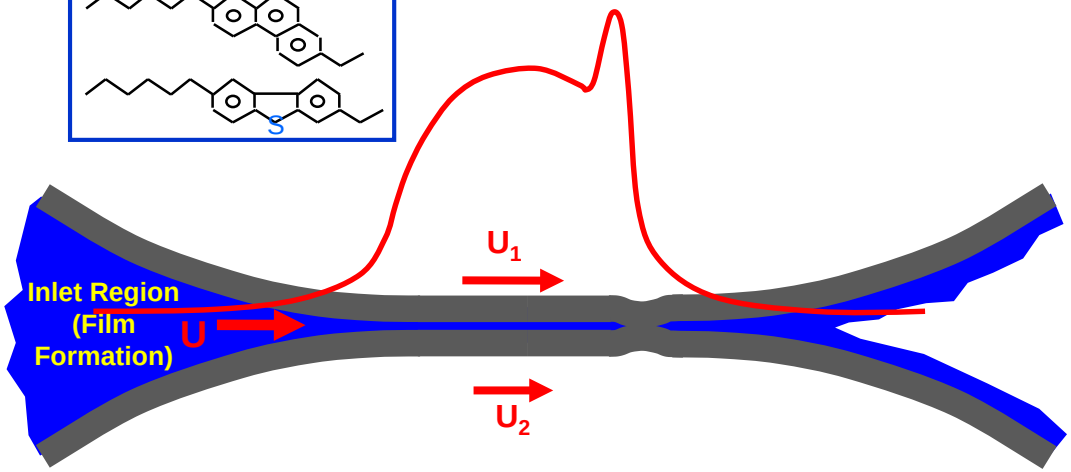
Losses are determined by characteristics of the oil under high pressure

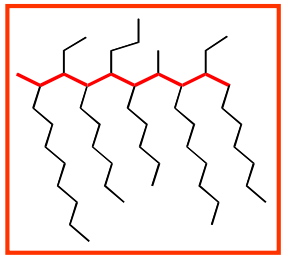
Traction Fundamentals - Theory

- Traction is dependent on molecular structure.
- **Mineral oil stocks** exhibit higher P-V coefficients due to their combination of aromatics, paraffins, et. al.
- **Synthetics (PAO)** are based on paraffin structures and exhibit lower P-V coefficient - hence lower traction.



It is more difficult for these molecules to slide past each other which creates more friction and heat in the contact region



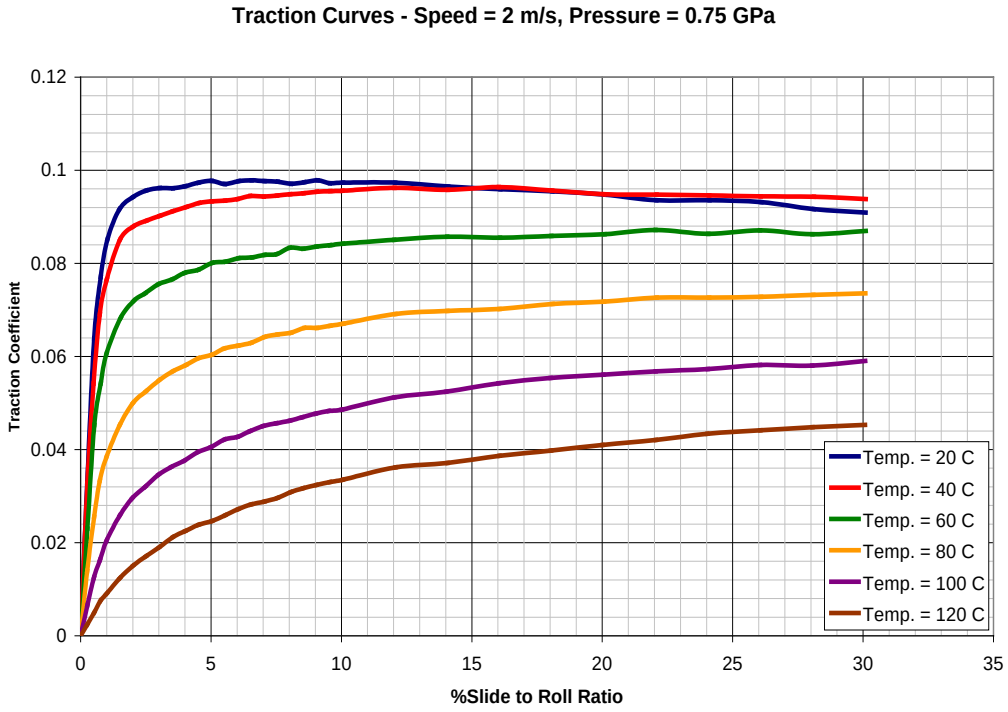


Molecules can slide past each other more easily, generating less heat.

Lower traction leads to less resistance in the EHL contact zone
Resulting in energy efficiency benefit and lower operating temperatures

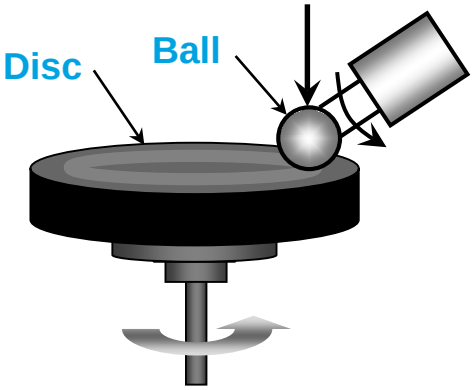
Mini Traction Machine (MTM)

Traction Curves at Various Conditions



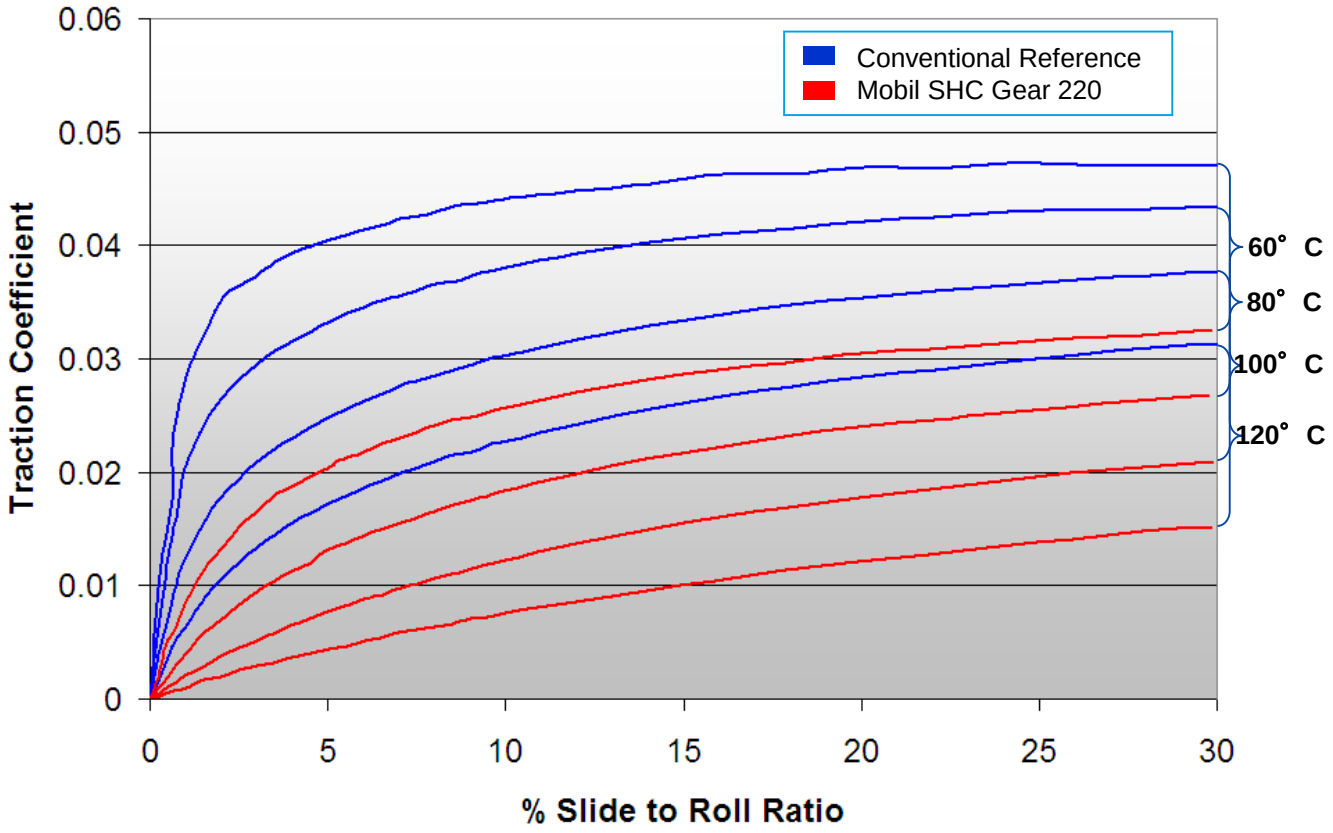
EHL Traction Curves are constructed under High Contact Load and Contact Pressure

Mini Traction Machine (MTM)

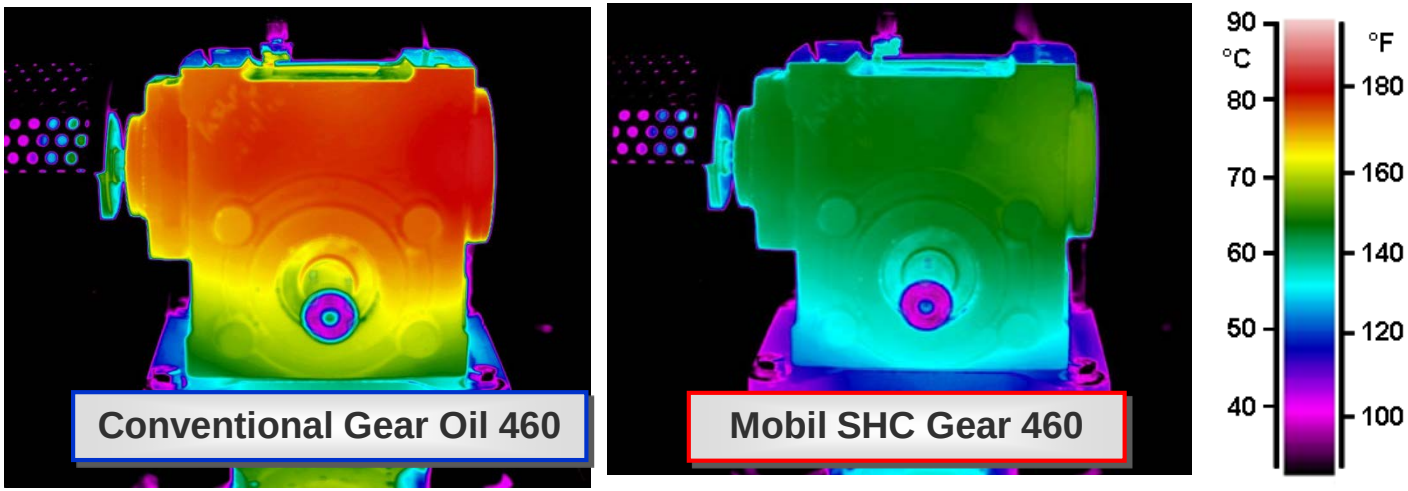


Low Traction Benefit - Mobil SHC Gear 220

Mobil SHC Gear delivers lower traction than mineral gear oil across a wide temperature range



Testing Confirms Energy Efficiency



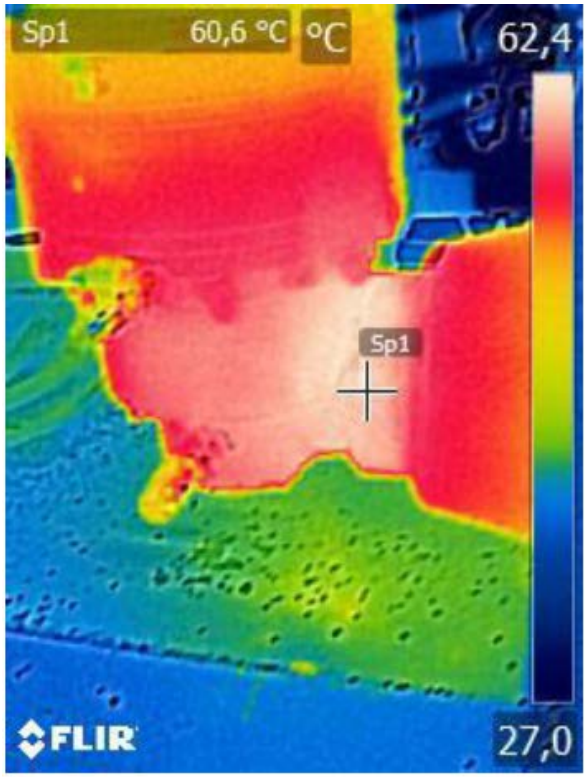
Mobil SHC Gear oil sump temperature is <u>16°C / 29°F</u> lower

- **Higher gearbox temperature indicates lower energy efficiency**
- **Lower gearbox temperature indicates higher energy efficiency**

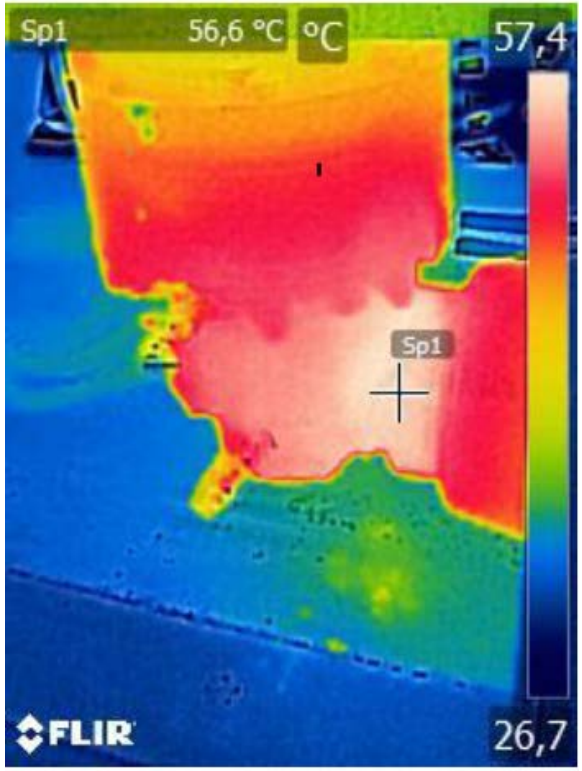
Thermographs from controlled testing indicate energy efficiency benefit of Mobil SHC Gear versus conventional gear oil

Mobil SHC 630 in Brevini Bevel Gearbox - plastic mill (Italy)

Semi-Synthetic Gear Oil
ISO VG 220 working Temperature 60.6°C



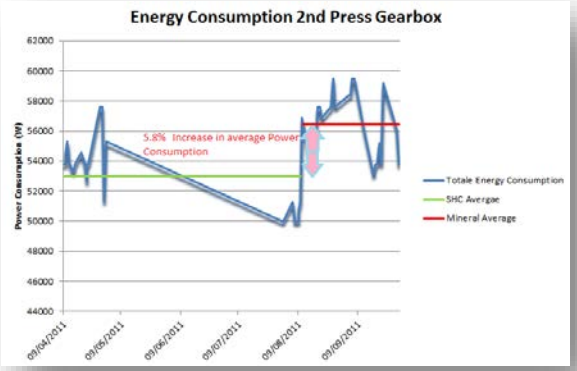
Mobil SHC 630 ISO VG 220
working temperature 56.6°C



Estimated Gearbox efficiency improvement **0,8%**

Mobil SHC 632 – Smurfit Kappa (UK)

- **Paper Mill Press Drive**
- **Efficiency improvement vs. mineral oil**
  - **8°C drop in operating temperature**
- **> 3300 Operating hours**
  - **No signs of oxidation**
  - **Wear metals ≤ 2 ppm**
- **Energy Efficiency Improvement of 6,5%**



Mobil SHC Gear 220 – Taconite Mine (US)

- **Sector: Mining**

- **<u>Equipement</u>**
  - **Taconite Primary Ore Conveyor Gearbox**
  - **Input: 1150Hp (845 Kw), 1792 RPM**
  - **Reduction: 39.4:1**
  - **Output: ~45 RPM**

- **<u>Demonstration Summary</u>**
  - **Operating hours: > 1500 hours**
  - **Oil condition: Excellent**
  - **No signs of oxidation**
  - **Wear metals 0 ppm**

Mobil SHC Gear 220 – Taconite Mine (US)

Energy Efficiency Improvement of <u>3,6%</u> with Mobil SHC Gear 220 Vs Mineral Oil

- > 5000 Operating hours
  - No signs of oxidation
  - Wear metals ≤ 2 ppm

PROOF OF PERFORMANCE

Mobil SHC

Mobil SHC Gear 220 Improves a Mining Operation's Gearbox Efficiency, Reliability and Protection, Saving More Than USD $7,000 Annually

Falk Helical Gear Double Reduction Gearbox
Mining Operation
Minnesota, United States

Situation
A Minnesota-based mining company was operating a conveyor driven by Falk size 44.5 x 15ZZS double reduction gearboxes. These gearboxes, which were lubricated with a mineral-based gear oil, have a high energy demand and are critically important to the customer's operation. Thus, the mining operation was interested in exploring ways to improve the reliability and efficiency of these gearboxes.

Recommendation
To help meet the customer's goals, ExxonMobil engineers recommended use of **Mobil SHC Gear 220**. In addition, ExxonMobil engineers also worked closely with the mining operation to develop an energy efficiency test protocol to evaluate the synthetic gear oil's capabilities.

Result
Use of **Mobil SHC Gear 220** increased gearbox efficiency by an average of 3.6 percent, improved gear and bearing protection, and the customer expects to triple current oil drain intervals. Collectively, these benefits helped the mining operation save USD $7,400 annually in energy, labor and lubricant expenses.

The product performance of **Mobil SHC Gear 220**, alongside the application expertise provided by local ExxonMobil engineers, is helping to improve customer productivity potential.

***Mobil SHC Gear Series** oils help improve energy efficiency in gearbox applications for the Minnesota-based mining operation.*

For more information on Mobil SHC and other Mobil Industrial Lubricants and services, call your local company representative or visit www.mobilindustrial.com.

www.mobilindustrial.com

This Proof of Performance is based on the experience of a single customer. Actual results can vary depending upon the type of equipment used and its maintenance, operating conditions and environment, and any prior lubricant used.

Mobil SHC Gear provided an energy efficiency improvement of 3.6%

Other successful field experiences

Coeur Mexicana Mining Company:Falk Helical Gearbox change from mineral oil to Mobil SHC Gear 320 reduced operating temperature of **10°C**

Cement Plant (Turkey): 2,5% energy efficiency improvement in 110 KW driven elevator gearbox with Mobil SHC Gear 320

Xinyu Iron & Steel (China): 3,2% energy efficiency improvement and 6,7 °C decrease in conveyor gearbox replacing mineral oil with Mobil SHC 630

Paper Mill (Germany): 5% decrease energy consumption on spur gear in a wet end twin wire press with Mobil SHC Gear 320 vs conventional mineral oil

Ceramic Mill (Turkey): 2,4% energy efficiency imporvement against conventional mineral oil With Mobil SHC Gear 320

Energy Efficiency Summary in Gearboxes

- **Many lubricated contacts in Industrial equipment operate under EHL conditions**
- **Losses in EHL contacts depend on fluid traction (internal friction) properties**
- **Mobil SHC Gear has lower traction than conventional gear oils**
- **Potential gear oil energy efficiency benefit depends on gear types, number of gear reduction stages, duty cycle, and lubrication conditions**

Mobil SHC Gear delivers up to 3.6% energy efficiency* benefit versus conventional gear oil

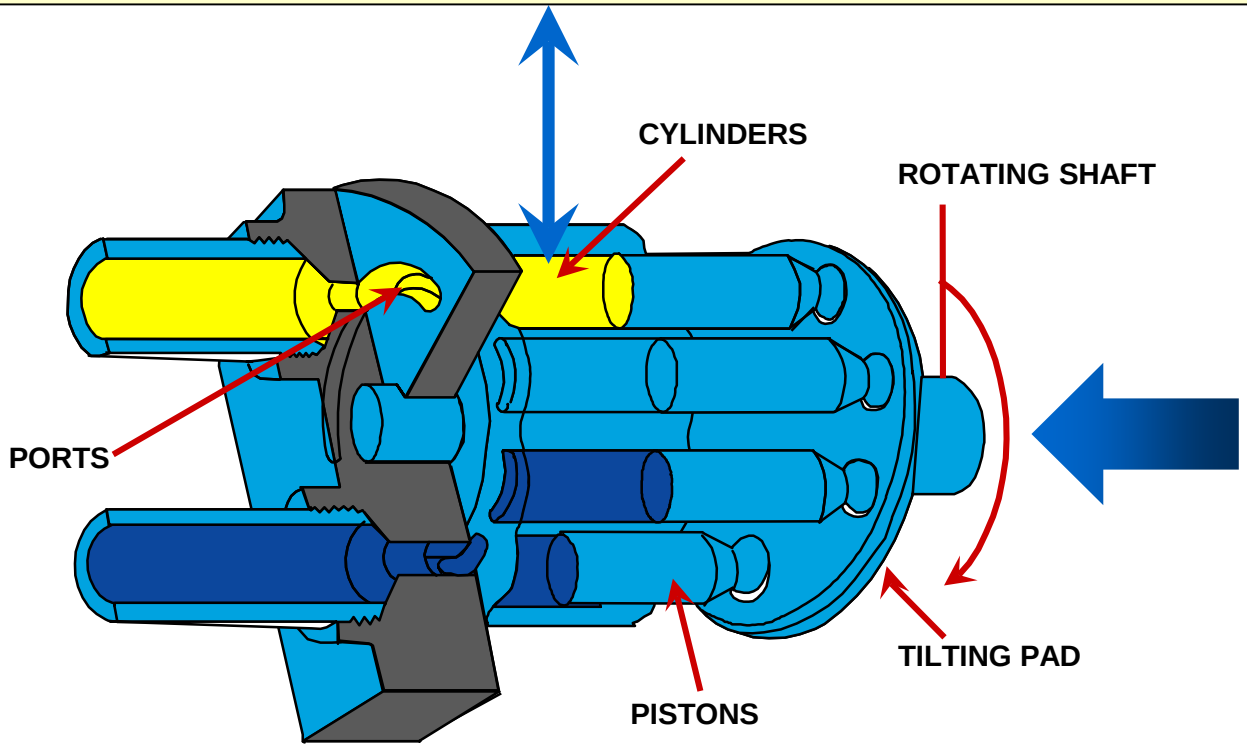
*Energy efficiency relates solely to the fluid performance when compared to conventional (mineral) reference oils of the same viscosity grade. The technology used provides up to 3.6% efficiency compared to the reference when tested in a worm gearbox under controlled conditions. Efficiency improvements will vary based on operating conditions and application.

Energy Efficiency in Hydraulics with

Mobil DTE 10 Excel

Hydraulic Efficiency : Theory

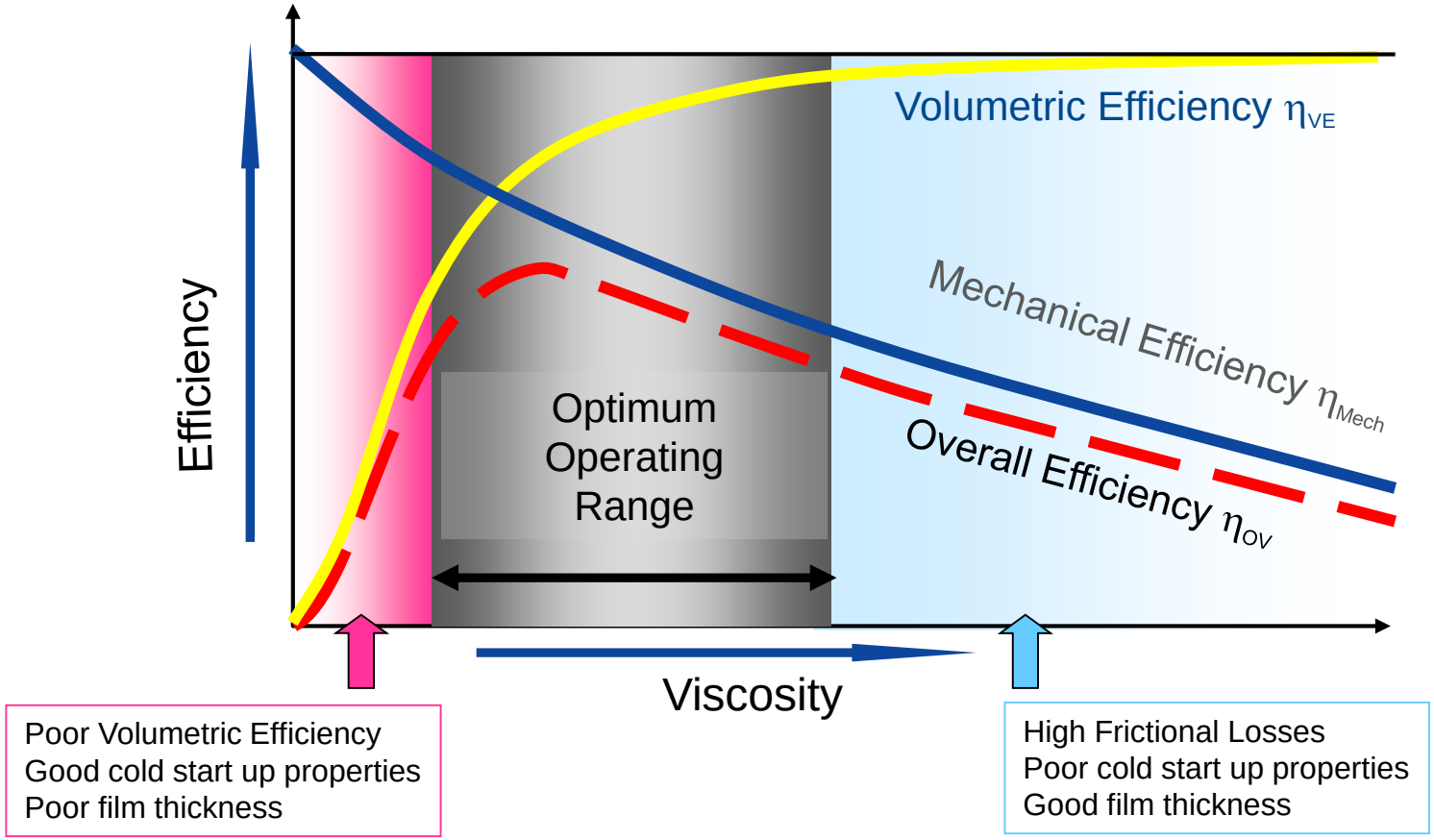
- **Volumetric Efficiency: All Pumps have internal leakage paths**
- **In an axial piston pump, oil leaks through the clearance between the cylinder and piston**



Mechanical Efficiency:

- **Energy is Consumed to rotate pump and overcome fluid frictional losses**

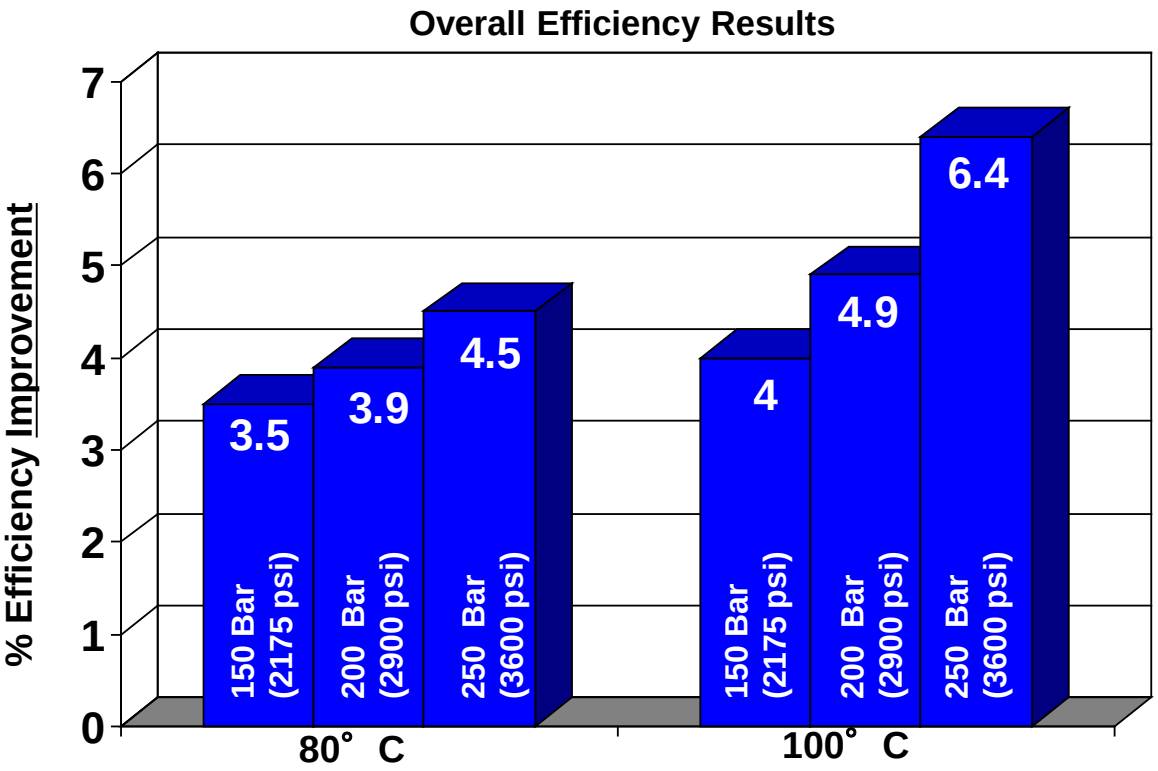
Hydraulic Efficiency : Theory



- **Oil viscosity has a significant impact on hydraulic efficiency**
- **Overall efficiency is a balance between Mechanical and Volumetric**
- **Shear Stable High VI fluids enable increased hydraulic efficiency**

Reference: The Benefits of Maximum Efficiency Hydraulic Oils, Romax – "Machinery Lubrication Magazine"

Efficiency Demonstration -Mobil DTE 10 Excel



Mobil DTE 10 Excel provides efficiency benefits:

- **Up to 6.4% overall hydraulic efficiency benefit versus reference fluids**

Hydraulic Efficiency Rig Test – Denison T6C vane pump

- **Controlled test to measure overall hydraulic efficiency of high VI fluids**
- **Efficiency benefits measured relative to ISO 46 100 VI**

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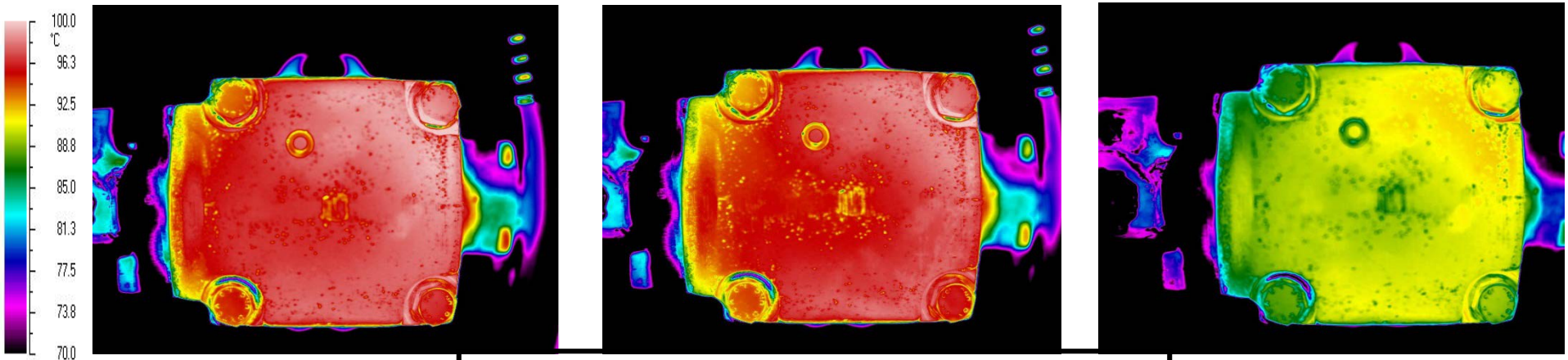
Thermal Imaging Efficiency Demonstration

Simple Hydraulic Circuit without Heat Exchanger (no cooling)

Reference Fluid, ISO VG 46 VI 100	Competitive High VI Fluid	Mobil DTE 10 Excel 46



End of Test Average Pump Temperatures*

97.4 °C	**96.5 °C**	**90.3 °C**
23 minutes	**24.5 minutes**	26.6 minutes

Mobil DTE 10 Excel Reduced Pump Temperature = Improved Efficiency

* Note: Average pump temperature as measured by thermal camera over a consistent defined area of the pump cover plate. End of test times vary based on system heat accumulation.

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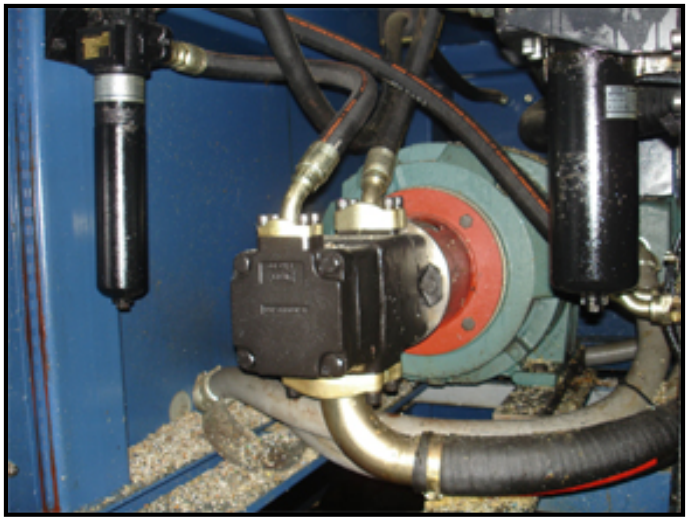
DTE 10 Excel - Plastic Injection Molding (US)

- **Van Dorn Caliber, Model 1430**
  - **Electric motors: 1- 100 Hp (73Kw) , 2 – 75 Hp (55Kw)**
  - **Hydraulic pumps: 4 – fixed volume vane pumps, 1- variable volume axial piston pump**
  - **330 Gallon reservoir volume**
- **A – B – A, with Fluke 1760 Power Analyzer from 500 amp, 480 VAC feed**
  - **Continuous Operation Energy Savings = up to 2.2% (+/- 0.3%)***
  - **Peak Energy Savings = 4.1%***

DTE 10 Excel

$2,185 / Year

Electricity Savings*



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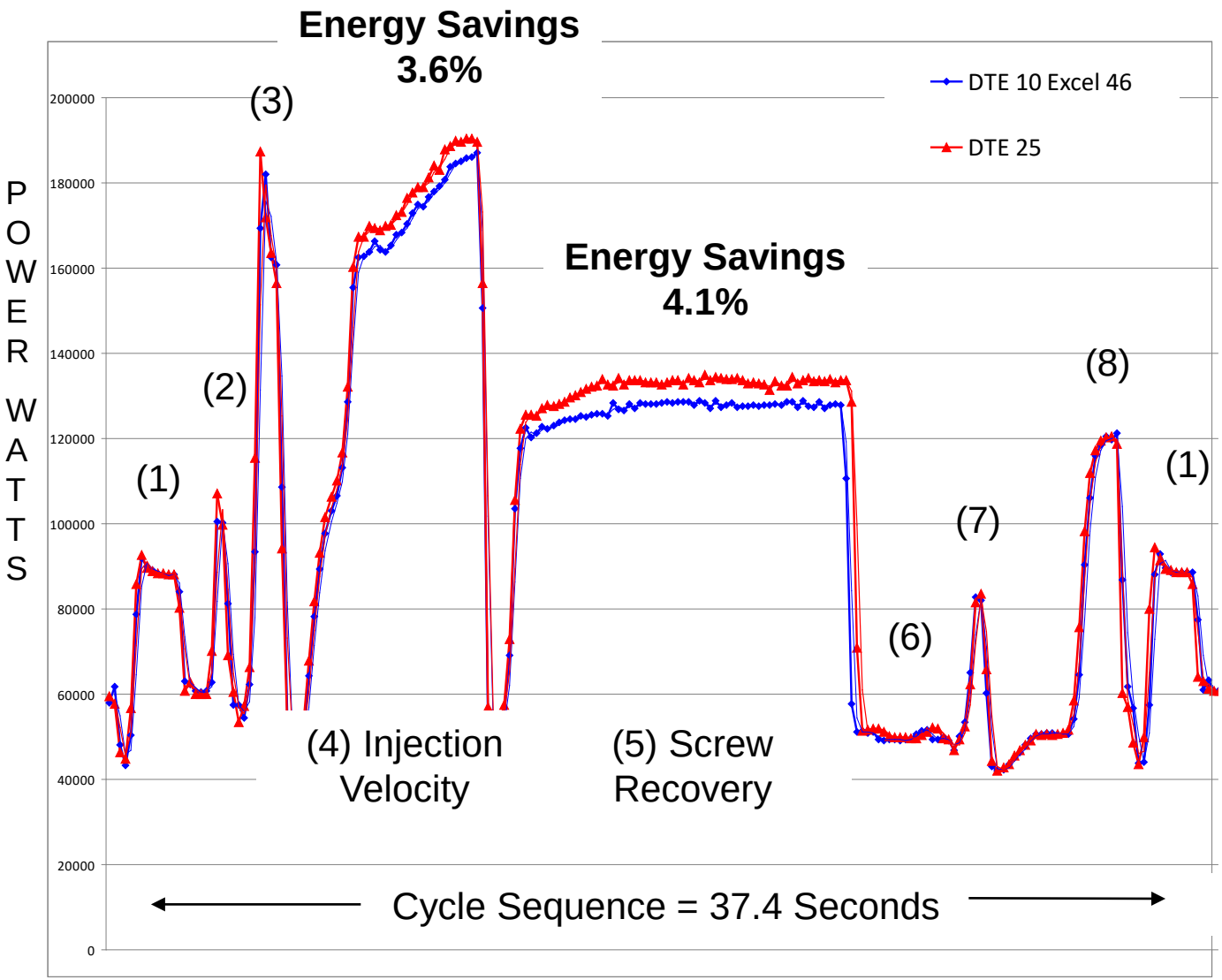
* Energy savings reduction shown are for specific test and machine conditions in this demonstration. Similar results are not guaranteed.
Field test protocol developed by Exxon Mobil Corp.

DTE 10 Excel - Plastic Injection Molding (US)



2.2% Continuous Operation Energy Savings*

Cycle Actions

1. Eject Parts
2. Clamp Close
3. Tonnage Lock-up
4. Injection Velocity
5. Screw Recovery
6. Cure Time
7. De-Compress
8. Clamp Open
1. Eject Parts (repeat)

ExxonMobil

* Energy savings reduction shown are for specific test and machine conditions in this demonstration. Similar results are not guaranteed.

Other Successful Field Experiences

Volkswagen AG (Wolfsburg,Germany): Kraus Maffei Injection Molding, Mobil DTE 10 Excel 46 achieved **3,7%** energy saving against conventinal mineral hydrdaulic oil with an yearly consumption reduction of 330000 KWh

Ceramika Konskie (Konskie,Poland): Cycle reduction from **12.7 to 10.8** seconds in Sacmi Imola PH 3200 press with 17% productivity increase with Mobil SHC 525

Hafner & Krullman (Germany): 3% decrease in energy consumption on Kraus Maffei 350/3000CX injection molding machines with Mobil DTE 10 Excel 46 agains competitor HPLV oil

Large Consumer Good plant (Greece): Bekum plastic injection molding machine, Cycle time reduction from **9.5 to 7.2** seconds with 24% productivity increase with Mobil DTE 10 Excel 46

Other Successful Field Experiences

Bic Plant (Greece): Mobil DTE 10 Excel 46 provided **3,1%** power improvement in Engel plastic injection molding machine against conventinal competitor mineral oil *(Preliminary results)*

Plastic plant (Bulgaria) *:* **2,14%** energy savings demonstrated on a Battenfeld TM 1000/525 PIM machine for standardized production output.

Energy Efficiency in Gas Engines

With Mobil SHC Pegasus 30

Field Experience in Cogeneration Gas Engine

Energetus (Guimaraes, Portugal) : Mobil Pegasus SHC 30 provided **1.1%** gas consumption reduction on an MTU 16V 4000 natural gas cogeneration unit versus premium mineral SAE 40 gas engine oil and more than doubling the oil drain interval for a monetary saving of 16500€/Y

Conclusion Energy Efficiency with Mobil Lubricants

- **Up to 3,5%** **Energy Efficiency in gearboxes with Mobil SHC 600 / SHC Gear**
- **Up to 6+%** **Energy Efficiency in Hydraulic Systems with Mobil DTE 10 Excel**
- **Up to 1,5%** **Fuel Efficiency in Gas Engines with Mobil SHC Pegasus 30**
- **Up to 4,7%** **Fuel efficiency in Heavy Duty Diesel Engine and Powertrain with Mobil Delvac 1 LE 5W-30 and Mobilube 1 SHC 75W-90**