

ENERGY SAVING STRATEGIES FOR PLASTICS INJECTION MOLDING: LUBRICATION

ADAM MCMURTREY, EXXONMOBIL, SPRING, TX

Abstract

Plastics injection molding machines require an extensive amount of energy, and energy costs typically represent one of the major line items in a company's operating budget. A typical injection molding operation spends almost as much on energy expenditures as it does on direct labor. As operators look to reduce costs and enhance sustainability, they typically turn to the more obvious levers – such as new equipment, lighting retrofits, and more. But, one of the easiest and most frequently overlooked opportunities to improve energy efficiency is lubrication. This paper outlines how lubrication influences energy efficiency, key lubrication-related energy saving opportunities, and how operators can implement the right lubrication strategy to reduce energy costs, improve their bottom line, and enhance sustainability.

Introduction

Plastics injection molding machines require an extensive amount of energy, and energy costs typically represent one of the major line items in a company's operating budget. A typical injection molding operation spends almost as much on energy expenditures as it does on direct labor. As operators look to reduce costs and enhance sustainability, they typically turn to the more obvious levers – such as new equipment, lighting retrofits, and more. But, one of the easiest and most frequently overlooked opportunities to improve energy efficiency is lubrication. This paper outlines how lubrication influences energy efficiency, key lubrication-related energy saving opportunities, and how operators can implement the right lubrication strategy to reduce energy costs, improve their bottom line, and enhance sustainability.

Injection molding machines: optimizing for energy efficiency

Today's plastic injection molding machine technology is far more energy efficient than 20 years ago. At a conservative estimate, modern hydraulic plastic injection molding machines are 25% more energy efficient than those manufactured in 1997. Meanwhile, today's best all-electric machines may be

up to 80% more energy efficient than their 20-year old hydraulic predecessors.

But, in almost every case, the cost of energy required to run a plastic injection molding machine over a 10- year period will be greater than its initial purchase cost. This cost gap will only widen as energy prices increase.

For this reason, energy assessment must become part of the purchasing process for every new plastic injection molding machine. Considering the whole life cost of a machine is difficult but it is the only way to control future energy expenditure. It will help ensure that an attractive low cost machine does not become an energy hog that raises production costs through its entire lifetime. This includes looking at every aspect of the machine's operation – down to the lubricant used.

Check your hydraulic oil

Hydraulic oil expenditure represents a fraction of the cost of running plastic injection molding machinery. But, a small change in hydraulic oil can result in big performance breakthroughs, such as prolonged component life, improvements in overall equipment efficiency and reduced cycle times.

Operating challenges

Throughout the injection molding process, hydraulic oil is exposed to compression, shear stresses and a wide range of temperatures. Exposure to these conditions can trigger molecular breakdown in the oil, reducing its ability to lubricate and protect machine components. A conventional or lower quality hydraulic oil offers less lubricity and protection, forcing equipment to work harder – ultimately exerting more energy.

High temperature operating conditions will also cause oxidation within the hydraulic oil, which subsequently creates an increase in viscosity and a build of destructive lacquer. Along with oxidation and corrosion, hydraulic oils can also become contaminated by water, dust, wear debris and other materials throughout the injection molding process.

Contamination triggers pump failures and ultimately increases filtration costs.

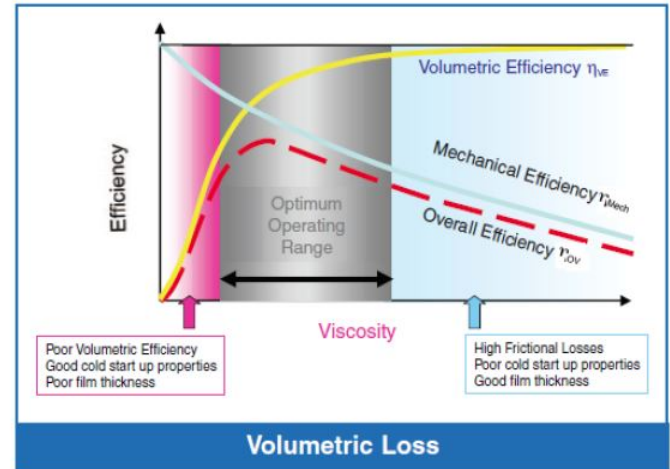
Switch to advanced hydraulic oil

To combat all of these issues, it is important to use a hydraulic oil with excellent shear stability and a high viscosity index. High performance hydraulic oils maintain their optimum viscosity across a wide range of operating conditions, helping to protect equipment, improve energy efficiency and extend oil drain intervals. That, in turn, can help to reduce maintenance, cut costs and enhance operational safety by reducing employee interaction with machinery. Extending oil drain intervals can also cut waste lubricant disposal, improving a company's overall environmental credentials.

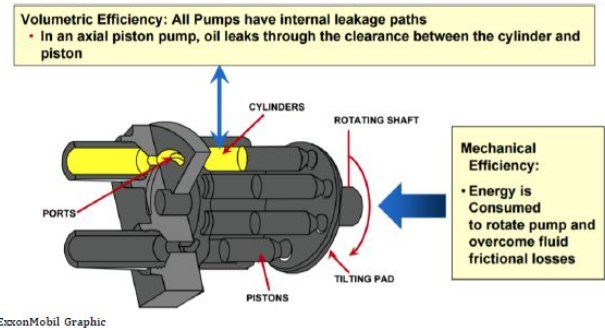
The science behind advanced hydraulic oils

In hydraulic systems, a pump cannot be 100% efficient in its energy conversion, typically losing energy in two main areas: mechanical losses, where energy is lost to friction; and, volumetric losses, where energy is lost as a result of internal fluid leakage. Both types of energy loss are primarily a function of the hydraulic fluid's viscosity and lubricity properties. Specially formulated high performance hydraulic fluids can reduce the magnitude of both mechanical and volumetric losses by utilizing a high viscosity index.

Viscosity index (VI) is an empirical and unitless number used to specify the fluctuation in viscosity with respect to temperature. The viscosity of a fluid with a high VI does not change as rapidly with temperature when compared to a fluid with a lower index. The technology advantages of a higher VI include increased energy efficiency and a reduction in power consumption, as well as a longer operating life and cleaner oil. Together, these benefits help the equipment suffer less "energy loss" during the normal course of operation.



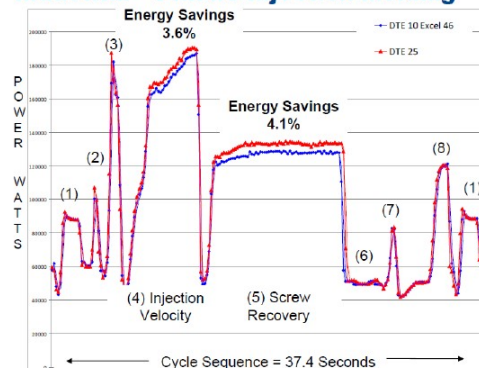
ExxonMobil Graphic



ExxonMobil Graphic

As shown in the graph below, which maps the energy consumption of an injection molding machine when using a conventional hydraulic oil (red line) compared to a more advanced oil (blue line), the more advanced oil delivers significant energy savings at key moments during operation.

Industrial – Plastic Injection Molding



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)

Identifying the energy efficiency opportunity

To properly identify if lubrication can in fact deliver valuable energy efficiency savings, operators should take advantage of several lubrication-related services.

First, many suppliers offer energy efficiency studies, whereby the supplier's engineering team conducts a full energy study. The process often entails close collaboration with your maintenance team to do the following:

- Determine objectives, expectations, focus and scope
- Coordinate and oversee pre-test, test and post-test work
- Develop a detailed test protocol
- Respect all safety and labor rules and ensure complete confidentiality
- Document results and recommendations

These studies end with a full report that details the right lubrication technologies and maintenance practices that operators should follow to reduce equipment energy consumption.

In addition to a full energy efficiency study, operators should take advantage of a regular used oil analysis program. This program can deliver invaluable insights into how both a machine and its respective lubricant are performing, helping operators take corrective action as needed to maintain optimal equipment performance and efficiency.

Lubrication as an energy efficiency lever: field examples

Two recent examples from the field highlight the significant energy efficiency benefits that lubrication can deliver.

In one instance, a leading plastics manufacturer switched to a higher performance hydraulic oil for its Arburg Allrounder 820S injection molding machines, leading to a 5.1% reduction in energy consumption. In addition to enhancing energy efficiency, the new lubricant enhanced the overall efficiency of the equipment, reducing maintenance costs and improving safety through a decrease in human-machine interaction.

In another example, a Wisconsin-based plastics manufacturer was able to reduce the electricity demand in a Van Dorn 300HT24 plastic injection molding machine by 3.3% by switching to a high viscosity index hydraulic fluid. The company partnered with its lubricant supplier to conduct a full energy efficiency study to verify the results. This study was also conducted in partnership with Wisconsin's statewide energy efficiency program, which validated the hydraulic fluid as an energy-efficient technology under its energy efficiency incentive program. To qualify as energy efficient, the oil was required to demonstrate that it provided users with a payback between one-and-a-half and eight years, depending on operating conditions.

Conclusion

New lubrication technologies are providing plastics injection molding companies with new opportunities to help reduce energy consumption and improve profitability and sustainability. However, to take advantage of these opportunities, operators must understand the role that lubrication plays in driving equipment efficiency as well as the lubrication-related services that can help identify the true opportunity.

Mobil ServSM Engineering Services and Mobil SHCTM 634 synthetic oil helps steel manufacturer eliminate lubrication related gear failures



Energy lives hereTM

Danieli gear reducers | Steel producer | Virginia, United States

Situation

A steel producer in Virginia operates a cooling bed that contains four Danieli gear reducers. Operating at temperatures as high as 200°F and under wet conditions, the gear reducers were experiencing failures at least once per year while using a competitive oil. As a result, the company frequently experienced bearing failures totaling US \$42,600 per bearing replacement. In an effort to reduce unscheduled downtime and maintenance costs, the company approached **Mobil ServSM Engineering Services** to help identify a solution to improve operations under extreme heat and wet conditions.

Recommendation

After a thorough gear inspection, **Mobil Serv Engineering Services** recommended switching to **Mobil SHCTM 634** synthetic gear oil. Formulated with excellent filterability, water separation and oxidation resistance properties, **Mobil SHC 634** synthetic gear oil is designed to provide improved protection under extreme temperatures and wet conditions.

Impact

Since switching to **Mobil SHC 634** synthetic gear oil nine years ago, the company has not experienced a single lubrication-related failure in its gear reducers. As a result, the company experienced reduced maintenance costs, unscheduled downtime and less equipment exposure for maintenance technicians.

Benefit

The company reports that **Mobil SHC 634** synthetic gear oil has helped eliminate all lubrication-related gear failures, which reduced maintenance costs and unscheduled downtime.

Generated company-estimated annual savings of

US \$383K

Industrial
Lubricants



Advancing productivity

Helping you reach your Safety, Environmental Care and Productivity goals through our innovative lubricants and services is our highest priority. That's Advancing Productivity. And that's how we help you achieve your broader vision of success.

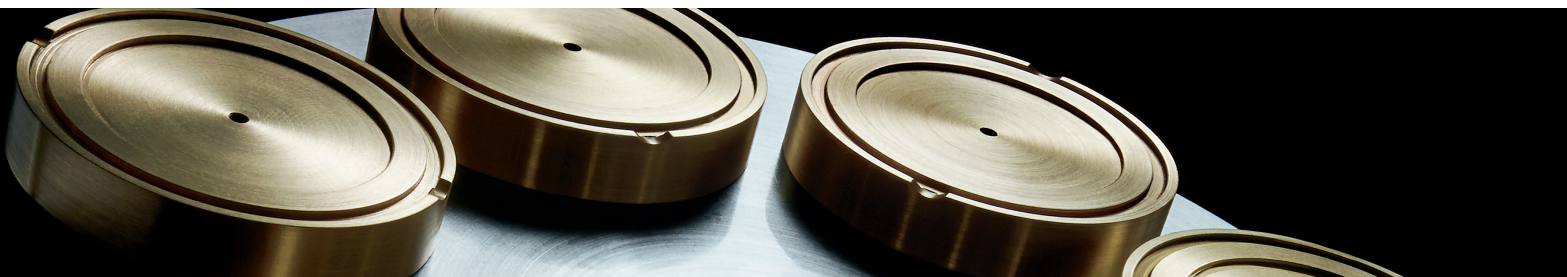
This Proof of Performance is based on the experience of a single customer. Actual results can vary depending upon the type of equipment used and its maintenance, operating conditions and environment, and any prior lubricant used. In this document, ExxonMobil means Exxon Mobil Corporation or one of its affiliates.

© 2018 ExxonMobil. All trademarks used herein are trademarks or registered trademarks of Exxon Mobil Corporation or one of its subsidiaries. POP 2018-015

mobil.com/industrial

Are your lubricants working for or against you?

Aligning your oil with operating environments



Energy lives here

Well-lubricated machinery and equipment are vital to your business—and your profits. Many manufacturers don't realize how greatly their operating environments can affect lubricants. In fact, the following conditions can drastically reduce the efficiency of your operations if quality lubricants are not in place.

We can help you select the right lubricants for the task

At Mobil, we offer a full suite of advanced lubricants developed for manufacturing operations like yours. Our experts know the plastics industry and can help you deal with the conditions that compromise effective lubrication of your machinery and products.

From hydraulic oil to gear and bearing greases to compressor lubricants, we can help you optimize your entire range of lubricants for the best equipment performance.

We can help you predict the problems you might encounter

In addition to advanced-technology lubrication products, Mobil provides a range of professional

services to help you evaluate your operating environments and assess the impact of the environment on your lubricants and productivity. Our services include:

Mobil Serv™ Lubricant Analysis

Fast, accurate oil sample analysis gives you critical information on the health of your operation.

Hydraulic system inspection

Our experts will inspect and report on the condition of your critical plant hydraulic systems and recommend maintenance best practices to improve system reliability.

Comprehensive leak detection

Advanced, ultrasonic, and ultraviolet (UV) leak detection to locate costly faults in critical plant systems and provide maintenance best practices to help prevent or reduce leaks.

Additional services include plant services to understand storage and handling, equipment failure analysis, inspections for energy efficiency and thermography, drain interval recommendations, training, and contamination control.



Maturing environments
that allow contaminants
into lubricants



Hardworking conditions,
such as extreme high
temperatures and
pressure



Resource-intensive
environments
that overuse energy
resources

Mobil DTE 10 Excel™ 46 hydraulic oil helps U.S. plastics manufacturer reduce energy consumption



Energy lives here™

Plastic injection molding machine | EVCO Plastics manufacturer | DeForest, Wisconsin, United States

Situation

EVCO Plastics is a global plastics manufacturer that operates plastic injection molding machines in its DeForest, Wisconsin plant, all of which were lubricated using a conventional mineral-based lubricant. Because of its long-standing commitment to sustainability in manufacturing, the company is continuously seeking opportunities to minimize energy and resource consumption throughout its operation. For this reason, the company partnered with ExxonMobil to identify a solution that could help improve the energy efficiency of its injection molding machines.

Recommendation

ExxonMobil engineers recommended switching to **Mobil DTE 10 Excel™ 46** hydraulic oil. Formulated with robust anti-wear properties, lower traction coefficient, and shear stable high viscosity index improver (VII). **Mobil DTE 10 Excel 46** is designed to help improve overall hydraulic efficiency. ExxonMobil engineers also recommended implementing routine **Mobil Serv™ Lubricant Analysis** to monitor fluid and equipment health.

Impact

After transitioning to **Mobil DTE 10 Excel 46**, detailed assessments conducted by both EVCO Plastics and ExxonMobil confirmed a 3.3% reduction in energy consumption in the company's molding machines. As a result, the company was able to reduce overall oil need, energy consumption and overall operating costs.

Benefit

EVCO Plastics reports that **Mobil DTE 10 Excel 46** hydraulic oil helped reduce energy consumption by 3.3%, generating company-estimated annual savings of US \$1,353 per plastic molding machine.

Reduced energy
consumption by
3.3%

Industrial
Lubricants



**Advancing
Productivity™**

Advancing productivity

Helping you reach your Safety, Environmental Care and Productivity goals through our innovative lubricants and services is our highest priority. That's Advancing Productivity. And that's how we help you achieve your broader vision of success.

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. In this document, ExxonMobil means Exxon Mobil Corporation or one of its affiliates.

© 2018 ExxonMobil. All trademarks used herein are trademarks or registered trademarks of Exxon Mobil Corporation or one of its subsidiaries. Other trademarks shown are property of their respective owners.
HIPOP 2017-024

mobil.com/plastics



Mobil DTE 10 Excel Helps Plastics Manufacturer to Reduce Energy Consumption and Generate Estimated Annual Savings of USD \$1,699/Machine

Arburg Allrounder 820S
Hansen Plastics Corporation
Elgin, Illinois, United States

Situation

Hansen Plastics is a leading plastics manufacturer based in Illinois operating 70 plastic injection molding machines. The high energy demands of these machines led the company to approach ExxonMobil to conduct an energy-efficiency study to help determine an alternative lubrication solution capable of reducing energy consumption while simultaneously providing outstanding equipment protection.

Recommendation

Working with Hansen Plastics, ExxonMobil engineers proposed an energy efficiency study on an Arburg Allrounder 820S machine with the current competitive ISO VG 46 hydraulic oil and **Mobil DTE 10 Excel™ 46** hydraulic oil. Formulated with selected base oils and a proprietary additive system, **Mobil DTE 10 Excel 46** is scientifically engineered to help provide exceptional hydraulic system efficiency, including potential energy efficiency benefits.

Result

Hansen Plastics maintenance personnel reported the energy efficiency study results definitively showed the plastic injection molding machine experienced a 5.1% reduction in energy consumed when using **Mobil DTE 10 Excel 46** hydraulic oil. In addition, a productivity improvement of 0.21 second average cycle time reduction was experienced operating with **Mobil DTE 10 Excel 46**. These improvements resulted in a company estimated annual energy savings of \$1,699 for this machine.

The evaluation performed by the Hansen Plastics maintenance team and ExxonMobil engineers measured power consumption and cycle time under matching production conditions during the reference and test periods. In addition, equipment operation of material used and material throughput per hour were similar. Convinced of the performance of **Mobil DTE 10 Excel 46** hydraulic oil, the Hansen Plastics plans to convert the additional machines to help improve operational efficiency.



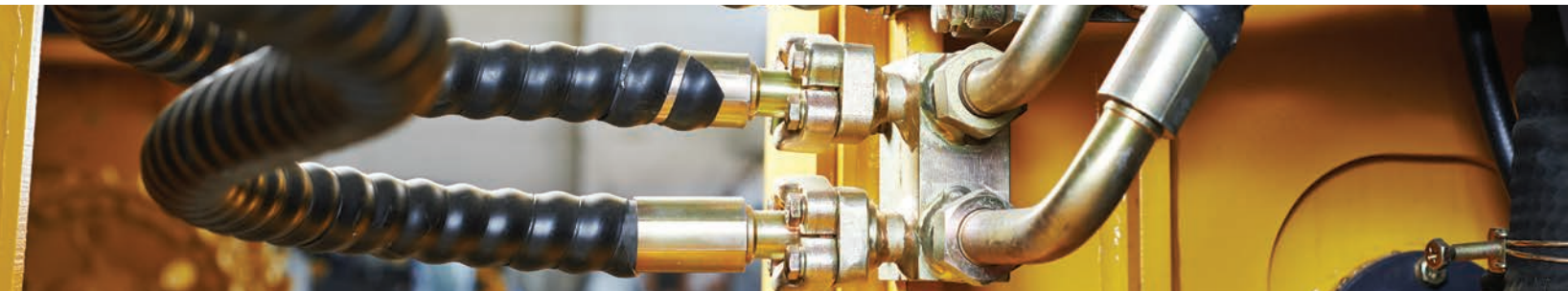
Advancing Productivity™

Mobil DTE 10 Excel 46 hydraulic oil helped Hansen Plastics Corporation improve the energy efficiency of its plastic injection molding machines, and improve production cycle times.

For more information on Mobil-branded industrial lubricants and services, please contact your local company representative or visit mobilindustrial.com.

Mobil DTE 10 Excel™ Series

High-performance hydraulic oils



Energy lives here

Key benefits



Help minimize maintenance costs and downtime by keeping systems clean up to 3 times longer than competitive oils tested*



Can help reduce power consumption and enhance equipment production through exceptional hydraulic efficiency



Reliable starting and pump protection at a wide temperature range

Minimize power consumption and maintenance costs while maximizing productivity with Mobil DTE 10 Excel™ Series zinc-free hydraulic oils. Formulated to handle the demands of today's high-pressure industrial and mobile equipment, these state-of-the-art oils provide:

- Hydraulic system efficiency designed to surpass even our standard-setting Mobil DTE™ 20 Series oils
- Long oil and filter change intervals
- Powerful equipment protection designed to help limit breakdowns

Up to

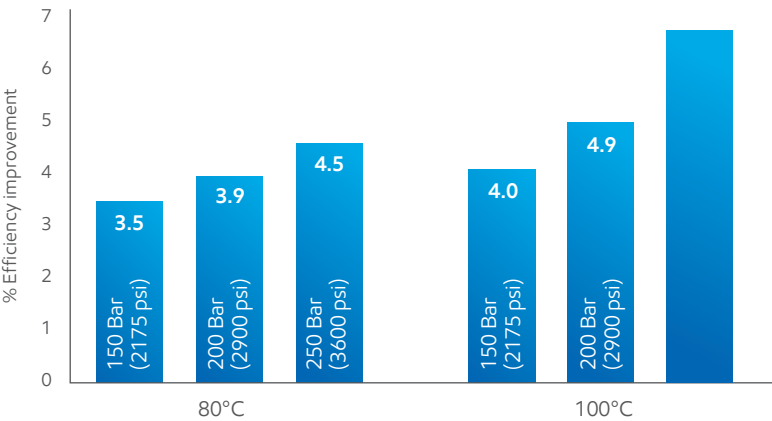
6%

increase in hydraulic efficiency*

Mobil DTE 10 Excel™ Series lubricants provided hydraulic pump efficiency benefits up to 6 percent when compared with a typical reference hydraulic fluid in controlled bench testing.

Hydraulic efficiency – bench test

Overall efficiency results for Mobil DTE 10 Excel™



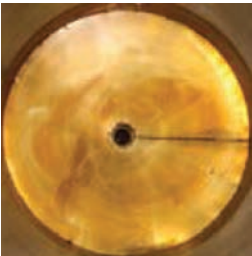
*The energy efficiency of Mobil DTE 10 Excel relates solely to the fluid performance when compared to conventional Mobil-branded hydraulic fluids. The technology used allows up to 6% increase in hydraulic pump efficiency compared to Mobil DTE 20 series when tested in standard hydraulic applications under controlled conditions. The energy efficiency claim for this product is based on test results on the use of the fluid conducted in accordance with all applicable industry standards and protocols. Results may vary based on operating conditions and equipment.

Mobil DTE 10 Excel™ Series

Typical properties*

Mobil DTE 10 Excel Series	15	22	32	46	68	100	150
ISO Viscosity Grade	15	22	32	46	68	100	150
Viscosity, ASTM D 445							
cSt @ 40°C	15.8	22.4	32.7	45.6	68.4	99.8	155.6
cSt @ 100°C	4.07	5.07	6.63	8.45	11.17	13.00	17.16
Viscosity Index, ASTM D 2270	168	164	164	164	156	127	120
Brookfield Viscosity ASTM D 2983, cP @ -20°C			1090	1870	3990	11240	34500
Brookfield Viscosity ASTM D 2983, cP @ -30°C			3360	7060	16380	57800	
Brookfield Viscosity ASTM D 2983, cP @ -40°C	2620	6390	14240	55770			
Tapered Roller Bearing (CEC L-45-A-99), % Viscosity Loss	5	5	5	7	11	7	7
Density 15°C, ASTM D 4052, kg/L	0.8375	0.8418	0.8468	0.8502	0.8626	0.8773	0.8821
Copper Strip Corrosion, ASTM D 130, 3 hrs @ 100°C	1B	1B	1B	1B	1B	1B	1B
FZG Gear Test, DIN 51354, Fail Stage	-	-	12	12	12	12	12
Pour Point, °C, ASTM D 97	-54	-54	-54	-45	-39	-33	-30
Flash Point, °C, ASTM D 92	182	224	250	232	240	258	256
Foam Sequence I, II, III, ASTM D 892, ml	20/0	20/0	20/0	20/0	20/0	20/0	20/0
Dielectric Strength, kV, ASTM D877	45	54	49	41			
Acute Aquatic Toxicity (LC-50, OECD 203)	pass	pass	pass	pass	pass	pass	pass

Ultra keep-clean performance



Leading competitor
750 hours



Mobil DTE 10 Excel™ Series
2,500 hours

In demanding proprietary MHFD testing, Mobil DTE 10 Excel Series hydraulic oils outlast competitive mineral-based products, keeping systems cleaner more than three times longer.

Industrial Lubricants



Advancing Productivity™

Safety

With significantly enhanced oil and filter replacement intervals, Mobil DTE 10 Excel™ Series oils minimize the need for maintenance and its inherent safety risks arising from direct contact with equipment.

Environmental Care†

Through exceptional hydraulic efficiency, Mobil DTE 10 Excel Series oils can potentially help reduce power consumption compared to standard hydraulic oils. Long lubricant life helps minimize the need for waste oil disposal.

Productivity

By helping you achieve trouble-free equipment operation, Mobil DTE 10 Excel Series lubricants can help you achieve new heights of operational productivity.

*Typical properties are typical of those obtained with normal production tolerance and do not constitute a specification. Variations that do not affect product performance are to be expected during normal manufacture and at different blending locations. The information contained herein is subject to change without notice. All products may not be available locally. For more information, contact your local ExxonMobil contact or visit exxonmobil.com. ExxonMobil is comprised of numerous affiliates and subsidiaries, many with names that include Esso, Mobil, or ExxonMobil. Nothing in this document is intended to override or supersede the corporate separateness of local entities. Responsibility for local action and accountability remains with the local ExxonMobil-affiliate entities.

†Visit mobilindustrial.com to learn how certain Mobil-branded lubricants may provide benefits to help minimize environmental impact. Actual benefits will depend upon product selected, operating conditions and applications.

© 2015 Exxon Mobil Corporation. All rights reserved.
All trademarks used herein are trademarks or registered trademarks of Exxon Mobil Corporation or one of its affiliates unless otherwise noted.



Mobil DTE 10 Excel 46 Helps Cement Producer Increase Hydraulic Efficiency and Performance, Generating an Annual Savings of More Than USD \$4,300

**Seram-Equilibrium Crane
Cement Producer
Missouri, United States**

Situation

A Missouri-based cement producer uses a Seram-Equilibrium crane to unload barges of raw material. Periods of very low temperatures during the winter months created start-up delays in the crane's hydraulic system, which wasted valuable production time. The company approached ExxonMobil to provide reliable options for reducing start-up delays, increasing hydraulic efficiency and improving oil durability.

Recommendation

ExxonMobil engineers recommended **Mobil DTE 10 Excel™ 46** hydraulic oil. This premium-performance lubricant is formulated with a high viscosity index, which helps maintain maximum hydraulic efficiency and component protection over a wide temperature range.

Result

Use of **Mobil DTE 10 Excel 46** hydraulic oil helped eliminate winter start-up delays, and improved productivity through estimates of reduced cycle time by two percent and improved fuel efficiency by 0.5 percent. Collectively, these benefits helped the cement producer improve hydraulic efficiency, availability and productivity, generating annual cost savings of USD \$4,313.

The product performance of **Mobil DTE 10 Excel 46** hydraulic oil, alongside the application expertise provided by local ExxonMobil engineering support, is helping to improve customer productivity potential.



***Mobil DTE 10 Excel 46** hydraulic oil helped a cement producer improve hydraulic system performance on this Seram-Equilibrium crane, saving more than USD \$4,300 per year.*

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

www.mobilindustrial.com

©2012 Exxon Mobil Corporation
All trademarks used herein are trademarks or registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.
POP 2011-045

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.