31st ELGI Annual General Meeting

13th -16th April 2019

Divani Caravel Hotel Athens-Greece

Paper Synopsis

Ken Hope

Chevron Phillips Chemical Company

Co-author: Paul Bessette

Triboscience & Engineering

Ken graduated with a Ph.D. in physical chemistry from the University of Alabama at Birmingham in 1988 and has over 25 years of experience in the lubricant industry. He served on the Board of Directors of STLE from 2006 – 2017 and is the current STLE Treasurer and the Global PAO Technical Services Manager for Chevron Phillips. He has also presented many technical papers at STLE, NLGI, AICHE and SAE meetings and holds nineteen US patents

mPAO Advantages in lithium, polyurea and aluminium complex greases

- *Focus is put on a newly developed blending matrix for calculated properties of low and high viscosity PAO blends*
- *Three different greases based on various thickeners have been prepared with a blend of PAO 6 and mPAO 65 and their properties have been investigated.*

Following a general introduction to PAO, this presentation will focus on a newly developed blending matrix for investigating various calculated properties of potential low and/or high viscosity PAO blends. The second part of the presentation will cover three different greases prepared with PAO 6 and mPAO 65 using three thickener types (Lithium, Polyurea and Aluminum complex). The properties, applications and advantages of the prepared greases will be presented. The grease development work was done in conjunction with Paul Bessette of Triboscience & Engineering.

George S. Dodos - Eldon's
Co-authors: Paul Bonner, Kevin Duncan - Croda

Dr. George S. Dodos has a Diploma and a PhD degree in Chemical Engineering from the National Technical University of Athens in Greece. He is working with ELDON'S S.A., involved mainly in research and development of new innovative products and in technical services. He also holds a Research Associate position in the Laboratory of Fuel Technology and Lubricants in the National Technical University of Athens with his research activities currently being focused in the field of renewable fuels and biobased lubricants. He has several publications in international peer-reviewed journals and conference proceedings on topics such as oxidation stability, tribological behaviour and microbial contamination of lubricants and fuels. He is affiliated to a number of international organizations including SAE and ACS. George is the chairman of the ELGI Biobased Greases WG

Performance assessment of different bio-based and biodegradable ester base oils on lubricating grease performance

- *Saturated and unsaturated Esters were chosen that comply with the latest EU Ecolabel scheme for lubricants.*
- *Grease based on Lithium and Calcium soaps have been prepared and evaluated.*
- *Significant differences were found with respect to oxidative stability and hydrolytic stability of the greases depending on the structure and the chemistry of the ester used.*

There are large chemical differences, and therefore performance differences, between the various bio-based and biodegradable oils in the market place that are available to grease manufacturers wishing to offer a more sustainable product line. This paper starts to link the performance of some of these environmentally adapted base oils to the performance of lubricating greases, to assess which properties of the base oils are retained in the formulated grease.

The base oils chosen were all esters complying with the requirements of the latest 2018 revision of the EU Ecolabel scheme for lubricants (>60% biodegradable in 28 days for a complex, multi-constituent substance) and the finished greases prepared conformed to the EN 16807 renewability definition (>25% renewable carbon). Esters ranged from a highly unsaturated and hydrolytically unstable triglyceride ester, to a fully saturated hydrolytically stable branched polyol ester. Mineral oil was used as the control. Lithium and Calcium Fatty acid salts were used as the thickening agents in the prepared greases as these are the thickening systems used in conjunction with Ecolabel - or other environmental scheme - compliant greases.

We tested the hypothesis that improving hydrolytic stability of the biodegradable ester base oil will improve its resilience to the grease making process. It is already known that hydrolytic breakdown can be controlled through ester design, with branched synthetic esters offering far superior hydrolytic stability to natural triglyceride esters.
It is also shown that the reduction of unsaturation possible with synthetic esters follows through to improved grease oxidation performance. Other characteristics such as mechanical stability and low temperature performance were also measured and evaluated. As a conclusion of the study, a series of thickener and ester chemistry combinations are proposed and ranked based on the overall performance requirements of the formulated grease. Since application requirements in the field vary, the most appropriate combination of ester base oil and thickener system will also be case dependant as shown by the evaluation results.

Lou A Honary
Environmental Lubricants Manufacturing
Co-author Saeed Soleimani
Engineer, Environmental Lubricants Manufacturing

Dr. Lou Honary is an emeritus professor and founding director of the National Ag-Based Lubricants (NABL) Center at the University of Northern Iowa. He formed the UNI-NABL Center in 1991 for biobased lubricants research and development. He currently serves as the president of Environmental Lubricants Manufacturing Company. A company he formed with the University Foundation to commercialize biobased lubricants and greases that had been patented at the University. Honary has served as officer, board member, and editorial board member in several technical organizations His services on State and Federal committees include USDA/DOE Biomass Research and Development Advisory Committee, and Iowa Governor Tom Vilsack's Life Sciences Advisory Committee. Dr. Honary is an esteemed international expert in the field of biobased lubricants with 8 US patents; and has authored several book chapters and a book on biobased lubricants.

A comparative study of high pressure vs. low pressure grease dispensing systems for applying rail curve grease

- *Two different grease lubricators have been installed in an S-shape track curve.*
- *Friction data was collected as well as daily temperatures, grease flow and other relevant data*
- *The results can help the railroads personnel, the grease manufacturers and the designers of grease lubricators.*

This paper will report on the results of over two years of field test investigation of two grease dispensers on a short line railroad. The northern Iowa region offers extremes of hot and cold temperatures suitable for investigation of the effectiveness of each system in applying grease at each extreme.
Grease dispensing equipment also called lubricators are typically battery operated and the batteries are charged by solar collectors. A wheel sensor placed ahead of the lubricators senses the arrival of the train wheels and signals the battery operated electric motor to run the pump to force the grease into the grease delivery bars attached to the inside of the track gage face.

Two grease lubricators from two OEMs were placed in the middle of an S shaped track curve, each feeding the grease to one of the tracks. The S shaped track was selected as the test location to assure that each applicator is treated the same. Since the applicators are installed in the middle of the S shaped track, there is a curve on each side of each applicator which, along with the two-way traffic, provides near identical situations for both units. A tribometer was used to measure the dynamic coefficient of friction at multiple locations in both north and south side of the applicators. The data collected at each measurement location includes the friction readings on both Top of Rail (TOR) and Gauge Face (GF). The TOR friction measurements are beneficial for monitoring the migration of the grease to the top of rail and adjusting the grease pumps outputs accordingly. Additionally, the collected data included daily temperature readings, grease flow via an automated flow recorder, and other pertinent information.

The results should be helpful to railroads friction management personnel, grease manufacturers, and grease lubricator designer and manufacturers.

Andreas Dobler
Technical University of Munich
Co-authors: K.Michaelis; T.Tobie; J. Hülskamp; F.Kiemann; K. Stahl
Gear Research Centre (FZG), Technical University of Munich & Caterpillar Global Mining

Andreas Dobler was born in Passau, Germany in 1987. After completing his “Abitur” (A-levels) in 2006, he studied Mechanical Engineering at the Technical University of Munich (TUM) until 2012. This was combined with various internships in automation and the commercial vehicle industry. Between 2012 and 2017, he was Research Associate and Doctorial Candidate at FZG where his main topics were tribological failure modes on gears and how they are influenced by gear size and gear lubrication. Since 2017, he is the Team Leader in “Lubrication and Geometry” within the department of “Load Carrying Capacity of Cylindrical Gears” at FZG.

Main influencing parameters on the wear characteristics of grease lubricated hard-soft gear pairings

- *Systematically experiments have been carried out using a FZG back-to-back machine.*
- *The results give a deeper understanding of the mechanisms that cause gear failures in grease-lubricated hard-soft gear pairings.*

In heavy industry applications, e.g. in the primary or mining sector, various types of machines are used that are driven by large, open, grease-lubricated gear drives with a case-hardened pinion and a softer, through-hardened rim wheel. Some examples are ball mills, rotary kilns, driers and mixing drums used in the cement, lime, steel, paper and fertilizer industries and in mineral processing as well as slewing gears of shovels, excavators, draglines and cranes.

Due to the absence of a closed housing, the gears are often exposed to environmental influences like sand and water contamination or other debris. Also, a sufficient lubricant supply is not always ensured. Moreover, the hard pinion can act abrasively like a file on the significantly softer wheel. All these aspects cause a high risk for excessive wear and thus for severe gear failures. The wear intensity and the gear drive lifetime cannot be predicted reliably in most practical applications because the effects of the main influencing parameters like gear hardness, gear roughness, grease type and lubricant contamination are not completely understood.

This study shows a series of systematic experiments on a model gear test rig based on the FZG back-to-back machine. Various influencing parameters and their interactions are discussed with respect to their effects on gear wear. The results give a deeper understanding of the mechanisms that can cause gear failures in grease-lubricated hard-soft gear pairings. They also provide an extended database for better lifetime calculations. On this basis, a calculation study for the wear lifetime of an exemplary grease lubricated gear drive is performed.

Sergei Glavatskih
KTH Royal Institute of Technology, Sweden
Co-authors: M.Ploss, Y.Tian - KTH
J.Leckner, R.Westbroek, Axel Christiernsson - International

S.Glavatskih is a chair Professor in Machine Elements at the KTH Royal Institute of Technology, Sweden, and a visiting Professor at Ghent University, Belgium. He is an elected member of the Royal Swedish Academy of Engineering Sciences. His research interests include mechanochemical systems, machine design and tribotronics. The focus is on the development of more sustainable, environmentally adapted and energy efficient components and systems such as rolling and sliding bearings, gears, wet clutches, seals, threaded fasteners, lubricants (oils, greases, aqueous lubes and ionic liquids).

Non-halogenated ionic liquids as additives to greases

- *Ionic liquids can increase the electrical conductivity of greases.*
- *By choosing the right ionic liquids also frictions and wear properties of greases can be improved.*

Electrical conductivity of greases can be increased by adding ionic liquids. They are composed of cations and anions, charge carriers. Ionic conductivity depends on the chemistry of ions and the lubricants that they are mixed with. Ionic liquids have also shown good tribological properties in terms of friction and wear reduction. We report our latest results on the functionality of non-halogenated ionic liquids in lithium complex and polypropylene greases. The lubricating performance of the greases with ionic liquids has been studied in sliding and rolling contacts over a wide temperature range.

Gareth Fish - Lubrizol
The Lubrizol Corporation

Gareth Fish gained a B.Sc. in Chemistry (1984) and a Ph.D. in Tribology (1990) at Imperial College of Science, Technology and Medicine, London, England. From 1988-1990, he worked at the UK Ministry of Defence, Fuels and Lubricants Branch, the Royal Arsenal in Woolwich, England specialising in military lubricants and greases. From 1990-2002, he worked at GKN Technology Ltd, Wolverhampton, England as a tribologist on automotive transmission components and greases. From 2002-2007, he worked for GKN Automotive Inc., Auburn Hills, Michigan, in charge of tribology, lubricants and sealing materials testing. From 2007 to the present, he has represented the Lubrizol Corporation, initially as Grease Technology Manager and now Technical Fellow in the Industrial Additives Division. He is a Member of the Royal Society of Chemistry, the Energy Institute, STLE, ASTM, and SAE. He is the Chair of ASTM D02.G07 Grease Research Techniques and D02.B04 Automotive Greases. From 2013-14, he was the Chair of the STLE CLS committee and is now the Chair of the NLGI working group to develop the next generation grease standard. He is a Chartered Scientist, STLE CLS and NLGI CLGS and has authored more than 60 technical papers on grease and tribology, 3 book chapters and holds 3 US patents. He has also held more than 60 public classes on grease and tribology. He is the Winner of two NLGI Clarence E. Earle Memorial prizes, an NLGI Authors Award, and the Chevron Prize for grease publications. He is also the winner of an NLGI Fellows award and the NLGI SOPUS prize for teaching excellence. In 2015, he was presented with Best Paper Award at the ELGI Annual Meeting in Barcelona and the Best Paper Award at the CLGI meeting in Nanning, China

The development of lubricating greases for wind turbine applications

- *What are the special requirements for greases used in wind turbines?*
- *A new lab test has been developed that should help to foresee the suitability of such greases during the development phase.*

With the continued growth of wind turbines for renewable energy generation, a significant amount of work has been published looking at improved gearbox fluids. However, there has been little focus on the greases used in wind turbine components.

The grease lubricated components are main bearings to support the rotor assembly and pitch and yaw bearings. Depending on the pitch and yaw control mechanisms employed, they may also include open gear lubricants for gear mechanisms and can also include electric motors with grease lubricated bearings. In non-direct drive applications, there are shaft bearings on the generators.

In addition to standard tests for bearing greases, there are additional primary requirements that make the formulating of such greases a significant challenge. Fretting and corrosive wear are the main issues. To screen for this, a new corrosion and false brinelling test was developed. The ripple (riffle) test utilizes a four-point angular contact bearing, under an oscillatory (9 Hz) thrust loading of 70 kN for 1 million cycles with 1% NaCl solution flowing through at 6 mL /minute. At the end of test the amount of wear is measured and the visible corrosion is rated.

This paper will discuss issues with developing greases to meet the requirements of the ripple test and the standard bearing grease test requirements of friction, low wear, fretting, and corrosion.

Liwen Wei

Novitas Chem Solutions

Liwen is the founder and president of Novitas Chem Solutions, LLC. He has PhD degree in Chemistry from MIT and over 30 years of experience in the lube and grease industry. In 2006, Liwen founded Novitas as a technical consultant and today he serves as Chief Technology Officer, leading the research and development of grease additives and thickeners.

Quantum Leap in the manufacturing of polyurea grease

- *A method is outlined how to produce Polyurea greases with preformed PU thickeners.*

An innovative and a breakthrough in the making of preformed polyurea thickener (abbreviated as PUT) is disclosed. PUT made in this way exhibits a superior thickening efficiency and allows high quality polyurea grease to be made by simply heating/mixing/milling with alkylated naphthalene or naphthenic base oils. Compared to the traditional in-situ approach where one has to work with toxic substances such as MDI or TDI and hazardous amines, this quantum leap approach is easily manageable and can be readily customizable to a variety of novel polyurea compositions.

Ameneh Schneider
Optimol Instruments
Co-authors: Mehdi Fathi-Najafi & Jinxia Li
Nynas AB

Ameneh Schneider holds a PhD in Technical Chemistry from the Technical University of Vienna, Austria. Since then, her qualifications include 25 years of experience in engineering, research and development, mainly in the fields of tribology and lubricants. She has authored more than 20 publications and holds a patent in the field of ionic liquids as additives. Her present affiliation is as Tribology Consultant and Lubricant Expert at Optimol Instruments Prueftechnik GmbH in Munich, Germany.

Optimization of the performance of lubricating grease by using tribological tests

- *The formulation of high load and low speed lithium and lithium complex greases should be optimized by using the SRV test equipment.*

The aim of this study is to investigate, step by step, how the formulation of lithium and lithium complex greases for high load and low speed applications can be optimized by using Tribological tests. These kinds of greases are widely appreciated in the modern applications such as in windmills.
The thickeners chosen were lithium and lithium complex since more than 75 percent of the global production is based on these two thickener systems. Further, three straight cuts of mineral base oils with various viscosities (150, 375 and 600 mm2/s) and one additive package that consists of anti-oxidant, anti-wear and extreme pressure components have been used. All the greases have been produced in a laboratory pilot plant at atmospheric pressure.

Besides the characterization of the greases according to state of the art, the tribological properties of all formulated greases were studied by using the new generation of tribometer, SRV®5. In the first stage, the tribological tests were run with respect to various ASTM methods such as D 5706 B and 5707.

By running different tribological tests at conditions very close to application fields, this study shows how to develop new greases or improve their performances systematically.

Andreas Dodos – Eldon's

Co-authors: Mehdi Fathi-Najafi Nynas AB; John Kay - Stratco

Andreas Dodos received a Master's degree in Chemical Engineering and Environmental Technology from the University of Manchester, UK. He has spent the last 18 years at Eldon's SA, with duties mainly focused on industrial and marine lubricants development. Since 2007 he has been actively involved in product stewardship with focus on global regulatory developments. He is a member in a number of professional bodies such as the ELGI, the Hellenic Maintenance Society and National Tribology Centre. Since 2010 he has been the Chairman of the European REACH Grease Thickener Consortium and he is currently serving on the ELGI Board of Directors. Andreas has extensive experience in formulation and application of lubricating grease and since 2018 he is CLGS certified by the NLGI – Certified Lubricating Grease Specialist.

Grease Production, CO_2 emission..... a New Relationship!

- *How can CO2 emission during grease production be reduced by choosing the right base oils and the right equipment?*

Manufacturing conventional lithium grease is a very energy intensive operation and, surprisingly, to the knowledge of the authors, no one prior to a recent technical paper ~~[1]~~ has studied the energy consumption and possible environment impact of the grease manufacturing process. It is well known that carbon dioxide has been shown to be the major contributor to greenhouse emissions and global warming and energy consumption can be directly related to the manmade contribution of this gas.

The aim of this paper is to measure the energy consumption in an industrial scale production when a pressurized reactor is used and is further compared to traditional open kettle reactor. All the process parameters have been kept constant as well as the viscosity of the base oils used. The total energy (electrical for mechanical operations such as pumping, mixing and homogenizing as well as fuel for heating) consumed for production purposes is recorded for all production stages: vessel charging, cooking, cooling/diluting and homogenizing. The measured energy consumption used for each batch is then converted to normalised CO_2 emission and savings in utility cost for each of the batches evaluated. In order to make this comparative study more accurate, the finished greases have also been characterised according to the specification required by the end-users.

The authors believe that the outcome of this study could be a milestone in assessing grease production in terms of significant reduction of carbon dioxide and increase awareness of the impact of our industry in the global arena.

Dr. Vasu Bala - Tiarco Chemical

Co-author: Jim Hunt - Tiarco Chemical

Vasu Bala completed his PhD studies in Chemical Engineering from the Pennsylvania State University in 1993. Dr. Bala was employed at Afton Chemical, Cognis-Henkel and BASF Corporations from 1993 to 2017, serving various capacities as Technical Advisor and Global Technical Director. Dr. Bala is currently employed by Tiarco Chemical as Global Director for Technology & Quality. His responsibilities include developing new grease & lubricant technologies for North American, European, Japanese, & Chinese automotive OEM driveline and industrial systems. Current and past affiliations: Alpha Chi National Honor Society, Tau Beta Phi National Engineering Honor Society, Society of Automotive Engineers (SAE), TAE Germany, Industrial Tribology-UK, Society of Tribologists & Lubrication Engineers (STLE), National Lubricating Grease Institute (NLGI) and Who's Who for Outstanding Scientists.

Performance Considerations in Formulating High Performance Multi-Purpose EP Greases

- *The balance of high-load EP performance, wear and yellow metal corrosion is important to meet customers' requirements.*
- *Optimized additive blends will be presented also at the background of an increasing demand for energy efficiency.*

This paper discusses performance trends for Extreme Pressure (EP) greases and formulation considerations in meeting performance balances for load carrying capacity, wear and yellow metal corrosion. Current sourcing demands for key raw materials used in thickeners will be highlighted along with a brief overview on the attributes of the various common greases used. Original Equipment Manufacturers' (OEM) requirements and current global supply chains require an introspective view of possible changes in providing alternative greases and supporting new approvals. Supply of key raw materials and future OEM requirements are driving grease formulations and manufacturers to consider alternative chemistries to ensure long term sustainability in industrial and automotive markets.

OEM trends to continuously strive for energy efficiency, are driving gear box designs to higher power densities, lower sump capacities, lower speeds for reduced churning or traction losses, reduced grease and lubricant levels, and longer drain intervals. These drivers are placing higher performance demands on greases and lubricants. Greases and lubricants have to inherently be able to provide lubrication under high loads and low speeds, possess improved thermal and oxidative stability, and be able to operate in wide temperature ranges and harsher environments.

In meeting these higher performance trends in multipurpose EP greases, careful consideration is needed to the type and functionality of key EP, anti-wear and corrosion additives used. Typical additives used for load carrying are metal dithiocarbamates, sulfurised olefins, polysulfides, sulfurised esters and metal sulfides, for example molybdenum disulfide. In recent years, increasing use of ashless multifunctional additives in thiadiazoles and alkyl dithiocarbamates have gained popularity. These additives collectively can achieve higher load carrying capacity, but typical de-rate wear and corrosion performance. Test results on formulation options with select additives will be discussed to attain high load carrying capacity while improving anti-wear and corrosion performances.

Alder da Costa D'Ambros
Total Lubricants Division

Between 2002 and 2008, Alder da Costa D'Ambros studied mechanical engineering at Universidade Tecnologica Federal do Parana in Brazil and at Université de Technologie de Compiègne in France and, from 2008 to 2010, a Professional Master in Lubricants and Fuels at IFP School in France. In 2010, he joined Total in Lyon, France as a Research Engineer formulating transmission oils for the automotive market and, since 2015, he is the Grease Product Manager at Total (Nanterre, France) Alder holds two patents in the domain of transmission oil formulation.

Calcium sulfonate complex grease, a legendary technology adapted to future requirements

- *How do calcium sulfonate complex greases perform compared to lithium complex and poly urea greases?*
- *The key industrial applications of calcium sulfonate complex greases will be presented.*

A brief story of calcium sulfonate complex greases made by Total will be presented, from the early formulations produced 30 years ago until the latest updates in a continuous and successful quest to improve performance, productivity and HSE compliance.

Total's range of calcium sulfonate complex grease are benchmarked against other commercial calcium sulfonate products, lithium complex and polyurea greases. The key characteristics that differentiate this range of products from the other greases will be highlighted.

The industrial applications where calcium sulfonate complex greases have been applied with success during the last decades will be described with a specific focus on the advantages of this type of soap.

Finally, this paper will give an overview of the calcium sulfonate complex grease market, with perspectives and challenges for the years to come.

Lorraine Segreto
Tribotecc
Co-authors: Carmen Moser, Christian Schmied
Tribotecc

Lorraine Segreto holds a Master’s Degree in “Materials and Processing” where her main focus was on ceramics. Between 2007 and 2013, she worked as Project Manager for abrasives and lubricants at Tribotecc in Austria. She then became head of their lubricant department until 2016 when she took over her new job, still at Tribotecc, as “New Business & Innovative Technology Manager”. In May 2018, she gained her CLS Certification.

Solid lubricant – interactions with organic additives, performance booster or performance killer?

- *The study aims to observe the interaction between common organic additives and solid lubricants based on synthetic metal sulphides.*

Lubricating greases have to fulfil a lot of different tasks including lubrication and surface protection in order to increase the lifetime of working parts. Base oil and thickener have to be chosen carefully to give to the lubricant its basic properties. The fine tuning of the composition can be achieved by incorporating different types of additives: tackifiers, corrosion- and rust inhibitors, anti-oxidants, metal deactivators, extreme-pressure and anti-wear additives as well as solid lubricants. High performance additives can be in competition with each other as they generally interact with the metallic surface.

This study aims to observe the interaction between common organic additives and solid lubricants based on synthetic metal sulphides.

Florian Pape: Institute of Machine Design and Tribology (IMKT), Leibniz Universitaet Hannover
Co-author: G. Poll

Florian Pape works at the Institute of Machine Design and Tribology, Leibniz University Hannover, as a post-doctorate researcher. He works in the field of materials engineering, manufacturing engineering and tribology. His current research activities include the targeted adaption of local boundary zone properties in rolling bearing applications like material deposition, surface structuring and lubricant as well as dry effects.

Application of graphene in rolling element bearings

- Bearing surfaces have been functionalized with graphene platelets as a dry lubricant.
- The bearings were lubricated with grease containing graphene as an additive and without graphene.
- Under the test conditions the dry lubricant showed an improvement.

Graphene offers advantageous properties like high strength and electric conductivity. For wear protection, it can be used as dry lubricant in rolling bearing contacts, as well as an additive dispersed in oil or grease to improve the respective characteristics.

For these investigations, angular contact ball bearing surfaces were functionalized by graphene platelets as a dry lubricant. The dry lubricant forms as a thin film on the bearing surfaces. In addition, bearings were lubricated with grease containing graphene platelets. In this case, a small ratio of graphene was dispersed into the grease.

For the tests, the bearings were investigated under oscillating movements. During the tests, the pivoting angle was measured with a rotary encoder. In addition, the friction torque was recorded. As the balls' velocity at the reversal point is zero, the lubrication conditions are fundamental. The dry lubricated bearings were compared with non-lubricated bearings, grease lubricated bearings, and bearings lubricated with grease containing graphene. The respective load in the tribological contact was 1.5 GPa, the test frequency 5 Hz and the pivoting angle 48°. Laser scanning microscopy was used to investigate wear formation. It could be shown that the graphene dry lubricant featured beneficial properties under the given test conditions.

Emmanouil Georgiou - Falex
Co-authors: Dr Erik Willett - Functional Products
Dr George Dodos - Eldon's

Dr. Georgiou graduated as Metallurgist and Materials Science Engineer at the National Technical University of Athens (NTUA), Greece in 2003, and was – until 2009- project and doctoral researcher at the Laboratory of Physical Metallurgy (NTUA), investigating the surface properties of aluminium alloys.
After completing his PhD in 2009, he continued to his research as a Postdoctoral fellow (from 2010 until now) in the group of Surface Engineering and Tribology, Department of Materials Engineering (MTM) at the Katholieke Universiteit Leuven (KU Leuven), in Belgium.
Since 2014 he is working as Project Manager in Falex Tribology NV, in Belgium, and he is responsible for EU projects and tribological testing services for industrial customers.

Measuring Grease Tackiness Objectively

- *Multiple tackifier chemistries have been evaluated*
- *Main performance characteristics that were considered are water washout, shear stability, leakage tendency and oxidation stability.*

Tackiness imparted via high molecular weight polymers has been known to improve the cohesion and strength of grease. However, describing the level of tackiness in grease has remained very qualitative and subjective. Over the last few years a number of tests have been proposed to improve on the reliability of the "two-finger" test for the tackiness of grease.

The Falex TAA test approach has shown that the difference between 'low' – 'medium' – 'high' can be measured consistently. The method opens up new ways of interpretation on grease behaviour, for instance the effect of separation speed, temperature and the materials that the grease are lubricating (metal alloys, ceramics, polymers) can all be varied. In this study a number of tackifiers were studied in base greases to determine the sensitivity of the method and evaluate the correlation between tackifier composition and concentration on the measurement data. The automated and repeatable procedure would then allow more efficient development of tackifier additives and grease compositions, tailored to an application.

Multiple tackifier chemistries were evaluated based on the performance of greases formulated to measured levels of tackiness. Particular performance characteristics of greases that were investigated include: shear stability, water washout, leakage tendency and oxidation stability.

Tests were carried out on low consistency greases where typically a tackier product is required such as for wire-rope or open gear lubricants. Lithium based formulations were chosen as the carrier for the tests as this is the most commonly used grease on the market. Alternatively tests on more challenging grease formulations in terms of tackiness, such as Calcium sulphonate complex have also been evaluated.

A significant number of samples were tested by varying the tackifier chemistry and concentration as well as the grease thickener system. The samples have been ranked according to cohesiveness as well as overall performance of the grease.

Joe Kaperick

Afton Chemical

Joe Kaperick is a Senior R&D Advisor for Greases at Afton Chemical Corporation. Joe began working for Afton in their St. Louis manufacturing facility as an Analytical Chemist in 1991 and moved to their Richmond, Virginia headquarters in 1994. Joe received a Master's Degree in Analytical Chemistry from St. Louis University as well as undergraduate degrees in Chemistry, Fine Arts and Classical Humanities. He has been in the Industrial R&D area with a primary focus on Grease since 1999.

Joe is currently serving as President of NLGI, and has been recognized as a Certified Lubricating Grease Specialist by NLGI. He is also a member of STLE, the chair of the joint NLGI/ELGI Working Group on Grease Particle Evaluation, and the Chair of Section G.01 Chemical and Laboratory Tests for ASTM.

The Mythology of Grease – Fact or fiction?

- *Could so called historic facts about formulation of greases only be myths and legends or is there more to it?*
- *The paper questions some of these myths and tries to find answers.*

There are many myths and legends in the ancient world of grease and it's sometimes difficult to keep fact and fiction separate. This paper explores some of these common topics and attempts to "fact check" them with data generated using a variety of additives and testing from different performance areas. New trends in data analysis and formulation styles will also be included in this discussion.

Is there a difference between primary and secondary ZDDPs?

Does the grease thickener help prevent rust? Are all rust tests equal?

Is there really such a thing as synergistic combinations of antioxidants?

Is EP performance in a grease really "all about the sulphur"? Is all sulphur created equal?

Are all additive packages created equal? Does "one size fit all"?

Does the grease thickener really interact with performance additives?