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Synopsis Technical Papers

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Beyond Lithium: "Take the Bull by the Horns"

Polyamides: A Novel Alternative to Lithium Grease Thickeners

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Eric R. Sirianni, Ph.D. is a Senior R&D Scientist at INVISTA serving as the technical lead for new business development programs within INVISTA's Nylon Intermediates R&D group. Leveraging his expertise in small molecule synthesis, he has led multiple high-profile programs involving the development of new chemistries utilizing INVISTA Nylon intermediates.
Prior to joining INVISTA, Eric earned his Ph.D. in Chemistry from the University of Delaware, where he focused on organometallic and inorganic chemistry, and a Bachelor of Science degree in Chemistry from the University of South Carolina.

Jonathan Davis, M.Sc. is the New Business Development Technical Leader and R&D Scientist at INVISTA serving as a lead scientist in the development and optimisation of new products. He possesses a diverse background in research and networking that has served him well within the INVISTA team.
Before joining INVISTA, Jonathan earned his M.Sc. in Marine Science from the University of Auckland in New Zealand where he studied the behaviour and ecology of elasmobranchs, and a Bachelor of Science in Biology from the University of Texas.

Ethel Garnier, Ph.D. is INVISTA Upstream New Business Development Director. Ethel specialises in the identification of new disruptive trends in the industries that INVISTA serves and leading the New Business Development capability for INVISTA's Upstream business. She is an expert in the field of new technologies, supporting her organization on how to achieve efficient, effective, and sustainable innovation and business change using innovation processes and economic thinking. Ethel is a respected thought leader on Innovation Management and New Product Development. Ethel has a background in Research and Development, holding a PhD in Organic Chemistry from the University of Orleans (France). She has worked as a Principal Investigator in a variety of industries, e.g., military, pharmaceutical, fertilizer, and nylon. However, for the last 10 years, she's worked as a leader in new product development, innovation management, technology scouting and business development.

Paul A. Bessette is currently President of Triboscience & Engineering, Inc.
Paul has been involved with synthetic lubricants for over forty years, of which twenty-five years at Nye Lubricants and three years at Ciba-Geigy. Established in 2000, TS&E provides consulting services and ability to manufacture lubricants for both domestic and foreign customers with an emphasis on perfluorinated polyethers. Paul was Vice Chairman of NLGI Grease Education Course for ten years and was honoured with the NLGI Fellows Award, Meritorious Service Award, Achievement Award, Clarence E. Earle Memorial Award and Author's Award. He was also Associate Editor for Tribology, Transaction, Journal of Synthetic Lubricants and peer review for NLGI. He is a member of NLGI, and former member of STLE and ASTM.
Paul earned a Bachelor of Science in Chemistry from Lowell Technological Institute. His graduate work included polymer chemistry at Brooklyn Polytechnic Institute. He also has an MBA from University of Massachusetts at Dartmouth. Course work in tribology

Keywords: Lithium-free, pre-formed thickener, alternative, novel.

Synopsis

A new pre-formed polyamide-based grease thickener has been developed, which provides a high-performance alternative to lithium thickeners.

Can Calcium Limit Lithium reLiance

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Co-Author: Johanna Larsson

Johan has an MS and PhD in chemical engineering from Chalmers University of Technology in Gothenburg, Sweden. He worked for six years as a researcher, first at the Pasteur Institute in Paris and then at Chalmers University of Technology. In 2009 he joined Axel Christiernsson International as Senior Development engineer and since 2016 he is working as Group Technical Manager. Since 2021, Johan is also part-time Professor in Lubricant Design at KTH Royal Institute of Technology in Stockholm.

Keywords Anhydrous Calcium grease, Technology comparison, Thickener study

Synopsis

The purpose of this paper is to conduct a technology comparison between lithium and anhydrous calcium thickeners. The study aims to increase our understanding of the performance of the base systems without influence of additive components. The outcome will highlight the differences and provide a deeper understanding of the baseline for lithium and anhydrous calcium grease.

High Performance Alternatives to Lithium Greases

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Dr Gareth Fish is a Technical Fellow at the Lubrizol Corporation, Wickliffe, Ohio. He holds a PhD in tribology from Imperial College, London, and has more than 34 years grease industry experience. He is an internationally recognised, multiple award-winning author of more than 80 technical papers including 19 ELGI papers and won an ELGI Best Paper award in 2015. He is an STLE Fellow and Certified Lubrication Specialist (CLS) an NLGI Certified Lubricating Grease Specialist (CLGS) and 2020 recipient of the NLGI Award for Achievement. Previously worked at UK Ministry of Defence and GKN Automotive in UK and USA.

Keywords: Lithium greases, calcium greases, thermal stabilisers, new hybrid thickener

Synopsis

Current potential lithium alternatives are mixed soaps, calcium sulfonates, thermally stabilised anhydrous calcium, and urea-derivatives. These thickeners are all well known, as are their weaknesses. To overcome these challenges, a new thickener system has been developed.

Neutron imaging technique for understanding of urea type grease fluidity inside bearings

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Kazumi SAKAI, Ph.D. has worked for ENEOS Corporation, Japan. He is currently a Chief Researcher of Grease R&D Group, Lubricants R&D Department and responsible for research of grease lubrication and novel analytical methods for grease. He received a master's degree in applied chemistry from Tokyo Institute of Technology in Japan in 2007. He had received a Ph.D. Degree in Mechanical Engineering from Brno University of Technology in the Czech Republic by using the company overseas program (2015-2017).

Keywords neutron, imaging, bearing, channelling, churning, lubrication, visualisation

Synopsis

Grease fluidity has a great influence on bearing performance such as bearing torque represented by channelling and churning states. In order to understand grease fluidity in more detail, the visualisation of grease inside a bearing is essential and neutron imaging technology is one of the effective methods. The technology is based on a characteristic that a neutron passes through heavy elements and interacts to light elements. In other words, neutron can identify lubricants with light elements inside the bearing with heavy elements.

In this study, three types of urea greases with different thickeners were investigated. Each grease showed different bearing torque tendencies. After bearing rotations, neutron radiography and computed

tomography (CT) measurements of the greases distributed in the bearings were performed by using RADEN in the Materials and Life Science Experimental Facility (MLF) of the Japan Proton Accelerator Research Complex (J-PARC). CT images demonstrate grease distribution inside bearings. Image analysis for CT images revealed grease adhesion to bearing balls correlates to bearing torque results, in other words, less adhesion of grease to bearing balls contributes to reducing bearing torque, conversely, the remarkable adhesion of grease causes higher shear resistance for bearing ball rotations. The neutron imaging technology has successfully verified the common hypothesis by the direct observation of grease distribution inside bearings

Fully bioderived EAL greases - How could a roadmap away from Lithium look like?

Author: Ulf Gardenier KAJO
Co-Authors: Markus John & Martin Maass

Ulf is 54 years old and lives with his wife in Duesseldorf, Germany. In the 1990s he studied physics and business administration at the University of Aachen, completing his two courses with diploma theses on laser-optics and maintenance processes on freight-cars. Meanwhile, Ulf looks back on a 25-year journey in the consultancy area. He started his career at SIEMENS as an SAP consultant in the growing tide of business process-driven projects of large industrial companies motivated by the year 2000. Later, as a key account manager, he was responsible for his company's business with several global customers. In early 2022, Ulf decided to completely change his previous career path and joined KAJO, a German manufacturer of lubricating greases and oils. The challenge of entering the North American market with new innovative products was the main motivation for this move. He now heads KAJO's North American division as managing director.

Synopsis

What is a BIO or EAL grease and why getting rid of Lithium?

We provide a definition for the BIO or EAL greases that clarifies and corrects untested/false statements that are often heard in relation to the subject.
Besides pricing, there are other motivations to reduce or replace Lithium in specific grease application areas. An appropriate classification is provided.

A journey through the last decade of EAL greases

Significant progress has been made in terms of stability and performance in the last about 10 years when it comes to biodegradable and bioderived greases. Part of this journey has also been the replacement or reduction of Lithium in ester-based saponified greases. The stages of this journey are introduced through 3 examples of greases focusing on; application areas, motivations, challenges, and technical characteristics.

1. Pure Lithium – first excellent results
2. Lithium / Calcium – a successful approach to reduce Lithium combined with the next performance level
3. Calcium Sulphonate Complex – w/o Lithium and premium performance

Cost/benefit comparison – giving an example for this recurring discussion

"Low performance and high cost per grease volume, but good for the environment" is one of the typical statements about BIO or EAL greases. To demonstrate how this typical statement is not true, two greases are presented - a BIO and a mineral oil grease - for a construction application with a positive cost-benefit ratio for the BIO grease.

Chemical Interaction between Different Thickeners and Additives inside Greases

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Dr. Jisheng E, works as a consultant for GKN Driveline International GmbH and Shanghai GKN HUAYU Driveline Systems Co. Ltd. He is supporting work related to development and applications of lubricants used in companies. He obtained his Ph.D. degree in tribology in 1995 at Brunel University, UK. Since 1995, he. developed different special lubricants patented for GKN applications in constant velocity joints that technically support new generations of GKN products. He has 12 independent patents and published many papers. Since 1982, he has worked in the field of tribology with a wide experience related to lubricants, materials and tribology

Key words: Grease, Grease thickening mechanism, interaction of grease substances, additives, oils

Synopsis

According to the EU REACH regulations, lubricating grease is regulated in the category of mixtures. It means that, after making greases, no real chemical reaction should appear inside greases. The chemical interaction between thickeners, lubricants and additives is one of the key factors affecting greases. Using atomic force microscopy, the distribution of lithium soap fibres inside lubricating oil/additives was observed. It was found that the distance between lithium soap fibres was larger than the range reached by van der Waals and capillary forces. The chemical and physical phenomena of thickeners in organic substances were observed by a technique of "extreme dilution" of grease samples using polar and non-polar solvents. Based on the observation, it is proposed that grease could be formed by a primary gel system and a secondary gel system, which could be used to explain the phenomena observed by atomic force microscopy. “Different additives were selected and added to lithium base grease, polyurea base grease and calcium base grease to explore whether the primary and the secondary gel systems might appear inside the greases

It was found that the oil separation values were affected by different additives and base greases which could be related to two gel systems after considering additive polarity. Analysis of the elemental contents of the oil samples separated from the oil separation tests showed that different functional groups of the additives may have different chemical/physical interactions with different thickeners, resulting in changes in the chemical/physical behaviour of the primary gel system, further resulting changes in the secondary gel system and the oil separation characteristics of grease samples.

Choosing the Right Grease Polymer for Water-Resistant Industrial Greases

Author: Eric Willett
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Erik Willett is president of Functional Products Inc., a United States-based lubricant additive company focusing on polymer-based technologies. Dr. Willett has earned a Bachelors in Chemistry from the University of Akron and Doctorate in Polymer Science from the University of Akron. He has received NLGI's Development Author Award and Educational Excellence Awards and the NLGI India Chapter's PCC Gonsalves Memorial Award for educational and technical contributions to grease. He also serves as a 2024 TLT Magazine technical editor and a technical reviewer for NLGI Spokesman.

Keywords: Polymer, water sprayoff

Synopsis

Grease polymers are highly selective, low treat additives used to modify the behavior of greases without much revision to the basic formula of the grease. Three new trends drive interest to grease polymers. First, standards for water resistance (ASTM D4049 water sprayoff and ASTM D1264 water washout) are increasing due to the new NLGI HPM (High Performance Multiuse) specification and additional WR (Water Resistant) performance tag. Second, there is trend toward the exploration of "alternative" non-lithium thickeners which each present new advantages, but also new challenges to solve. Third, there is a move to highly refined or synthetic base oils to meet longer life and higher temperature operation in anticipation of electric vehicle lubrication.
As an extreme example, grease polymers have previously been shown to overcome significant difficulties in highly specialised H1 and biobased greases. If such highly deficient specialty greases can be addressed with polymer then there is significant opportunity to improve on standard industrial formulations too. This study focuses on the mainstream industrial grease market due to the three trends discussed above. Each trend creates a problem. The move from lithium to alternative thickeners will present a new material selection challenge due to the highly selective nature of grease polymers. Chemistries that were very useful for lithium greases may provide no benefit, or an antagonistic effect, to non-lithium greases if chosen poorly. This study will provide key insights on how to choose the right grease polymer for a given petroleum or synthetic industrial grease with lithium, calcium, aluminum, polyurea, or particle based thickeners for optimal water-resistant performance.

Simplification of CaSX grease production process through novel thickener additive development

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Born in 1961. Bela qualified as Mechanical engineer at the St István University Hungary. Having 25 + years of work career at various lubricant companies, like Mobil Oil, ExxonMobil, MOL Group.

Keywords: grease, calcium-sulphonate complex, thickener, additive

Synopsis

The significance of calcium sulphonate complex greases is growing. These premium greases have a high dropping point, excellent water resistance and very good mechanical and rolling stability. They also provide outstanding EP & AW properties, even without additives.

This study is focused on the development of a thickener additive for calcium sulphonate grease that functions similarly to an aluminium complex grease thickener. Utilising such an additive offers numerous advantages including easy handling, reduced steps in the technology process, decreased number of raw materials, simplification of procurement and inventory processes and a reduction in the number of components subject to chemical safety registrations.

Various samples were synthesised in the laboratory using different compositions and technologies. Their physico-chemical and compositional properties were investigated. Additionally, calcium sulphonate complex grease samples were prepared using these additives, and subjected to standard testing procedures, including application-specific tests.
Future plans entail investigating the storage stability of the promising additive samples and undertaking scale-up procedures based on experimental findings.

A Study on Properties of Diurea Grease Applied for Motor Bearing in EV

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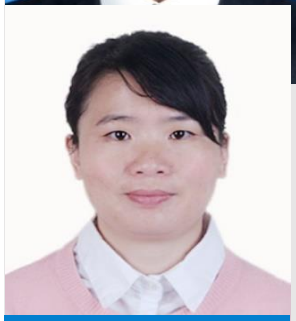

Ms. You Shu Ting
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Mr. Ng Hak Hong
BS, Chemistry, Nanyang University (Singapore) in 1973. MS, Industrial Engineering, National University (Singapore) in 1986. He joined Caltex Singapore (Chemist, Regional supply manager, 1973-1994). He worked at Sanko oil trading Pte Ltd, Singapore (Trading Director, 1995-2014). He works as Managing Director of Fujian Universal Oil Pte.,Ltd.(2015 onwards)

Mr. Seiji Okamura
BS, Chemistry Himeji Institute of Technology (Japan) in 1966 (Now, University of Hyogo). He had been associated with Nippon grease Co. for 45 years. He had been in charge of grease development and he was a director and a manager of technical research laboratory. Now he is a technical adviser of Fujian Universal Oil Pte. Ltd.

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Keywords: High Temperature & High speed, Low temperature, Rust prevention, low noise, Long grease life

Synopsis
This paper describes the results of comparing the performance (thermal stability, shear stability, low temperature property, rust prevention, low noise property, and grease life) of three diurea greases made with three different base oils and a grease currently used in EV (electric vehicle). It is believed that this will help in the development of grease compatible with future NEV (new energy vehicle) including high speed EV.

Novel Sulfonates for Next Level Performance Calcium Sulfonate Complex Greases

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Presenter: Ross Dworet
Lanxess Canada
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Mr. Wayne Mackwood is currently the Global Head of Detergent and Grease Technology for LANXESS, leading a highly skilled, dynamic and dedicated team of chemists at its West Hill, Canada Application Technology Centre. He is a recognised expert in the design, manufacture and use of Calcium Sulfonate Complex Grease and has developed over 150 grease formulations for use in a broad range of applications. He is also active in the development and introduction of new detergent technology and formulations for lubrication, corrosion inhibition, and grease manufacture. Wayne has spent the majority of his 30 year career as a Scientist but has also held roles in marketing and asset management. He has authored more than a dozen technical papers, contributed to numerous journal articles, holds two patents, and has given more than 20 presentations at leading conferences and seminars around the world. He has a Masters in Materials Engineering Science, with a focus on Tribology, from the University of Western Ontario. Wayne has been a member of the NLGI Board since 2011 and is currently serving as the NLGI Vice President. He also served on the STLE Board of Directors from 2008 - 2011 and remains active at the local section level. He was awarded the NLGI John A. Bellanti Sr. Memorial Award in 2019, the NLGI Golden Grease Gun in 2021, the NLGI Award for Educational Excellence in 2022, and the NLGI Fellows Award in 2023. In November 2023, he was awarded the LANXESS Robert W. Brown award for his technical contributions over his career at LANXESS.

Mr. Ross Dworet is the Global Product Manager, Detergents for LANXESS, as a senior member of the Transportation Additives segment in the Lubricant Additives Business Unit responsible for the commercial development of the sulfonate detergent portfolio for industrial, transportation, and grease feed applications. He is based in Shelton, Connecticut having been the previous Global Product Manager for Grease (CSC grease). Ross has presented in multiple commercial marketing forums and published in STLE's CMF+ publication in TLT. He had also previously served as a Technical Editor for TLT. He has been active in the lubricant additives industry for over 10 years in different capacities including manufacturing operations, technical service & development, and commercial. He holds a Bachelor of Science in Chemical Engineering from Northeastern University (Boston) and a MBA from Norwich University.

Ms. Sarah Korwek joined Lanxess in 2023 as the Global Product Manager-Grease and one of her major responsibilities is to launch new products and grease technology. Prior to joining Lanxess, she was the product portfolio manager at inline plastics. During her tenure at Inline plastics she helped launch over 2 dozen products, obtained her six sigma certification, and earned her first patent. She received her executive MBA at University of New Haven. Sarah is based out of Shelton, CT and when she is not keeping busy at Lanxess you can find her spending time with her family.

Mr. Jeremy Brideau is a research chemist with an advanced diploma from Seneca College in Toronto. He has 9 years of experience in the petroleum industry, 8 of which are from his current role at LANXESS Canada. While at LANXESS he has studied sulfonates, salicylates, and calcium sulfonate complex grease. He has become an expert in test methodology and product characterisation. His work on CSC grease lead to the development of several new grease formulations and the improvement of several others. Currently he is focused on sulfonate detergents and has become the resident expert in sulfonation chemistry at the West Hill production site in Canada. Jeremy is active in ASTM D02 committees and more recently with the STLE Toronto section, joining its local board of directors for 2024-25. .

Keywords: Calcium Sulfonate, Overbased, Calcium Carbonate, Calcium Sulfonate Complex Grease, Incidental Food Contact

Synopsis

Nearly all grease manufacturers and marketers today are either producing or exploring Calcium Sulfonate Complex (CSC) greases. The NLGI grease production survey tells us that the global demand for CSC greases is increasing at up to double digit growth rates. Lithium grease production is increasingly challenged on cost and availability. The cost gap has closed closer to CSC greases where benchmark performance of basic formulations is already high. The ever increasing demand on performance has pushed the development of higher tier, optimised CSC thickener feeds. An undertaking was initiated to design and produce a new overbased sulfonate from the ground up to complement existing the industry standard mineral oil based overbased sulfonate grease feed. This newly developed sulfonate is a low colour, mineral oil free, synthetic drop-in replacement thickener for standard CSC grease thickening. It has excellent solubility and produces CSC grease with excellent load and wear capacities, water resistance, corrosion resistance, and mechanical stability. Further, this overbased sulfonate is capable of producing excellent yields, imparting improved low temperature properties, and improved high temperature life. During an intensive assessment, the greases produced with this CSC feed were found to have extended oxidative and thermal service life. The initial sulfonate was developed to comply with HX-1, Kosher, and Halal requirements. This paper will review sulfonate technology, what defines a high performance sulfonate, the requirements for producing a CSC grease for Incidental food contact, and how an optimised sulfonate grease feed can improve the already excellent performance of a CSC grease

Beyond PTFE: when to keep and characteristics of alternative formulations

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Verena Leumann obtained her Diploma in chemical engineering from the University of Applied Sciences Georg Simon Ohm in Nuremberg, Germany. She is working for Setral Chemie GmbH in the product management since October 2011. Being the head of product management for several years, she is responsible for the development of the product range of lubricants at Setral. Trainings for national and international distributors, customers or new employees on tribology and high-performance lubricants are a focus of her work. She coordinates and participates in R&D projects of her company.

Dr. Alexander Friedrich studied chemistry at the Friedrich-Alexander University in Erlangen, Germany, where he received his PhD in organometallic chemistry. He is working for Setral Chemie GmbH since April 2021. In addition to chemical compliance, his main field of activity is the management of the R&D activities. This includes new developments and technologies reformulations based on regulatory requirements or product adaptions.

Keywords of our publication/presentation: PTFE, Additive, Thickener, PFAS, Energy Efficiency, Coefficient of friction

Synopsis

PTFE (= Polytetrafluoroethylene) is an important solid lubricant used in the formulation of lubricants for enhanced load carrying capability, for increased chemical resistance, for emergency running characteristics or even for thickening reasons. With these characteristics, PTFE has become an important ingredient in many oils, greases, bonded coatings, pastes, suspensions and more. It is widely used around the world in applications e.g., running under high loads, challenging low or high temperatures, under chemical attack, or simply for its white color. PTFE is even HX-1 registered for use in food grade lubricants with H1 requirement. Behind the background of the PFAS discussion, which had its last peak in September 2023, when the deadline for comments on the restriction proposal ended, the question arose: what is beyond PTFE?

This paper will show the important uses of PTFE, where alternatives are adequate and cases when PTFE-replacement is not a promising idea. A comprehensive tribological comparison of several formulations with and without PTFE completes the picture and demonstrates in which cases PTFE might be substituted or better kept in the formulation.

The Identification and Implementation of an Alternative Promoter for a Patented Calcium Sulphonate Grease Process

Author: Chris Pether
Afton Chemical

Chris Pether has been with Afton Chemical Ltd (Bracknell, United Kingdom) for over 26 years and is currently the Industrial Customer Technical Support Group Leader, leading a team supporting customers in Europe, Middle East, Africa & India. His previous roles have included Marketing and Technical Support for both Industrial and Driveline lubricant additives, with a predominant focus on Industrial lubricants, greases and application knowledge.

Chris holds a BSc in Applied Chemistry from Kingston University, and a Professional Diploma in Marketing form the Chartered Institute of Marketing. He has had several articles published in lubricant industry magazines and writes many more technical bulletins and newsletters within his organisation. Chris has 2 (adult) children and dog and likes to spend his time playing board games, taking long hikes in the countryside, and enjoying live punk rock music.

Keywords: Calcium Sulphonate Complex Grease, Lithium grease, Calcium Grease

Synopsis

For some time now Afton have promoted their patented process for manufacturing grease soap thickener using a 300TBN calcium sulphonate. This process offers several benefits in production time and cost savings, however, the inclusion of isopropyl alcohol as a promoter must be given serious consideration due to its low flash point (~13°C). This study examines how several alternative promoters were identified and screened, their HSES status considered, following through to the implementation and optimisation of the best candidate to full scale up batch production and performance evaluation.

Surrogates to lithium Greases: Multi-Pronged Approach towards Customer Requirement & Satisfaction”

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Co-Author: Kapil V Vyas; S C Nagar, V P Deshmukh & N S Ramanathan
Standard Greases

Eltepu has 37 years of experience in Development, Field Trials, Technical Services. He published over 50 papers and has 10 patents. Currently works as Chief Technology Officer in Standard Greases & Specialities Pvt Ltd (SGSPL). Director in SGSPL with21 years of rich experience in operations, business development and Marketing of lubricants.

Keywords: Softest Metal, Lithium alternates, Performance Evaluation, Pumpability

Synopsis

We shall discuss the different alternates evaluated against lithium greases. New non-lithium greases developed have been developed with physicochemical and performance test against the prevalent specification requirements.

Improvement of anhydrous calcium grease thickeners with different approaches as an alternative to lithium based greases

Author: Sevda ŞAHAN
Petrol Ofisi
Co-Authors: Ece KORKUT, Samed ERGENEKON, Emre Onan – Petrol Ofisi.

Sevda ŞAHAN, received her MsC in synthesis and evaluate polymeric nanoparticles in drug delivery systems at Hacettepe University in 2018. She has over 7 years’ experience in lubricant industry- R&D studies and formulations of different types of lubricating oils and greases. Since 2020, she has the role of managing quality control and R&D laboratory at Petrol Ofisi Technology Center.

Ece KORKUT, graduated from Yıldız Technical University with a bachelor degree. She has the role of R&D Engineer at Petrol Ofisi Technology Center. Her main product portfolio basis is on greases and industrial lubricants. Samed ERGENEKON, completed his Master's degree on Catalyst Synthesis for the Conversion of Waste Oils into Fuel at Ankara University in 2019. He works as an assistant specialist at Petrol Ofisi Technology Center and continues his PhD studies at Ankara

Keywords: Grease, lithium-free thickening technologies, anhydrous calcium grease

Synopsis

The importance of lithium-free thickening technologies is increasing day by day because of the usage of lithium-based batteries in automotive technologies. Recently, lithium-based products' costs are increasing and lack of lithium and lithium hydroxide would force the industry. In this study we have investigated the improvement of anhydrous calcium grease thickeners with different approaches. Performance parameters of the thickener measured with traditional applications and compared with marketed lithium greases.

The impact of the degree of the base oil solvency and viscosity on the performance of the polyurea greases

Author: Leandro Muntada Brugarolas
Co-Authors: Eva Ortega - Brugarolas
Mehdi Fathi-Najafi - Brugarloas

Synopsis

According to the latest NLGI's Grease Production Survey, presented at the NLGI annual meeting in June 2023, polyurea grease is representing 7.33 percent of the global grease production and growing in some countries such as China [1]. However, it is well known that polyurea grease was patented in 1952 by William C. Bryan et.al [2].

During the last 70 years, the polyurea formulations as well as their manufacturing processes have been improved significantly. Earlier polyurea grease exhibits a number drawbacks such as so-called age hardening, poor shear stability and poor pumpability. Today, polyurea greases have been recognised in a number of advanced and challenging applications due to their unique properties such as high degree of water resistance, high temperature, long life, low noise. Hence, two of the very fast-growing areas for this type of thickener system are in electrical cars and electrical motors.

PU substances are formed from a controlled reaction between one or more isocyanates and one or more amines, forming a urea bond between the co-reactants. The reaction parameters will determine the nature of the PU formed and the concentration of residual unreacted isocyanate/amine. Generally, although near stoichiometric quantities of reactants will be used, a slight excess of amine ensures that no free isocyanate remains. The reaction conditions (temperature, duration, etc.) will determine the ratio of oligomers that are formed, i.e., dimers, trimers, tetramers, etc. The main structural difference between groups of PU substances is due to the isocyanate that is used in the reaction. Three main isocyanates can be used in the manufacture of PU substances: methylene diphenyl diisocyanate (MDI), toluene diisocyanate (TDI) and naphthalene diisocyanate (NDI).

The aim of this experimental orientated work is to investigate the influence of the base oil solvency used in the performance of two type of di-urea thickener-based greases, short and long chain respectively. In total, ten different formulations have been examined in which the batch size and set-up were kept constant.
The outcomes emphasise the importance of the understanding the impact of the base oils and the formation of the thickener on its characteristics and performance.

A Study of Rust Inhibitors for Calcium Greases under Mild to Severe Dynamic and Static Test Conditions

Author: Amanda Harris
King Industries
Co-Author / Presenter: Dagmar Gartz

Dagmar Gartz, received a doctoral degree in chemistry (Dr. rer. nat) at the University Karlsruhe (TH), Germany. From 1997-2011 she was employed at C.H. Erbsloeh, a specialty distributor located in Krefeld, Germany. Over the years the position changed but always was focused on Lubricating Additives and establishing a European Lubricant Additive business. In 2012 she joined King Industries in Norwalk, US a producer of specialty chemicals. She is working home based in Germany as Technical Marketing Manager being responsible for the Lubricant Additive Business of King Industries in Europe.

Amanda Harris joined King Industries in 2013 after receiving her Bachelor of Arts in chemistry from Colgate University. Amanda started first as a Technical Service Chemist in the Lubricant Additives Division with a focus in grease performance testing and evaluation. In 2022, while continuing to work in the lab, she became the Product Manager for Grease Additives and has helped to address customer questions and make additive recommendations for a variety of grease applications. Amanda is active within ASTM, NLGI and STLE.

Keywords: additives, lithium thickener, calcium thickener, corrosion

Synopsis

As the high price and unpredictable supply of lithium continues to *plague the* grease *industry,* manufactures and customers find themselves in the difficult situation of deciding if they should stay with lithium grease at high prices or bear the cost and risk of switching to a non-lithium grease. One helpful contribution towards making a decision with confidence is comparing the performance of lithium greases against calcium greases. This paper will present data showing dynamic (Emcor) and static rust test results under mild to severe conditions focusing on additives for calcium greases

Grease Analysis in Wind Turbine. A Case Study

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Keywords Wind Turbine; Rheological Properties; Main bearings, Pitch Bearings & Generator Bearings, Degradation, Contamination, Wear Process.

Synopsis

Grease analysis has grown up in the last five - ten years, mainly in the main bearings, pitch bearings and generator bearings of wind turbines. Due to higher power and loads in onshore and offshore wind turbines, most of the manufactures have moved from oil lubrication systems to grease lubrication systems. These changes have extended the operating life of the components and help to decrease downtime, parts replacement, and labor costs. The main variables that must be considered in these bearings are load, speed, vibrations, heat, water washout contamination and environmental conditions. Other topics that should be taken into consideration are the physicochemical characteristics of the grease and the lubrication practices (manual or automatic systems).

Today, greases in use are mainly being analysed from the point of view of degradation, contamination and wear. However, the rheological properties of the greases (degree of consistency and oil separation) must also be considered.

Lubricating Grease from Cradle-to-Gate: A comprehensive Study

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Keywords: Sustainability, Product Carbon Footprint, Grease production, Cradle to gate, Re-refined oil, Base oil, Lubricating grease

Synopsis

The main purpose of the lubricants industry has often been the improved performance of machine elements and the minimisation of losses during the use phase. These efforts can be identified as improving energy efficiency through better lubricity, minimising wear through appropriate tribological systems and extending product service life using suitable additives. Technology today provides ever-improving options for the above parameters that lead to the development of more sustainable products as well for the industry as for the society. Each year, numerous technical papers are being published, highlighting operational performance parameters of lubrication products, but what happens before these products reach the use phase of their life cycle?

Can we improve the performance of lubricating grease, even before it reaches the application point? Obviously, the *formulation* and *production method* used will dictate the greases performance in the field, however, these are the same two parameters that will also provide the manufacturers and the end users with the sustainability performance of the product.

There are a number of methodologies published that go through step-by-step on how the product carbon footprint of a formulated product is calculated. Most of these models are fairly generic and even though they are useful as a tool, for example, they cannot intrinsically distinguish between a good and a better performing product particularly in the case of a formulated grease solely by looking at the carbon footprint.

However, in this study, the authors are applying a proven Product Carbon Footprint (PCF) model together with prior experience, by investigating three different grease thickener systems and a combination of different mineral base oils and one re-refined oil, with a known impact on product sustainability. The purpose of this industrial-scale study is to broaden the understanding of PCF and lifecycle-analysis understanding within the lubricating grease industry. Ultimately the expectation is that this work will act as a tool for developing benchmarks with regards to product sustainability within all bounds of the grease formulators accountability, from cradle to gate.

Behaviour of Solid Lubricants, as grease component, under various Tribological Contacts and temperature regimes

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Synopsis

The behaviour of lubricating grease in various tribological contacts has been discussed intensively for many decades, resulting in widespread knowledge about how various antiwear and extreme pressure additives may boost the performance of the lubricating greases in a well-defined tribological contact. The performance of a typical AW/EP additive depends on number of parameters such as the operating temperature, applied pressure and compatibility with other components in a grease formulation.

At the same time, we are witnessing a growing interest in the use of solid lubricants as AW/EP, such as Molybdenum disulfide (MoS_2) and IF-WS_2 (a submicron (nano) particle of Inorganic Fullerene-like Tungsten Disulphide) within industrial and demanding applications. Widely used four ball is not always a relevant method for simulate the Anti-wear and extreme pressure properties for lubricants containing solids. Previous studies have demonstrated that IF-WS_2 outperforms MoS_2 in various type of greases and base oils, preferably lithium and lithium complex greases in high viscous naphthenic oils.

The aim of this study is to compare performance differences for lubricating greases containing IF-WS_2 and ZDDP (Zinc Dialkyl-dithiophosphate) under various tribological conditions and temperature.

The chosen tests in this study are two SRV® tests according to ASTM D5706 and ASTM D7594 at different temperatures. Measurement of the electrical contact resistance during the tribo-testing in 2023 with SRV® gave more insight on the condition of the building of tribo-film and are considered in this investigation.

The outcome from this investigation offer another piece of information with regards to the formulation of high performance polyurea grease based upon naphthenic oil and combination of AW/EP additives. Specially with respect to fretting protection.

Re - thi(n)ck: A novel approach to improve the sustainable performance of lubricating greases through thickener recycling and reuse.

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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. in research and development of new innovative products and sustainable lubrication solutions. 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 focusing on sustainable and biobased fuels and lubricants. He has more than 100 publications in international peer-reviewed journals and conference proceedings on topics related to conventional and biobased lubricants and fuels. George has received the ELGI AGM Best Paper Award three times as well as the NLGI Author Award-Application. He is also an active member in the SAE Fuels and Lubricants Committee, and he acts as session organiser in the "Driveline Lubricants" session and lead session organiser in the recently formed "Lubricating Greases for Conventional and Electric Propulsion Systems" technical session (FFL 390). He is affiliated to several international organisations including ELGI, STLE, ASTM, SAE, ACS and IBBS. He chairs the joint ELGI/NLGI Biobased Greases WG and the End-of-Life TF in the ELGI

Synopsis

The economy is gradually transitioning to a circular model that extends resources, reduces waste, and requires a great deal of creative thinking. Both established and emerging global economies view waste as a bioresource for our next generation energy, chemicals, or platform molecules and materials. Waste minimisation can be achieved in an efficient way by focusing primarily on the first of the 3Rs, "reduce -reuse-recycle." In the past it has been demonstrated that the use of renewable raw materials as well as the reduction of the energy consumption in the grease production can contribute to an increasing sustainable profile of lubricating greases. In order to move forward the utilisation of waste materials and the re-use of end-of life components in the production of greases, can promote further the sustainable performance within a circular model.

In this paper, a first attempt is made to evaluate the potential of recycling and reusing the thickener content of used greases at the End-of-Life stage. A series of used greases were collected, analysed and subjected to extraction or separation process in order to recover the contained thickener. The properties of the recovered thickener were examined, and the latter was further processed and assessed as a pre-formed thickening agent in new grease preparations. The ability of the recycled thickener to produce mechanically and thermally stable grease formulations was examined, and a comparative assessment was carried out against conventional virgin formulations. This approach has the ability to increase the sustainable performance of certain greases and it can have a positive impact on the overall LCA by reducing the depletion of resources and by promoting the transformation of the value chain from linear to circular.