Introduction To Rheology Of Lubricating Grease Publication

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Rheological Characterization of Lubricants in Automotive Industries Through Development of a Novel Capillary Breakup Extensional Rheometer
LUBRICATION AND LUBRICANT RHEOLOGY- SYMPOSIUM- PAPERS- ASME- ASLE- ASTM.
The Rheology of Lubricants
Rheology of Petroleum - Based Lubricating Oils and Greases
An Introduction to Rheology

SCHULTZ GILLIAN

Rheological Properties of Lubricating Fluids ASTM International
Rheology is primarily concerned with materials: scientific, engineering and everyday products whose mechanical behaviour cannot be described using classical theories. From biological to geological systems, the key to understanding the viscous and elastic behaviour firmly rests in the relationship between the interactions between atoms and molecules and how this controls the structure, and ultimately the physical and mechanical properties. Rheology for Chemists An Introduction takes the reader through the range of rheological ideas without the use of the complex mathematics. The book gives particular emphasis on the temporal behaviour and microstructural aspects of materials, and is detailed in scope of reference. An excellent introduction to the newer scientific areas of soft matter and complex fluid research, the second edition also refers to system dimension and the maturing of the instrumentation market. This book is a valuable resource for practitioners working in the field, and offers a comprehensive introduction for graduate and post graduates. Extracts from reviews of 1st Edition: "... well-suited for self-study by research workers and technologists, who, confronted with technical problems in this area, would like a straightforward introduction to the subject of rheology." Chemical Educator, "... full of valuable insights and up-to-date information." Chemistry World

High Pressure Rheology for Quantitative Elastohydrodynamics John Wiley & Sons
Extensional rheology describes the response of fluids to elongational deformations, which is important to everyday phenomena such as jetting, drop impact and fragmentation. This thesis describes the development of an improved device to study the extensional rheology of complex fluids such as paints, motor oils, metalworking lubricants and waxes frequently used in the automotive industry. Key processes in the automotive industry can be potentially optimized with a better understanding of the rheology of these materials, including paint spray, auto-body coating, engine lubrication, and other processes involving high deformation rates. The experimental technique of capillary thinning is utilized for characterizing the fluids and an improved design of the Capillary Breakup Extensional Rheometer (CaBER) is introduced. The new instrument features higher resolution and faster sampling of the laser micrometer measurements, better controlled motor actuation, a novel environmental temperature control system as well as customized fixtures to facilitate the experiments. In this experimental setup, a liquid sample is rapidly stretched between two coaxial plates, which leads to the formation of a liquid bridge in the middle connecting hemispherical liquid reservoirs at each end. The temporal evolution of the radius of the resulting liquid bridge is controlled by inertial, viscous, elastic and capillary effects. By measuring the evolution in the mid-plane radius and the shape of the filament using a laser micrometer as well as a high-speed camera with a well-established image processing algorithm, we can probe the underlying fluid properties given specific constitutive models. The new extensional rheometer is validated using a number of different fluid systems, including a rheologically well-studied Newtonian calibration fluid of glycerol and a series of aqueous food thickeners. Exploratory tests also show the capabilities and limitations of the device through a series of calibration oils with distinct fluid properties. Three different materials used in automotive industries are tested. First, two commercially available motor oils with the same viscosity index (1OW-30) appearing identical in shear flow, as well as having similar surface tensions are selected. Capillary thinning measurements show that these fluids can be differentiated by the onset of strain-rate-thickening close to breakup, corresponding to the dimensionless Weissenberg number exceeding Wi ~\~ 0.5. This weakly elastic response for each lubricant can be modeled and understood using a simple second order fluid model, which is then numerically fit with the experimental data. Compared with the model parameters obtained from fitting the Newtonian and Hookean dumbbell models, consistency is observed in material properties including the extensional viscosities and the relaxation time, thus showing a smooth transition of the rheological characteristics as the filament profile evolves and the strain rate in the sample diverges. Second, a commercial waxy lubricant (DC-290) for the metal stamping process is selected. This material is first characterized through surface tension measurements, differential scanning calorimetry and shear rheometry to determine the onset of wax precipitation (at a wax appearance temperature of 47°C). Below this wax appearance temperature, the material shows a series of non-Newtonian behaviors, including a non-trivial yield stress, shear-thinning and thixotropic effects with dependence on temperature, shear rate and shear-history. These characterizations are further connected to the capillary thinning profiles inspected at different temperatures, demonstrating a transition from a stable liquid bridge that never breaks up due to the existence of a yield stress, to the inertio-capillary thinning profile resulting in liquid bridge corrugations and droplet formation. For a specific temperature of 40°C, the experimental diameter thinning at the mid-plane shows better correspondence to the prediction obtained from considering inertia-visco-capillary interactions than that obtained from only considering visco-capillary interactions or potential flow limit. Some discrepancies between the experimental results and the inertia-visco-capillary prediction still exist and relate to the yield stress. Finally, another commercial liquid lubricant (FC-6130), which was first independently characterized to be a low viscosity Newtonian fluid through shear rheometry, is examined using capillary thinning to determine the limits of the instrument. A variant of the capillary thinning technique, known as the slow retraction method (SRM) was applied using a smaller plate geometry in an attempt to minimize inertial as well as gravitational effects on the liquid bridge which adversely affect the accuracy of measurements for low viscosity materials. The resulting thinning profile close to breakup shows good correspondence to the prediction from visco-capillary interactions, indicating a purely viscous Newtonian response. The results from these experiments show the capabilities of the new capillary thinning system, and also reveal new strategies to characterize the extensional rheological properties of viscoelastic or weakly viscoelastic materials of relevance in the automotive industries. A deeper understanding of these materials will help in optimizing the industrial processes in which they are applied.

A Technique for Determining the Rheology of Lubricants at High Pressures and High Shear Rates Royal Society of Chemistry
Computational elastohydrodynamics, a part of tribology, has existed happily enough for about fifty years without the use of accurate models for the rheology of the liquids used as lubricants. For low molecular weight liquids, such as low viscosity mineral oils, it has been possible to calculate, with precision, the film thickness in a concentrated contact provided that the pressure and temperature are relatively low, even when the pressure variation of viscosity is not accurately modelled in detail. Other successes have been more qualitative in nature, using effective properties which come from the fitting of parameters used in calculations to experimental measurements of the contact behaviour, friction or film thickness. High Pressure Rheology for Quantitative Elastohydrodynamics is intended to provide a sufficiently accurate framework for the rheology of liquids at elevated pressure that it may be possible for computational elastohydrodynamics to discover the relationships between the behaviour of a lubricated concentrated contact and the measurable properties of the liquid lubricant. The required high-pressure measurement techniques are revealed in detail and data are presented for chemically well-defined liquids that may be used as quantitative reference materials. * Presents the property relations required for a quantitative calculation of the tribological behaviour of lubricated concentrated contacts. * Details of high-pressure experimental techniques. * Complete description of the pressure and temperature dependence of viscosity for high pressures. * Some little-known limitations on EHL modelling.
The Rheology of Lubricants McGraw Hill Professional
This book gives a thorough overview on recent developments in lubricant rheology, elastohydrodynamic lubrication and the effects of surface roughness and particulate contamination in the lubricant on the overall behaviour of a heavily loaded lubricated contact. One of the aims of the book is to make clear to the reader that a Newtonian model for the lubricant behaviour does not have enough degrees of freedom to be able to describe the friction - traction behaviour of heavily loaded lubricated contacts or the oil film build-up and collapse under surface asperities for rough surfaces. The book contains quite a lot of experimental data of lubricants at high pressures, both solidification pressures, compressibilities and shear strength increase coefficients, which make it possible to estimate the friction and power loss in heavily loaded lubricated contacts for different pressures, temperatures, sliding speeds, and lubricant types. This is the first time that data of this type has been included in a textbook and it is hoped that the questions highlighted will serve to initiate and guide future research in this field.
Fundamentals of Fluid Film Lubrication OUP Oxford
An introduction to the rheology of polymers, with simple math Designed for practicing scientists and engineers interested in polymer rheology science, education, consulting, or research and development, Introduction to Polymer Rheology is a comprehensive yet accessible guide to the study of the deformation and flow of matter under applied stress. Often considered a complicated topic for beginners, the book makes grasping the fundamentals of polymer rheology easy by presenting information in an approachable way and limiting the use of complex mathematics. By doing so, this introductory overview provides readers with easy access to the key concepts underlying the flow behavior of polymer melts, solutions, and suspensions. Incorporating sample problems that are worked through and explained on the page, as well as numerous practice problems to gauge learning comprehension, the book prepares new students and practitioners for moving on to more advanced concepts. Comprising twelve chapters, the book covers stress, velocity and rate of deformation, the relationship between stress and rate of deformation (Newtonian fluid), generalized Newtonian fluids, normal stresses and elastic behavior, experimental methods, small and large strain, the molecular origins of rheological behavior, elementary polymer processing concepts, quality control in rheology, and the flow of modified polymers and those with supermolecular structure. The essential reference for accurately interpreting polymer rheology data, Introduction to Polymer Rheology provides readers with an elementary understanding of the key issues and modern approaches to resolving problems in the field. An Instructor's Guide with answers to select problems in the text, 60 new problems with full solutions, hints for effective presentation of the material in the text, and an errata listing is available for professors using the book as a course textbook.
Rheology and Elastohydrodynamic Lubrication John Wiley & Sons
These proceedings review progress in the development of lubricants and in the understanding of the phenomena of lubrication. The contents include papers on the impact of automotive technology and environmental factors upon lubricant requirements, elasto-hydrodynamic lubrication, boundary lubrication, machine elements, bio-tribology, metal forming, rheology, lubricated wear and very thin film (nano metre) lubrication. Presented by leading scientists from 22 different countries, these proceedings provide an up-to-date review of developments in this field.
Lubricant Rheology at High Shear Stress World Scientific
Praise for the previous edition: "Contains something for everyone involved in lubricant technology" — Chemistry & Industry This completely revised third edition incorporates the latest data available and reflects the knowledge of one of the largest companies active in the business. The authors take into account the interdisciplinary character of the field, considering aspects of engineering, materials science, chemistry, health and safety. The result is a volume providing chemists and engineers with a clear interdisciplinary introduction and guide to all major lubricant applications, focusing not only on the various products but also on specific application engineering criteria. A classic reference work, completely revised and updated (approximately 35% new material) focusing on sustainability and the latest developments, technologies and processes of this multi billion dollar business Provides chemists and engineers with a clear interdisciplinary introduction and guide to all major lubricant applications, looking not only at the various products but also at specific application engineering criteria All chapters are updated in terms of environmental and operational safety. New guidelines, such as REACH, recycling alternatives and biodegradable base oils are introduced Discusses the integration of micro- and nano-tribology and lubrication systems Reflects the knowledge of Fuchs Petrolub SE, one of the largest companies active in the lubrication business 2 Volumes wileyonlinelibrary.com/ref/lubricants
The Relationship Between High-temperature Oil Rheology and Engine Operation Elsevier
The definitive book on the science of grease lubrication for roller and needle bearings in industrial and vehicle engineering. Grease Lubrication in Rolling Bearings provides an overview of the existing knowledge on the various aspects of grease lubrication (including lubrication systems) and the state

of the art models that exist today. The book reviews the physical and chemical aspects of grease lubrication, primarily directed towards lubrication of rolling bearings. The first part of the book covers grease composition, properties and rheology, including thermal and dynamics properties. Later chapters cover the dynamics of greased bearings, including grease life, bearing life, reliability and testing. The final chapter covers lubrications systems – the systems that deliver grease to the components requiring lubrication. Grease Lubrication in Rolling Bearings: Describes the underlying physical and chemical properties of grease. Discusses the effect of load, speed, temperature, bearing geometry, bearing materials and grease type on bearing wear. Covers both bearing and grease performance, including thermo-mechanical ageing and testing methodologies. It is intended for researchers and engineers in the petro-chemical and bearing industry, industries related to this (e.g. wind turbine industry, automotive industry) and for application engineers. It will also be of interest for teaching in post-graduate courses.

Lubricant rheology applied to elastohydrodynamic lubrication Elsevier

High-Pressure Rheology for Quantitative Elastohydrodynamics, Second Edition, contains updated sections on scaling laws and thermal effects, including new sections on the importance of the pressure dependence of viscosity, the role of the localization limit of stress, and new material on the shear dependence of viscosity and temperature dependence viscosity. Since publication of the original edition, the experimental methods, the resulting property data and new correlations have resulted in a revolution in understanding of the mechanisms of film formation and the mechanical dissipation. Describes lubricant rheology and dependence of lubricant viscosity and density on pressure and temperature Provides a detailed description of the relationship of lubricant properties on pressure, temperature and shear stress Includes data for many more liquids, including the recently characterized reference liquids

The High Shear Stress Rheology of Liquid Lubricants at Pressures of 2 to 200 MPa Elsevier

Comprehensive coverage of fluid film lubrication Written by global experts in the field, this in-depth engineering resource discusses the theory, design, analysis, and application of fluid film lubrication, providing proven methods for reducing friction in rotating machinery components. The book thoroughly addresses all aspects of the topic, from viscosity and rotor-bearing dynamics to elastohydrodynamic lubrication and fluid inertia effects. Fully worked examples, analytical and numerical methods of solutions, practice problems, and detailed illustrations are included in this authoritative reference. Fundamentals of Fluid Film Lubrication covers: Introduction to tribology Viscosity and rheology of lubricants Mechanics of lubricant films and basic equations Hydrodynamic lubrication Finite bearings Thermohydrodynamic analysis of fluid film bearings Design of hydrodynamic bearings Dynamics of fluid film bearings Externally pressurized lubrication Fluid inertia effects and turbulence in fluid film lubrication Gas-lubricated bearings Hydrodynamic lubrication of rolling contacts Elastohydrodynamic lubrication Vibration analysis with lubricated ball bearings Thermal effect in rolling–sliding contacts

Lubricants and Lubrication Elsevier

The steady shear flow characteristics of two liquid lubricants were measured in a new rheometer at shear stresses to 10 MPa. All measurements were performed well below the glass transition pressure. Both Newtonian and rate-independent (limiting shear stress) behaivor was observed.

Rheology of Lubrication and Other Industrial Processes Elsevier

Elasto-Hydrodynamic Lubrication deals with the mechanism of elasto-hydrodynamic lubrication, that is, the lubrication regime in operation over the small areas where machine components are in nominal point or line contact. The lubrication of rigid contacts is discussed, along with the effects of high pressure on the lubricant and bounding solids. The governing equations for the solution of elasto-hydrodynamic problems are presented. Comprised of 13 chapters, this volume begins with an overview of elasto-hydrodynamic lubrication and representation of contacts by cylinders, followed by a discussion on equations relevant to lubrication, including the Reynolds equation. The reader is then introduced to lubrication of rigid cylinders; the importance of film thickness in highly loaded rigid contacts; the elasticity of solids in contact; and the theory of elasto-hydrodynamic lubrication. Subsequent chapters focus on apparatus and measurements of film thickness and film shape; friction and viscosity; and lubrication of gears and roller bearings. This book will be of interest to tribologists.

Mechanics and Chemistry in Lubrication John Wiley & Sons

Those working with tribology often have a background in mechanical engineering, while people working with lubricant development have a chemistry/chemical engineering background. This means they have a tradition of approaching problems in different ways. Today’s product development puts higher demands on timing and quality, requiring collaboration between people with different backgrounds. However, they can lack understanding of each other’s challenges as well as a common language, and so this book aims to bridge the gap between these two areas. Lubricants: Introduction to Properties and Performance provides an easy to understand overview of tribology and lubricant chemistry. The first part of the book is theoretical and provides an introduction to tribological contact, friction, wear and lubrication, as well as the basic concepts regarding properties and the most commonly made analyses on lubricants. Base fluids and their properties and common additives used in lubricants are also covered. The second part of the book is hands-on and introduces the reader to the actual formulations and the evaluation of their performance. Different applications and their corresponding lubricant formulations are considered and tribological test methods are discussed. Finally used oil characterisation and surface characterisation are covered which give the reader an introduction to different methods of characterising used oils and surfaces, respectively. Key features: Combines chemistry and tribology of lubricants into one unified approach Covers the fundamental theory, describing lubricant properties as well as base fluids and additives Contains practical information on the formulations of lubricants and evaluates their performance Considers applications of lubricants in hydraulics, gears and combustion engines Lubricants: Introduction to Properties and Performance is a comprehensive reference for industry practitioners (tribologists, lubricant technicians, and lubricant chemists, etc) and is also an excellent source of information for graduate and undergraduate students.

Lubricants Elsevier

This book sets out to provide a guide, with examples, for those who wish to make predictions about the mechanical and thermal behaviour of non-Newtonian materials in engineering and processing technology. After an introductory survey of the field and a review of basic continuum mechanics, the radical differences between elongational and shear behaviour are shown. Two chapters, one based

on a continuum approach and the other using microstructural approaches, lead to useful mathematical desriptions of materials for engineering applications. As examples of nearly-viscometric and nearly-elongational flows, there is a discussion of lubrication and related shearing flows, and fibre- spinning and film-blowing respectively. A long chapter is devoted to the important new field of computational rheology, and this is followed by chapters on stability and turbulence and the all-important temperature effects in flow. This new edition contains much new material not available in book form elsewhere-for example wall slip, suspension rheology, computational rheology and new results in stability theory.

Rheology for Chemists John Wiley & Sons

Polymer Rheology is a fundamental discipline underlying modern polymer processing. The term rheology could be generally defined as the science of deformation and flow for non-traditional materials that display a nonlinear combination of viscous, elastic and plastic effects, such as polymers, food stuffs, lubricating greases etc. The rheology of polymeric liquids is the most complicated part of general rheology. As any scientific discipline it consists of coupled theoretical and experimental parts. The most difficult part for the first studies of polymer rheology is the theory. This textbook attempts to overcome this difficulty and provide the readers with a balanced knowledge of modern types of continuum theories, experiments and some applications.

Proprietes Rheologiques Des Lubrifiants ASTM International

Elastohydrodynamic lubrication (EHL) theory has been used to model the lubrication state of antifriction machine elements, where initial viscosity and pressure viscosity coefficients are essential parameters in film thickness modeling. Since the pressures of lubricants in the contact zone can be very high, it is important to know the rheological properties of lubricants in these pressure and temperature regimes. The characteristics of viscosity behavior as a function of pressure are also essential for a universal definition of the pressure viscosity coefficient in order to estimate film thickness in an EHL regime. In this study, viscosities and pressure-viscosity coefficients of ten commercial engine and gear oils and seventeen laboratory-produced oil/polymer viscosity modifiers (VM) additives are measured up to 1.3 GPa at 40, 75 and 100 °C. For the first time, a sharp increase in the viscosity and piezoviscous factor is observed in both mineral-based and synthetic-based oils with different VMs. Analysis of the experimental results indicates that sharp increase in viscosity observed in these experiments are believed to arise from physical changes in the VMs, that is liquid-solid phase transition. Evidence is offered that polymer properties such as molecular weight, concentration and structure influence the onset of the phase transitions. A modified Yasutomi model, which normally describes the pressure dependence of the viscosity of lubricants very well, fails to predict the viscosity of the specimens above the onset of sharp increase in viscosity. A design of experiment (DOE) analysis using Design-Expert software indicates that pressure and temperature are the most critical parameters in the viscosity variation. Tribological tests demonstrate that wear in the contact, zone occurs at temperatures and stresses that coincides with the VM phase transitions in both commercial and laboratory synthesized oil/VMs. Tribological results also indicate that the onset of the sharp increase in viscosity can have significant and unanticipated consequences on the elastohydrodynamic contact and can adversely affect EHL theory. The onset of the steep rise in viscosity may also affect the torque and power losses in a mechanical system. Hence, this previously unknown behavior of the lubricant with VMs should be seriously considered in the application of lubricant in mechanical system.

The Rheology of Lubricating Grease Elsevier

Fundamentals of Tribology deals with the fundamentals of lubrication, friction and wear, as well as mechanics of contacting surfaces and their topography. It begins by introducing the reader to the importance of tribology in everyday life and offers a brief history of the subject. It then describes the nature of rough surfaces and the mechanics of contacting elastic solids and their deformation under load and friction in their relative motion. The book goes on to discuss the importance of lubricant rheology with respect to viscosity and density. Then, the principles of hydrodynamic lubrication are covered with derivations of the governing Reynolds and energy equations. Applications of hydrodynamic lubrication in various forms of bearings -- journal bearings, thrust bearings and externally pressurised bearings -- are outlined. The important and still evolving subject of elastohydrodynamic lubrication is treated in some detail, both at its fundamentals and its applications in thin shell or overlay bearings, cam-followers and internal combustion engine pistons. The fundamentals of biotribology are also covered, particularly its applications to endo-articular mammalian joints such as hip and knee joints and their arthroplasty. In addition, there is a treatment of the rapidly emerging knowledge of tribological phenomena in lightly loaded vanishing conjunctions (nanotribology), in natural systems and very small devices, such as MEMS and high density data storage media. There is also a new chapter on the rapidly emerging subject of surface texturing to promote retention of microreservoirs of lubricant, acting as microbearings and improving lubrication of otherwise poorly lubricated conjunctions. This book targets the undergraduate and postgraduate body as well as engineering professionals in industry, where often a quick solution or understanding of certain tribological fundamentals is sought. The book can also form an initial basis for those interested in research into certain aspects of tribology.

Grease Lubrication in Rolling Bearings Open Dissertation Press

This text introduces the subject of rheology in terms understandable to non-experts and describes the application of rheological principles to many industrial products and processes.

High Pressure Rheology for Quantitative Elastohydrodynamics Editions TECHNIP

Although it is widely recognized that friction, wear and lubrication are linked together in a single interdisciplinary complex of scientific learning and technological practice, fragmented and specialized approaches still predominate. In this book, the authors examine lubrication from an interdisciplinary viewpoint. They demonstrate that once the treatment of lubrication is released from the confines of the fluid film concept, this interdisciplinary approach comes into full play. Tribological behavior in relation to lubrication is then examined from two major points of view: one is mechanical, not only with respect to the properties and behavior of the lubricant but also of the surfaces being lubricated. The other is chemical and encompasses the chemistry of the lubricant, the surfaces and the ambient surroundings. It is in the emphasis on the interaction of the basic mechanical and chemical processes in lubrication that this book differs from conventional treatments.

The Rheology of Lubricants Under Impact Conditions

This dissertation, "An Investigation of the Rheological Behaviour of Lubricants Using the Optical

Impact Viscometry Technique" by □□□, Pat-lam, Patrick, Wong, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. DOI: 10.5353/th_b3123203 Subjects: Lubrication and lubricants - Viscosity - Measurement Rheology