1. Experimental analysis of the power losses induced by a high-speed lip seal under oil bath lubrication

Luc, Amar (1); Erwan, Fourt (2); Kevin, Leclerc (2)
Source: *Tribology International*, v 219, July 2026; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2026.111873; **Article number:** 111873; **Publisher:** Elsevier Ltd
Author affiliation: (1) LAconsulting, France (2) Technical Center of Mechanical Industries (Cetim), France
Abstract: The electrification of automotive powertrains raises major challenges in efficiency and thermal management. Among the contributors to load-independent power losses, lip seals remain insufficiently characterized at high rotational speeds and under oil-bath lubrication. In this work, the behaviour of an industrial Viton (FKM) lip seal was experimentally investigated over a wide speed range (0–12 100 rpm, 25 m.s–1) and under various lubrication conditions, from fully immersed oil baths to unlubricated operation. A dedicated high-speed test rig enabled direct measurement of friction torque, lip temperature, and leakage. Results shows that the oil level is a dominant parameter governing the seal behaviour. Increasing the oil bath level led to a non-negligeable increase of the seal friction torque. However, higher immersion ensures uniform cooling, while tangent configurations lead to non-uniform circumferential temperatures due to oil film break-up by centrifugation. A factor is proposed to consider the increase of the friction torque generated by the oil bath level. After correcting the cylindrical churning contribution of the shaft, the seal torque remains nearly constant with speed for immersed configurations, while a slight decrease is observed for tangent lubrication, indicating mixed lubrication behaviour for the latter. Under unlubricated conditions, friction torque remains comparable to lubricated operation, but wear rate increases by an order of magnitude, highlighting the essential lubricating and cooling role of the oil bath. Comparison with ISO/TR 14179 standards confirms that ISO/TR 14179-2 and ISO/TR 14179-1 requires calibration of the linear coefficient. © 2026 The Authors. (31 refs)
Main heading: Electric motors
Controlled terms: Electric losses - Friction - ISO Standards - Leakage (fluid) - Lubricating oils - Powertrains - Seals - Torque - Tribology
Uncontrolled terms: Automotive powertrains - Experimental analysis - Friction torque - High Speed - Lip seals - Load independent - Oil bath lubrication - Oil baths - Powerloss - Thermal
Classification Code: 606 Lubrication and Tribology - 606.1 Lubricants - 610.1 Pipe, Piping, and Pipelines - 610.1.1 Pipe Accessories - 662.3 Automobile Components and Materials - 663.2 Heavy Duty Motor Vehicle Components - 704.2 Electric Equipment - 705.3 Electric Motors - 902.2 Codes and Standards - 1009.1 Energy Conservation - 1301.1.1 Mechanics - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Funding text: The authors are grateful to CETIM (Technical Center for Mechanical Industries) for supporting this work.
Database: Compendex
Data Provider: Engineering Village

2. Exploring the sealing properties of thermodynamic lubrication in ultra-high-speed dry gas seals considering heat transfer modeling

Ding, Junhua (1); Miao, Yue (2); Yu, Shurong (1, 2); Wang, Shipeng (3); Ding, Xuexing (1)
Source: *Journal of Mechanical Science and Technology*, v 40, n 1, p 385-399, January 2026; **ISSN:** 1738494X, **E-ISSN:** 19763824; **DOI:** 10.1007/s12206-025-1232-z; **Publisher:** Korean Society of Mechanical Engineers
Author affiliation: (1) Key Laboratory of Advanced Pumps, Valves, and Fluid Control System of the Ministry of Education, Lanzhou University of Technology, Lanzhou; 730050, China (2) Gansu Province Special Equipment Inspection and Testing Institute, Lanzhou; 730050, China (3) State Key Laboratory of Tribology in Advanced Equipment, Tsinghua University, Beijing; 100084, China
Abstract: This research delves into the thermodynamics and lubrication of ultra-high-speed dry gas seals vital for crucial equipment. It develops an energy equation that includes heat transfer, gas states, and corrections for centrifugal and turbulence effects. The accuracy of the model, which is combined with the turbulent Reynolds equation, to predict performance is confirmed experimentally. Findings show that when considering heat transfer processes, leakage rate increases with rising rotational speed and pressure. Opening force exhibits an initial slight decrease, then gradually increases with increasing rotational speed, whereas it increases with elevated medium pressure. The variation trend of the stiffness leakage ratio is exactly opposite that of the opening force. Optimized groove parameters are provided for various performance, stability, and overall demands. © The Korean Society of Mechanical Engineers and Springer-Verlag GmbH Germany, part of Springer Nature 2026. (30 refs)
Main heading: Sealants
Controlled terms: Heat transfer coefficients - Lubrication - Seals
Uncontrolled terms: Dry-gas-seal - Energy equation - Experimental study - Heat transfer model - Lubrication / - Opening force - Property - Rotational speed - Thermodynamic lubrications - Ultra high speed
Classification Code: 214 Materials Science - 302.2 Heat Transfer - 606.2 Lubrication - 610.1.1 Pipe Accessories
Database: Compendex
Data Provider: Engineering Village

3. Impact of friction speeds on the wear mechanisms of X-shaped nitrile rubber seals in oil-rich lubrication condition

Tan, Deqiang (1); Yang, Qiao (1); Yang, Wen (1); Hu, Yue (1); He, Qiang (1); Yang, Xiaoqiang (1)
Source: *Wear*, v 570, June 1, 2025; **ISSN:** 00431648; **DOI:** 10.1016/j.wear.2025.205933; **Article number:** 205933; **Publisher:** Elsevier Ltd
Author affiliation: (1) College of Aviation Engineering, Civil Aviation Flight University of China, Guanghan; 618307, China
Abstract: During aircraft landing, the complex damping oscillations of the landing gear shock absorbers, particularly the rapid changes in actuation speed, significantly impact the service life of the seals. This study aimed to investigate the effects of varying friction speeds on the wear characteristics of rubber seals. To this end, we used a specially designed platform to systematically test seal wear and analyse the wear behaviour and mechanisms of X-shaped nitrile rubber (NBR) seals under oil-rich lubrication conditions. Results indicated that the wear mechanisms of NBR seals differ significantly under typical friction speeds of 2.42 m/s, 3.23 m/s, and 4.85 m/s. At the lower friction speed of 2.42 m/s, wear predominantly manifested as slight abrasive wear. At the medium friction speed of 3.23 m/s, abrasive wear intensified, accompanied by the expansion of fatigue cracks. At the higher friction speed of 4.85 m/s, adhesive wear became predominant, resulting in noticeable surface melting and flake-like spalling. The friction behaviour between NBR and GCr15 pairs was primarily influenced by adhesive forces and hysteresis forces, which were significantly affected by material viscoelasticity and friction speed. Additionally, oxidation and frictional heating effects were markedly enhanced at high friction speeds, leading to a significant increase in the coefficient of friction and more pronounced fluctuations. This study provides both a theoretical foundation and practical guidance for understanding and optimizing the wear behaviour of rubber seals under various operating conditions. © 2025 Elsevier B.V. (48 refs)
Main heading: Aircraft landing
Controlled terms: Fatigue crack - Fatigue crack propagation - Landing gear (aircraft) - Seals - Shock absorbers
Uncontrolled terms: Friction speed - Lubrication / - Lubrication condition - NBR rubber seal - NBR rubbers - Nitrile rubbers - Oil-rich lubrication - Rubber seals - Wear behaviors - Wear mechanisms
Classification Code: 214.1.2 Fatigue, Cracks and Fracture - 610.1.1 Pipe Accessories - 652.1 Aircraft - 652.3 Aircraft Instruments and Equipment - 1401.2 Hydraulic Equipment and Machinery
Funding Details: Number: 52205239,52105132, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 25QYCX0026, Acronym: -, Sponsor: Sichuan Provincial Science and Technology Support Program; Number: -, Acronym: -, Sponsor: Sichuan Provincial Science and Technology Support Program; Number: 24CAFUC04005,24CAFUC04006, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities;
Funding text: This research was supported by the National Natural Science Foundation of China (52105132 , 52205239); the Fundamental Research Funds for the Central Universities (24CAFUC04006 , 24CAFUC04005) and the Sichuan Province Science and Technology Support Program (25QYCX0026).
Database: Compendex
Data Provider: Engineering Village

4. Solution and Analysis of Thermal Elastohydrodynamic Lubrication Model for Combined Seals (*Open Access*)

Zhang, Xinghua (1); Wu, Haosheng (1); Zhang, Yi (2); Yao, Li (2)
Source: *Processes*, v 14, n 7, April 2026; **E-ISSN:** 22279717; **DOI:** 10.3390/pr14071091; **Article number:** 1091; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) China France Bohai Geoservices Co., Ltd., Tianjin; 300457, China (2) School of Mechanical Engineering, Southwest Petroleum University, Chengdu; 610500, China
Abstract: In this paper, considering the influence of high-temperature and high-pressure environments on the operating characteristics of rotary combined seals, a mathematical model of rotary composite seals is established based on the thermo-elastohydrodynamic lubrication theory. Furthermore, based on a static analysis of the composite seal and by using the deformation influence coefficient matrix method under the small deformation theory, the elastic deformation distribution of the composite seal under the action of oil film pressure is determined. Combined with the hydrodynamic lubrication equation, the energy equation for the temperature field, and the viscosity-temperature equation, the thermo-elastohydrodynamic lubrication model of the rotary composite seal is solved using the finite difference method, and the oil film thickness distribution and oil film pressure distribution during the operation of the composite seal are calculated. The results show that the sealing medium pressure has a significant effect on the sealing performance. In the axial direction, the

oil film pressure first increases and then decreases, while remaining within a stable fluctuation range. © 2026 by the authors. (25 refs)
Main heading: Finite difference method
Controlled terms: Elastohydrodynamic lubrication - Elastohydrodynamics - Film thickness - High pressure effects - High temperature effects - Lubricating oils - Seals - Temperature
Uncontrolled terms: Combined seals - Composite seals - Finite-difference methods - High pressure - Lubrication / - Lubrication models - Oil film pressure - Rotating seals - Thermal elastohydrodynamic lubrication - Thermo-elastohydrodynamic lubrication
Classification Code: 208.4 Thin films - 215.2 Testing of Non-mechanical Properties of Materials - 301.1.1 Liquid Dynamics - 302.1 Thermodynamics - 606.1 Lubricants - 606.2 Lubrication - 610.1.1 Pipe Accessories - 1201.9 Numerical Methods - 1301.1.2 Physical Properties of Gases, Liquids and Solids - 1301.5 Condensed Matter Physics - 1301.6 Radiation
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

5. Lubrication flow law and cooling mechanism considering cavitation in mechanical seals with Rayleigh step pattern

Ma, Xuezhong (1); Li, Congcong (1)
Source: *Applied Thermal Engineering*, v 258, January 15, 2025; **ISSN:** 13594311; **DOI:** 10.1016/j.applthermaleng.2024.124755; **Article number:** 124755; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Petrochemical Engineering, Lanzhou University of Technology, Lanzhou; 730050, China
Abstract: The purpose of this research is to obtain the cavitation cooling characteristics and flow law in mechanical seals with Rayleigh step pattern. A new cooling approach has been proposed, which is of great significance to preventing liquid film vaporization and limiting thermal deformation of sealing face. Based on the previous literatures focused only on cavitation or viscous heat, the thermohydrodynamic lubrication (THD) and hydrodynamic lubrication (HD) numerical models with cavitation in mechanical seals are developed to obtain the cavitation cooling characteristics and flow mechanism by FLUENT software. The results show that the liquid film cavitation occurs severely in the reverse Rayleigh step and generates a remarkable local cooling effect to the fluid film and sealing faces, which leads to a temperature rise reduction of up to 39.2% and a leakage rate reduction of up to 72.7%. Meanwhile, the high-temperature zone at downstream side migrates upstream, especially, forming temperature valley and peak zones at liquid film rupture and reformation boundaries. The cooling level is controlled by the intensity and area of cavitation. Moreover, the vapor phase block of cavitation, the pressure flow and the shear flow collectively generate a vortex flow behind the cavitation zone in the reverse Rayleigh step. The center and intensity of vortices are closely related to the cavitation area, viscous heat, shear flow and pressure flow. Under THD conditions, the vortex is enhanced due to the viscosity loss and the small cavitation area. The cavitation, viscous heat and vortex flow have important effects on the sealing performance. © 2024 Elsevier Ltd (47 refs)
Main heading: Shear flow
Controlled terms: Cavitation - Film cooling - Rayleigh number - Sealing (finishing) - Seals - Viscous flow - Vortex flow
Uncontrolled terms: Cooling characteristics - Cooling flows - Cooling mechanism - Flow law - Mechanical seals - Pressure flow - Rayleigh-step - Step patterns - Thermo-hydrodynamic lubrication - Viscous heat
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 216 Materials Processing - 301.1 Fluid Flow - 301.1.1 Liquid Dynamics - 301.1.5 Flow of Fluid-Like Materials - 610.1.1 Pipe Accessories - 651 Aerodynamics
Funding Details: Number: 52465022,52005236, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 22JR5RA289, Acronym: -, Sponsor: Natural Science Foundation of Gansu Province; Number: 02/062205, Acronym: LUT, Sponsor: Lanzhou University of Technology;
Funding text: This research was funded by the National Natural Science foundation of China (No.52465022, No.52005236), the Natural Science foundation of Gansu Province (No.22JR5RA289), and the Hongliu Distin-guished Young Talent Support Program of Lanzhou University of Technology (No. 02/062205).
Database: Compendex
Data Provider: Engineering Village

6. An axial elastic deformation of cermets on elastohydrodynamic lubrication of wavy-tilt-dam mechanical face seals

Zhang, Baojun (1, 2); Wang, Zeping (2); An, Junqing (1); Liu, Sihang (1); Lei, Mingkai (1)
Source: *Industrial Lubrication and Tribology*, v 77, n 3, p 445-456, February 26, 2025; **ISSN:** 00368792, **E-ISSN:** 17585775; **DOI:** 10.1108/ILT-10-2024-0382; **Publisher:** Emerald Publishing

Author affiliation: (1) School of Materials Science and Engineering, Dalian University of Technology, Dalian, China (2) Sinoseal Holding Co., Ltd, Chengdu, China
Abstract: Purpose: This paper aims to investigate the lubrication characteristics of siliconized graphite with a wavy-tilt-dam (WTD) pattern applied to the hydrodynamic face seals. Design/methodology/approach: It focuses on two friction pairs, carbon graphite versus tungsten carbide (CG-TC) and siliconized graphite versus siliconized graphite (SG-SG), through a three-dimensional elastic hydrodynamic lubrication numerical model that integrates finite difference method and finite element method. The consequence of axial elastic deformation of sealing pair materials on film thickness, film pressure, cavitation and sealing performance for a WTD mechanical face seal under full working conditions of ΔP = 0.8, 5.3 and 15.8 MPa are analyzed theoretically. Findings: The nuclear hydrodynamic WTD face seal generates a convergent gap and exhibits a dual-characteristic behavior of hydrodynamic and hydrostatic effects under various ΔP. Compared to the CG-TC, the SG-SG shows a lower minimum film thickness, decreasing by 3.9%, 17.3% and 35.1%. The flow leakage rate decreases by 47.8%, 52.1% and 75.4%. In addition, the film stiffness increases by 46.8%, 49.8% and 97.8%. Thus, the SG-SG better deals with the dynamic tracking problem, and the sealing performance is stable. The strength and hardness of siliconized graphite enhance WTD sealing performance and improve cavitation control in high-pressure applications. Originality/value: The lubrication characteristics of the siliconized graphite with a WTD pattern could inform the future design of hydrodynamic shallow groove wavy seals in boiler feedwater engineering implements under high-pressure conditions for the nuclear power industry. Peer review: The peer review history for this article is available at: https://publons.com/publon/10.1108/ ILT-10-2024-0382/ © 2025, Emerald Publishing Limited. (40 refs)
Main heading: Cavitation
Controlled terms: Concrete construction - Elastic deformation - Elasticity - Elastohydrodynamic lubrication - Elastohydrodynamics - Embankment dams - High pressure effects in solids - High pressure engineering - Leakage (fluid) - Nuclear industry - Sealing (finishing) - Silicon wafers
Uncontrolled terms: Axial elastic deformation - Face seals - Film-thickness - Hydrodynamic wavy-tilt-dam face seal - Lubrication / - Lubrication characteristics - Mechanical - Peer review - Sealing performance - Siliconized graphite
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 216 Materials Processing - 217.2 Concrete - 301.1.1 Liquid Dynamics - 441.1 Dams - 606.2 Lubrication - 610.1 Pipe, Piping, and Pipelines - 714.2 Semiconductor Devices and Integrated Circuits - 901 Engineering Profession - 1001 Nuclear Energy and Technology - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Funding Details: Number: 2023YFB3408102, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China; Number: -, Acronym: NKRDPC, Sponsor: National Key Research and Development Program of China;
Funding text: Funding: This study received support from National Key Research and Development Program of China, Grant no. 2023YFB3408102.
Database: Compendex
Data Provider: Engineering Village

7. Development and Validation of a Fluid-Solid Coupling Model for Rotary Lip Seals Under Grease Lubrication

Chen, Shengshan (1); Chen, Li (2); Zhou, Pengxiang (2); Shan, Huaping (2); Zhang, Jianguo (3); Guo, Fei (1)
Source: *Journal of Tribology*, v 148, n 3, March 1, 2026; **ISSN:** 07424787, **E-ISSN:** 15288897; **DOI:** 10.1115/1.4069746; **Article number:** 034401; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) State Key Laboratory of Tribology in Advanced Equipment, Tsinghua University, Beijing; 100084, China (2) DC Technical Center of SGCC, SGCC, Beijing; 100052, China (3) State Grid Ningxia Electric Power Co. Ltd., Electric Power Science Research Institute, Yinchuan; 750002, China
Abstract: Lip seals are crucial for preventing lubricating media leakage and intrusion of abrasive particles into rotating shaft oil tanks. While numerical simulations have advanced the understanding of oil-lubricated lip seals, grease's rheological complexities hinder accurate modeling. To address this limitation, this study proposes a novel fluid-solid coupling model tailored specifically for lip seals operating under grease lubrication conditions. By integrating deterministic surface topography, thermal characteristics of the seal working area, and the flow separation method, the model achieves precise solutions for seal performance parameters. Experiments validate this model, elucidating the effect of grease and operating parameters on characteristics such as friction torque and leakage rate. This research advances lip seal analysis, offering insights for optimizing grease-lubricated lip seal systems. © 2025 by ASME. (40 refs)
Main heading: Flow separation
Controlled terms: Heat transfer - Leakage (fluid) - Lubricating greases - Lubrication - Seals - Surface topography - Topography
Uncontrolled terms: Abrasive particles - Accurate modeling - Coupling models - Fluid solid coupling model - Fluid-solid coupling - Grease lubrication - Lip seals - Lubrication condition - Rotary lip seals - Rotating shaft
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 301.1 Fluid Flow - 302.2 Heat Transfer - 606.1 Lubricants - 606.2 Lubrication - 610.1 Pipe, Piping, and Pipelines - 610.1.1 Pipe Accessories

Funding text: The Science and Technology Project funded by State Grid Corporation of China (Grant No. 5500-202449135A-1-1-ZN).
Database: Compendex
Data Provider: Engineering Village

8. Computational fluid dynamics analysis of the impact of the shaft counterface on the lubrication and sealing mechanism of rotary shaft seals (*Open Access*)

Gerhard, Jacqueline (1); Grün, Jeremias (1); Baumann, Matthias (1); Bauer, Frank (1)
Source: *Tribology International*, v 213, January 2026; **ISSN:** 0301679X; **DOI:** 10.1016/j.triboint.2025.111055; **Article number:** 111055; **Publisher:** Elsevier Ltd
Author affiliation: (1) University of Stuttgart, Institute of Machine Components, Pfaffenwaldring 9, Baden-Württemberg, Stuttgart; 70569, Germany
Abstract: Rotary shaft seals are used to seal flooded, partially flooded or splashed shaft outlets from machine housings, making them essential components in many technical applications. These highly complex tribological systems consist of not only the sealing ring, but also the shaft counterface, the fluid to be sealed, and the ambient fluid. Consequently, the shaft counterface significantly influences the tribological system, and, therefore, the functionality of the seal. As well as affecting the friction and wear of the sealing system, shaft lead is often responsible for leakage and, consequently, system failure. While these effects have traditionally been investigated through experimentation, this study introduces a numerical approach to analyse the impact of the shaft counterface on the lubrication and sealing mechanisms of rotary shaft seals. The results reveal correlations between surface parameters and the functionality of the sealing system, providing valuable insights for deriving more suitable tolerance limits for shaft lead in the future. © 2025 The Authors (42 refs)
Main heading: Computational fluid dynamics
Controlled terms: Elastohydrodynamic lubrication - Seals - Tribology
Uncontrolled terms: Computational fluid - Fluid-dynamics - Lead structure - Lubrication mechanism - Rotary shaft seal - Rotary shafts - Sealing mechanisms - Shaft counterface - Shaft seals - Tribological systems
Classification Code: 301.1.4 Computational Fluid Dynamics - 606 Lubrication and Tribology - 606.2 Lubrication - 610.1.1 Pipe Accessories
Funding Details: Number: 509140813, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft; Number: -, Acronym: DFG, Sponsor: Deutsche Forschungsgemeinschaft;
Funding text: This research was funded by the German Research Foundation (DFG) as part of the project 509140813 .
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

9. Transient Lubrication Characteristics and Wear Behavior in VL-Type Reciprocating Seals

Ren, Mingqiang (1); Ma, Yi (1); Meng, Xiangkai (1); Peng, Xudong (1); Jiang, Jinbo (1)
Source: *Journal of Tribology*, v 148, n 9, September 1, 2026; **ISSN:** 07424787, **E-ISSN:** 15288897; **DOI:** 10.1115/1.4071638; **Article number:** 092702; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) College of Mechanical Engineering, Zhejiang University of Technology, No. 288, Liuhe Road, Hangzhou; 310023, China
Abstract: V-Lip type (VL-type) reciprocating seals are widely used in critical applications such as aerospace and heavy machinery due to their superior sealing performance and durability. With increasingly extreme operating conditions, understanding the synergistic relationship between transient lubrication and the wear process in VL-type reciprocating seals is critical for preventing seal failure and ensuring long-term reliability. In this study, a transient mixed lubrication numerical model for VL-type reciprocating seals was established by comprehensively considering transient effects, fluid–structure interaction, lip wear, and temperature-dependent material properties. Based on a database of initial static contact pressure and contact width obtained through finite element analysis and neural networks, the time-varying characteristics of the liquid film evolution, contact characteristics, and wear behavior at the sealing interface during the outstroke and instroke under transient conditions with pressure and speed variations of 1–20 MPa and 10–700 mm·s–1. Furthermore, the influences of temperature-induced material property changes (–30–135 °C) on the instantaneous liquid film characteristics, wear depth, leakage, and frictional force were examined. The results show a sharp increase in contact stress and aggravated friction and wear at a low temperature of –30 °C, and an increase in leakage and a weakening pumping effect at a high temperature of 135 °C. The findings could provide a theoretical basis for the material selection and structural design of high-performance VL-type reciprocating seals. Copyright © 2026 by ASME. (35 refs)
Main heading: Copyrights

Controlled terms: Durability - Electric contacts - Friction - Interfaces (materials) - Seals - Structural design - Temperature - Tribology - Wear of materials
Uncontrolled terms: Critical applications - Film evolution - Heavy machinery - Liquid film evolution - Lubrication characteristics - Mixed lubrication - Reciprocating seals - Sealing performance - Transient conditions - Wear behaviors
Classification Code: 214 Materials Science - 214.1 Mechanical Properties of Materials - 302.1 Thermodynamics - 408 Structural Design - 606 Lubrication and Tribology - 610.1.1 Pipe Accessories - 704.1 Electric Components - 902.3 Legal Aspects - 1301.1.1 Mechanics
Funding text: The National Natural Science Foundation of China (Grant No. 52375211). The Zhejiang Provincial Natural Science Foundation of China (Grant No. LMS26E050026).
Database: Compendex
Data Provider: Engineering Village

10. Lubrication heating behavior of elliptical groove face seals under multi-point conditions

Yang, Jing (1); Deng, Kui (1); Bai, Shaoxian (1)
Source: *International Journal of Heat and Fluid Flow*, v 112, March 2025; **ISSN:** 0142727X; **DOI:** 10.1016/j.ijheatfluidflow.2024.109736; **Article number:** 109736; **Publisher:** Elsevier B.V.
Author affiliation: (1) College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou; 310032, China
Abstract: With the increasing requirement of multi-point working conditions, the problem of lubrication heat in liquid face seals attracts more attentions, which often results in a high risk of seal failure due to unstable opening force and leakage. The precise design considering heating effect of face grooves under complex working conditions is necessary. Here, based on the fluid lubrication theory, a thermo-dynamic model for liquid face seals with elliptical groove was established to analyze the lubrication heat behavior. The novelty of this model is to take the complex seal structure, cavitation effect and fluid thermo-viscous effect into consideration together, which was validated by experimental work. The temperature distribution and temperature rise were investigated for both smooth and elliptical groove face seals. The effects of rotational speed, film thickness and sealing pressure on temperature distribution and sealing performance of liquid film were further studied. When the film thickness increasing from 2 to 5 μm, the maximum temperature for face seals with elliptical groove and smooth surface decreases from 355.6 K to 350.45 K and from 354.9 K to 350.4 K, respectively. The values of maximum temperature present no obvious difference for both smooth and elliptical faces. However, it is found that elliptical groove presents an obvious influence on temperature distribution of liquid sealing film. The maximum temperature occurs near the inner diameter for the smooth face, but near the outer diameter for the elliptical groove face. The obtained results also suggest that the cavitation effect and hydrodynamic effect induced by shear effect make the sealing performance unstable, accompanying multi-peaks phenomena under multi-velocity and multi-pressure conditions. Face grooves could provide a potential way to control temperature distribution in precise sealing design. © 2024 Elsevier Inc. (55 refs)
Main heading: Cavitation
Controlled terms: Liquid films - Seals - Temperature distribution
Uncontrolled terms: Cavitation effect - Condition - Elliptical groove - Ellipticals - Face seals - Liquid face seal - Lubrication / - Lubrication heat behavior - Multi-point condition - Multi-points
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 301 Fluids - 301.1.1 Liquid Dynamics - 302.2 Heat Transfer - 610.1.1 Pipe Accessories
Funding Details: Number: 52375212, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China;
Funding text: The research was financially supported by the National Natural Science Foundation of Chnia (52375212).
Database: Compendex
Data Provider: Engineering Village

11. Development of Hydrodynamic Mechanical Face Seal for Aircraft Engine Gearboxes With Gas–Liquid Hybrid Lubrication

Tokunaga, Yuichiro (1); Kimura, Wataru (1); Kasahara, Hidetoshi (1)
Source: *Journal of Engineering for Gas Turbines and Power*, v 148, n 8, August 1, 2026; **ISSN:** 07424795, **E-ISSN:** 15288919; **DOI:** 10.1115/1.4070466; **Article number:** 081005; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) Eagle Industry Co., Ltd., 1500 Katayanagi, Saitama-ken, Sakado-shi; 350-0285, Japan
Abstract: In high-speed rotating equipment such as turbomachinery, low-loss, low-wear, and low-leakage sealing technology is needed to achieve higher efficiency, longer service life, and lower environmental impact. The authors have proposed a hydrodynamic mechanical face seal based on "gas–liquid hybrid lubrication" technology, which maintains a noncontacting gap between sliding surfaces from very low speed rotation immediately after startup to very high speed rotation, and are investigating its application to various high-speed rotating equipment. The gas–liquid hybrid lubrication technology is a new

technology that uses liquid hydrodynamic lubrication to maintain a noncontacting state at very low speeds during startup and stop and automatically transitions to gas lubrication at high speeds and operates with lower losses compared to liquid lubrication. Numerical analysis has shown the lubrication characteristics of this seal. Then rotating tests were conducted to evaluate the sliding surface temperature of the new technology in comparison with conventional seals, simulating the environment of an aircraft gearbox. The results indicated that the sliding surface temperature did not increase from low-speed to high-speed rotation, and it was also experimentally confirmed that the seals operated stably and without contact. Furthermore, no leakage was observed, and good sealing characteristics were confirmed. These results demonstrate the feasibility of a seal that achieves low loss, long life, and low leakage when applied to aircraft gearboxes. Copyright © 2026 by ASME. (24 refs)
Main heading: Surface properties
Controlled terms: Air lubrication - Aircraft engines - Environmental impact - Fighter aircraft - Gas turbines - Gears - Hydrodynamics - Rotating machinery - Rotation - Sealing (finishing) - Seals
Uncontrolled terms: Face seals - Gas liquids - High-speed rotating - Hybrid lubrication - Low leakage - Low speed - Low-loss - Mechanical - Rotating equipment - Sliding surface
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 216 Materials Processing - 301.2 Hydrodynamics - 601.1 Mechanical Devices - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 606.2 Lubrication - 608.3 Gas Turbines and Engines - 610.1.1 Pipe Accessories - 652.1.2 Military Aircraft - 653 Aircraft Engines - 1301.1.1 Mechanics - 1301.1.2 Physical Properties of Gases, Liquids and Solids - 1502.1 Environmental Impact and Protection
Database: Compendex
Data Provider: Engineering Village

12. Research on heat transfer enhancing mechanism and cooling performance of herringbone groove on rotor outer sidewall in high-speed contact mechanical seals

Ma, Xuezhong (1); Xie, Qingxiang (1)
Source: *Huagong Xuebao/CIESC Journal*, v 76, n 10, p 5277-5289, October 25, 2025; **ISSN:** 04381157; **DOI:** 10.11949/0438-1157.20250449; **Publisher:** Materials China
Author affiliation: (1) School of Petrochemical Engineering, Lanzhou University of Technology, Gansu, Lanzhou; 730050, China
Abstract: To address the issue of overheating in the end faces of contact mechanical seals under high-speed conditions, a novel contact mechanical seal structure with herringbone grooves on the outer side of the rotating ring was proposed. A fluid-solid heat transfer numerical model was established based on computational fluid dynamics (CFD) to examine the distributions of the flow field, temperature field, pressure field, and velocity field within the seal ring and the seal cavity. The heat transfer characteristics of fluid flow in the herringbone groove region and the seal cavity were analyzed, revealing the convective heat transfer mechanism and cooling principles. The results demonstrate that the pressure differential flow induced by the herringbone groove structure significantly enhances the mixing effect between the fluid near the heat transfer surface and the fluid in the seal cavity. Additionally, it increases the turbulence intensity near the groove walls. This flow thins the hydrodynamic and thermal boundary layers near the outer wall, raises the local Nusselt number, and improves heat transfer efficiency. As rotational speed increases, the heat transfer performance of the herringbone-grooved mechanical seal also improves. The influence of herringbone groove angle, depth, number of grooves, and end-face distance on heat transfer was analyzed, with the number of grooves and end-face distance having the most significant impact. Compared with traditional mechanical seals, the end-to-end temperature rise of mechanical seals with herringbone grooves on the outer side was significantly reduced. At a speed of 10000 r/min, the temperature rise decreased by 38.8 K, a 22.1% reduction. This significant reduction in seal temperature rise provides a theoretical basis for the optimized design and engineering application of high-performance contact mechanical seals. © 2025, Materials China. All rights reserved. (34 refs)
Main heading: Computational fluid dynamics
Controlled terms: Boundary layers - Flow of fluids - Heat convection - Heat transfer performance - High pressure engineering - High temperature engineering - Seals
Uncontrolled terms: Contact mechanical seal - Cooling performance - End faces - Heat transfer enhancing mechanism - Herringbone groove on outer side surface - Layer thinning - Mechanical seals - Seal cavities - Thermal boundary layer - Thermal boundary layer thinning
Classification Code: 301.1 Fluid Flow - 301.1.3 Aerodynamics (fluid flow) - 301.1.4 Computational Fluid Dynamics - 302.2 Heat Transfer - 610.1.1 Pipe Accessories - 651 Aerodynamics - 901 Engineering Profession - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Database: Compendex
Data Provider: Engineering Village

13. [Separation mechanism and gas-liquid mixed lubrication model of cryogenic reusable mechanical seal](#) (*Open Access*)

Zhao, Yangyang (1); Zhang, Guoyuan (1); Chen, Yu (1); Zhao, Weigang (2); Luo, Xun (1); Li, Yunlong (1)
Source: *Results in Engineering*, v 29, March 2026; **E-ISSN:** 25901230; **DOI:** 10.1016/j.rineng.2025.108783; **Article number:** 108783; **Publisher:** Elsevier B.V.
Author affiliation: (1) School of Mechano-Electronic Engineering, Xidian University, Xi'an; 710071, China (2) Xi'an Aerospace Propulsion Institute, Xi'an; 710071, China
Abstract: The pairs' contact friction and fluid phase transition between the seal's gap significantly affect the service life and operational stability of the cryogenic reusable mechanical seal in liquid rocket engines. To enhance the reliability, a mathematical model considering the separation mechanism and mixed lubrication of fluid phase transition for a hydrodynamic-hydrostatic mechanical seal is proposed. The impact of repeated start-stop on the cryogenic reusable mechanical seal performance is studied by the roughness parameter. The results show that reducing the fluid inlet pressure and temperature can decrease the separation speed of the mechanical seal, and the gas phase ratio is 0 (no phase transition) when the fluid inlet temperature is –1 to 31,500 r·min–1, and the maximum temperature rises from 155 K to 243 K. Copyright © 2025. Published by Elsevier B.V. (50 refs)
Main heading: Copyrights
Controlled terms: Cryogenics - Gases - Hydraulics - Lubrication - Rockets - Seals
Uncontrolled terms: Contact friction - Cryogenic reusable mechanical seal - Fluid phasis - Fluid-phase - Gas liquids - Mechanical seals - Mixed lubrication - Mixed lubrication models - Operational stability - Separation mechanism
Classification Code: 301 Fluids - 305.4 Cryogenics - 606.2 Lubrication - 610.1.1 Pipe Accessories - 654.2 Rocket Engines - 801.3 Physical Chemistry - 902.3 Legal Aspects - 1401.1 Hydraulics
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Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

14. [Adaptive Lubrication Enhancement of Piston Ring Seals via Fluid Pressure-Induced Waviness for High-Power Clutches](#) (*Open Access*)

Wang, Bochao (1); Jia, Xingyun (1); Bao, Qiaoqiao (2); Qiu, Jiang (2)
Source: *Lubricants*, v 14, n 2, February 2026; **E-ISSN:** 20754442; **DOI:** 10.3390/lubricants14020093; **Article number:** 93; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) Ministry of Chemical Safety Education Engineering Research Centre, Beijing University of Chemical Technology, Beijing; 100020, China (2) AECC Hunan Aviation Powerplant Research Inst, Zhuzhou; 412000, China
Abstract: High-power clutches operating under high-frequency engagement–disengagement cycles demand piston ring seals with exceptional leakage control and tribological reliability. Conventional architectures often experience lubrication failure and severe adhesive wear during transient pressure fluctuations. This research proposes an autonomous intelligent sealing strategy leveraging fluid pressure-induced morphological evolution. By strategically integrating periodic macroscopic structural relief features on the non-sealing surface, the sealing interface transforms into a micron-scale wavy topography in response to hydraulic loading. This structurally embedded intelligence significantly improves fluid pressure distribution, facilitating a transition toward a more favorable lubrication regime. Furthermore, a "self-healing and positional stagnation" logic is elucidated: upon pressure dissipation, the induced waviness elastically recovers to a planar state to ensure sealing integrity, while the ring maintains its axial position due to the predominant frictional resistance of the secondary seal. This synergistic mechanism effectively precludes deleterious dry friction during the clutch disengagement phase. High-fidelity numerical investigations, benchmarked against established experimental data, identify the rectangular groove configuration as the optimal geometry for maximizing waviness amplitude (≈1.5 μm). This research provides a robust framework for developing responsive, zero-wear intelligent seals in advanced power transmissions. © 2026 by the authors. (32 refs)
Main heading: Clutches
Controlled terms: Adhesives - Friction - Seals - Tribology - Wear of materials
Uncontrolled terms: Circumferential waviness - Fluid pressure-induced forming - Fluid pressures - High power - High-power clutch - Hydrodynamic lubrication - Oil-feed engagement–oil-starved disengagement - Piston ring seal - Piston-rings - Ring seals
Classification Code: 210 Adhesive Materials - 214 Materials Science - 602.2 Mechanical Transmissions - 606 Lubrication and Tribology - 610.1.1 Pipe Accessories - 1301.1.1 Mechanics
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Research Funds for the Central Universities; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities;
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Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

15. Investigation on the influencing mechanism and quantitative evaluation of stirred heat effect in high-speed mechanical seals (*Open Access*)

Ma, Xuezhong (1); Xiao, Xiaoxin (1)
Source: *Case Studies in Thermal Engineering*, v 67, March 2025; **ISSN:** 2214157X; **DOI:** 10.1016/j.csite.2025.105839; **Article number:** 105839; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Petrochemical Engineering, Lanzhou University of Technology, Lanzhou; 730050, China
Abstract: Stirred heat is much severe in mechanical seals under high-speed conditions, which significantly affects seal's heat transfer and dissipation characteristics. A three-dimensional thermohydrodynamic numerical model consisting of the fluid film, sealed chamber and sealing rings is developed to investigate the influencing mechanism of stirred heat by the comparative analyses of fluid flow, heat generation and transfer and evaluates its influence level by the parameterized analyses about the rotational speed, flushing flow rate, sealing pressure and sealing face structure. Firstly, in terms of cooling flow, the cold fluid flow from sealed chamber into sealing gap is impeded by the high-speed shear effect of rotor outer sidewall, and a larger vortex namely a flow dead zone is generated at the spiral groove root due to the turbulent flow regime, which significantly impede the cooling level of fluid film and sealing end faces. Secondly, in terms of heat generation, because of the high-speed shear effect of rotor, a much larger effective viscosity, radial velocity gradient, turbulence intensity and turbulence dissipation rate are generated by the turbulent flow in sealed chamber, which are responsible for the significant stirred heat. Finally, in terms of heat transfer, the temperature difference between the sealing rings and sealing chamber fluid is narrowed by the stirred heat, suppressing the convective heat transfer level. The above phenomena lead to an increase in the overall and sealing face temperature rises, and a deterioration of the sealing performance. The rotational speed has the most significant impact on the stirred heat. At the most severe, temperature rise of stirred heat for seal is up to 34 %, the decrease of load-carrying capacity is up to 17 %. Increasing flushing flow rate has a positive effect on the dissipation of stirred heat. The sealing face structure hardly affects the stirred heat generation and transfer. © 2025 The Authors (37 refs)
Main heading: Turbulent flow
Controlled terms: Film cooling - Radial flow - Rotational flow - Sealing (finishing) - Turbulence - Vortex flow
Uncontrolled terms: Fluid films - High Speed - High-speed mechanical seal - Influencing mechanisms - Mechanical seals - Quantitative evaluation - Sealed chambers - Sealing performance - Stirred heat - Turbulence effect
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 216 Materials Processing - 301.1 Fluid Flow - 301.1.1 Liquid Dynamics - 301.1.2 Gas Dynamics - 301.2 Hydrodynamics - 651 Aerodynamics
Funding Details: Number: 52465022,52005236, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 02/062205, Acronym: LUT, Sponsor: Lanzhou University of Technology;
Funding text: This research was funded by the National Natural Science foundation of China (No.52465022, No.52005236) and the Hongliu Distinguished Young Talent Support Program of Lanzhou University of Technology (No.02/062205).
Open Access type(s): All Open Access, Gold, Green
Database: Compendex
Data Provider: Engineering Village

16. A novel coupled computational method for thermo-elastohydrodynamic lubrication problem in reciprocating seals (*Open Access*)

Xu, Minglang (1); Wang, Yajing (1); Yuan, Guoyu (1); Qu, Guangzhong (1); Zhou, Zhenhuan (1); Xu, Xinsheng (1)
Source: *International Journal of Heat and Mass Transfer*, v 254, January 2026; **ISSN:** 00179310; **DOI:** 10.1016/j.ijheatmasstransfer.2025.127641; **Article number:** 127641; **Publisher:** Elsevier Ltd
Author affiliation: (1) State Key Laboratory of Structural Analysis, Optimization and CAE Software for Industrial Equipment, School of Mechanics and Aerospace Engineering, Dalian University of Technology, Dalian; 116024, China
Abstract: In engineering, reciprocating seals generate frictional heat during operation, leading to complex thermo-fluid-structure interactions within the sealing region. These interactions pose significant challenges in computational methods efficiently predicting the sealing performance. In this paper, a novel finite element method (FEM) based coupled computational method (FEMCM) is proposed for the thermo-elastohydrodynamic lubrication problem (TEHL) in reciprocating

seals. In the FEMCM, the structure domain and the lubricating fluid domain are discretized using the FEM, and the thermo-fluid-structure coupling within the sealing region is achieved by a novel thermohydrodynamic lubrication element (THLE). Consequently, a monolithic finite element formulation for the TEHL is established and the unknowns within the sealing region are obtained simultaneously. In numerical examples, comparison studies are performed to demonstrate the accuracy of the FEMCM first, and then the advantages of the FEMCM are illustrated by comparing with the influence coefficient matrix method. Results show that the newly proposed FEMCM significantly enhances computation efficiency, making it suitable for complex seal design and optimization. © 2025 Elsevier Ltd (56 refs)
Main heading: Elastohydrodynamic lubrication
Controlled terms: Computational efficiency - Finite element method - Friction - Numerical methods - Seals - Structural design
Uncontrolled terms: Element method - Fluid-structure interaction - Frictional heat - Lubrication / - Reciprocating seals - Sealing performance - Thermo fluids - Thermo-fluid-structure interaction - Thermo-hydrodynamic lubrication - Thermohydrodynamic lubrication element
Classification Code: 301.1 Fluid Flow - 408 Structural Design - 606.2 Lubrication - 610.1.1 Pipe Accessories - 1102.1 Computer Theory, Includes Computational Logic, Automata Theory, Switching Theory, Programming Theory - 1201.9 Numerical Methods - 1301.1.1 Mechanics
Funding Details: Number: 2023-MS-118, Acronym: -, Sponsor: Natural Science Foundation of Liaoning Province; Number: -, Acronym: -, Sponsor: Natural Science Foundation of Liaoning Province;
Funding text: This work was supported by the Natural Science Foundation of Liaoning Province [grant number 2023-MS-118].
Open Access type(s): All Open Access, Hybrid Gold
Database: Compendex
Data Provider: Engineering Village

17. Impact of Surface Roughness and Coning on Hydrodynamic Face Seals During an Idling Process of Main Coolant Pump in Mixed Lubrication Regime

Zhang, Baojun (1, 2); An, Junqing (1); Liu, Sihang (1); Wang, Zeping (2); Zhang, Chening (2); Lei, Mingkai (1)
Source: *Journal of Tribology*, v 147, n 11, November 1, 2025; **ISSN:** 07424787, **E-ISSN:** 15288897; **DOI:** 10.1115/1.4068739; **Article number:** 114401; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) Surface Engineering Laboratory, School of Materials Science and Engineering, Dalian University of Technology, Dalian; 116024, China (2) Sinoseal Holding Co., Ltd., Chengdu; 610045, China
Abstract: The hydrodynamic face seal of the main coolant pump (MCP) of a nuclear power plant operates under hydrodynamic lubrication. At low idle speed, the seal faces may touch, transitioning the lubrication regime from hydrodynamic to mixed. A new equation for the film thickness on the coning face with a wavy-tilt-dam (WTD) is developed, applying the average Reynolds equation with the Jacobson-Floberg-Olsson (JFO) boundary and using a statistical asperity contact model. Surface roughness and coning influence the minimum film thickness, load-carrying capacity, and friction coefficient, determining the shift from mixed to hydrodynamic lubrication. Under ΔP = 0.8 MPa and 20 r/min, the no-coning WTD face seal remains noncontact at σ = 0.1 μm, while it makes contact at σ = 0.56, 0.35, and 0.28 μm. The WTD face seals with fconing = 1.0 μm at all σ are in contact. Smoother surfaces reduce the summit contact probability, promoting the seal face to lift off. Coning decreases the hydrodynamic effect, leading to lower hmin and a higher chance of rough summit contact. A test rig is built, and the idling process is simulated 50 times, revealing a contact wear pattern at σ = 0.1 μm with fconing = 1.0 μm, while no wear pattern is observed with low coning. The 0-0.3 μm coning value and σ = 0.1 μm are appropriate for WTD face seals under mixed lubrication. This research provides a basis for the stable operation of hydrodynamic WTD face seals in MCP. Copyright © 2025 by ASME. (38 refs)
Main heading: Copyrights
Controlled terms: Coolants - End effectors - Film thickness - Friction - Hydrodynamics - Lubrication - Nuclear fuels - Nuclear power plants - Pumps - Reynolds equation - Seals - Surface roughness - Wear of materials
Uncontrolled terms: Coning - Face seals - Hydrodynamic lubrication - Hydrodynamic wavy-tilt-dam face seal - Idling process - Lubrication regimes - Main coolant pumps - Mixed lubrication - Seal faces - Surface roughness and asperity
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 208.4 Thin films - 214 Materials Science - 301.1 Fluid Flow - 301.2 Hydrodynamics - 606.2 Lubrication - 609.2 Pumps - 610.1.1 Pipe Accessories - 731.5 Robotics - 803 Chemical Agents and Basic Industrial Chemicals - 902.3 Legal Aspects - 1001 Nuclear Energy and Technology - 1001.2.1.2 Nuclear Fuels for Fission Reactors - 1001.2.2.1 Fusion Materials and Fuels - 1201.2 Calculus and Analysis - 1301.1.1 Mechanics
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Funding text: National Key R&D Program of China under Grant Nos. 2023YFB3408102 and 2024YFB3410503.
Database: Compendex
Data Provider: Engineering Village

18. Multiobjective Structure-Material Codesign Optimization of Hydraulically Controllable Reciprocating Seals With Mixed Thermoelastohydrodynamic Lubrication Analysis

Wang, Bingqing (1); Li, Xiaoxuan (1); Li, Yuntang (1); Peng, Xudong (2); Chen, Yuan (1); Li, Xiaolu (1)
Source: *Journal of Tribology*, v 148, n 2, February 2026; **ISSN:** 07424787, **E-ISSN:** 15288897; **DOI:** 10.1115/1.4069519; **Article number:** 024401; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) College of Mechanical and Electrical Engineering, China Jiliang University, Hangzhou; 310018, China (2) College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou; 310023, China
Abstract: The controllable reciprocating seal (CRS) is a new generation of intelligent seal with a performance regulation function, but its high-performance design optimization method remains unclear, which is an important issue that determines its entire life cycle. To address it, this article takes hydraulically controllable reciprocating seals (HCRS) as the research object and employs a mixed thermoelastohydrodynamic lubrication (TEHL) model to establish a structure-material multiobjective codesign optimization model that integrates static and dynamic sealing performance. The optimal combination of sealing structure and material parameters is obtained with the objective functions of minimizing the maximum von Mises stress, net leakage, and frictional power loss. By comparing the static and dynamic sealing performance of seals under three methods of the single structural design optimization, the single material design optimization, and the structure-material collaborative optimization under each of the optimal parameters, the superiority of the collaborative design optimization method proposed in this article has been demonstrated. Compared with the single structural or material optimization methods, its maximum von Mises stress, net leakage, and frictional power loss have been improved by 66.81%, 21.73%, and 43.67%, respectively. Therefore, the collaborative design optimization of structural and material parameters is a more efficient optimization design method and is recommended for engineering applications. Copyright © 2025 by ASME. (32 refs)
Main heading: Seals
Controlled terms: Friction - Life cycle - Lubrication - Multiobjective optimization - Optimal systems - Shape optimization - Structural design - Structural optimization
Uncontrolled terms: Co-designs - Codesign optimization - Controllable reciprocating seal - Lubrication analysis - Mixed lubrication - Mixed thermo-elastohydrodynamics - Mixed thermoelastohydrodynamic lubrication analyze - Optimisations - Reciprocating seals - Sealing performance - Thermoelastohydrodynamic lubrications
Classification Code: 214 Materials Science - 408 Structural Design - 606.2 Lubrication - 610.1.1 Pipe Accessories - 913.1 Production Engineering - 961 Systems Science - 1201.7 Optimization Techniques - 1301.1.1 Mechanics
Funding Details: Number: 52005470, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 52475544, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: LMS25E050001, Acronym: -, Sponsor: Natural Science Foundation of Zhejiang Province; Number: LZ23E050002, Acronym: -, Sponsor: Natural Science Foundation of Zhejiang Province;
Funding text: The Natural Science Foundation of Zhejiang Province (LMS25E050001). The National Natural Science Foundation of China (52005470, 52475544). The Natural Science Foundation Key Project of Zhejiang Provincial (LZ23E050002).
Database: Compendex
Data Provider: Engineering Village

19. Research on the Lubrication and Thermal Effects of Single-Metal Seals on Sealing Performance

Meng, Weidong (1); Wang, Haijuan (2); Ma, Hai (2); Zhang, Yi (3); Yao, Li (3)
Source: *Lubricants*, v 14, n 2, February 2026; **E-ISSN:** 20754442; **DOI:** 10.3390/lubricants14020047; **Article number:** 47; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) Petroleum Engineering Management Department, SINOPEC Henan Oilfield Branch Company, Nanyang; 473132, China (2) Petroleum Engineering Technology Research Institute, SINOPEC Henan Oilfield Branch Company, Nanyang; 473132, China (3) School of Mechanical Engineering, Southwest Petroleum University, Chengdu; 610500, China
Abstract: This paper investigates the impact of lubrication and thermal effects on the performance of single-metal seals in roller cone bits, and it establishes the geometric, material, and operating parameter models for the single-metal seal. Based on the theory of statistics, the Greenwood–Williamson (G–W) model is employed to predict the contact stress of micro-protrusions on the sealing pair surface. This study establishes a Thermal Elastohydrodynamic Lubrication (TEHL) coupling model for single-metal seals, which utilizes the deformation matrix method to characterize the microscopic deformation of the sealing interface. The central difference method is applied to solve the oil film thickness and temperature distribution in the axial and film thickness directions of the sealing surface. The results indicate that the sealing zone is predominantly under rough peak contact pressure, operating in a mixed-lubrication state. Oil film thickness negatively correlates with static contact pressure, and seal pressure and pre-compression displacement significantly influence lubrication performance. Experiments validate the numerical simulation results, with a mean relative error of less than 15%, confirming the model's effectiveness. This study offers a theoretical basis for optimizing single-metal seal design, enhancing the reliability and lifespan of roller cone bits in harsh conditions. © 2026 by the authors. (28 refs)
Main heading: Elastohydrodynamic lubrication

Controlled terms: Cones - Elastohydrodynamics - Electric contacts - End effectors - Lubricating oils - Reliability theory - Seals - Thermal effects
Uncontrolled terms: Lubrication / - Materials parameters - Oil film thickness - Operating parameters - Rollercone bits - Sealing performance - Single-metal seal - Thermal - Thermal elastohydrodynamic
Classification Code: 208.4 Thin films - 214 Materials Science - 215.2 Testing of Non-mechanical Properties of Materials - 301.1.1 Liquid Dynamics - 302 Thermodynamics and Heat Transfer - 606.1 Lubricants - 606.2 Lubrication - 610.1.1 Pipe Accessories - 704.1 Electric Components - 731.5 Robotics - 1201.14 Geometry and Topology - 1202.2 Mathematical Statistics
Database: Compendex
Data Provider: Engineering Village

20. [Numerical Investigation on Lubrication of Reciprocating Seals for Metal Rectangular Packing Based on an Improved Mixed Elastohydrodynamic Lubrication Method]

Fan, Zhihan (1); Wang, Hui (2); Zhang, Limin (3); Guan, Tingting (2); Yuan, Xiaoshuai (3); Zhang, Hao (1)
Source: *Journal of Tribology*, v 148, n 3, March 1, 2026; **ISSN:** 07424787, **E-ISSN:** 15288897; **DOI:** [10.1115/1.4069856]; **Article number:** 034402-1; **Publisher:** American Society of Mechanical Engineers (ASME)
Author affiliation: (1) School of Mechanical Engineering, Beijing Institute of Technology, Beijing; 100081, China (2) PetroChina Dalian Lube Oil Research and Development Institute, Dalian; 116031, China (3) Department of Structural Technology, China North Engine Research Institute, Tianjin; 300400, China
Abstract: In the second stage of ultra-high-pressure ethylene compressors, operation pressures can reach up to 250 MPa, often resulting in wear failure of the plunger–packing friction pair. The conventional mixed elastohydrodynamic lubrication (EHL) model is inadequate for accurately modeling the behavior of metallic sealing packings with rough surfaces. This study proposes an improved method by integrating the Greenwood–Tripp contact model with traditional mixed EHL theory. The results demonstrate strong concordance with existing research, showcasing the efficacy of the proposed approach. Furthermore, the lubrication behavior of metal rectangular sealing elements under complex and highly variable operating conditions is examined. Contrary to the conventional EHL prediction that a higher plunger velocity improves the fluid load-carrying capacity, the present results show that it actually enlarges the cavitation zone within the contact region. Notably, the peak asperity pressure occurs in the latter part of the instroke, where the load is maximized and the velocity remains comparatively high, rather than at the termination of the compression stroke, despite the latter being characterized by high overall pressure but low velocity. Additionally, elevated operating temperatures are shown to increase the friction coefficient while concurrently reducing the leakage rate, potentially creating a positive feedback loop that raises interface temperature and accelerates wear during practical operations. The proposed model is validated through experiments conducted with actual materials from the plunger–packing configuration in hyper compressors, and experimental measurements of friction coefficients corroborate numerical simulations based on the tested sample contact model. Copyright © 2025 by ASME. (30 refs)
Main heading: Elastohydrodynamic lubrication
Controlled terms: Compressors - Elastohydrodynamics - End effectors - Ethylene - Failure (mechanical) - Friction - Interfaces (materials) - Outages - Packing - Safety engineering - Temperature - Tribology - Wear of materials
Uncontrolled terms: Contact modeling - Friction coefficients - Hyper-compressors - Improved mixed elastohydrodynamic lubrication - Lubrication / - Numerical investigations - Packing wear failure - Reciprocating motion - Reciprocating seals - Rectangular mental seal
Classification Code: 214 Materials Science - 301.1.1 Liquid Dynamics - 302.1 Thermodynamics - 601.2 Machine Components - 606 Lubrication and Tribology - 606.2 Lubrication - 609.1 Compressors - 706.1.2 Electric Power Distribution - 731.5 Robotics - 804.1 Organic Compounds - 914 Safety Engineering - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

21. [Cooling flow and temperature control mechanism in novel hydrodynamic-hydrostatic hybrid mechanical seals with externally pressurized fluid] (*Open Access*)

Ma, Xuezhong (1); Xiao, Xiaoxin (1)
Source: *Applied Thermal Engineering*, v 265, April 15, 2025; **ISSN:** 13594311; **DOI:** [10.1016/j.applthermaleng.2025.125561]; **Article number:** 125561; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Petrochemical Engineering, Lanzhou University of Technology, Lanzhou; 730050, China
Abstract: The purpose of this research is to reveal the cooling flow and temperature control mechanism of the novel hydrodynamic-hydrostatic hybrid mechanical seal with externally pressurized fluid. A new cooling method is proposed and the high-risk area of thermal failure is eliminated in high-speed mechanical seals. In view of the previous literatures focused only on the load-carrying capacity, an integrated thermo-hydrodynamic-hydrostatic numerical model consisting

of the fluid film, sealing chamber fluid, externally pressurized fluid and sealing rings is developed to investigate the cooling flow characteristics and temperature control principles by FLUENT software. The results show that: Firstly, the externally pressurized cooling fluid generates an annular high-pressure region at inner-diameter side and builds a new second pressure flow towards outer-diameter side to induce the thermal mixing effect, thereby cooling the fluid film and sealing faces and forming a low-temperature zone at inner-diameter side. A circulating flow occurs in the middle of sealing face due to the low pressure which generates a high-temperature zone relatively. Secondly, two vortices are generated by the radial impact as the high-pressure fluid film flows back into the sealed chamber. Increasing rotational speed or external pressure significantly enhances the heat transfer of stator outer sidewall by expanding the vortex area. Finally, the cooling effect is the best under the high external pressure, low sealing pressure and large orifice radius, with the maximum temperature and inner-diameter side temperature decreasing by 50 % and 78 %, respectively. The cooling behavior keeps the inner-diameter side temperature below 325 K, regardless of rotational speed or film thickness. On balance, the novel seal and cooling method are of great significance to prevent the film vaporization and sealing face thermal deformation. © 2025 Elsevier Ltd (56 refs)
Main heading: Vortex flow
Controlled terms: Aerodynamics - Film cooling - High pressure effects in solids - High pressure engineering - Orifices - Pressurization - Rotational flow - Seals
Uncontrolled terms: Hydrodynamic-hydrostatic hybrid mechanical seal - Inner diameters - Mechanical seals - Mixing effects - Pressure flow - Sealed chambers - Second pressure flow - Taylor vortex - Thermal mixing - Thermal mixing effect
Classification Code: 301.1 Fluid Flow - 301.1.3 Aerodynamics (fluid flow) - 610.1 Pipe, Piping, and Pipelines - 610.1.1 Pipe Accessories - 651 Aerodynamics - 901 Engineering Profession - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Funding Details: Number: 52465022,52005236, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NSFC, Sponsor: National Natural Science Foundation of China; Number: 02/062205, Acronym: LUT, Sponsor: Lanzhou University of Technology; Number: -, Acronym: LUT, Sponsor: Lanzhou University of Technology;
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Database: Compendex
Data Provider: Engineering Village

22. Salinity Effect in Seawater Thermoelastohydrodynamic Lubrication of Double Spiral Groove Face Seals (*Open Access*)

Bai, Shaoxian (1); Yang, Demin (1); Yang, Jing (1)
Source: *Materials*, v 19, n 2, January 2026; **E-ISSN:** 19961944; **DOI:** 10.3390/ma19020285; **Article number:** 285; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou; 310032, China
Abstract: A rise in seawater salinity results in an increase in its viscosity, which presents a coupled influence on the distribution of fluid pressure, temperature and deformation at the sealing face, leading to fluctuations in sealing performance and forming the salinity effect in seawater thermoelastohydrodynamic lubrication (TEHL). Here, for a double spiral groove face seal, a TEHL model is established and numerical analysis is carried out, taking account of the salinity effect and cavitation effect, with the aim to ensure that the seal maintains stable performance under varying conditions of sea depth and speed. It is found that the effect of salinity on the opening force and leakage rate exhibits obvious nonlinear variations. As salinity rises from 0 to the standard 35 g/kg, the opening force changes by about 5%, and there is a transition between forward and reverse leakage, with variations of approximately ±100%. More importantly, the double spiral grooves offer the potential for a zero-leakage design in seawater face seals, even under pressures exceeding 4 MPa, through precise design. Additionally, the double spiral groove face seal shows excellent adaptability under multipoint conditions and can facilitate a zero-leakage design in varying pressure, speed and temperature conditions. This provides theoretical support for deep-sea equipment and applications in other extreme environments. © 2026 by the authors. (30 refs)
Main heading: Seals
Controlled terms: Lubrication - Seawater effects
Uncontrolled terms: Double spiral groove - Face seals - Fluid pressures - Fluid temperatures - Opening force - Pressure deformation - Salinity effects - Sea water salinity - Thermoelastohydrodynamic lubrications - Zero leakage design
Classification Code: 471.4 Seawater, Tides and Waves - 606.2 Lubrication - 610.1.1 Pipe Accessories
Open Access type(s): All Open Access, Gold, Green
Database: Compendex
Data Provider: Engineering Village

23. [Experimental and numerical analysis of heat transfer and thermal deformation in small-dimension liquid mechanical seals](#) (*Open Access*)

Ben-Abdelwahed, Amine (1, 2); Liu, Shaolin (1, 2); Sommier, Alain (1, 2); Reungoat, David (1, 2)
Source: *International Journal of Heat and Mass Transfer*, v 241, May 15, 2025; **ISSN:** 00179310; **DOI:** 10.1016/j.ijheatmasstransfer.2025.126754; **Article number:** 126754; **Publisher:** Elsevier Ltd
Author affiliation: (1) Univ. Bordeaux, CNRS, INRAE, Bordeaux INP, I2M, UMR 5295, USC 1368, F-33400, Talence, France (2) Arts et Métiers Institute of Technology, CNRS, INRAE, Bordeaux INP, I2M, UMR 5295, F-33400, Talence, France
Abstract: This paper presents an experimental and numerical analysis of heat transfer and thermal deformation in small-dimension (1.4 mm) liquid mechanical seals operating in an unstable dynamic tracking mode. The studied non-contacting mechanical seal is used in a liquid pump for turbojets. The study aims to estimate the values of pressure, temperature, and thermal deformations that can prevent excessive wear of the sealing rings and control the increase in leakage rate or power loss during operation. Experimental investigations were conducted under a nominal inner pressure of 0.7 MPa, across a wide range of rotational speeds (from 1000 to 6000 rpm), and at low Reynolds numbers (Re © 2025 The Authors (40 refs)
Main heading: Reynolds number
Controlled terms: Convergence of numerical methods - Digital elevation model - Heat transfer coefficients - Lubricant films - Seals - Temperature - Viscosity of liquids
Uncontrolled terms: Experimental and numerical analysis - Experimental study - Inner pressure - Lubrication / - Mechanical seals - Rotational speed - Sealing fluids - Thermal deformation - Thermodynamic modelling - Unstable dynamics
Classification Code: 301.1 Fluid Flow - 301.1.1 Liquid Dynamics - 302.1 Thermodynamics - 302.2 Heat Transfer - 606.1 Lubricants - 606.2 Lubrication - 610.1.1 Pipe Accessories - 1106.2 Data Handling and Data Processing - 1106.3.1 Image Processing - 1201.9 Numerical Methods - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Funding Details: Number: -, Acronym: SGAR, Sponsor: Secrétariat Général pour les Affaires Régionales, Etat en Région Aquitaine;
Funding text: The authors gratefully acknowledge the support provided by the Région Aquitaine for this work under the SYRENA project.
Open Access type(s): All Open Access, Hybrid Gold, Green
Database: Compendex
Data Provider: Engineering Village

24. [Cavitation Flow and Cooling Mechanism in Mechanical Seals with Double Row Reverse Step](#)

Ma, Xuehong (1); Li, Congcong (1)
Source: *Zhongguo Jixie Gongcheng/China Mechanical Engineering*, v 36, n 10, p 2266-2273, October 25, 2025; **ISSN:** 1004132X; **DOI:** 10.3969/j.issn.1004-132X.2025.10.013; **Publisher:** Chinese Mechanical Engineering Society
Author affiliation: (1) College of Petrochemical Engineering, Lanzhou University of Technology, Lanzhou; 730050, China
Abstract: : The thermal-hydrodynamic lubrication (THD) numerical model of mechanical seals with double row reverse Rayleigh steps was established by the CFD method, and the THD characteristics and cavitation flow laws were investigated. The results indicate that large-scale cavitation occurs in the double row reverse Rayleigh step, forming a low-temperature region, which has a significant cooling effect on the liquid film end face and sealing ring. It may be seen from the changes in speed, pressure, and groove depth that larger cavitation areas are correlated with high-speed, low-pressure and shallow grooves. The level of cavitation cooling depends on the cavitation area, and on the cavitation intensity. Temperature valleys and peaks are formed at the rupture and reformation boundaries of the liquid film in the groove, and vortex flow is formed under the combined action of pressure flow and shear flow. The edge position of the vortex corre-sponds well with the position of cavitation regeneration and the end of the high-temperature zone. The for mation of large-area cavitation effect in the reverse step groove also leads to good suction effect in the seal, greatly reducing the seal leakage rate. © 2025, Chinese Mechanical Engineering Society. All Rights Reserved. (21 refs)
Main heading: Cavitation
Controlled terms: Cooling - Liquid films - Seals - Shear flow - Temperature
Uncontrolled terms: Cavitation flow - Cooling mechanism - Double row reverse step - Double rows - Flow mechanisms - Hydrodynamic lubrication - Mechanical seals - Rayleigh-step - Thermal - Viscous heat
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 301 Fluids - 301.1 Fluid Flow - 301.1.1 Liquid Dynamics - 301.1.5 Flow of Fluid-Like Materials - 302.1 Thermodynamics - 302.2 Heat Transfer - 610.1.1 Pipe Accessories
Database: Compendex
Data Provider: Engineering Village

25. [Rubber: Fluorosilicone (FVMQ) High Temperature Fuel and Oil Resistant For Seals In Fuel Systems and Specific Engine Oil Systems](#)

Source: *SAE Technical Standard*, 2025; **DOI:** 10.4271/AMS7273D; **Publisher:** SAE International
Standard designation: AMS7273
Standard ID: AMS7273D
Abstract: This specification covers a fluorosilicone (FVMQ) rubber in the form of molded rings.AMS7273D results from a Five Year Review and update of this specification. A qualified products list requirement has been added to this specification. Acceptance tests have been defined for seal sizes other than those listed in ARP3050.AMS7273D has been reaffirmed to comply with the SAE Five-Year Review policy. © 2025 SAE.
Main heading: Acceptance tests
Controlled terms: Fuel systems - Seals - Specifications
Uncontrolled terms: Engine oil - Fluorosilicones - High temperature fuel - Oil system
Classification Code: 608.1.1 Internal Combustion Engine Components - 610.1.1 Pipe Accessories - 902.2 Codes and Standards - 913.3 Quality Assurance and Control
Versions: 5
Status: Active - Latest, reaffirmed
Database: Compendex
Data Provider: Engineering Village