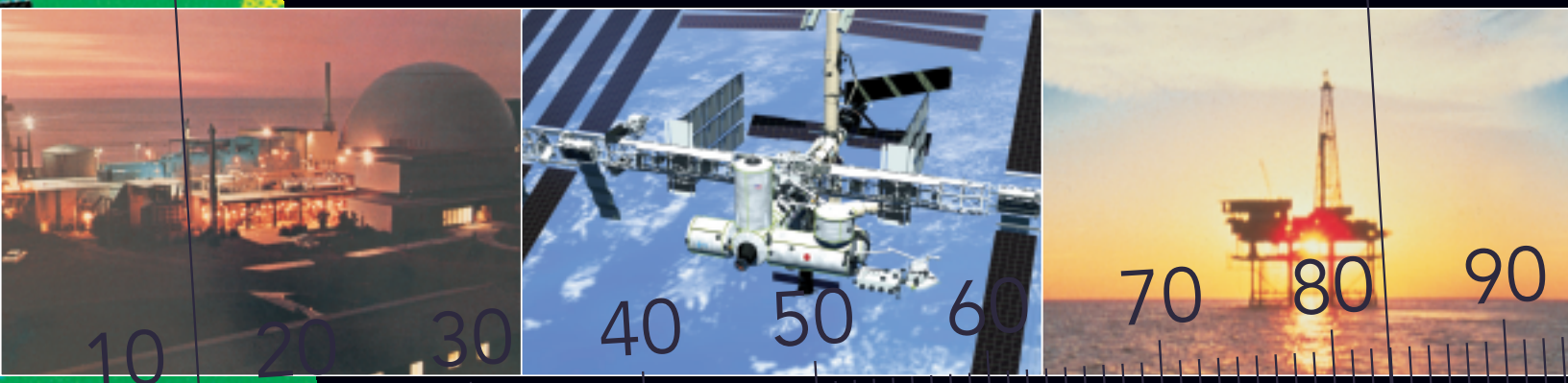
Kalsi ENGINEERING



Mechanical Design

Analysis

Testing

Research & Development

Valve & Seal Technology

Company Background

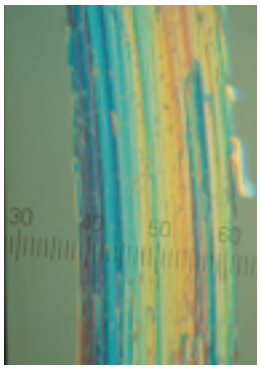
Kalsi Engineering, Inc., a high technology firm, was founded in 1978 to provide engineering services in the areas of research and development, design, analysis, and testing of mechanical equipment and structures. Our facilities are located in Sugar Land, Texas, approximately 17 miles from downtown Houston and easily accessible from the airports.

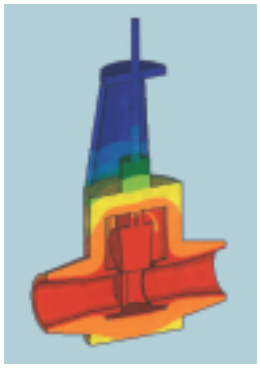
Our staff has an outstanding background and record of accomplishments in developing practical and cost effective solutions to mechanical engineering problems in a wide range of applications in the power generation, oil field, petrochemical, aerospace, defense, manufacturing, and mining industries.

Our organization is recognized worldwide for technical excellence and development of innovative products. The numerous industry milestones, guidelines, technical publications, new products, and patents that have resulted from our work continue to provide long-term benefits to our clients.

Core Capabilities & Services

- Structural, fluid, and thermal analysis
- Design and product development
- Mechanical and flow testing
- Tribology . . . friction, wear, and lubrication
- Valve technology
- Seal technology
- Failure analysis



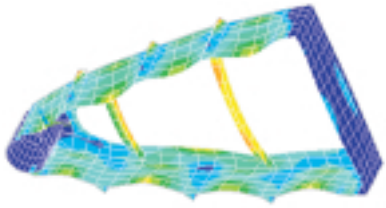


Our Clients

We have a diversified client base that includes equipment manufacturers, oilfield service companies, petrochemical plants, nuclear power plants, aerospace engineering companies, architect/engineers, industry research organizations, and government agencies. In addition to serving individual clients, we have successfully completed many multiple-client and joint-industry group-sponsored projects.

ANALYTICAL SERVICES

The Kalsi Engineering staff has extensive experience in applying advanced analysis techniques to provide cost-effective solutions to our clients' problems. We follow a rigorous approach in developing mathematical models based on first principles as well as in applying finite element analyses (FEA) and computational fluid dynamics (CFD) techniques to solve problems involving complex fluid, thermal, mechanical, and tribological interactions.

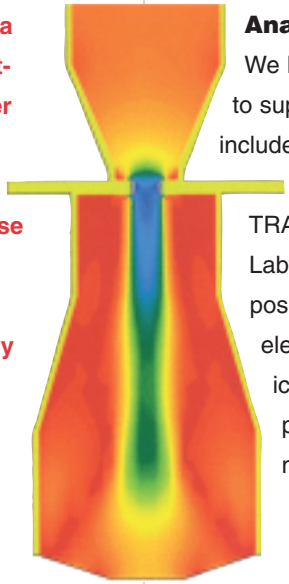


Analysis Capabilities

- Classical solid mechanics/stress analysis
- Finite element analysis: static, dynamic, linear, nonlinear
- Fatigue and fracture mechanics
- Fluid flow, heat transfer, and computational fluid dynamics
- Shock, vibration, impact, and seismic
- Tribology . . . friction, wear, and lubrication
- Mathematical models and software development
- ASME, API, ANSI Code analysis
- Independent third-party analyses and reviews

Transient dynamic analysis of a geophysical float subjected to impact of pressure waves led to the understanding and elimination of fatigue failures.

CFD analysis of hot gases flowing through a nozzle in catalytic cracker plant piping pinpointed the root cause of erosion damage to the refractory lining.



Analysis Tools

We have an extensive network of computers to support engineering analysis. Software tools include several general purpose, commercially available programs, e.g., ANSYS, FLOTRAN, PRO/Engineer, SDRC/Ideas, LabTech, Labview, and DADiSP, as well as special purpose programs developed in-house for finite element analysis, computational fluid dynamics, hydrodynamic lubrication analysis, and prediction of mechanical equipment performance.

Analysis Examples

- Coupled fluid flow and heat transfer CFD analysis used to determine convective film coefficients and temperature distributions in a centrifugal pump seal cavity
- Large displacement FEA including material and geometric nonlinearities, and temperature effects to predict the performance of elastomeric components, e.g., special designs of marine bearings, seals, packings, and downhole centralizers/shock isolators
- Elastohydrodynamic lubrication analysis to support the development of novel high load capacity journal and thrust bearings concepts
- Shock, vibration, and heat transfer analysis of PC board assemblies subjected to severe down hole drilling conditions to prevent fatigue and overheating failures
- Detailed thermofluid modeling of flow in the main pipe and its interaction with a dead leg branch to explain the mechanism for the observed high temperatures at the branch end

Software Development

When required, specialized software is developed for client-specific application and general industry use.

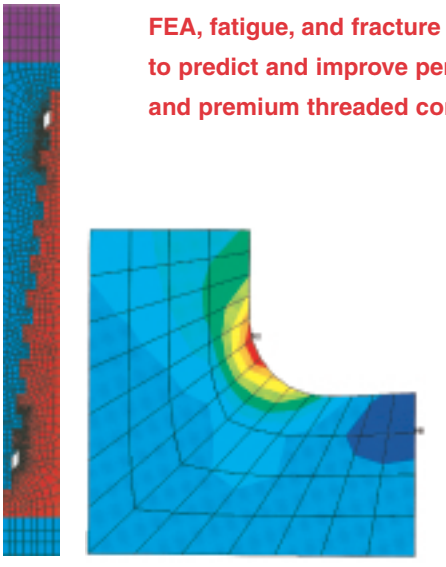
- PulsTran™, a software to predict attenuation, dispersion, and reflection of pressure pulses generated downhole and transmitted to the drilling rig at the surface
- Validated mathematical models and software to reliably predict performance of various types of valves over a wide range of operating conditions, including accident conditions
- Hydraulic network analysis software for plant piping systems including pumps, valves, heat exchangers, etc.
- JarPro®, a jarring analysis software, to optimize jar placement in drillstrings
- CVAP®, a validated program to predict wear/fatigue of valve internals and to prioritize check valve maintenance
- LTAFLA, a validated program to predict fatigue life of motor powered worm gear actuators subjected to variable-magnitude ramp loads
- RSCAPI, a software to predict performance of API rotary shouldered drillstring connections

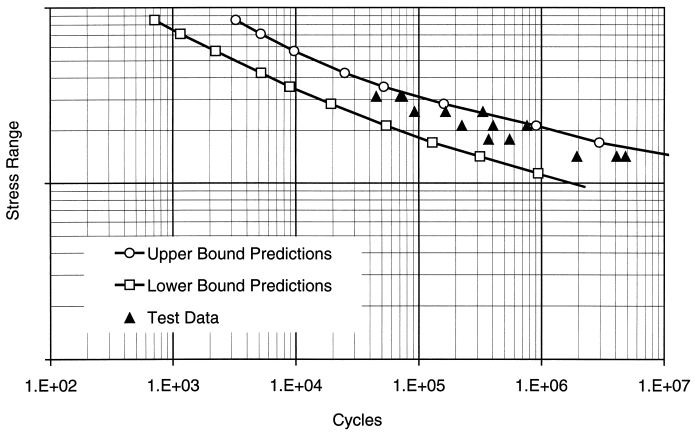
Training and Seminars

To train users in the application of the specialized software, seminars can be conducted either at the client's site or at our facility. Other seminar topics include ASME/API code stress criteria and its application in the design and analysis of pressure vessels and piping components; valve and actuator design/selection; and sealing.

A mathematical model based upon first principles was developed to predict complex fluid structure interaction and buckling of electromechanical cables.

FEA, fatigue, and fracture mechanics analyses are routinely employed to predict and improve performance and fatigue life of standard API and premium threaded connectors.





DESIGN & TESTING

Kalsi Engineering has a proven track record in developing new designs and products from concept to full production. Our design team is supported by our comprehensive analysis and testing capabilities. Our engineers and designers have extensive experience in machining, welding, tooling, and other manufacturing processes used in the fabrication of a broad range of mechanical and structural equipment. We utilize state-of-the-art, computer-aided design software tools to support our design and development activities.

Insights gained from analysis and testing led to an improved gate valve for critical service in nuclear power plants. The design eliminates the severe galling and degradation commonly observed in conventional designs under blowdown conditions.

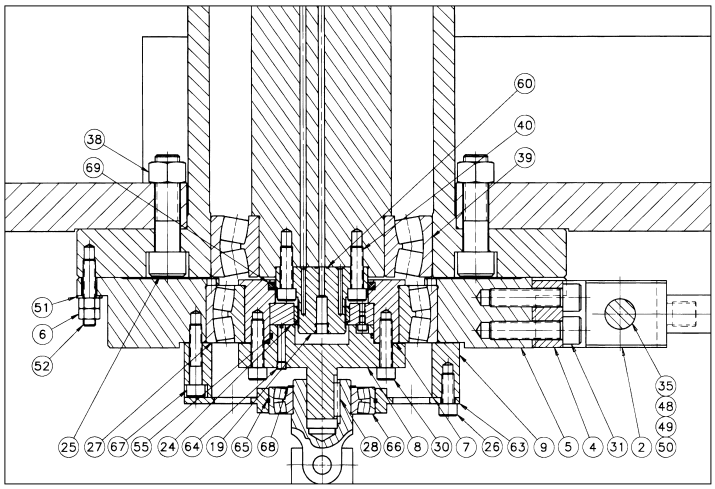
Our accomplishments are reflected by numerous improvements and patents related to valves, static and dynamic seals for demanding applications, downhole drilling tools, bearings, measurement-while-drilling equipment components, wellhead equipment, and unique thread geometries. We have formed world-class alliances to market our technology, and several of our patented products are licensed to multi-national companies for manufacturing and worldwide marketing.

Design & Product Development Capabilities

- Conceptual and detail design of mechanical/structural equipment
- Detailed manufacturing drawings
- Prototype design and fabrication
- Product testing and evaluation
- Development of proprietary/patentable products
- Design of specialized test fixtures

Examples

- High pressure, high speed wash pipe assembly design for drilling and coring swivels
- Design and development of a new generation of automated welding machines for hard surface overlays on large surfaces
- Design of space station mock-up hardware used for astronaut training in NASA's Neutral Buoyancy Laboratory
- Sealed bearing assemblies for downhole drilling motors and rotary steerable tools
- An improved wedge gate valve design for critical nuclear power plant applications
- A nonlocking lubricated tapered plug valve design suitable for operation under sharp hydraulic transients



Unique test fixtures are routinely designed, detailed, and fabricated by our staff to faithfully simulate equipment performance in our laboratory.

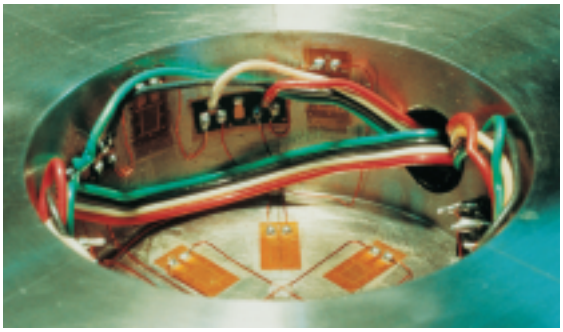
- Design of turbine impellers for downhole power generators to provide the desired speed, torque, and erosion life characteristics
- Design of unique elastomeric thrust bearings to carry high thrust loads in an abrasive environment
- Development of a high-accuracy test stand for qualifying electric motor-powered gear actuators for valves

Full-scale tests were conducted on a fixture designed to qualify 42" diameter high-pressure rotary seal assemblies for a friction welding machine.

Mechanical & Flow Testing Capabilities

- Structural integrity, fatigue life, and performance qualification testing
- Flow loop testing per ANSI/ISA standards
- Shock, vibration, impact, and seismic testing
- Strain gage testing
- Friction, wear, lubrication, and galling testing
- High pressure, elevated temperature testing
- Scale model testing
- Unique test fixtures to simulate performance of complex systems
- On-site support for field testing

Our testing laboratory is routinely used to evaluate performance characteristics, life and degradation of mechanical/structural equipment, hydraulic/rotating machinery, pressure vessels, and piping components. The laboratory is equipped with several digital data acquisition systems and instruments for pressure, flow, shock, vibration, temperature, and strain measurements. To meet our clients' needs, we provide on-site support to perform instrumented tests in the field when required.



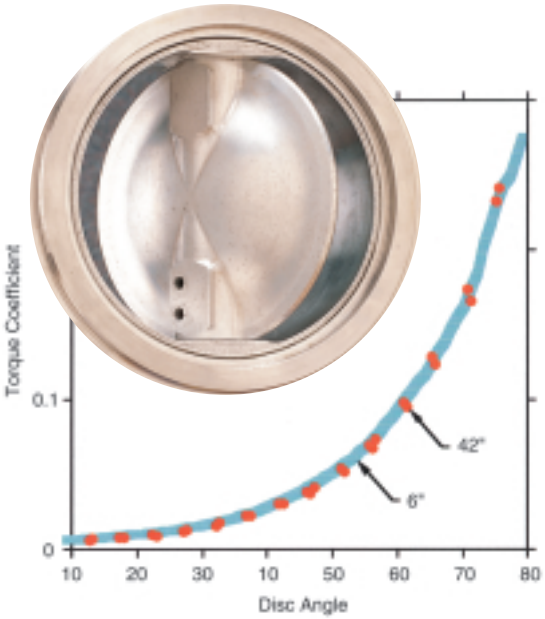
Strain gages were used to measure stresses and axial and bending loads in a mechanical device subjected to repeated impacts.

Examples

- Field measurement of transient dynamic stresses, accelerations, and impact energy in casing connectors under hammer driving loads
- Bending moment, axial load, and torsional load tests on pipe, connectors, flanges, and valves to determine structural, sealing, and operational limits
- Evaluation of mechanical face seals, elastomeric lip seals, plastic seals, and proprietary design seals, to determine operational limits
- Flow tests to determine Cv, choking, and cavitation characteristics of valves of different designs and manufacturers
- High pressure, high temperature tests to qualify components for downhole environment

VALVE TECHNOLOGY

Our continuous involvement with valve technology has resulted in the development of reliable analytical models, design improvements, and innovative solutions to persistent valve/actuator problems that have defied the industry for decades. Our expertise spans from the conceptual stage through detail design, analysis, prototype development, testing, manufacturing; troubleshooting; and root cause analysis of valve and actuator problems.

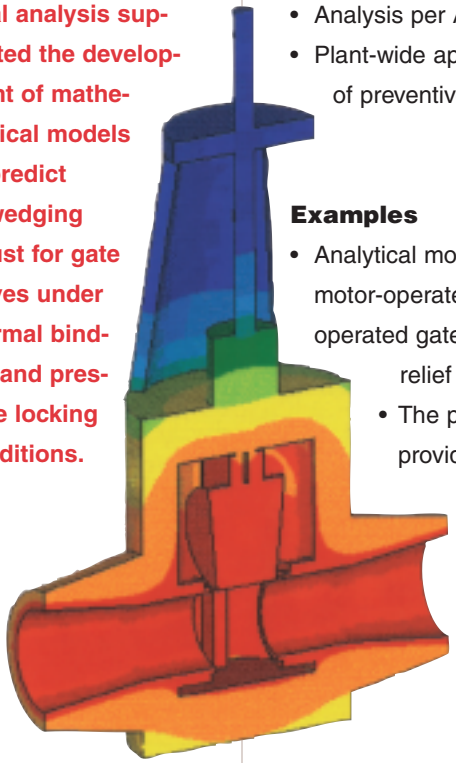


Analytical model predictions including effect of upstream flow disturbances on hydrodynamic torque for butterfly valve discs of different shapes were validated by scale model and full-scale testing.

Capabilities

- Valve research and development
- New valve designs for demanding applications
- Mechanical and flow loop testing
- Qualification of designs to meet structural and performance specifications
- Analytical models to predict performance under conditions difficult/expensive to test
- CFD analysis to quantify forces and moments on valve internals
- Valve/actuator design modifications
- Analysis per ASME and API code requirements
- Plant-wide application reviews and development of preventive maintenance programs

Coupled fluid flow, thermal, and structural analysis supported the development of mathematical models to predict unwedging thrust for gate valves under thermal binding and pressure locking conditions.



Examples

- Analytical models to predict performance of motor-operated, air-operated, and hydraulically operated gate, butterfly, and globe valves; safety relief valves; and check valves
- The patented Sentinel gate valve to provide tight shut-off and eliminate degradation in critical nuclear power plant applications
- A tapered plug valve that eliminates taper locking of the plug under rapid hydraulic transients
- Bending moment tests on valves to determine internal distortions as well as structural and performance capabilities under simulated piping loads
- Wear and fatigue models for check valves to prevent failure and to prioritize maintenance
- A low impact, gaseous cryogenic pressure relief valve with modulating pressure control for NASA's ground support facilities
- Evaluation of instability problems in several air-operated control valve applications, and development of generic sizing criteria for stable operation

FAILURE ANALYSIS

Extensive experience in root cause analysis and testing, augmented by our in-depth understanding of the design and performance aspects of mechanical equipment enables us to provide a complete failure analysis service to our clients.

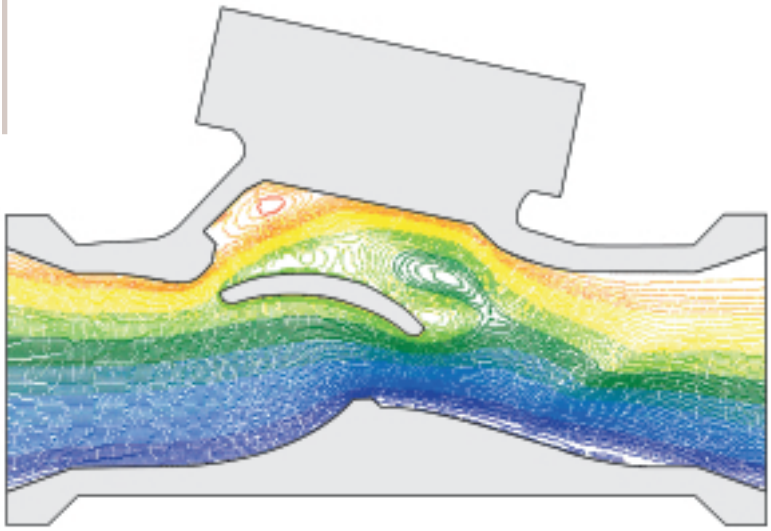
Often we conduct tests to deliberately take equipment to failure to support an investigation and confirm failure mechanisms. In some cases the objective of a failure analysis is to improve performance and reliability of the equipment by design modifications that can be retrofitted. We provide complete analysis, testing, independent review, and expert witness testimony services to investigate failures in mechanical equipment and structures. Our clients include equipment manufacturers, equipment users, plants, law firms, and insurance companies.

Our staff takes a disciplined approach in identifying whether a failure is caused by design deficiencies, material defects, operational overloads, abuse, misapplication, inadequate maintenance, or use beyond design life.

Examples

- Investigation into the failure of drill pipe tool joints in an offshore drilling application
- Failure of a number of 48" pipeline flanges and valves at a crude oil tanker loading terminal due to hydraulic transients
- Failure of a combination friction clutch and brake mechanism in a high speed automatic punch
- Investigation of a steam turbine failure by overspeeding
- Main steam safety valve failures caused by excessive vibration due to acuostic resonance
- Root cause analysis of repetitive failures of a feedwater pump impeller shaft
- Investigation of multiple swing check valve failures during reduced power operation
- Fatigue life determination of electric motor powered actuators by cycle testing to failure

Torsional overload resulted in failure of a threaded tubular connection.

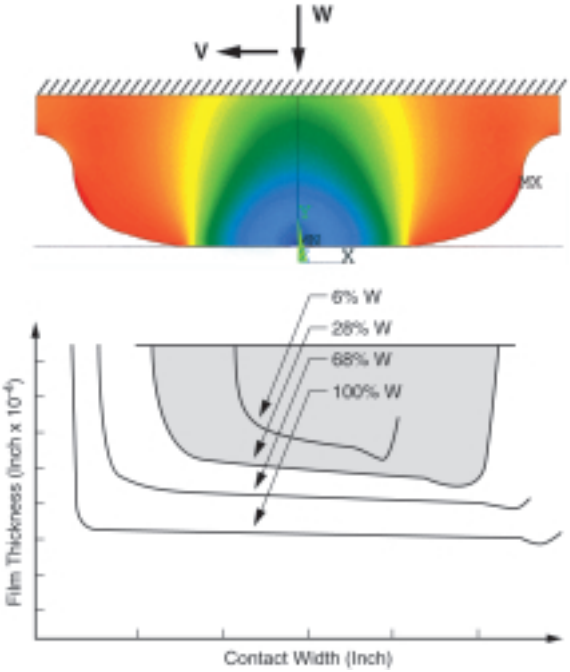


Root cause of the failure of a tilting disc check valve to close and cause a reactor scram was determined by CFD. Design modifications identified by analysis were implemented and confirmed to eliminate the problem.

TRIBOLOGY

Tribology, a word coined in the 1960s from the Greek “tribos” for “rubbing,” is the science of interacting surfaces in moving contact involving multi-disciplines of friction, lubrication, and wear. Tribological issues are frequently the underlying cause of mechanical equipment failures and degradation. Kalsi Engineering personnel have been supporting the industry by providing fundamentally sound tribological solutions to dynamic sealing, bearing, and mechanical contact problems by analysis, testing, research, and development.

Optical interference fringe studies confirmed the film thicknesses and operation of an elastomeric rotary seal concept that generates hydrodynamic lubrication.



Elastohydrodynamic and macro-hydrodynamic lubrication analysis and testing were performed to design a high load capacity, abrasive-tolerant, mud lubricated rubber thrust bearing for downhole turbines.

Capabilities

- Hydrodynamic/elastohydrodynamic lubrication analysis
- Analytical modeling of metal-to-metal (hard) and elastomer/polymer-to-metal (soft) contacts by finite element analysis including material and geometrical nonlinearities
- Subscale and full-size testing to evaluate performance and life of lubricated and unlubricated contacts
- Friction, wear, and galling testing of components
- Wear prediction modeling and accelerated wear testing to confirm predictions
- Evaluation of lubricants, greases, surface treatments, and abrasive environments
- Testing and evaluation of friction coefficients and durability of hard surface coatings and treatments

Laboratory tests confirmed analytical predictions of lower friction coefficients obtained with a novel bearing designed for high load / high speed applications.

Oilfield and Petrochemical

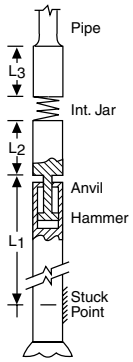
To produce oil & gas and supply the end products to customers as efficiently and cheaply as possible, the petroleum industry relies heavily on continuing technological advances. Kalsi Engineering has made significant contributions towards the accomplishment of these advances by providing state-of-the-art analysis and testing services, and by developing innovative designs and patents for a variety of mechanical equipment used in the oilfield and petrochemical industries. This includes downhole tools, wellhead and drilling equipment, pressure vessels and piping components, reactor vessels, heat exchangers, valves, and pumps.

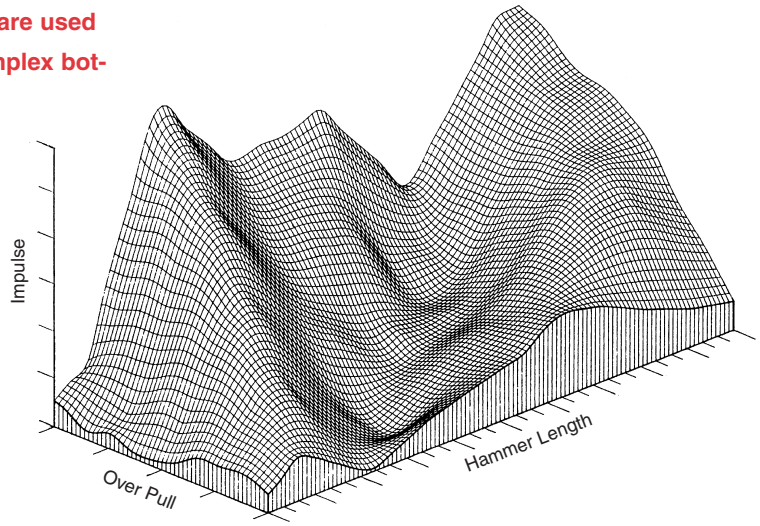
Examples

- Innovative bearing and seal designs for drill bits, downhole drilling motors, advanced rotary steerable systems, and high pressure rotary blowout preventers
- Measurement-while-drilling mud pulse telemetry valves, turbines, and sensors
- High pressure, high speed wash pipes used in drilling and coring swivels
- JarPro®, a jarring analysis program, to optimize jar placement
- Hydraulic pressure pulse transmission software PulsTran™
- Analysis and performance testing of API rotary shouldered, casing, and tubular connections
- Development of a novel thread form and connection geometry for a high fatigue strength tool joint
- Analysis and elimination of leakage problems in heat exchanger flanges due to mechanical and thermal distortions under piping loads and moments
- Stress analysis of reactor pressure vessels and flanges; buckling analysis of elliptical heads under external pressure to increase operating pressure limits
- FEA and CFD analyses of valves and piping in high temperature flue gas and catalytic converter applications to eliminate disc binding and erosion problems

Downhole turbine impellers were designed and optimized by an analytical model to provide the desired speed, torque, and erosion characteristics.

Impulse predictions by JarPro® are used to optimize jar placement in complex bottom hole assemblies.





Nuclear Power Generation

Reliable and predictable performance of equipment is critical to the safety and economical operation of nuclear power plants. Mechanical equipment problems and failures are a leading contributor to unscheduled shutdowns, safety concerns, and high maintenance cost. Kalsi Engineering has achieved industry-wide recognition due to our technical excellence while serving individual utilities, multiple-utility groups, NSSS Owners' groups, and the Electric Power Research Institute (EPRI) and their Nuclear Maintenance Application Center (NMAC) on projects of major industry significance.

Analyses and tests were performed to evaluate structural capability, and fatigue life of motor-operated worm gear actuators. This multi-utility sponsored project provided a generic increase in actuator ratings, saving the industry millions of dollars.

Capabilities

- Structural, fluid, and thermal analysis
- Laboratory and flow loop testing
- Root-cause analysis
- Design modifications
- Plant-wide reviews; development and implementation of programs to address generic issues
- Training and seminars
- Independent review and assistance in utility self-assessment programs

Examples

- Development of motor-operated valve performance prediction models and application guides for gate, globe, butterfly, and check valves for EPRI and NMAC
- Pressure locking and thermal binding methodologies and software
- Air-operated and hydraulically operated actuator stability and sizing methodology
- Reactor coolant pump seal modifications and testing under accident conditions to improve reliability under plant transients
- Independent review of a mechanical model for reactor core rod cluster control assembly insertion to predict force margins and prevent sticking
- Tilting pad thrust bearing hydrodynamic lubrication analysis and performance prediction under temperatures exceeding the normal limits

Flow loop tests on instrumented check valves were performed to validate the CVAP® wear and fatigue model and to support the development of condition monitoring methods for periodic verification testing.

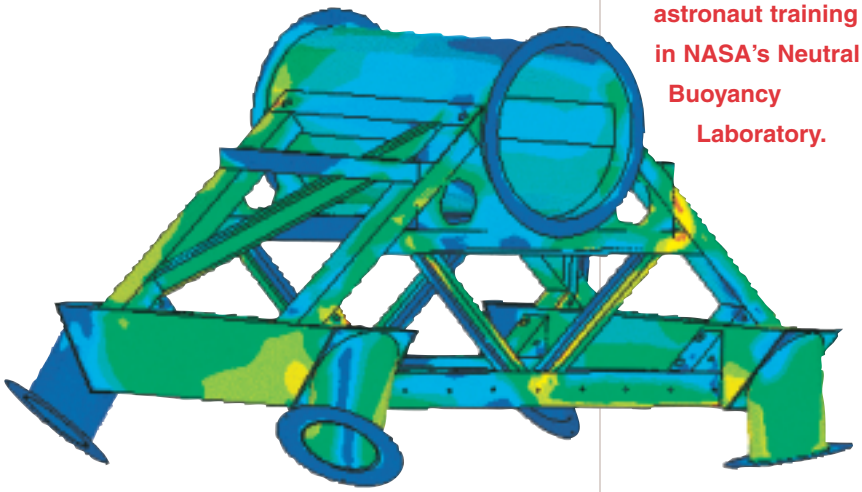
A comprehensive matrix of tests was conducted on a specially designed test fixture that simulated dynamic fluid forces and moments on a gate valve disc during travel to support the EPRI MOV Performance Prediction Program.

Aerospace and Defense

Our personnel have expertise in stress and thermofluid analysis of mechanical and structural equipment, hardware qualification, and the development of analytical models as well as in the design and testing of hardware for the aerospace and defense industries. We have provided services to NASA, aerospace engineering firms, the Department of Defense, and other government agencies. Our staff has been involved in the Space Station, Space Shuttle, Saturn, and Skylab projects.

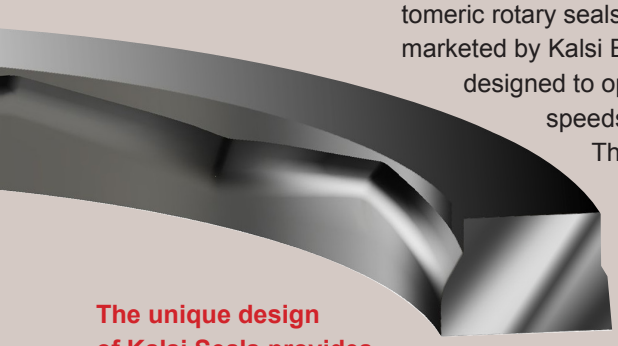
Examples

- Design and detailed fabrication drawings for space station mock-up hardware
- Design of a new gaseous cryogenic pressure relief valve with modulating pressure control characteristics to eliminate impact problems at NASA ground support facilities
- Design of a miniature high temperature, high pressure, low noise throttle valve for underwater propulsion systems in defense applications
- Conceptual and detailed design, analysis, prototype development, manufacturing, and testing of unique thermal enclosure systems, heat exchangers, and refrigerator/ incubator modules used in the space shuttle
- Development of analytical models to predict the performance of a spacecraft thermal control system, aero-thermodynamics of reentry vehicles, space shuttle thermal protection system, and ground support equipment
- Test support for wind tunnel, plasma arc chamber, and thermal/vacuum chamber testing



Three-dimensional FEAs were performed to assist in the design of space station simulation hardware used for astronaut training in NASA's Neutral Buoyancy Laboratory.

KALSI SEALS PRODUCT LINE



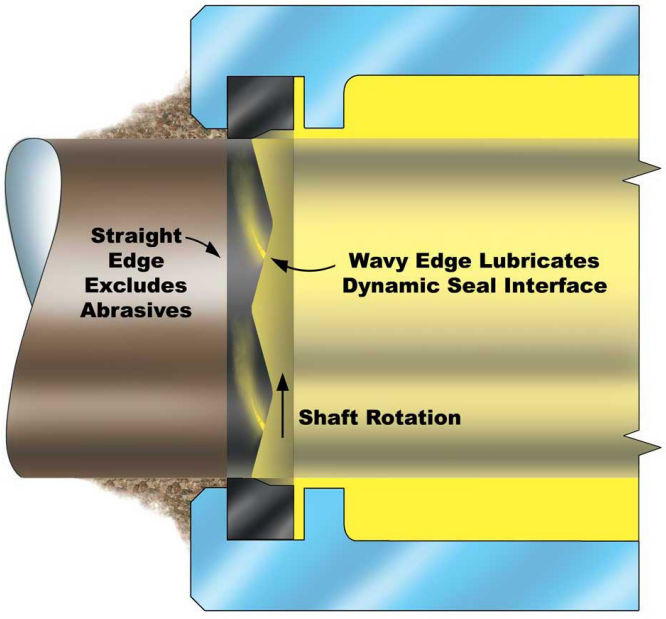
The unique design of Kalsi Seals provides hydrodynamic lubrication even under high differential pressure.

Fundamental research in elastohydrodynamic lubrication resulted in a family of patented elastomeric rotary seals that are manufactured and marketed by Kalsi Engineering. The seals are designed to operate at high pressures and speeds while excluding abrasives. They are used extensively in oilfield drilling and production tools, and in severe service applications in other industries. Kalsi Seals provide an advantage over mechanical face seals in environments such as shock and vibration; frequent start/stops; and changing pressure, speed, and temperature.

The one-piece elastomeric seal operates on the hydrodynamic lubrication principle. The development effort included large deformation finite element analysis and elastohydrodynamic lubrication analysis. Film thickness predictions and performance have been verified by optical interferometry studies, and by years of laboratory tests, field tests, and commercial use.

Technical literature and implementation guides are available to assist the end user. Application-specific customer conditions can be simulated in our well-equipped laboratory. A variety of elastomers is available to accommodate fluid, pressure, and temperature requirements.

Seals are available in a wide range of styles and sizes ranging from 3/8” to 42”. Custom sizes can be provided upon request.

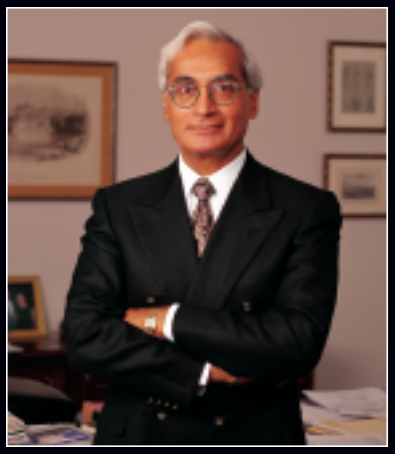


How it works...

Kalsi Seals are installed in a housing groove and compressed against a shaft, and they seal statically in the same manner as a conventional O-ring. The dynamic sealing lip incorporates a wavy edge on the lubricant side and a straight edge on the environment side.

As rotation occurs, the waves cause the rotational velocity to hydrodynamically wedge a thin lubricant film into the dynamic sealing interface. This hydroplaning effect lubricates the seal and shaft surfaces, and prevents the typical dry rubbing wear and high friction associated with conventional rubber and plastic seals.

When rotation stops, the hydrodynamic action stops, and the static seal is reestablished.



Dr. M.S. Kalsi

Our clients, the industries we serve, and our organization continue to benefit from the numerous industry guidelines, technical publications, patents, and innovative products that result from our work.

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