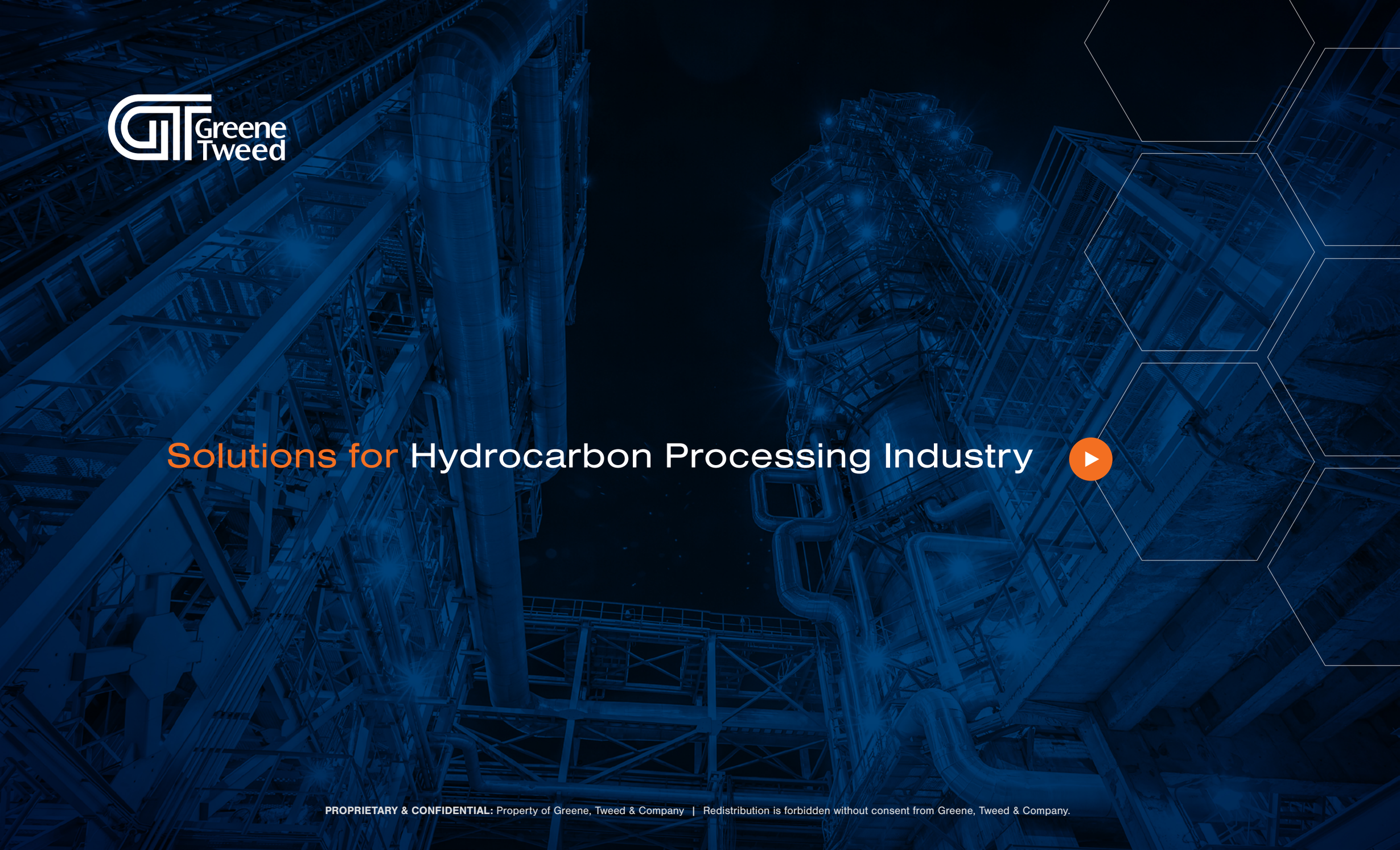


Solutions for Hydrocarbon Processing Industry

Why Greene Tweed?

We are scientists, engineers, thinkers, technologists, collaborators, and creators who understand critical details in materials technology.

We create:

Landing gear seals relied upon in 80%+ of commercial aircraft

Elastomeric seals which withstand 35,000+ pound per square inch (PSI) under 3 miles of ocean in deep water oil & gas wells

Composite wear parts that increase pump reliability to keep oil refineries running

Seals which enable the manufacture of chips that power next-generation mobile devices

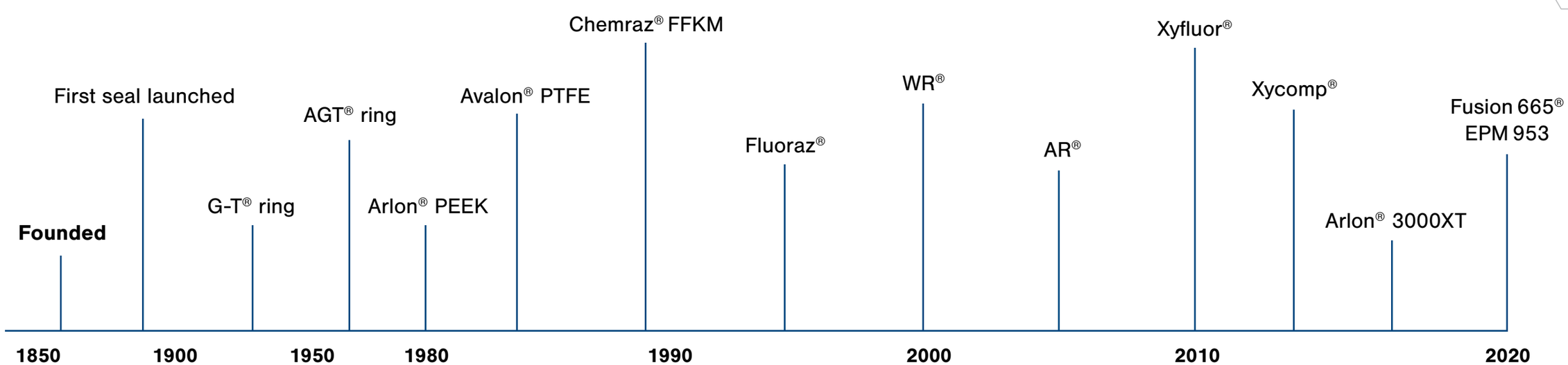
Custom-designed structural components that reduce aircraft weight to improve fuel efficiency

Electrical and fiber optic connectors which reliably transmit signals in the harshest environments

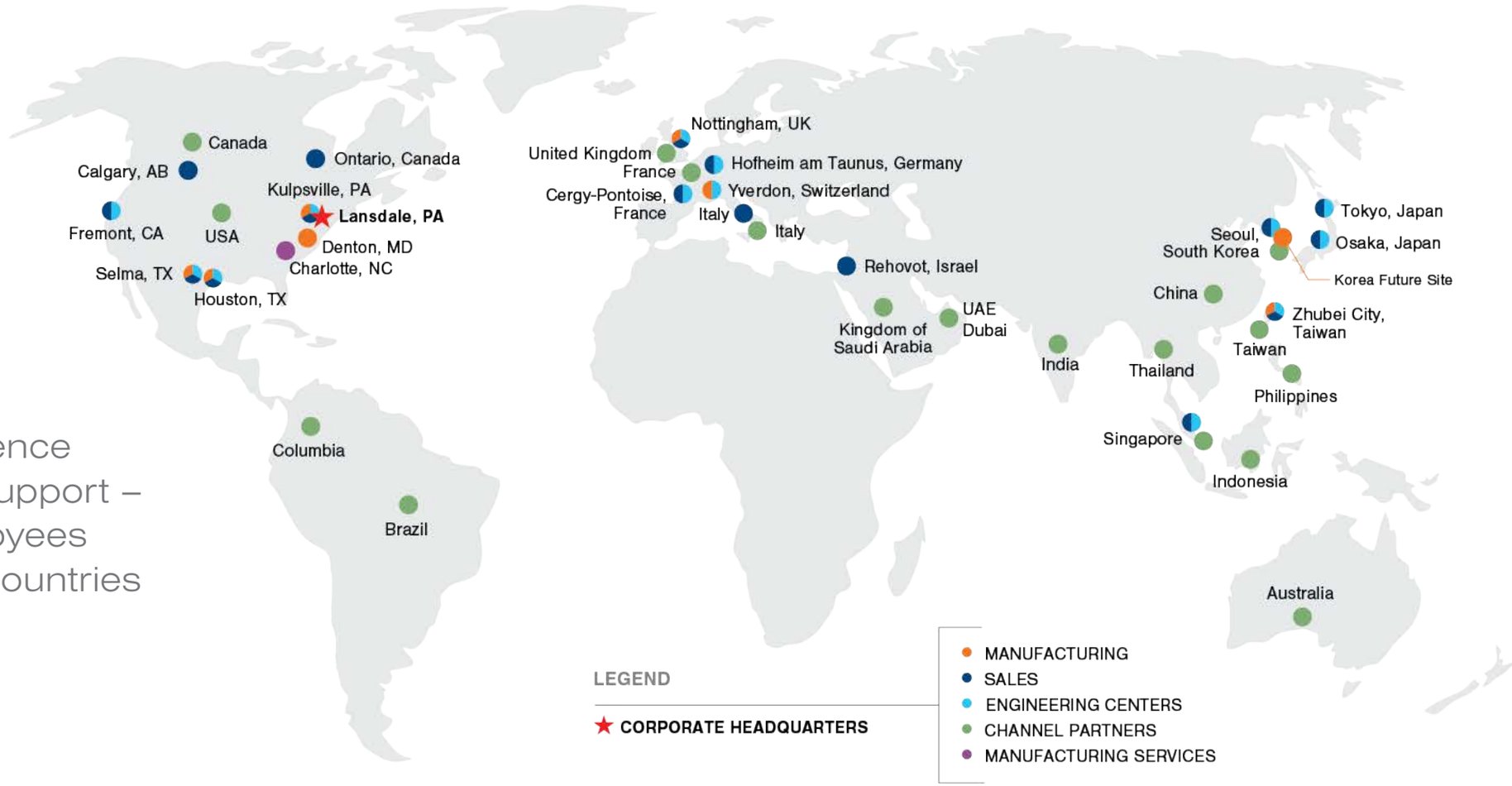
1,700 employees across 11 countries support the most advanced global companies.

A History of Innovation

Passion for innovation advances next generation materials that deliver reliability, safety, and efficiency to enable our customers' leading-edge applications



Where We Are



Global Presence with Local Support – 1,700 Employees Across 11 Countries

Who We Are, What We Do

+150 years of material expertise & industry knowledge

On-going customer support

In-depth understanding of your application environment and use

Customized, engineered, quality solutions

Advanced, proprietary material technologies

Engineering expertise & continuous partnership through product development

Manufacturing

Facilities

United Kingdom, United States, Switzerland, Taiwan, Korea

Certifications

ISO 9001:2015
ISO/IEC 17025:2017
AS9100:2016
EN9100:2018

Cleanrooms

Class 100 & 1000

Compression and injection molding capabilities

State-of-the-Art Manufacturing

Materials Lab

Quality control of raw materials

Plasma Lab

Semiconductor parts testing using process gases

Accredited Testing Lab

ISO/IEC 17025:2017

Product Testing Lab

Pump wear rig, landing gear rig, sealing pressure vessel test rig, structural composites testing

Finite Elements Analysis (FEA)

Markets We Serve

Aerospace & Defense | Oil & Gas | Semiconductor | Life Sciences | Industrial Operations | Chemical Processing | Agriculture

Products We Manufacture

Wear & Abrasion Solutions

Structural Components

Electrical & Fiber Optic Connectors

Chemraz®

Sealing Solutions

Machined Plastics

Composite Value in Pumps and Mechanical Seals

Wear and Abrasion Resistant Composite Materials

When used in pumps and mechanical seals, Greene Tweed's wear and abrasion resistant composite bushings and wear rings result in:

- Improved system reliability
- Improved shaft stability
- Elimination of secondary damage
- Reduced chance of cavitation
- Extended life pumping solids
- Enhanced efficiency
- Safer equipment

Sealing Solutions Value in Pumps and Mechanical Seals

PTFE, PEEK, and Elastomeric Sealing Solutions

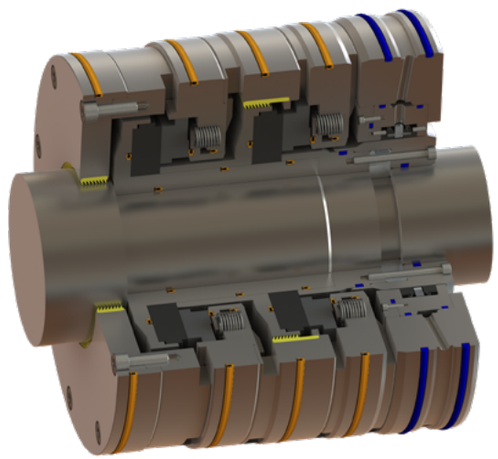
When used in pumps and mechanical seals, Greene Tweed's Avalon® (PTFE), Arlon® (PEEK), and elastomeric gaskets and sealing solutions result in:

- Excellent leakage control in a wide range of operating conditions
- High- and low-temperature resistance
- Aggressive fluid compatibility
- Pump longevity and longer MTBR
- Enhanced efficiency
- Safer equipment

Solutions by Equipment

Pumps

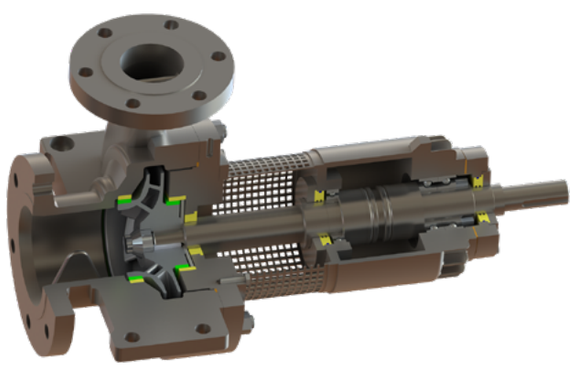
Mechanical Seals



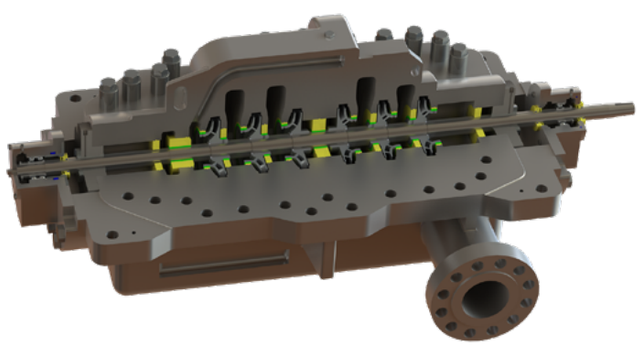
Solutions by Equipment

PUMPS

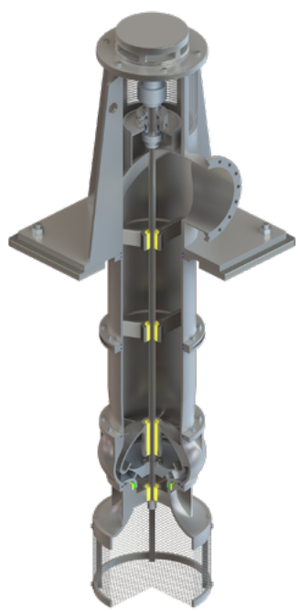
Overhung



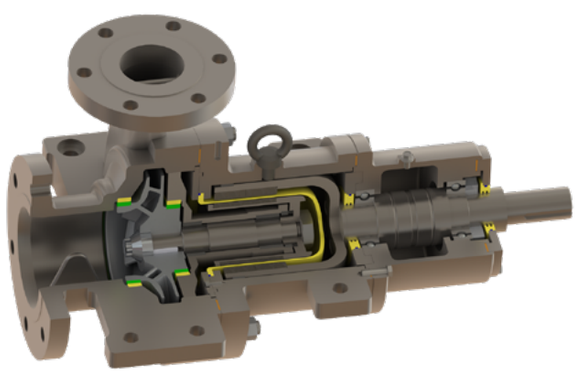
Between Bearings



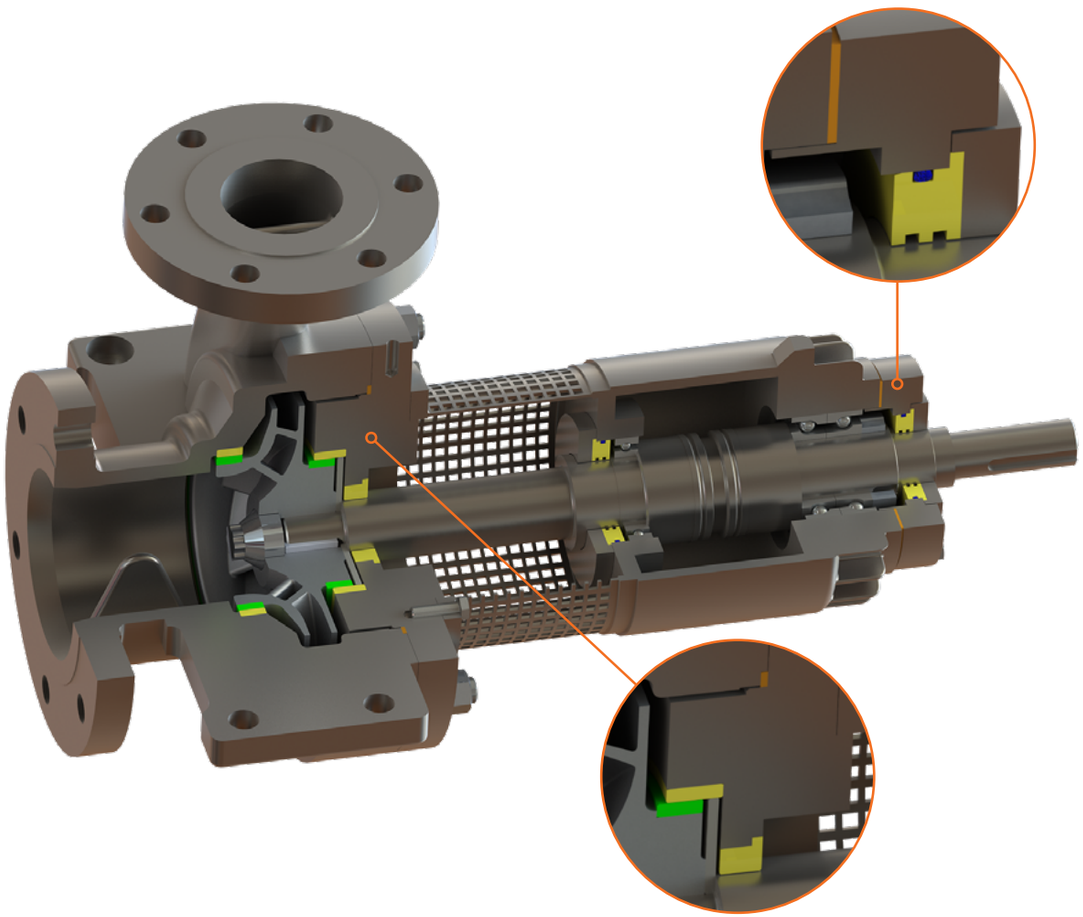
Vertical



Magnetic Drive



Solutions for Overhung Pumps



Throat/Throttle Bushings, Case Wear Rings and Labyrinth Seals:

WR®/AR® Composites

Impeller Wear Rings:

WR®/AR® Composites

Static Interface Gaskets:

Avalon® PTFE-Based Materials

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

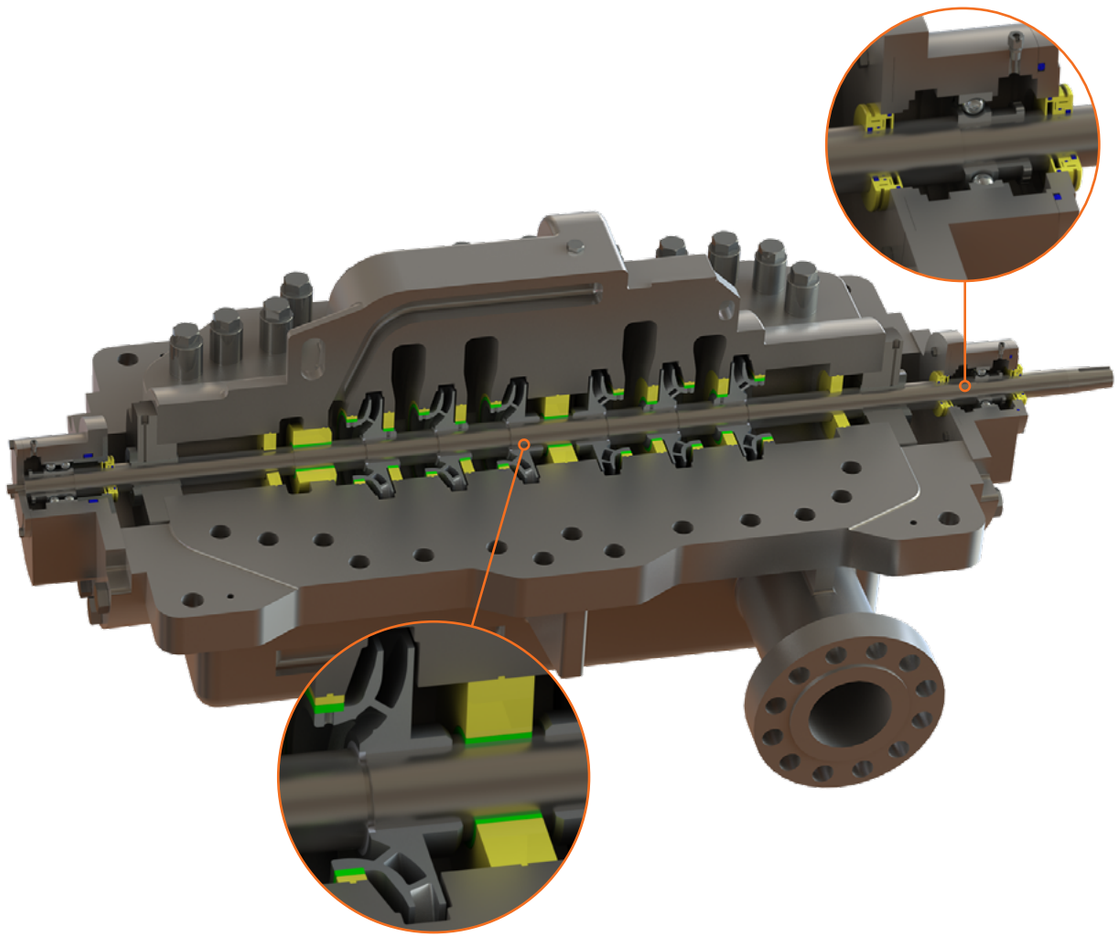
Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

EPDM
Outstanding resistance to hot water/steam, polar solvents, and ozone

Solutions for Between Bearings Multistage Pumps



Throat/Throttle Bushings, Case Wear Rings and Bearing Isolators:

WR®/AR® Composites

Impeller and Shaft Wear Rings:

WR®/AR® Composites

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

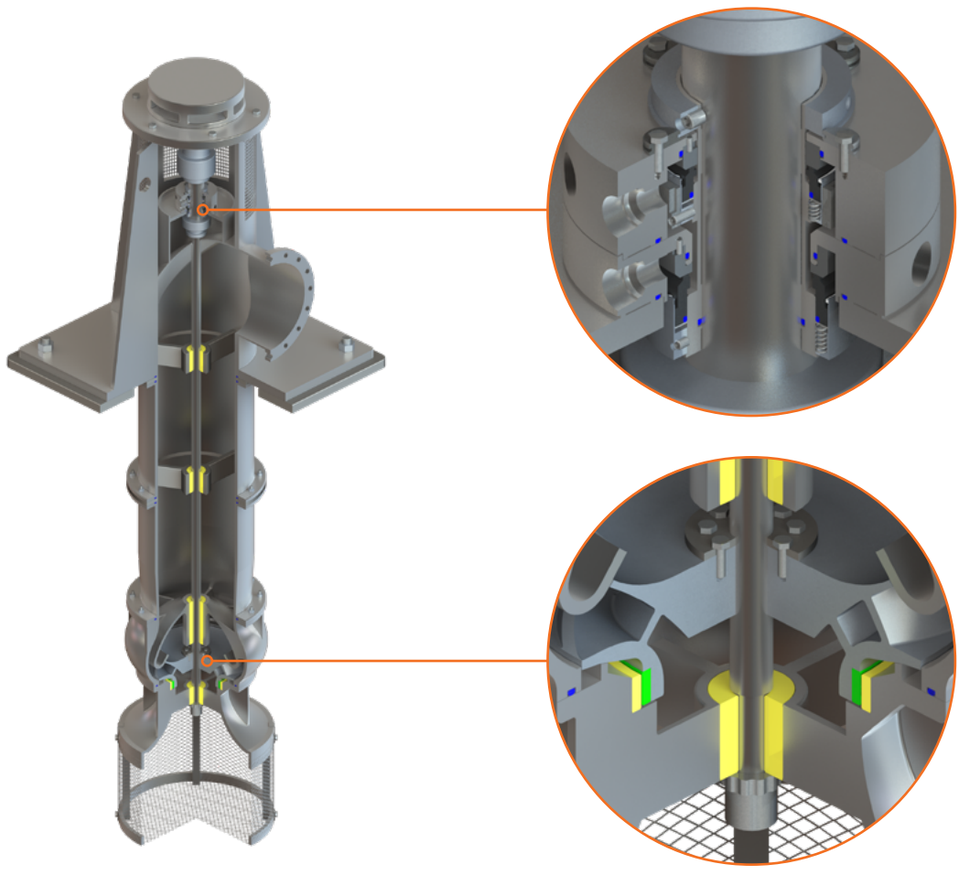
Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

EPDM
Outstanding resistance to hot water steam, polar solvents, and ozone

Solutions for Vertical Pumps



Line Shaft, Bowl and Bell Bearings and Case Wear Rings:

WR®/AR® Composites

Impeller Wear Rings:

WR®/AR® Composites

Seal Stacks/Packings:

Avalon® PTFE-Based Lip Seals/ Spring Energized Seals (MSE®)

Avalon® PTFE and Arlon® PEEK Based Support Rings

Avalon®, Arlon® & Elastomeric Based Vee-Stacks

Palmetto Graphite and Braided Packings

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

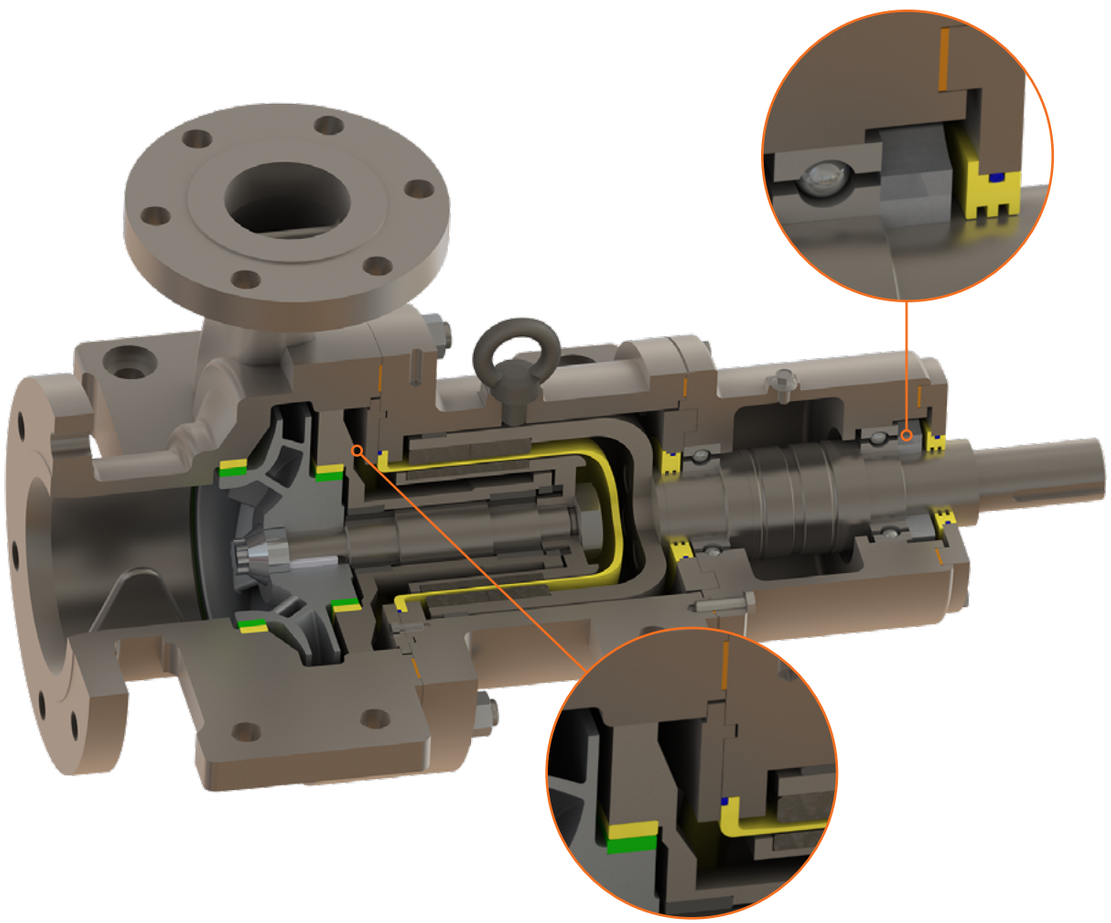
Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

EPDM
Outstanding resistance to hot water steam, polar solvents, and ozone

Solutions for Mag Drive Pumps



Composite Pump Shells, Throat / Throttle Bushings, Case Wear Rings and Labyrinth Seals:

Xycomp® Composites
WR®/AR® Composites

Impeller Wear Rings:

WR®/AR® Composites

Static Interface Gaskets:

Avalon® PTFE-Based Materials

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

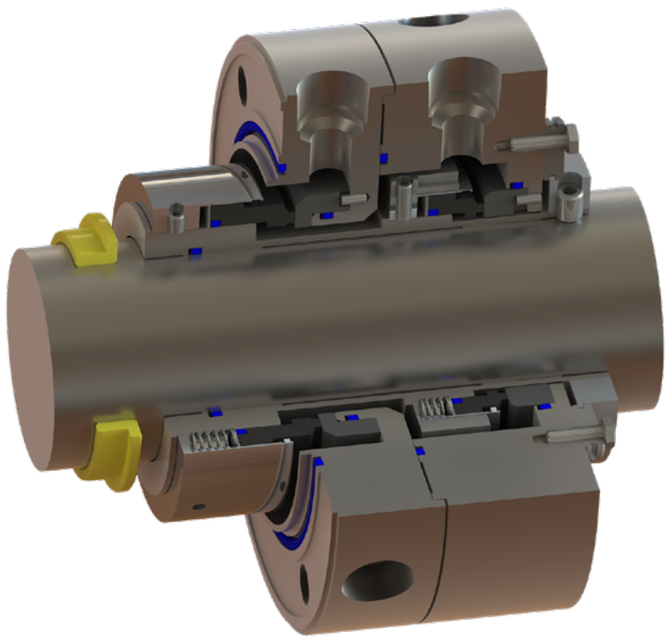
Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

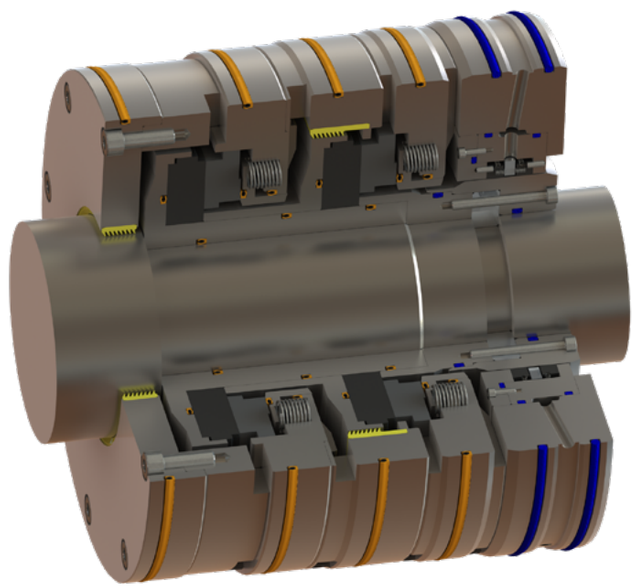
EPDM
Outstanding resistance to hot water steam, polar solvents, and ozone

Mechanical Seals

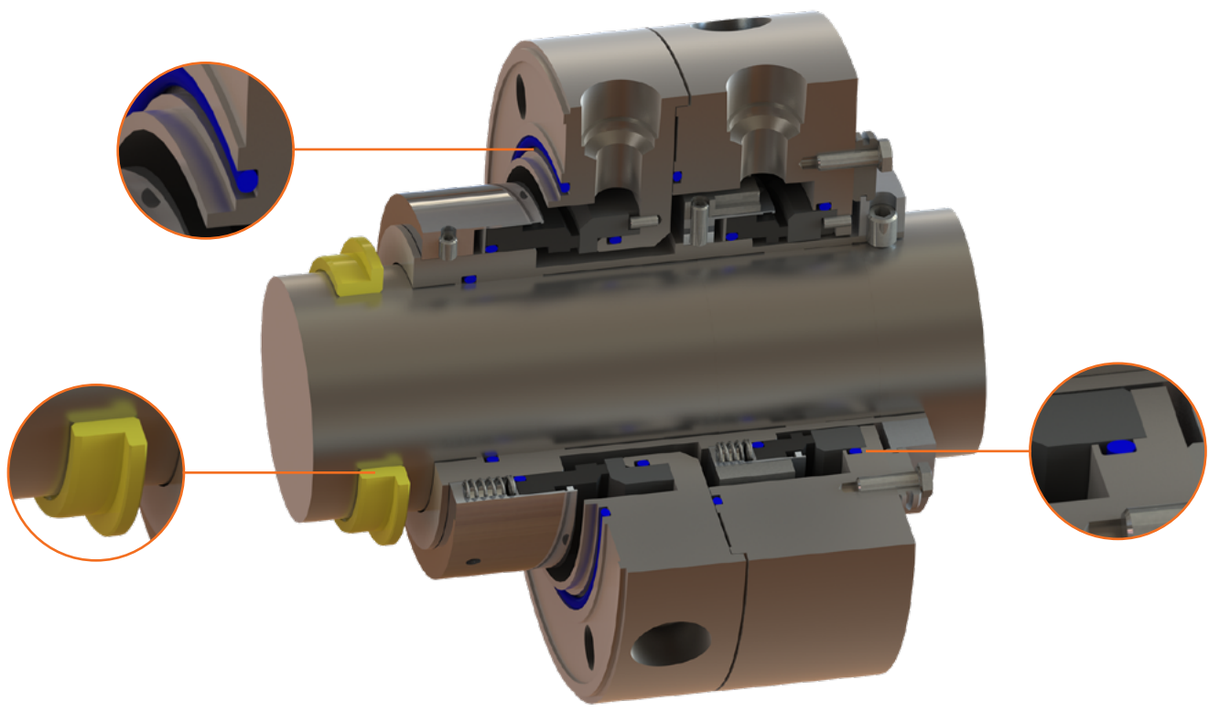
WET SEAL



GAS SEAL



Solutions for Wet Seals



Throat/Throttle Bushings:

WR®/AR® Composites

Coatings:

Enduro® LF10 Coating

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

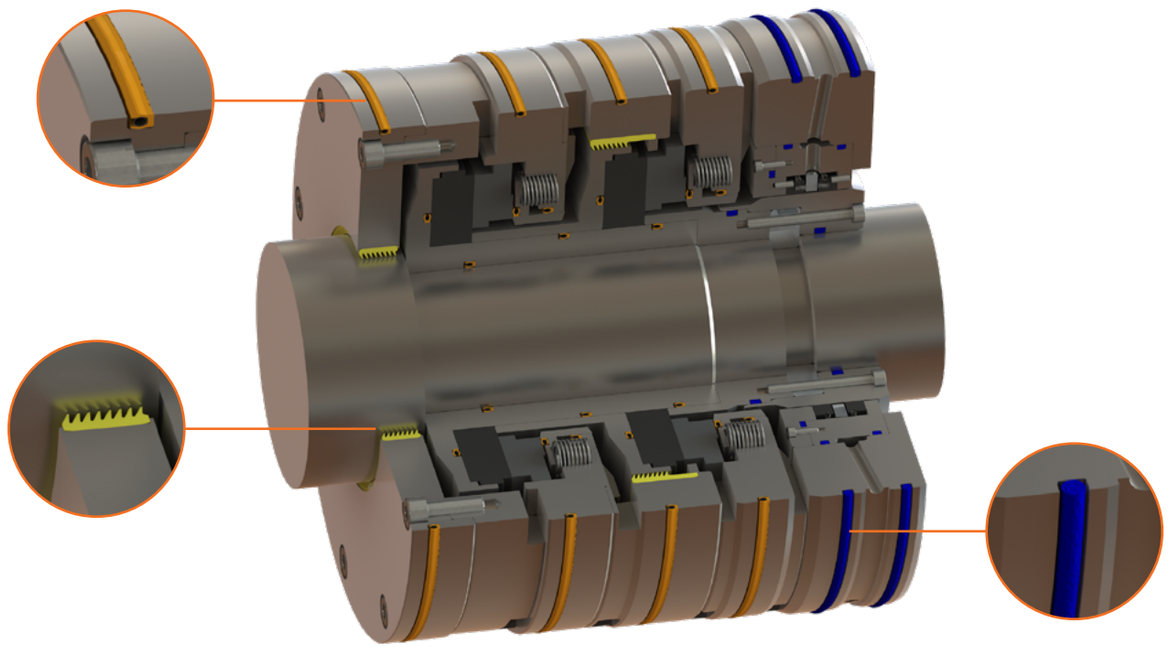
Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

EPDM
Outstanding resistance to hot water steam, polar solvents, and ozone

Solutions for Gas Seals



Labyrinth Seal:

WR®/AR® Composites

Spring Energized Seal (MSE®):

Avalon® PTFE-based seal materials and high strength metal alloy springs

Elastomeric Sealing Solutions:

Chemraz® (FFKM)
Highest chemical compatibility/highest temperature resistance of all elastomers

Fusion® (FKM)
Chemical compatibility and low- and high-temperature resistance

Xyfluor® (Highly Fluorinated Elastomer)
Excellent low-temperature capabilities and chemical compatibility

Fluoraz® (FEPM)
Chemical resistance against acids and bases

EPDM
Outstanding resistance to hot water steam, polar solvents, and ozone

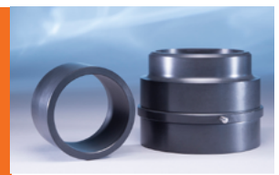
Coatings:

Enduro® LF10 Coating

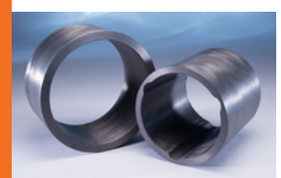
Thermoplastic Composite Materials Overview

Thermoplastic composites are produced using thermoplastic polymers as matrix materials, which soften upon heating to elevated temperatures for processing, and harden upon cooling. High-performance thermoplastic polymers used for thermoplastic composites provide a number of benefits compared to traditional thermoset resins, such as epoxies, including higher service temperature capability, lower moisture uptake, improved toughness, and increased chemical resistance.

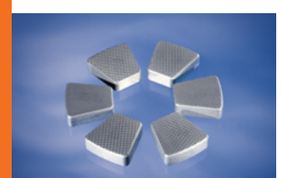
WEAR SOLUTIONS



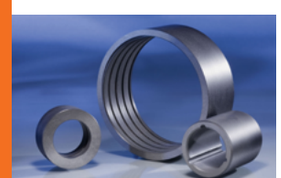
WR® 300
PEEK Reinforced with short, random carbon fiber
Wear resistant
Sub-zero up to 275°F (135°C)



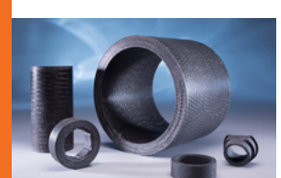
WR® 525
PEEK reinforced with continuous hoop-wound carbon fibers
Highest pressure applications
Best wear resistance
Sub-zero up to 525°F (274°C)



WR® 575
PEEK reinforced woven carbon fiber
Sub-zero up to 480°F (249°C)

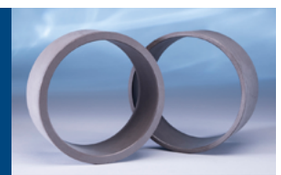


WR® 600
PFA reinforced with short, random carbon fiber
Chemical resistance & Dry run capability
Sub-zero up to 500°F (260°C)



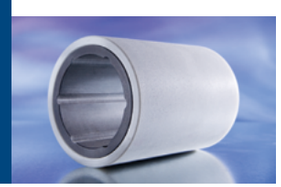
WR® 650
Braided carbon fiber filled with PFA
Best chemical resistance
Best dry run capability
Sub-zero up to 500°F (260°C)

ABRASION SOLUTIONS



AR® 1
Filled PTFE
Abrasion resistant
Sub-zero up to 120°F (50°C)

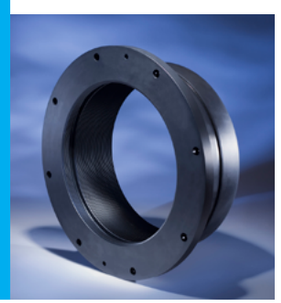
AR® HT
Proprietary blend of PTFE & PEEK
Best Abrasive resistance
Sub-zero up to 250°F (120°C)



Xycomp® Holder
Composite-made bearing holder to replace bronze, super duplex or S.S. in corrosive environment applications

EFFICIENCY SOLUTIONS

Xycomp® Shell
PEEK reinforced with continuous carbon fiber
Pressure up to 600 psi (40 bar)
Temperature up to 356°F (180°C)



WR® Laby Seal
Extensive chemical compatibility
Improved equipment efficiency
Sub-zero up to 525°F (274°C)

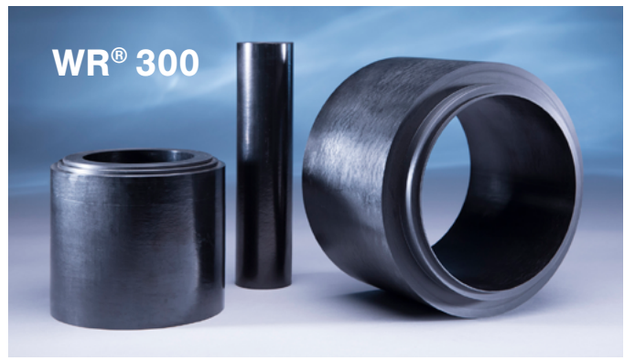
Wear-Resistant (WR®) Composites – PEEK

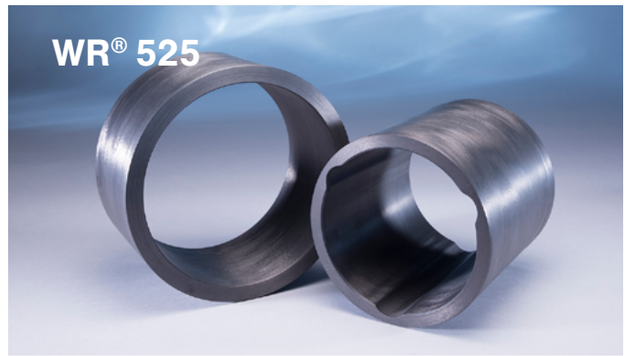
Carbon-fiber-filled PEEK Wear-Resistant (WR®) Composites

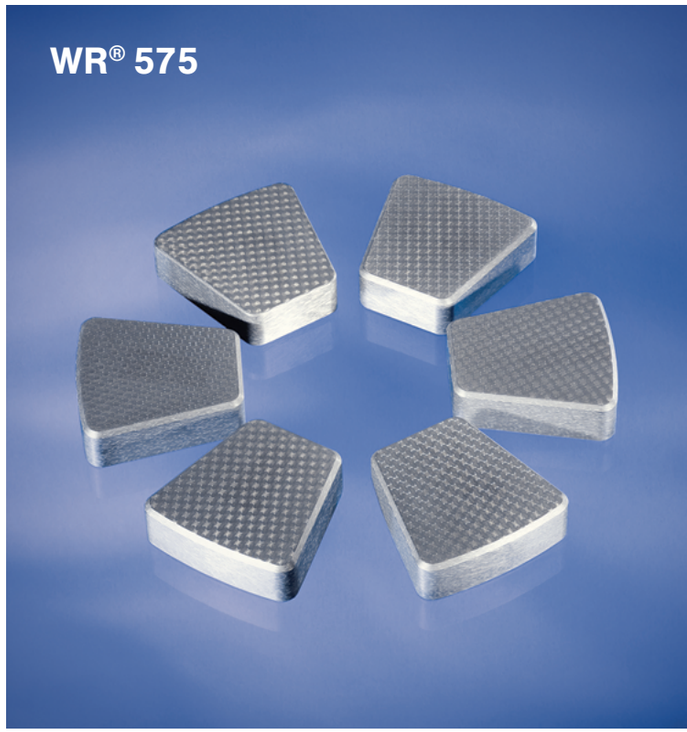
- Potential for up to 50% reduction in running clearances to maximize pump performance
- High corrosion resistance
- Broad temperature and chemical compatibility
- Non-seize/non-gall properties
- WR® components will preferentially wear if contact occurs with rotating metal parts
- Extended pump service life

GT PEEK Materials

- WR® 300
- WR® 525
- WR® 575







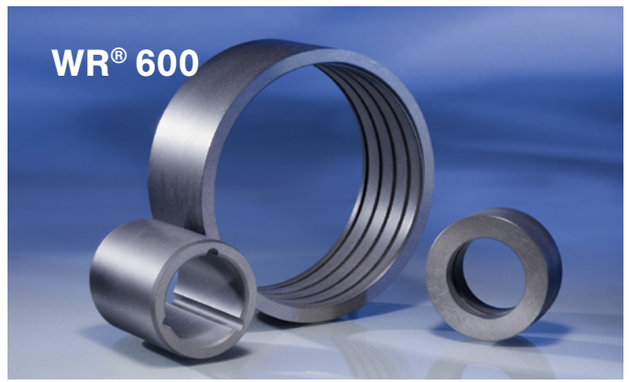
Wear-Resistant (WR®) Composites – PFA

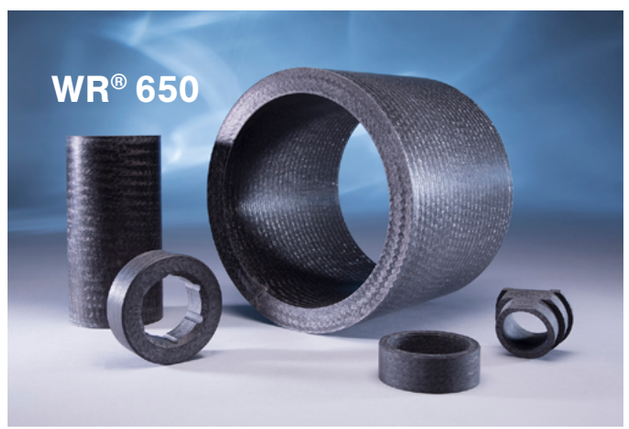
Carbon-fiber filled PFA composites

- PFA (Perfluoroalkoxy) – Semi-crystalline thermoplastic fluoropolymer
- Universal chemical resistance – Chemical Compatibility guide
- Best in class dry run capability
- WR® 650 radial thermal expansion similar to steel and axial lower than 2D material

GT PFA Materials

- WR® 600 – short, random carbon fiber (2D)
- WR® 650 – braided carbon fiber (3D)





	PEEK		PFA	
Chemical	**23°C**	**100°C**	**23°C**	**100°C**
Aqua Regia	C	C	A	A
Aniline	A	B	A	A
Benzene Sulphonic Acid	C	ND	A	A
Bromine (dry)	C	C	A	A
Bromine (wet)	C	C	A	A
Chlorine (dry)	C	C	A	A
Chlorine (wet)	C	C	A	A
Chlorosulfonic Acid	C	C	A	A
Chromic Acid, Conc.	C	C	A	A
Dimethylsulphoxide (DMSO)	B	B	A	ND
Diphenylsulphone (DPS)	B	C	A	A
Ferric Chloride	B	B	A	A
Fluorine (dry)	C	C	A	C
Formic Acid	B	B	A	A
Hydrobromic Acid (70%)	C	C	A	A
Hydrochloric Acid, Conc.	A	B	A	A
Hydroflouric Acid (40%)	C	C	A	A
Hydroflouric Acid (70%)	C	C	A	A
Iodine	B	ND	A	A
Methylethyl Ketone (MEK)	A	B	A	A
Nitric Acid, 30% Conc.	B	ND	A	A
Nitric Acid, 50% Conc.	C	C	A	A
Nitric Acid, Conc.	C	C	A	A
Oleum	C	C	A	A
Ozone	A	B	A	A
Phenol, Conc.	C	C	A	A
Sulphuric Acid, <40% Conc.	B	B	A	A
Sulphuric Acid, >40% Conc.	C	C	A	A

PEEK properties
http://www.zeusinc.com/materials/pfa/chemical-resistance-chart-pfa
http://www.zeusinc.com/materials/peek/chemical-resistance-chart-peek

PEEK has limited chemical resistance in 28 chemicals

PFA has only 1 limitation based on the same chemicals

Key
A - Good
B - Fair/Questionable
C - Unsatisfactory
ND - No Data

Abrasion-Resistant (AR®) Composites & Xycomp® Bearing Holder

Abrasion-Resistant (AR®) Composites

- Thermoplastic and carbon-filled PEEK & PTFE composites (AR®-1) & (AR®-HT)
- Exceptional abrasion resistance
- Broad chemical compatibility and corrosion resistance (AR®-HT)
- Excellent shock and impact resistance
- Non-seize/non-gall properties
- AR® components will preferentially wear if contact occurs with rotating metal parts
- Extended pump service life

Xycomp® Bearing Holder

- Benefits include weight saving, corrosion resistance, and cost over Duplex for seawater pumps.

Xycomp® Pump Shell

Xycomp® Pump Shell Delivers

- Zero loss
- High strength composite pump shells
- Low weight
- Corrosion resistance
- Dimensional stability
- Approved by leading magnetic drive pump OEM

Applications

- Methyl tert-butyl ether (MTBE) column reflux pumps
- Amine circulation pumps

Wear & Abrasion Solutions for HPI

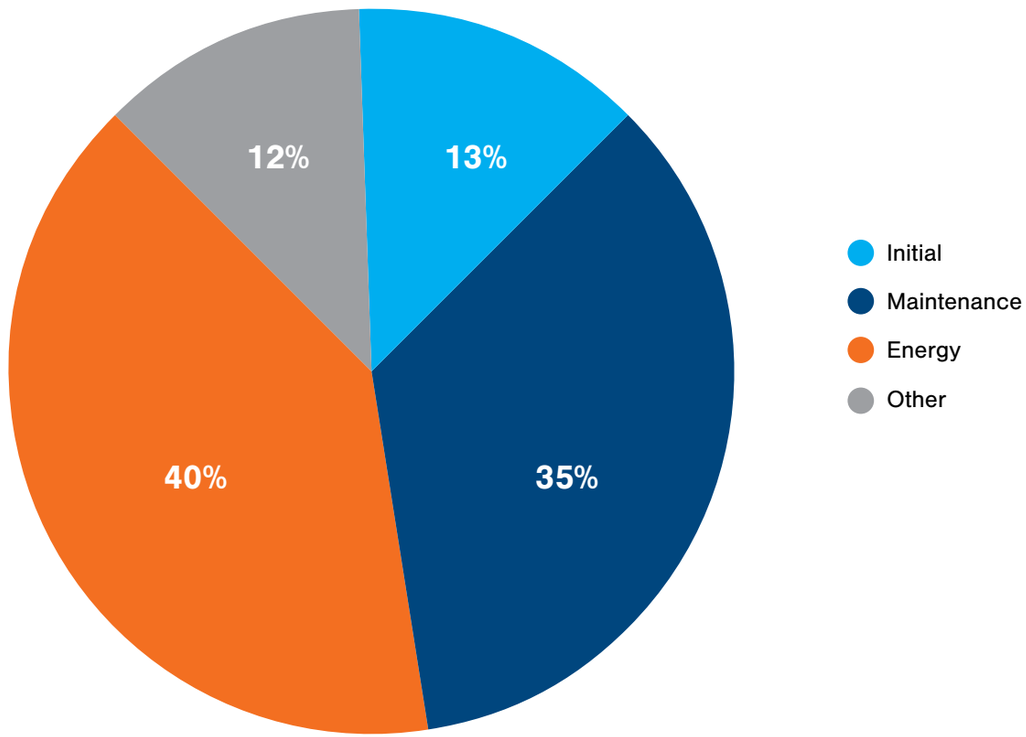
30+ years experience

- Extensive portfolio of solutions used throughout the refining processes
- Over the last 30 years, Greene Tweed has replaced metallic wear parts with AR®/WR® composites in more than 10,000 pumps within refineries

Reduce Total Cost of Ownership

- Increase equipment availability and efficiency
- Able to withstand upset conditions
- Eliminates secondary damage
- Enables standardization: material selection, inventory, speed to repair

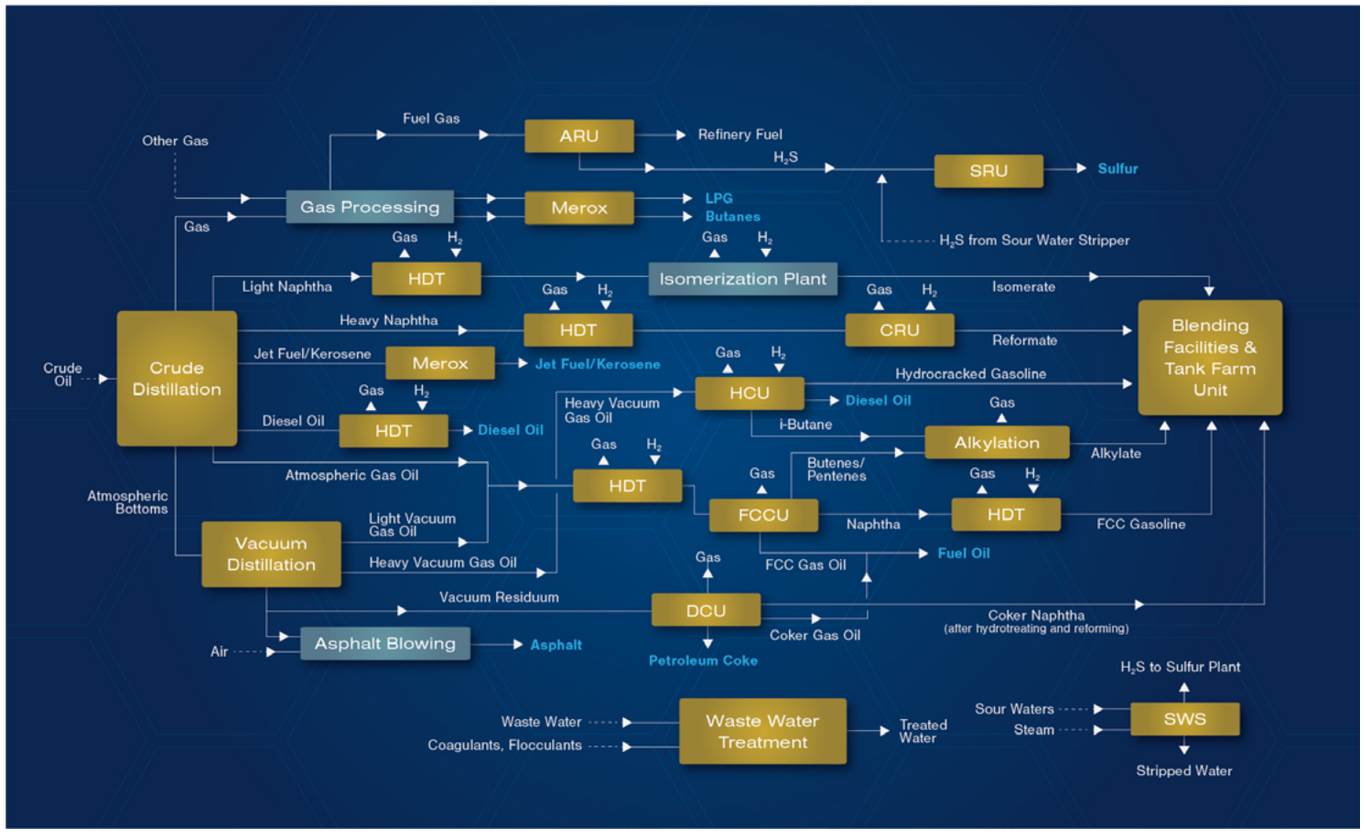
Pump Life Cycle Cost



Source: Information in above graph was cited in a 2003 executive summary published jointly by The Hydraulic Institute, Europump and the U.S. Department of Energy.

Virtual Refinery

Click the graphic to access the virtual refinery

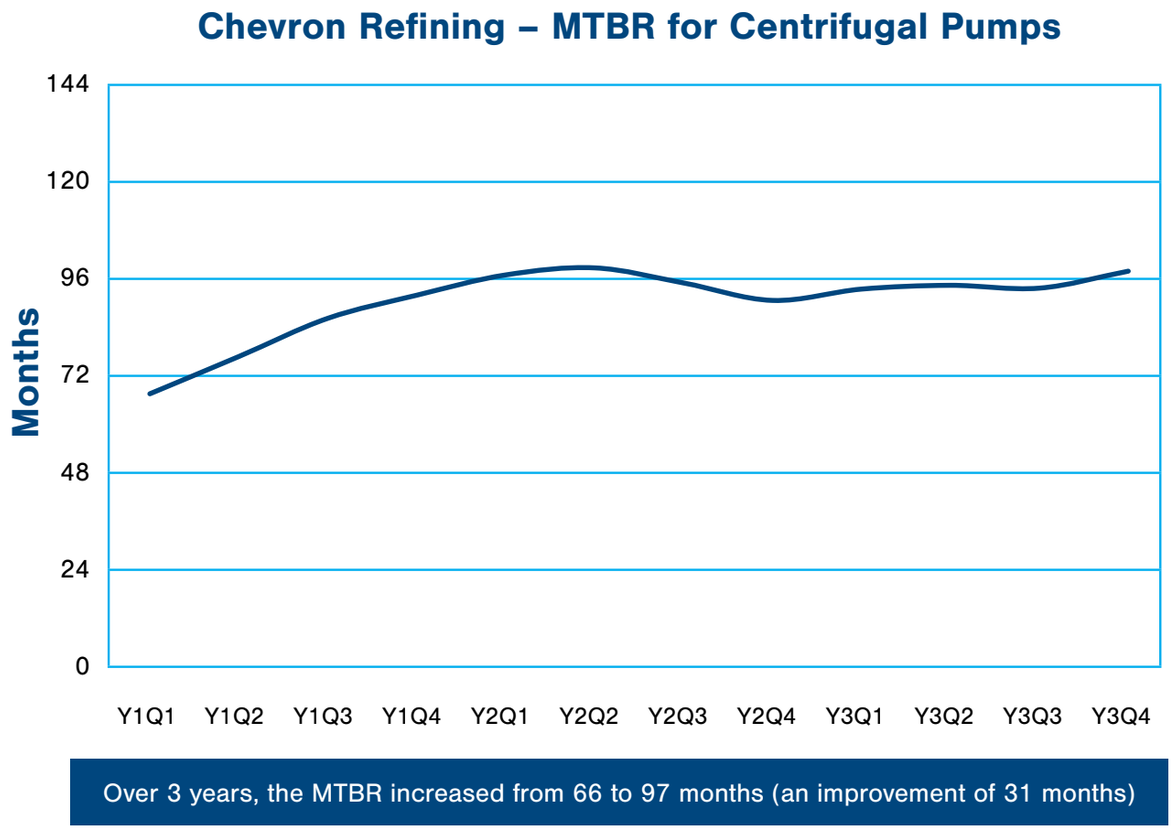


Case History: Chevron US Refining MTBR

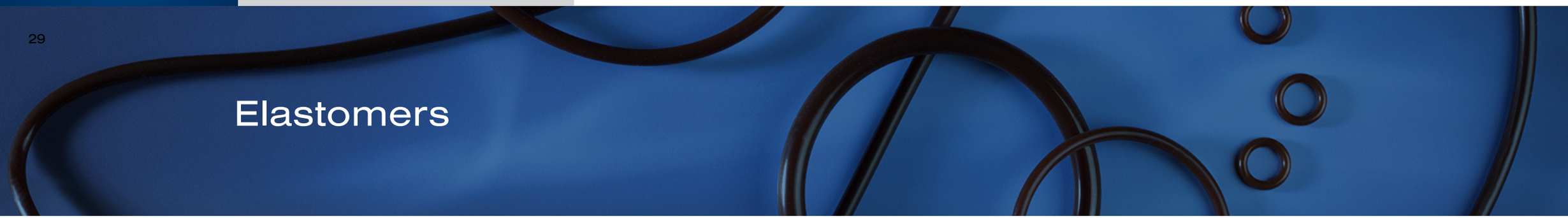
Chevron monitors rotating machinery reliability on a regular basis

The reliability impact of WR®/AR® composites in centrifugal pumps has been closely analyzed and is now clearly understood (MTBR)

As a result, **Chevron specifies WR®/AR® composite products in every pump candidate**



Our Materials



Elastomers

Chemraz® FFKM	Ethylene Propylene	Fluoraz® FEPM
Highest chemical compatibility/highest temperature resistance of all elastomers	Outstanding resistance to hot water/steam, polar solvents and ozone	Chemical resistance against acids and bases
Fusion® FKM	**Nitriles**	**Xyfluor®**
Offers chemical compatibility & low-/high-temperature resistance	Features good resistance to water and oil	Excellent low-temperature capabilities and sour gas resistance

Our Materials: Elastomers

Broadest Portfolio of High-Performance
Elastomeric Materials for Pumps and Mechanical Seals

Chemraz® FFKM – Perfluoroelastomers			
Chemraz® 505	-30°C to 232°C -22°F to 446°F	75A	Universal FFKM compound
Chemraz® 541	-16° C to 230° C 3°F to 446°F	76A	Universal FFKM compound
Chemraz® 526	-20°C to 250°C -4°F to 482°F	95A	RGD resistant FFKM, ISO23986/NORSOK M-710 certified
Chemraz® 555	-12°C to 316°C -10°F to 600°F	80A	Best-in-class combination of chemical resistance and broad temperature range
Chemraz® 605	-20°C to 260°C -4°F to 500°F	80A	Increased temperature limit and steam resistance over Chemraz 505
Chemraz® 615	-18°C to 324°C 0°F to 615°F	80A	High temperature FFKM
Chemraz® SD625	-20°C to 260°C -4°F to 500°F	80A	FDA and USP Class VI compliant FFKM
Chemraz® 678	-40°C to 230°C -40°F to 446°F	90A	Low temperature FFKM with RGD resistance

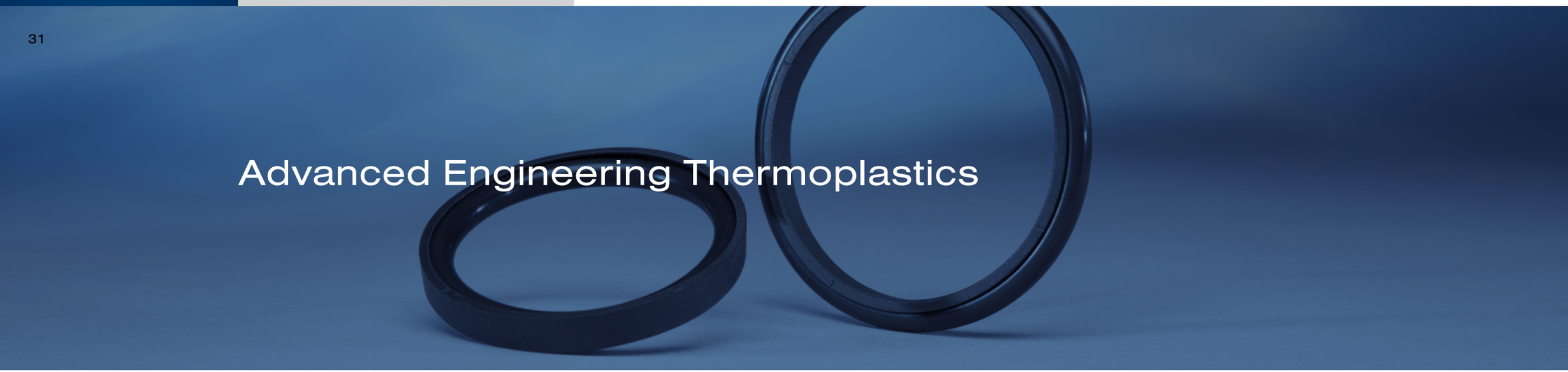
Fusion® FKM – Fluoroelastomers			
Fusion® 935	-37°C to 232°C -35°F to 450°F	90A	General purpose, moderately RGD resistant FKM
Fusion® 938	-37°C to 232°C -35°F to 450°F	90A	ISO23986 / NORSOK M-710 certified. Sour gas (>10%) and Methanol resistant
Fusion® 665	-57°C to 232°C -70°F to 450°F	75A	Ultra-low temperature FKM
Xyfluor® Highly Fluorinated Elastomer			
Xyfluor® 860	-60°C to 232°C -76°F to 450°F	70A	Ultra-low temperature capability with chemical resistance close to FFKM
Fluoraz® FEPM			
Fluoraz® 797	-5°C to 232°C 23°F to 450°F	80A	Recommended for steam and hot water applications
Fluoraz® 799	-7°C to 232°C 20°F to 450°F	90A	Recommended for steam and hot water applications

EP - Ethylene Propylene			
EPM 952	-54°C to 150°C -65°F to 302°F	80A	General purpose EP with outstanding resistance to hot water/ steam, polar solvents and ozone
EPM 953	-65°C to 150°C -85°F to 302°F	80M	Ultra-low temperature EP
NBR - Nitrile			
HNBR 207	-40°C to 177°C -40°F to 350°F	70A	A general purpose HNBR
NBR 964	-54°C to 135°C -65°F to 275°F	75A	General purpose NBR with good resistance to water and oil
NBR 987	-60°C to 100°C -76°F to 212°F	65A	Ultra-low temperature NBR
XNBR 984	-29°C to 107°C -20°F to 225°F	90A	High durometer carboxylated NBR material

Greene Tweed has many other compounds available – **contact us to learn more.**

Low Temperature | High Temperature | Steam and Hot Water | RGD (Rapid Gas Decompression) | Superior Chemical Compatibility

Our Materials



Advanced Engineering Thermoplastics

Arlon® PAEK (PEEK, PEK, PEKKEK)	Avalon® Fluoropolymers (PTFE)
Used for machined parts, including backup rings; for chemical compatibility, corrosion resistance, temperature requirements and high-pressure environments	Used for machined parts, including “jackets” for spring-energized seals requiring good chemical compatibility, a broad temperature range, low permeability and low friction

Our Materials: Thermoplastics

Avalon® – PTFE-Based

Avalon® 01	Virgin PTFE	Suitable for a variety of applications, including metal spring energized (MSE®) seals and bushings, and within seal assemblies	
Avalon® 09	Graphite Filled PTFE	Provides good wear and extrusion resistance and can be used in MSEs and v-rings, in a service temperature range of -436° to 500°F (-260° to 260°C)	
Avalon® 11	Carbon and Graphite Filled PTFE	Provides extrusion resistance and can be used as backup rings	
Avalon® 57	Polyimide Filled PTFE	Capable of excellent elevated temperature sealing and wear performance	
Avalon® 89	Thermoplastic and Carbon Filled Lubricated PTFE	Certified to ISO 23936-2 for fluid aging by an independent third-party laboratory; exhibits high creep and wear resistance	

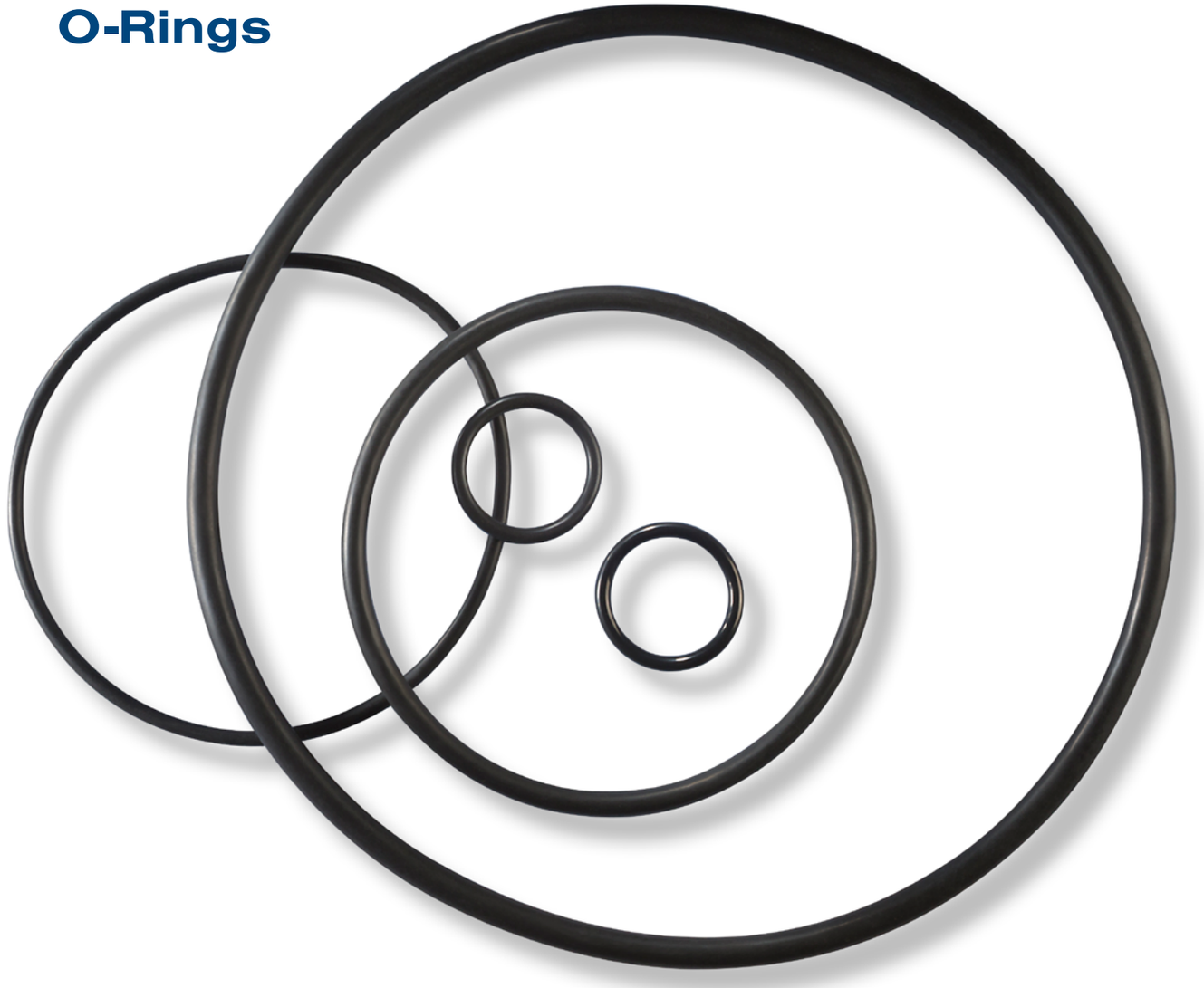
Arlon® – PEEK-Based

Arlon® 1000	Virgin PEEK	Offers a unique combination of mechanical, thermal, chemical, and electrical properties; ISO 23936-2 certified for fluid aging by an independent third-party laboratory	
Arlon® 1260	Carbon Filled PEEK	A high-performance, carbon-filled thermoplastic ideal for applications requiring corrosion resistance and dimensional stability (highest strength and modulus of all Arlon® grades)	
Arlon® 1330	Lubricated PEEK	Ideal for applications requiring exceptional wear resistance and chemical compatibility; provides good dimensional stability without the addition of carbon fibers	
Arlon® 1555	Carbon, Graphite and PTFE Filled PEEK	Excellent high-load-bearing material	
Arlon® 3000XT	Cross-Linked PEEK	Patented and ISO-23936-2-certified cross-linked PEEK that provides highly improved mechanical properties in high-pressure, high-temperature applications and enhanced performance in electrical applications	

Low Temperature High Temperature High Sealability* High Strength/Load Bearing

*Note: Sealability is relative to other materials within the same class (i.e. PTFE vs. PEEK); PTFE based materials tend to seal better than PEEK materials

O-Rings



The o-ring is a simple yet effective seal design

- Economical and easy to install
- Seals effectively up to 1500 psi
  - Thermoplastic backup rings added for pressures >1500 psi
- Handles a wide range of media and temperature
- Offered in AS568 or ISO 3601-1 standard sizes
  - Non-standard sizes available upon request

O-rings are used in many seal locations within pumps and mechanical seals

- In pumps, most static seals are o-rings
- In mechanical seals, many static seals are o-rings, and some limited dynamic seals are o-rings as well (such as the sliding o-ring on the stationary face seal)

G-T® Rings

G-T® Rings provide a more robust, stable seal design when compared to o-rings

- Bi-directional, elastomeric contact sealing
- Integrated thermoplastic backup rings provide extrusion resistance and stability
- Large, flat static seal surface eliminates seal rolling or spiraling failure (especially in dynamic applications or during installation)
- G-T® Ring design can be retrofitted into any radial o-ring seal location
  - Unidirectional version (GTL™ Ring) also available
  - For flat interface seal locations, Greene Tweed offers a similar product line called the Static Face Seal

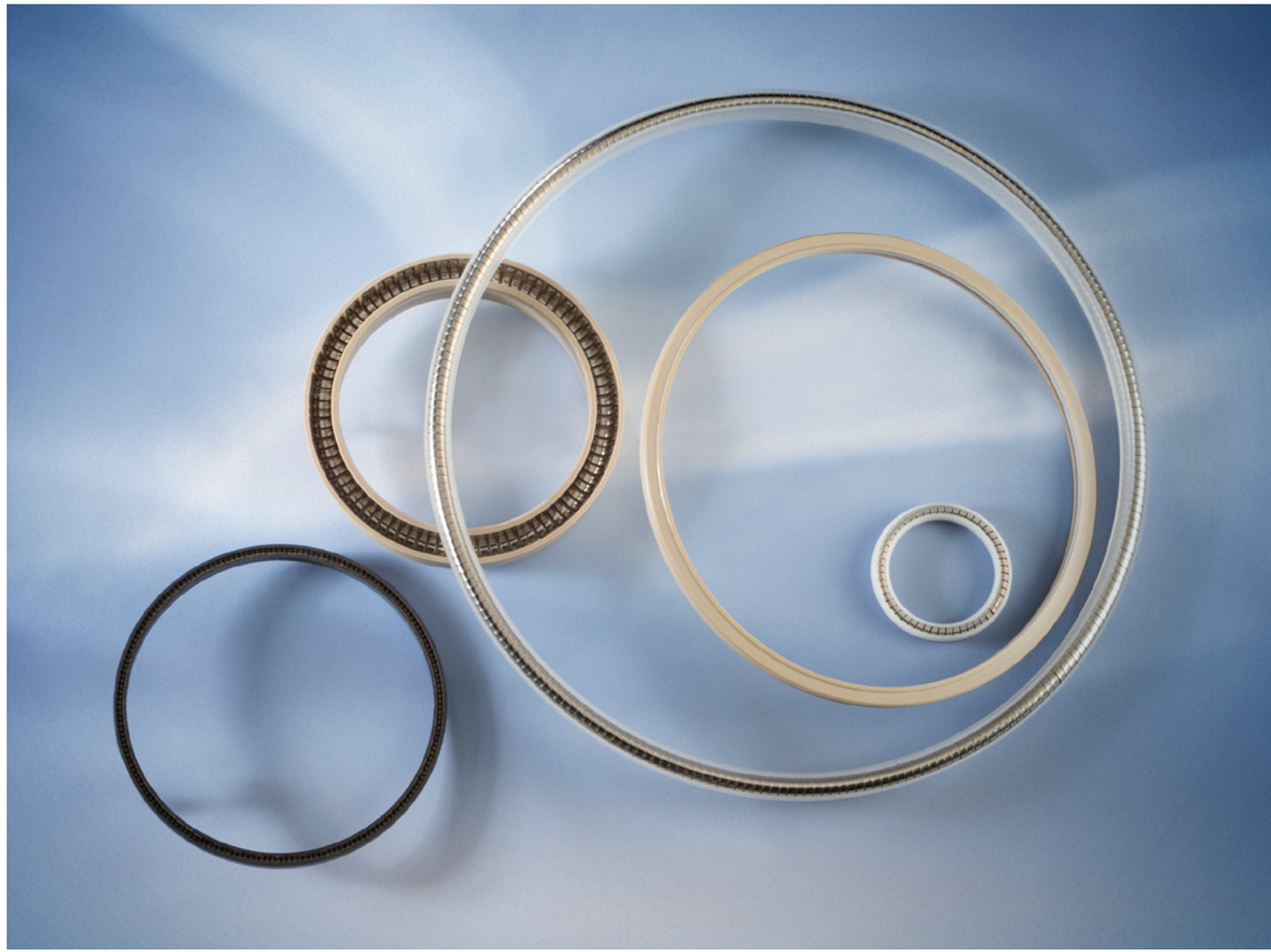
G-T® Ring

Static Face Seal

MSE® Seals

MSE® seals are unidirectional metallic spring energized PTFE contact seals

- PTFE jacket and corrosion-resistant metal spring are virtually chemically inert, allowing for use in a variety of media types
- Material make-up enables a wide range of operating pressures and temperatures, including cryogenic conditions
- For use in both static and dynamic applications, the MSE® seal thrives in dynamic conditions through low breakout and running friction as well as wear resistance



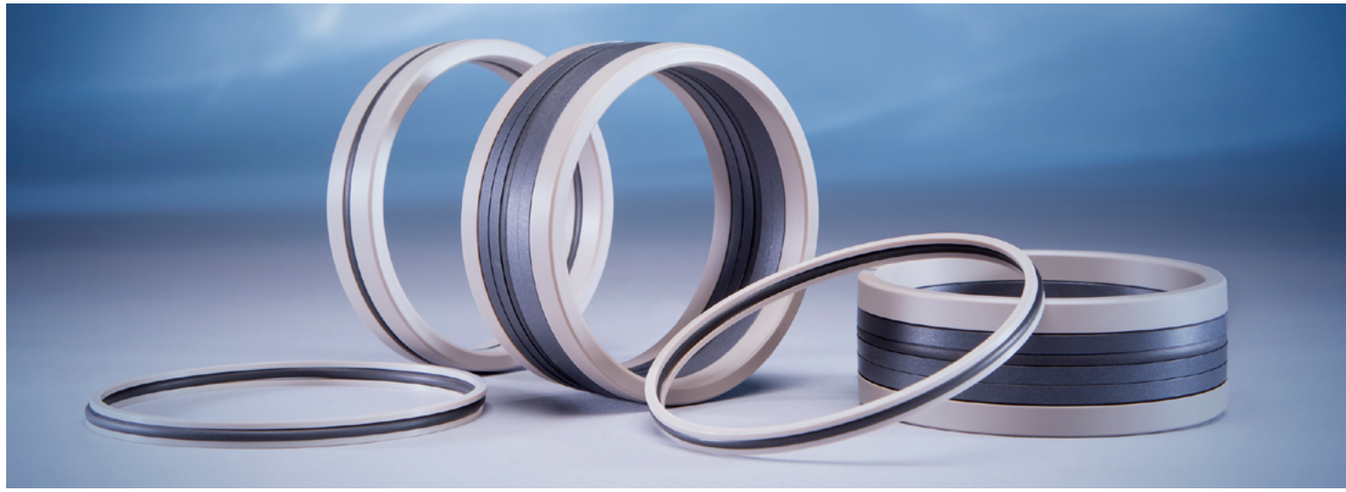
Seal Stacks and Packings

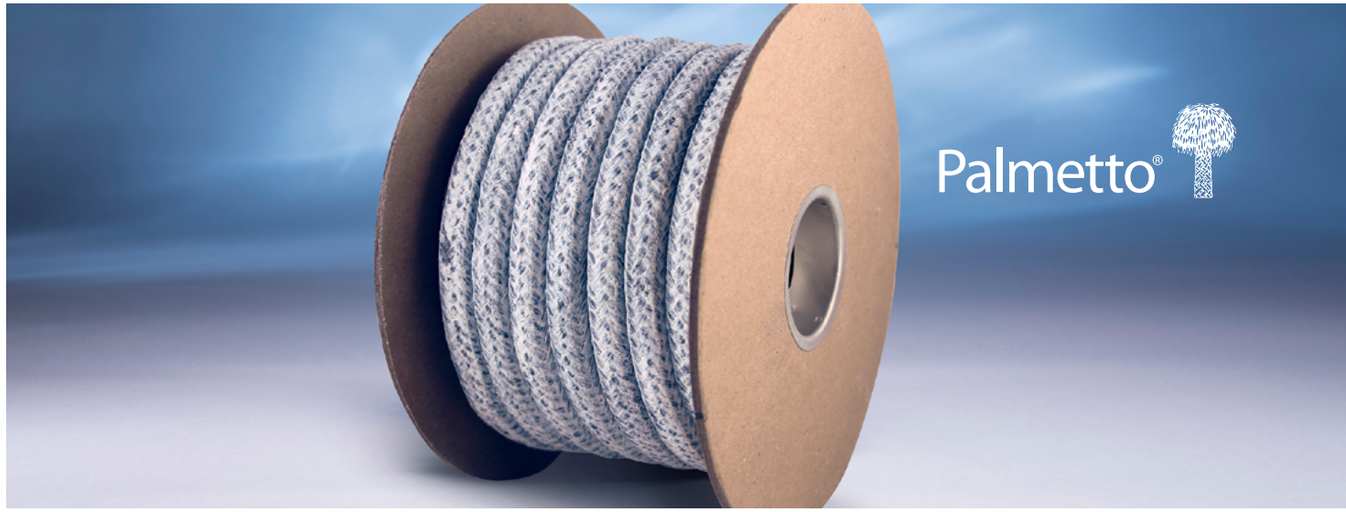
Seal Stacks

- Self-energized, redundant sealing
- Lip/spring-energized
  - Same pressure, temperature, friction/wear and compatibility advantages as MSE® Seal
- Vee-stacks
  - Incorporation of elastomer/PTFE rings result in low leakage

Packings

- Palmetto, Inc., is a subsidiary of Greene, Tweed & Co
  - Manufacturer of braided mechanical packing
  - More than 130 years of experience
  - Sold and distributed worldwide





Enduro® LF10 Coating

LF10

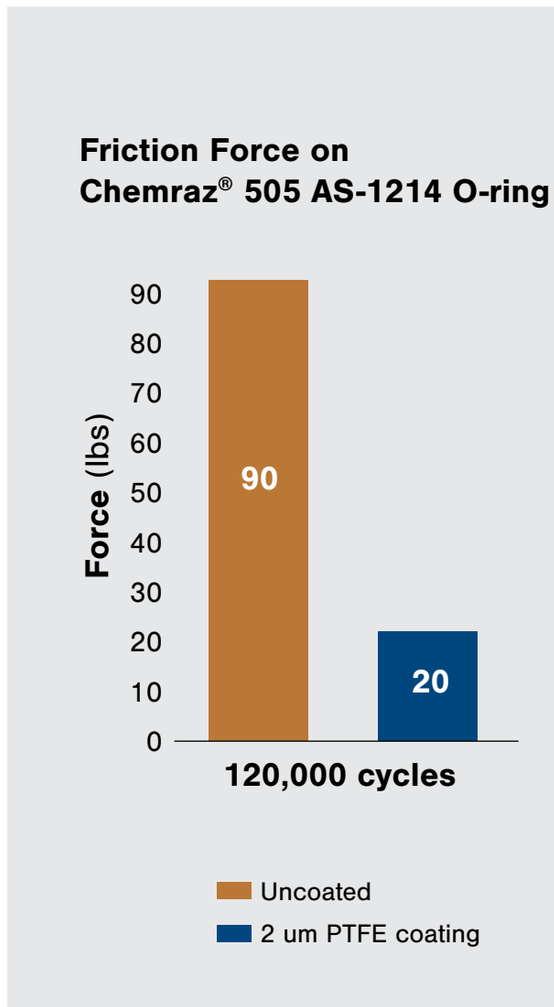
- Conformal, thin PTFE coating that can be applied to polymeric, ceramic, elastomeric & metal substrates

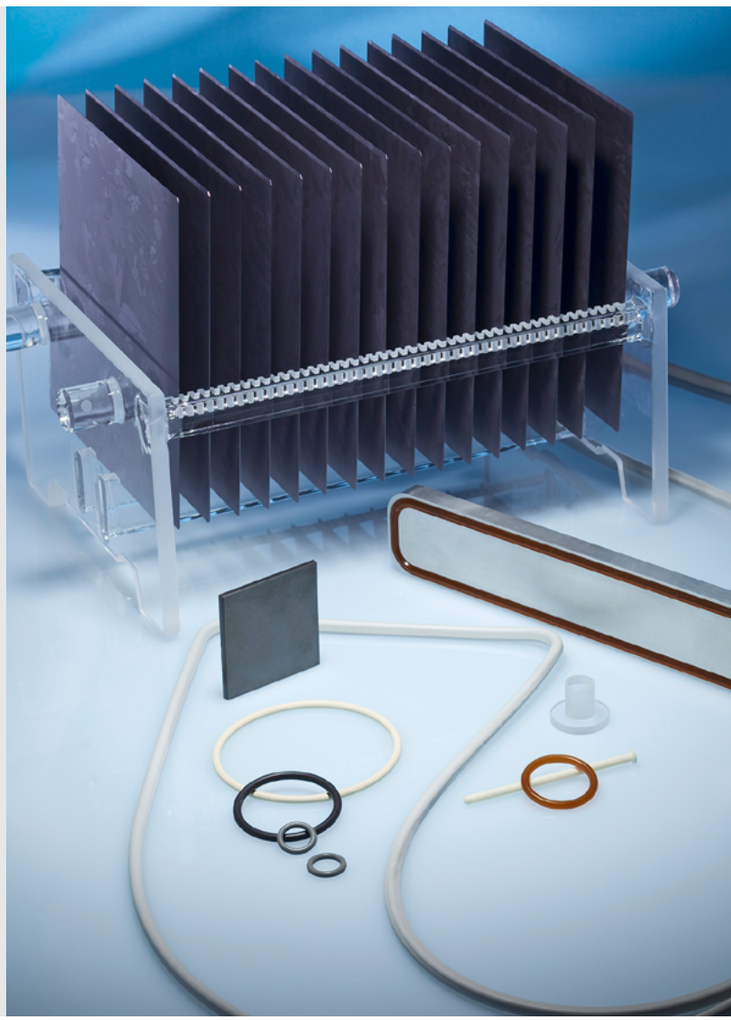
Benefits:

- Low sticking force, reduced friction & wear
  - Up to 95% sticking force reduction and 77% friction reduction
- Hydrophobic
- Flexible and conformal

Value Proposition

- Friction/sticking reduction, improving ease of installation, grease substitute





Involvement with API Committees

Voting member of API;
Task force member of 610 (New build pumps);
617 (New build compressors);
682 (New build mechanical seals);
697 (Pump repair)

Implementation of non-metallic wear parts
since 9th edition of API-610

Nonmetallic Wear Part Materials

Material	Temperature Limits °F (°C)		Application
	min.	max.	
Polyether ether ketone (PEEK) Chopped-carbon-fiber filled	-20 (-30)	275 (135)	Stationary parts
PEEK Continuous-carbon-fiber wound	-20 (-30)	450 (230)	Stationary or rotating
Perfluoroalkoxy/Carbon-fiber (PFA/CF)	-50 (-46)	450 (230)	Stationary parts
Carbon graphite			
Resin-impregnated	-55 (-50)	550 (285)	Stationary parts
Babbitt-impregnated	-400 (-240)	300 (150)	
Nickel-impregnated	-400 (-240)	750 (400)	
Copper-impregnated	-400 (-240)	750 (400)	

Nonmetallic wear part materials that are proven compatible with the specified process liquid may be proposed within the above limits. See 6.7.5 c).
Such materials may be selected as wear components for mating against a suitably selected metallic component such as hardened 12% Cr steel or hard-faced austenitic stainless steel. Materials may be used beyond these limits if proven application experience can be provided and if approved by the purchaser.

AR® HT/WR® 300

WR® 525

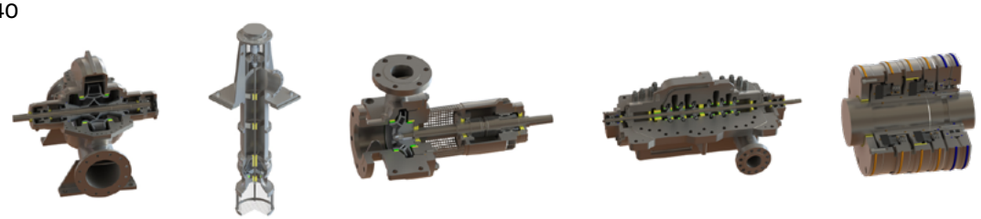
WR® 600/WR® 650

Additional Case Studies, White Papers, and Guides

Service for Pumps and Mechanical Seals

Total Engineering Support

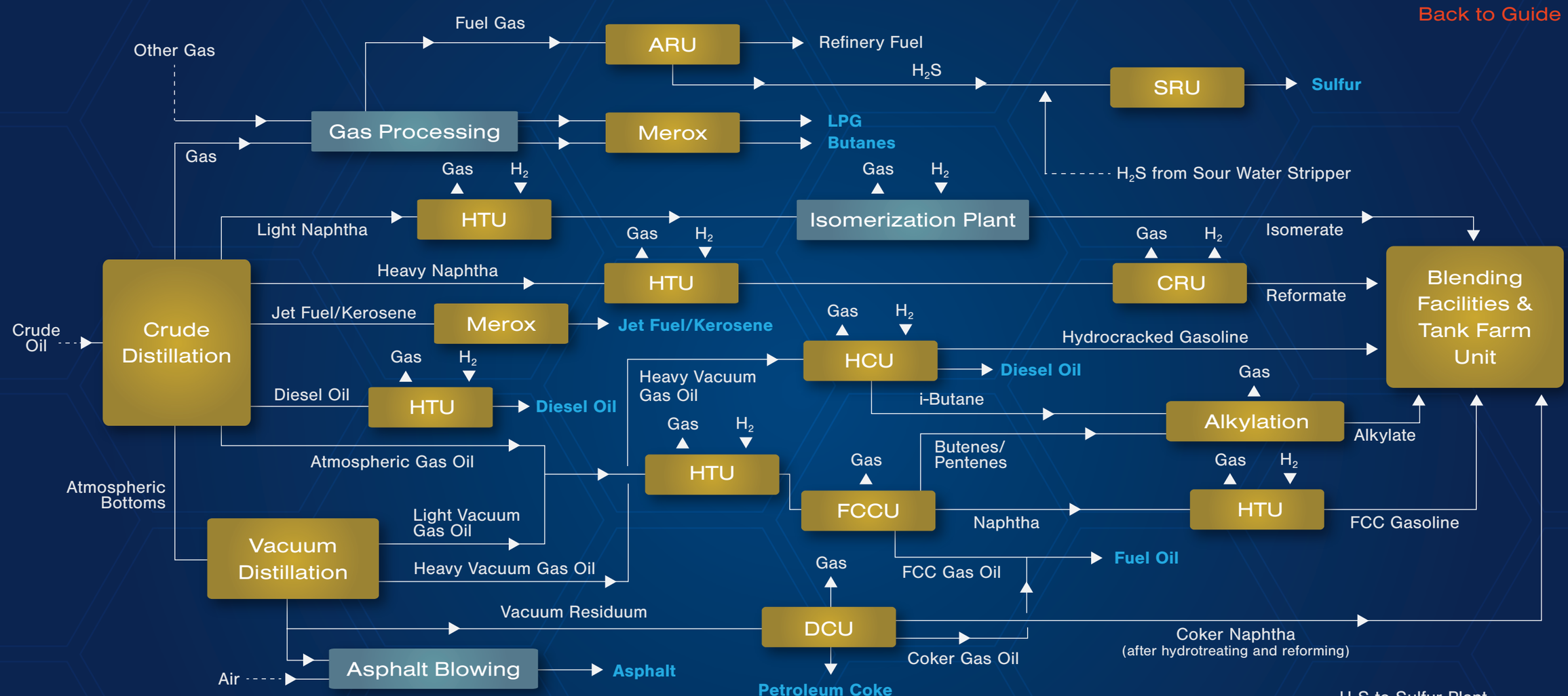
40



VIRTUAL REFINERY

A unique experience in non metallic pump wear parts for refineries. READ MORE >

Back to Guide



Select a block to learn about the solutions Greene Tweed offers refineries

- Finished products are shown in blue.
- Sour waters are derived from various distillation tower reflux drums in the refinery.
- The "other gases" entering the gas processing unit includes all the gas steams from the various process units.

The list below does not represent the total pump population that could be converted with our products. These are just some examples of pump applications related to the refinery unit where WR®/AR® products have already successfully been applied.

RETURN TO VIRTUAL REFINERY

APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Flashed Crude Pump	BB2	Desalted Crude	300	78.0	150.0
Kerosene Pumparound Pump	OH2	Kerosene	446	71.0	100.0
Crude Overhead Water Pump	OH2	Sour Water	120	15.0	65.0
Light Vacuum Gas Oil (LVGO) Pump	OH2	Light Vacuum Gas Oil	250	42.0	107.0
Ejector Condensate Pump	OH2	Sour Water	125	2.3	75.0
Ejector Slop Oil Pump	OH3	Ejector Slop Oil	120	4.5	53.0
Stabilizer Overhead Pump	OH2	LPG	100	154.0	200.0
Splitter Bottoms Pump	BB2	Heavy Naphtha	355	47.0	82.0
Crude Bottom Reflux Pump	OH2	Naphtha	325	25.0	63.0
Crude Overhead Product Pump	OH2	Naphtha	120	12.5	63.0
2nd Stage sour water Pump	OH2	Sour Water	300	145.0	300.0
First Stage sour Pump	OH2	Sour Water	300	165.0	300.0
Splitter Overhead Pump	OH2	Naphtha and LPG	105	42.0	85.0
Tempered Water Pump	–	Condensate	175	26.0	26.0
Offgas Compressor Drum Pump	OH2	Naphtha and LPG	120	3.6	55.0
Interstage Liquid Pump	OH2	LPG/Naphtha	105	27.7	-
Kerosene Product Pump	OH2	Kerosene	410	48.0	75.0
Desalter Flash Colun Bottoms Pump	OH2	Sour Water	225	8.0	75.0
Benzene Stripper Reflux Pump	OH2	Water	100	4.0	4.0
Crude Preheater Condensate Pump	OH2	Condensate	262	4.7	20.0
Raw Crude Charge Pump	OH2	Heavy Canadian Crude Blend	90	36.5	193.0

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Fractionator Top Pumparound Pump	-	Hydrocarbon	360	71.6	71.6
Fractionator Distillate Pump	-	Distillate	113	28.7	28.7
Stripper Feed Pump	OH2	Hydrocarbon	165	208.0	208.0
Debutanizer Reflux Pump	VS6	Hydrocarbon	182	180.0	180.0
Absorber Bottoms Pump	-	Naphtha	141	207.8	207.8
Stripper Bottoms Pump	BB2	Hydrocarbon	283	238.1	238.1

RETURN TO VIRTUAL REFINERY

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Depropanizer Feed Circulating Caustic Pump	OH2	Caustic (3 to 10 wt% NaOH)	172	264.7	395.0
Depropanizer Charge Pump	BB5	Hydrocarbon	169	97.9	115.0
Depropanizer Reflux Pump	OH2	Hydrocarbon	165	214.8	290.0
Depropanizer Feed Wash Water Pump	OH2	Water	250	3.5	26.0
Deisobutanizer Charge Pump	VS6	Hydrocarbon	94	10.9	105.0
Effluent Recycle Pump	OH2	Hydrocarbon	78	8.8	105.0
DIB Reflux Pump	OH2	Hydrocarbon	171	89.7	135.0
DIB Reflux Pump	OH2	Hydrocarbon	398	110.4	145.0
Caustic Booster Pump	OH2	Caustic (10 wt% NAOH)	110	143.2	200

RETURN TO VIRTUAL REFINERY

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Separator Pump	BB3	Aromatic Hydrocarbon	115	78.0	112.2
Debutanizer Reflux Pump	OH2	Hydrocarbon	100	148.0	185.3
Caustic Circulation Pump	OH2	1 wt% Caustic	106	9.1	9.1

RETURN TO VIRTUAL REFINERY

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RETURN TO VIRTUAL REFINERY

APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Distillate Pumparound Pump	OH2	Distillate	376	51.8	97.9
Distillate Product Pump	OH2	Distillate Product	365	38.0	86.0
Fractionator Reflux Pump	OH2	Hydrocarbon	100	16.0	62.5
Fractionator Overhead Water Pump	OH2	Sour Water	100	16.3	61.2
First Stage Suction Drum Pump	OH2	Hydrocarbon or Water	100	12.1	58.9
Interstage Drum Naphtha Pump	OH2	Hydrocarbon	100	55.2	117.4
Compressor Interstage Drum Water Pump	OH2	Water	100	56.8	116.3
Stripper Feed Pump	OH2	Hydrocarbon	100	194.0	283.0
Stripper Bottoms Pump	OH2	Hydrocarbon	298	194.9	285.8
Presaturator Liquid Pump	OH2	Hydrocarbon	100	184.7	264.4
Debutanizer Bottoms Pump	OH2	Debutanizer Bottoms	400	187.2	258.5
Debutanizer Reflux Pump	BB2	Hydrocarbon	100	177.4	280.0
Distillate Flush Oil Pump	OH2	Distillate Flush Oil	100	15.0	63.0
Condensed Blowdown Water Pump	OH2	Water	140	17.3	61.0
Light Slop Oil Pump	OH2	Light Slop Oil	140	18.0	62.0
Quench Spray Water Pump	OH2	Quench Spray Water	140	17.0	61.0
Quench Water Pump	OH2	Quench Water	140	2.4	26.0
Storm Water Pump	VTP	Storm Water	100	0.0	-
Oily Water Pump	OH-ANSI	Water + Hydrocarbon	100	0.0	-
Caustic Circulation Pump	OH2	20 deg Be' Caustic	100	54.8	110.0
Amine Water Wash Circulation Pump	OH2	Water	100	182.0	410.0
CNS Overhead Pump	OH2	Light Coker Naphtha	100	20.0	61.0
CNS Bottoms Pump	OH2	Heavy Coker Naphtha	286	28.0	64.0
Water Wash Recirculation Pump	OH2	Water	111	187.0	293.0
Product Booster Pump	OH2	LPG	100	175.0	400.0
C3/C4 Splitter Overhead Pump	OH2	Propane/Propylene	105	254.8	337.0
Caustic Prewash Circulation Pump	OH2	10 deg Be' Caustic	100	181.0	410.0
Caustic Water Addition Pump	OH2	Water	100	0.0	4.0
Distillate PA Pump	OH2	Distillate	419	45.7	113.5
Distillate Product Pump	OH2	Distillate	401	29.8	99.4
Heavy Distillate Recycle Pump	OH2	naphtha	150	8.2	83.1
Fractionator Overhead Pump	OH2	Sour Water	150	8.4	83.6
First Stage Suction Drum Pump	OH2	Hydrocarbon	150	4.9	79.7
Interstage Drum naphtha Pump	OH2	Unstabilized Naptha	150	49.6	106.2
Interstage Drum Water Pump	OH2	Sour Water	150	49.7	106.9
Stripper Feed Pump	OH2	Unstabilized naphtha	150	192.3	276.1
Stripper Bottoms Pump	OH2	Stripper Bottoms	325	194.1	276.6
Presaturator Pump	OH2	Prersaturator Liquid	150	185.9	278.1
Debutanizer Reflux Pump	OH2	Sour C3/C4	150	185.6	285.0
Lean Oil Booster Pump	OH2	Debutanizer Bottoms	150	150.8	261.4
Water Wash Recirculation Pump	OH2	Sour Water	165	187.2	285.8
Heavy Slop Oil Recycle Pump	BB2	Heavy Slop Oil	419	5.6	88.5
Light Slop Oil Pump	OH2	Light Slop Oil	190	12.9	81.6
Distillate Flush Oil Pump	OH2	Distillate Flush Oil	300	14.0	59.0
Recovered Amine Pump	OH2	Recovered Amine	150	237.1	278.8
Condensed Blowdown Pump	OH2	Condensed Blowdown Water	190	11.8	82.6
Quench Water Pump	OH2	Quench Water	190	-0.8	24.1

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Lean Amine Pump	BB3	Lean Amine	140	237.0	290.0
Stripper Overhead Reflux Pump	OH2	Wild Naphtha	170	126.0	184.0
Fractionator Top Pumparound Pump	OH2	Naphtha	450	86.0	135.0
Fractionator Overhead Liquid Pump	OH2	Wild Naphtha	175	38.0	87.0
Fractionator Overhead Sour Water Pump	OH2	Sour Water	175	41.0	91.0
Debutanizer Reflux Pump	OH2	Liquid Petroleum Gas	150	135.0	182.0
Naphtha Splitter Reflux Pump	OH2	Naphtha	150	30.0	87.0
Heavy Naphtha Product Pump	BB2	Heavy Naphtha	405	48.0	87.2
Foul Water Pump	OH2	Foul Water	330	43.9	90.4
Coker Gas Oil Feed Pump	OH2	Coker Gas Oil	230	60.0	109.0

RETURN TO VIRTUAL REFINERY

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Feed Charge Pump	BB3	Naphtha	100	6.7	80.0
Stripper Reflux Pump	OH2	Wild Naphtha	115	138.0	180.0
Reactor Charge Pump	OH2	Kerosene	100	10.0	125.0
Lean Amine Pump	BB2	40% MDEA	130	298.0	-
HP Stripper Reflux Pump	OH2	Hydrocarbon	120	127.4	200.0
LP Stripper Reflux Pump	OH2	Wild Naphtha	100	26.8	85.0
LP Stripper Overhead Sour Water Pump	OH2	Sour Water	100	27.7	100.0
Foul Water Pump	OH2	Sour water	100	19.9	120.0

RETURN TO VIRTUAL REFINERY

Merox Unit | Pump Application Examples

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RETURN TO VIRTUAL REFINERY

APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Feed Pump	OH2	Hydrocarbon/Hydrogen/H2S	100	144.4	276.3
Suction Drum Pump	OH2	Hydrocarbon/Hydrogen/H2S	100	89.4	265.8
Absorber Upper Intercooler Pump	OH2	Absorber Upper PA Return	132	309.5	391.2
Absorber Lower Intercooler Pump	OH2	Absorber Lower PA Return	145	300.0	384.0
Sponge Oil Pump	OH2	Lean Sponge Oil	110	102.2	130.0
Depropanizer Overhead Pump	BB2	Depropanizer Reflux	100	227.0	263.0
Debutanizer Overhead Pump	BB2	Debutanizer Reflux	100	68.0	110.0
Debutanizer Bottoms Pump	BB2	Debutanizer Bottoms	300	77.1	364.0
Lean Amine Pump	OH2	Lean Amine	130	297.0	425.0
Amine Water Wash Circulation Pump	OH2	Water	100	328.4	421.0
Propane Caustic Prewash Circulation Pump	OH2	10 deg Be' Caustic	100	318.8	427.0
Water-Caustic Addition Pump	OH3	Water-Caustic Addition	120	0.0	150.0
Butane Caustic Prewash Circulation Pump	OH2	10 deg Be' Caustic	100	135.9	245.0
Caustic Circulation Pump	OH3	Caustic	100	52.8	111.7
Caustic Charge Pump	OH2	Caustic 18.7% by Weight	140	-0.1	(0.1)
Spent Caustic Pump	OH2	Spent Caustic	100	0.0	-
Spent Caustic Charge Pump	OH2	Spent Caustic	100	3.0	56.0

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RETURN TO VIRTUAL REFINERY

APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Sour Water Pump	OH2	Sour Water	120	14.4	14.4
NH3 Sour Water Pump	OH2	Sour Water	195	11.9	11.9
Quench Water Pump	OH2	Sour Water	210	6.8	50.0
Rich Amine Pump	OH2	Amine	109	33.1	33.1
Flashed Condensate Pump	OH2	Flashed Condensate	212	-	2.1
Oily Water Sump Pump	OH-ANSI	Oily Water	95	2.1	2.1
Oily Water Sump Pump	VTP	Storm Water	95	0.5	0.5
Steam Condensate Pump	OH-ANSI	Condensate	296	51.4	51.4
Stripper Reflux Pump	OH2	Sour Water	120	19.0	75.0
Lean Amine Pump	OH2	Lean Amine	166	18.0	75.0
Sour Water Pump	OH2	Sour Water	120	14.4	14.4
NH3 Sour Water Pump	OH2	Sour Water	195	11.9	11.9
Quench Water Pump	OH2	Sour Water	210	7.7	50.0
Rich Amine Pump	OH2	Amine	109	33.1	33.1
Amine Acid Gas Condensate Pump	OH2	Sour Water	230	12.2	102.9
Sour Water Acid Gas Condensate Pump	OH2	Sour Water	230	12.2	102.9
Sulfur Loading Pump	OH2	Molten Sulfur	300	285.0	285.0
TGTU-1/2 Quench Water Pump	OH2	Sour Water	215	7.5	60.5
TGTU-1/2 Quench Water Pump	OH2	Sour Water	215	7.5	60.5
TGTU-1/2 Rich Amine Pump	OH2	Rich Amine	157	29.9	60.5
TGTU-1/2 Rich Amine Pump	OH2	Rich Amine	157	29.9	60.5
Lean Amine Pump	OH2	Lean Amine	270	25.0	102.9
Amine Stripper Reflux Pump	OH2	Sour Water	170	18.1	102.9
Flash Drum Hydrocarbon Pump	OH2	Flash Drum Hydrocarbon	140	12.6	12.6
Rich Amine Pump	OH2	Flash Drum Hydrocarbon	140	12.6	75.0
Regenerator Reflux Pump	OH2	H2S and CO2 Saturated Rich MDEA	120	17.2	17.2
Lean Amine Pump	OH2	Lean MDEA	199	12.7	12.7
Fresh Amine Pump	OH2	Lean MDEA	80	-	0.3
Flash Drum Hydrocarbon Pump	OH2	Flash Drum Hydrocarbon	140	12.6	12.6
Rich Amine Pump	OH2	Flash Drum Hydrocarbon	140	12.6	12.6
Regenerator Reflux Pump	OH2	H2S and CO2 Saturated Rich MDEA	120	17.2	17.2
Lean Amine Pump	OH2	Lean MDEA	199	12.7	12.7
Condensate Pump	OH-ANSI	Saturated Reboiler Condensate	296	53.1	75.0
Amine Sump Pump	OH-ANSI	Water - MDEA	139	0.7	0.7
Rich Amine Flash Drum Hydrocarbon Pump	OH2	Hydrocarbon	160	7.5	60.5
Rich Amine Pump	OH2	Rich Amine	195	10.7	60.5
Lean Amine Pump	BB2	Amine	312	27.3	102.9
Amine Regenerator Reflux Pump	OH2	Sour Water	170	17.9	102.9
Amine Charge Pump	OH2	Amine	130	-2.3	8.2
Amine Sump Pump	-	Amine	100	0.0	-

Sour Water Stripper - SWS | Pump Application Examples

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APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Sour Water Transfer Pump	OH2	Sour Water	110	9.9	58.0
Stripper Charge Pump	OH2	Sour Water	110	0.0	-
Slop Oil Recovery Pump	OH2	Slop Oil	110	-0.4	9.3
Oil Level Drum Slop Oil Recovery Pump	OH2	Slop Oil	110	-	-
Condensate Pump	OH-ANSI	Water (Steam Condensate)	296	51.7	75.0
SWS Pump-Around Pump	OH2	Sour Water	201	19.0	19.0
Stripped Water Pump	OH2	Stripped Water	176	22.0	75.0
Flashed Condensate Pump	OH2	Flashed Condensate	212	3.4	3.4
HP Wash Water Pump	OH2	Wash Water	110	98.1	98.1
Sour Water Flash Drum Hydrocarbon Pump	OH2	Slop Oil	140	6.9	60.5
Sour Water Transfer Pump	OH2	Sour Water	140	9.0	60.5
Sour Water Stripper Charge Pump	OH2	Sour Water	150	-2.3	20.6
Stripped Sour Water Pump	OH2	Sour Water	310	27.7	90.8
SWS Pumparound Pump	OH2	Sour Water	256	65.4	90.8

RETURN TO VIRTUAL REFINERY

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RETURN TO VIRTUAL REFINERY

APPLICATIONS	PUMP MODEL OR TYPE	ENVIRONMENT PARAMETERS			
		MEDIA	TEMP. (°F)	SUCTION P (PSI)	
				RATED	MAX.
Soft Water (motor driven) Pump	OH2	Soft Water	95	-3.5	15.5
Soft Water (steam driven) Pump	OH-ANSI	Soft Water	95	-3.5	15.5
Zeolite Softener Brine Pump	OH-ANSI	Brine Solution	95	-2.8	(2.8)
HP BFW Pumps (steam driven) Pump	BB3	High Pressure Boiler Feed Water	300	24.5	65.7
HP BFW Pumps (motor driven) Pump	BB3	High Pressure Boiler Feed Water	300	24.5	65.7
Hot Condensate Pump	OH2	Steam Condensate	267	30.1	64.1
LP BFW Pump	OH2	Boiler Feed Water	300	24.5	65.7
Cold Condensate to GME Users Pump	BB3	Steam Condensate	267	30.1	65.6
Filtered Water Pump	-	Filtered Water	95	-0.1	17.3
Cooling Water Pump	VTP	Water	115	2.6	5.5
Potable Water Pump	OH-ANSI	Potable Water	95	-0.2	(0.2)
Clearwell Pump	-	Clarified Water	95	-0.2	6.1
Filter Backwash/Sludge Sump Pump	VTP	Water	115	0.0	5.2
Sour Naphtha Pump	OH2	Sour Naphtha	100	-0.5	8.8
Sweet Naphtha to NHT Pump	OH2	Sweet Naptha	100	-1.5	10.9
Rich Amine Pump	OH2	Rich Amine	140	77.0	114.7
Butane to Gasoline Blending Pump	VS6	n-Butane	100	3.0	3.0
PGLN Supply to Blend Headers Pump	VS6	PGLN	110	8.5	8.5
Gasoline Group 4 Shipping Pump	VS6	Gasoline	80	-2.4	15.0
Kerosene to Diesel Blend Header Pump	OH2	Kerosene	100	-8.3	2.9
Platformate Pad Sump Pump	-	Water	80	0.4	0.4
High Octane Platformate Blend Pump	BB2	Platformate	110	-0.4	16.6
High/Low Octane Platformate Swing Blend Pump	BB2	Platformate	110	-0.6	16.6
Gasoline Pump Pad Sump Pump	-	Water	-	0.4	0.4
GME Crude Charge Pad Sump Pump	-	Water	-	0.4	0.4
GME Sump Pump	-	Water	-	0.4	0.4
GME Crude Charge Pump	-	Crude Oil	80	-7.7	20.0
GME East Crude Blend Pump	VS6	Crude Oil	80	-7.4	20.0
GME West Crude Blend Pump	VS6	Crude Oil	80	-7.4	20.0
Propane Transfer Pump	VS6	Propane	110	201.0	250.0
Storm Water Pump	-	Storm Water	115	0.0	5.2
Oily Water Pump	OH-ANSI	Oily Water	115	0.0	5.2
Raffinate to Gasoline Blending Pump	BB2	Raffinate	100	-0.1	(0.1)
Toluene to Gasoline Blending Pump	OH2	Toluene	100	-0.5	(0.5)
Alkylate to Gasoline Blending Pump	BB2	Alkylate	100	-0.3	(0.3)
PGHN to Gasoline Blending Pump	BB2	PGHN	100	-1.2	(1.2)
Mixed Naphtha/PGHN Swing Blend Pump	VS6	Mixed Naphtha/PGHN	110	-1.9	(1.9)
Mixed Naphtha Blend Pump	VS6	Mixed Naphtha	110	-1.9	(1.9)
Natural Gasoline Blend Pump	OH2	Natural Gasoline	110	-1.0	12.0
Alkylate/Natural Gasoline to Blending Pump	OH2	Natural Gasoline	110	-1.0	12.0
Gasoline Blend Stock Sump Pump	-	Water	80	0.4	0.4
Skimmed Oil Pump	OH2	Oil with water	100	0.0	-
API Effluent Pump	VTP	Waste Water w/ oil & silt	140	1.7	5.0
Storm Water Pump	OH-ANSI	Storm Water	80	0.2	0.2
Digester Sludge Pump	OH-ANSI	Activated Sludge	100	0.0	-
Equipment Drain Sump Pump	-	API Effluent	100	0.4	0.4
IGF Skim Pump	OH-ANSI	-	140	5.0	5.0
AIS Effluent Pump	-	AIS Effluent Water	150	0.6	0.6
Closed Circuit Cooling Water Recirculation Pump	-	Closed Circuit Cooling Water Recirculation Pumps	95	0.0	-
AIS Feed Pump	OH-ANSI	Waste Water	120	7.5	7.5
AIS Waste Sludge Pump	OH-ANSI	Waste Sludge	95	1.1	1.1
Effluent to River Pump	BB1	Treated Waste Water Effluent	145	0.0	-
Equalization Tank Pump	-	Waste Water	140	-3.7	(3.7)
Raw Water Supply Pump	-	River Water	87	4.3	15.6
Asphalt Transfer Pump	BB2	Asphalt	350	-2.7	14.3