

Solutions for the mining, mineral processing and cement industries

Machined seals



Sealing solutions customized



for your system performance

SKF is a supplier of top quality, highly reliable products to the mining, mineral processing and cement industries. Customers benefit from SKF's comprehensive field experience and extensive knowledge in sealing technology.

Optimized sealing solutions

SKF helps customers to achieve their strategic goals:

- Improved safety at work
- Increased productivity
- Reduced effects of contamination
- Increased service life
- Reduced Total Cost of Operation (TCO)
- Reduced consumption of operating media and energy consumption
- Increased Mean Time Between Failures (MTBF)

SKF provides the most flexible options for the entire mining, mineral processing and cement industries: sealing solutions and Advanced Engineered Plastic Parts (AEPP) for wet, abrasive and contaminating environments.

Competences

SKF is a leading supplier for standard and custom engineered sealing solutions. Based on many years of experience, especially in the area of mining machinery, SKF is able to support the industries with

- on-site solution analysis,
- application engineering,
- material development for high speed solutions, increased wear resistance, reduced friction etc.
- integrated solutions consisting of seals and advanced engineered plastic parts,



- just-in-time availability of standard seals and customized sealing solutions,
- moulded seals for higher volume orders.
- Gaskets for flange connections
- Static seals and O-rings
- Advanced engineered plastic parts

Customers benefit from flexibility and short delivery times for customized seals. SKF machined seals are always made from high-performance materials and cover the following product groups:

- Hydraulic and pneumatic sealing systems
- Sealing solutions for rotary distributors and joints
- Radial shaft seals
- V-rings

Finding the most suitable sealing solution is a complex and rewarding task. SKF's experience shows that a sealing system can always be optimized.

The right sealing solution for extreme conditions

Whenever reduced maintenance costs, increased productivity or process reliability are important – SKF is there with improved machined sealing solutions for the mining, mineral processing and cement industries.

The following points are essential when selecting the right seal for the harsh operating conditions of the mining, mineral processing and cement industries.

Operating environment

The purpose of sealing is to keep operating fluids or lubricants in the system and/or contaminants out.

Aggressive contamination can be a concern. Abrasive particles, cooling fluids and emulsions may affect the sealed machine part.

Fluids

Fluids affect the sealing system in many ways. The sealing material has to be compatible with internal or external fluids. These could be lubricants, coolants, operating media in a hydraulic system, but also auxiliary cleaning or assembly media.

Operating parameters

The impact of type, speed and duration of the motion on the sealing lip is critical. Motion can be linear, rotating or pivoting, continuous or discontinuous. Operating pressures as well as possible system and application related pressure peaks are also to be considered.

Elevated temperatures may also affect the seal and its performance. In most cases, media temperature and motion speed determine the actual temperature at the sealing lip, but an elevated ambient temperature can also affect the performance of the seal.

Machine design

The operating fluid determines the seal selection in rotating as well as in reciprocating equipment.

In rotating equipment, the machine can be lubricated with grease, oil-, or oil-air. In a reciprocating application, the operating fluid can be hydraulic oil, water-based fluid or compressed air.

Shaft misalignment must be considered when choosing the sealing lip design for rotating applications. Shaft-To-Bore Misalignment (STBM) and Dynamic Run-Out (DRO) are also relevant. For large sized reciprocating machines, the rod misalignment may also be of concern. The structural condition of the seal's counterface strongly affects the sealing performance.

Housing design and its structural condition determine the seal design. Open housings require a self-retaining sealing solution. Closed housings provide a perfect fit for elastomeric seals. SKF supplies customized seals for standard and non-standard housing dimensions.

Improvement potentials

Finally, the most important indicators for possible improvements are existing seal performance and reasons for seal failure and /or necessary seal replacement.

The seal's performance can affect productivity, process reliability, MTBF and maintenance schedules. Optimizing a sealing solution can be a complex task. SKF applies its experience to customers' specific operating environment to jointly identify system optimization and cost saving potentials (in terms of TCO) generated by an optimized sealing solution.





Machined seals concept

SKF is a leading player in the global custom-made machined seals market, specializing in complete sealing services for the mining, mineral processing and cement industries. SKF serves many countries worldwide with its global sales network.



Standard seals

- Seals in standard dimensions
- Extensive range of materials
- On-time availability



Customized seals

- Standard seal profiles modified to specific requirements
- Virtually unlimited dimensions
- Extensive range of materials
- On-time availability (approx. 24 hours)



Custom engineered seals

- Application engineering service
- Customer related designed sealing solutions
- Virtually unlimited dimensions and profiles
- Extensive range of materials
- Short delivery time

Due to the flexible production process, SKF can supply standard and special seals in customized dimensions and high performance sealing materials up to 4 000 mm in diameter as one piece. Large seals with diameters up to 10 000 mm and above are assembled using a special welding technique. SKF's machined seals centres provide global availability with truly local service, being very close to the end customer. In some selected locations you can also find:

Advanced engineered plastic parts

Turned, milled and moulded parts made of high performance plastic materials.

Other business and services

Maintenance and repair of hydraulic and pneumatic cylinders; gaskets and products manufactured using water-jet cutting technology.





Great variety of sealing applications

SKF provides a large variety of customized seals for machines in the mining, mineral processing and cement industries, covering hydraulic seal kits with piston, rod and wiper seals, rotary seals, multi-lip seals and custom engineered solutions for a great variety of applications.

Underground mining

- Continuous miners and longwall shearers
- Roof support systems
- Shuttle cars
- Specialised personnel and service vehicles
- Roof bolting systems
- Drilling units
- Conveyor systems

Opencast mining

- Dragline hydraulic and mechanical systems
- Power shovel hydraulic and mechanical systems
- Loader hydraulic systems
- Haul vehicles
- Haul vehicles hydraulic systems
- Haul and mine roads maintenance units
- Bulldozers
- Bulldozers hydraulic systems and track pin sealing
- Conveyor systems
- Conveyor system drive and tail units
- Belt scraper systems
- Crushers
- Breaker and crushing units
- Workshop and maintenance equipment
- Drills

Processing

- Wash plant, pumps, gearboxes
- Ball and SAG mill trunnion and gearbox drive systems
- Bulk handling loading and unloading systems
- Bucket wheel hydraulic and drive systems

SKF offers time-saving retrofit split element sealing solutions for:

- Gearboxes and drive units
- Pumps
- Difficult access sealing
- Worn shaft/rod sealing
- Ball and SAG mill trunnion and gearbox drive systems (where lengthy strip down is a costly problem)



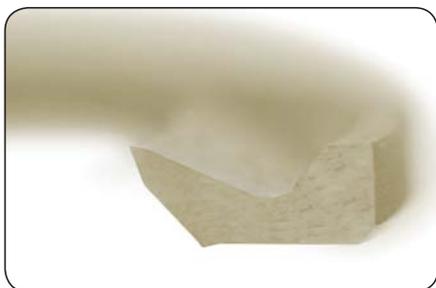


① Solutions for hauler strut cylinders

When transporting molten slag, temperatures outside the slag pot can be in excess of 120 °C.

The strut cylinders are located very close to the slag pot and therefore the wiper is exposed to these high temperatures.

The replacement of the split brass wiper, retained with a wave spring, with a one piece PEEK wiper greatly decreased the incidence of ingress as well as simplifies the installation. By introducing the appropriate sealing profile in combination with high performing materials (SKF Ecopaek), SKF achieved a much simpler installation process as well as improved wiping resulting in a significantly extended service life.



② Seals for large diameter applications

In mining and mineral processing, dismantling large scale machinery for the replacement of seals is time consuming and related downtime costs are considerable.

Welding large diameter polyurethane seals

SKF has developed a procedure that allows welding of large diameter polyurethane seals on site maintaining the full sealing capacity. For SKF, installing replacement seals is a common process that allows customers to keep production downtime to a minimum.

Split seal assemblies

Access to seals is often limited, especially in gearboxes, as the drive unit and coupling must be removed to facilitate a seal replacement.

By retrofitting with a customized seal made of SKF Ecorubber-2 (FKM), replacements can be completed approximately in an hour. Furthermore, the unique seal design features have extended seal life compared to standard rotary seals.



③ Seals for ball and SAG mills

The harsh working environment of ball and SAG mills and their size provide a challenging dilemma. The seal must provide superior oil inclusion functions as well as being able to exclude foreign materials from the bearing chamber, even during wash-down.

Trunnion seal upgrade

A special engineered double lip seal, also available in triple lip configuration for oil inclusion, is a split seal designed to minimize downtime. G-ECOPUR provides long sealing life as well as reduced wear on the trunnion surface. The purging facility incorporated into the seal allows the removal of contaminants and therefore further increases the seal life.

This seal design has a proven track record in remote mine sites in some of the harshest conditions in the world.

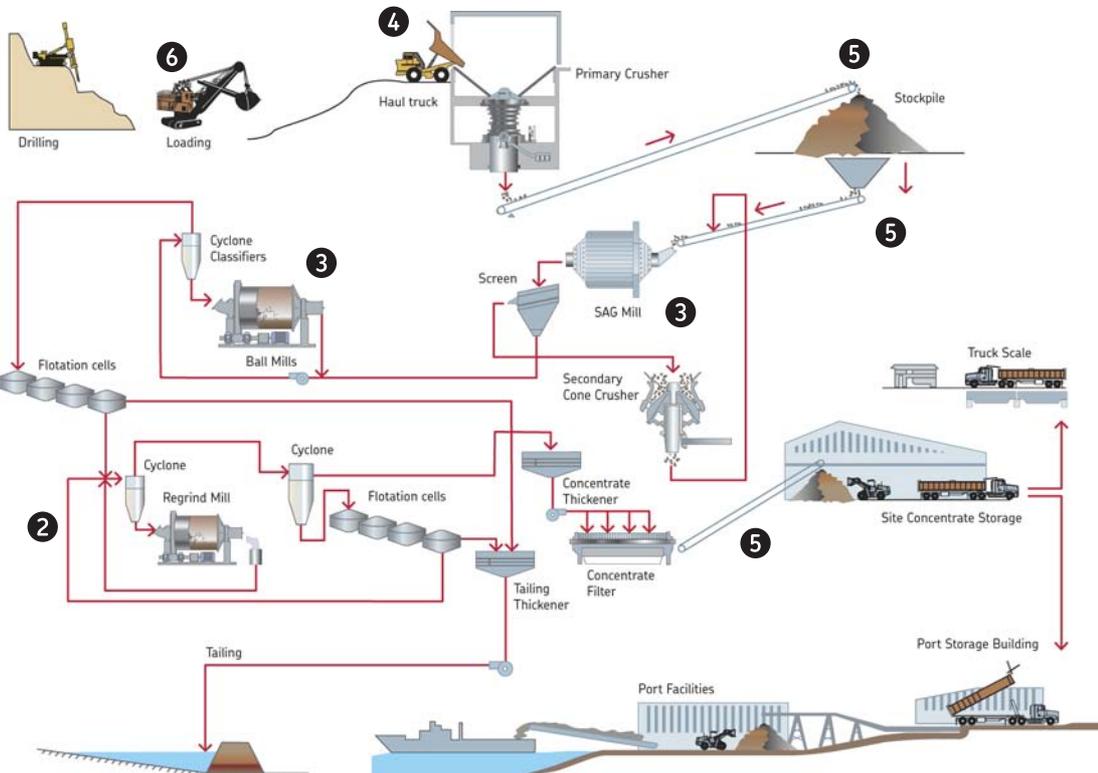
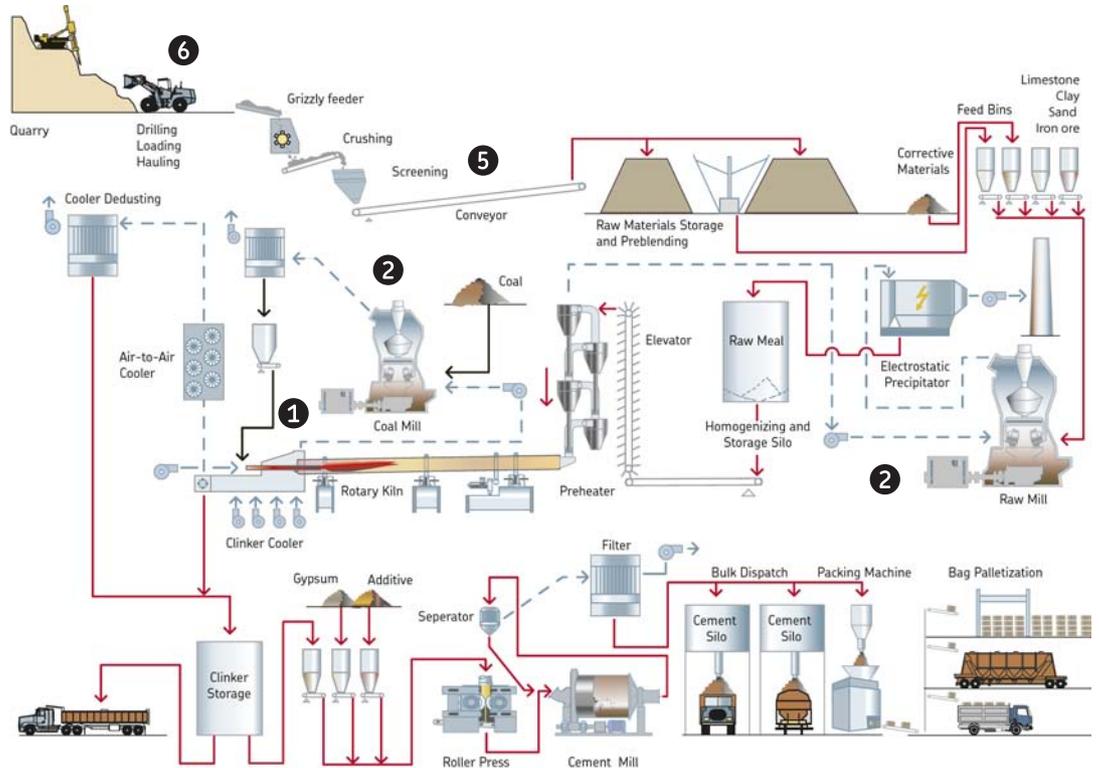




Cement and mining process

Cement

- 1 High temperature
- 2 Large diameter seals
- 3 Wear and reliability



Mining

- 4 Sliding speed
- 5 Functionality
- 6 Pressure



4 Seals for rear suspension cylinders

The mining industry can provide a wide range of adverse and varied conditions, sometimes unexpected and unforeseen.

Haul truck suspension cylinders are designed to operate at relatively slow speeds and full strokes when carrying a full payload. But when the trucks are empty, the length of the stroke is greatly reduced and the speed greatly increased depending on road surface conditions.

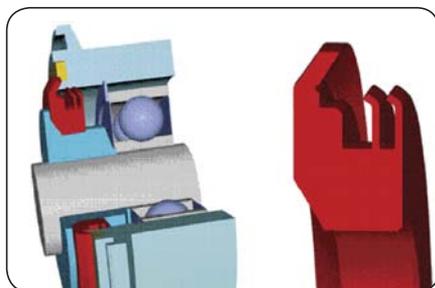
The shorter stroke, combined with faster speed, results in less lubrication, higher friction and, ultimately, failure. By modifying the standard S03-P profile and introducing the S-ECOPUR friction modified polyurethane, SKF was able to significantly extend the service life of the seal.



5 Bearing seal for coal mining conveyor guide wheels

Stock piling and retrieving coal is a necessary function carried out using a stacker/reclaimer. Loading coal onto a conveyor belt requires a scraper to remove the wet coal dust from the belt. The belt scraper is guided by wheels, which are subjected to very aggressive conditions.

The original solution consisting of a labyrinth seal and a rotary shaft seal failed due to coal dust, causing high wear and bearing failures. SKF provides a sealing solution to replace the standard seals arrangement. By using a specially designed seal made of the abrasion resistant H-ECOPUR and including a wear strip made of SKF Ecotex as a counterface for the wiper segment, only minor changes to the existing seal housing were necessary. The bearing life was extended from 6 weeks (worst case) to approximately 2 years with minimal maintenance required. Based on the seal geometry, easy regreasing of the bearings could also be achieved.

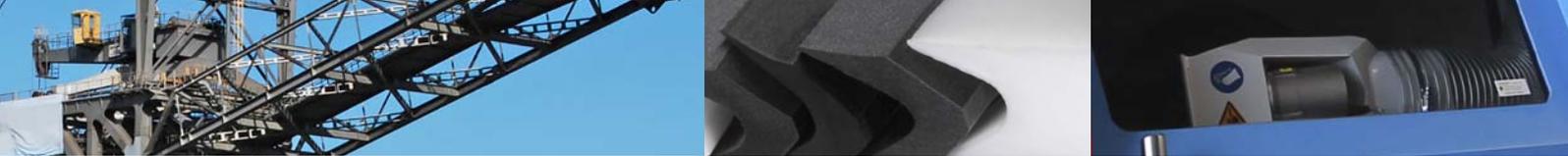


6 Seals for lift and tilt cylinders

The extremely adverse and varied conditions experienced by haul trucks on mine sites all over the world can put standard seals and sealing materials to the test. SKF offers a broad range of sealing materials and profiles that are suitable for the coldest winter conditions, e.g. in Canada, as well as for the high humidity experienced such as in south east Asia.

SKF is able to analyze causes of premature seal failure and design and manufacture a solution with minimal downtime and maximum performance, especially extended service life of the seals.





Optimized for your system performance

With more than 100 years of experience, SKF provides advanced sealing solutions and meets the requirements of applications and processes for the mining, mineral processing and cement industries. This focus has led to the development of new, reliable products and materials specifically engineered, designed and optimized for your system performance.

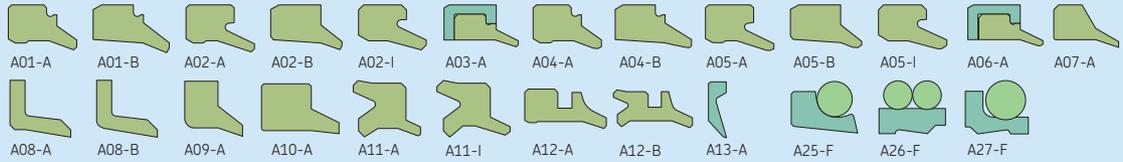
After a detailed study of the customer's operation and needs, SKF will check its comprehensive list of standard products to find a suitable solution; alternatively, SKF can engineer customized solutions.

The unique SKF total service approach provides a solution with considerable advantages over conventional arrangements. With the SKF SEALJET system, SKF supplies seals in a wide range of different sizes and offers cost-effective sealing solutions on demand – without any tooling costs or delays.

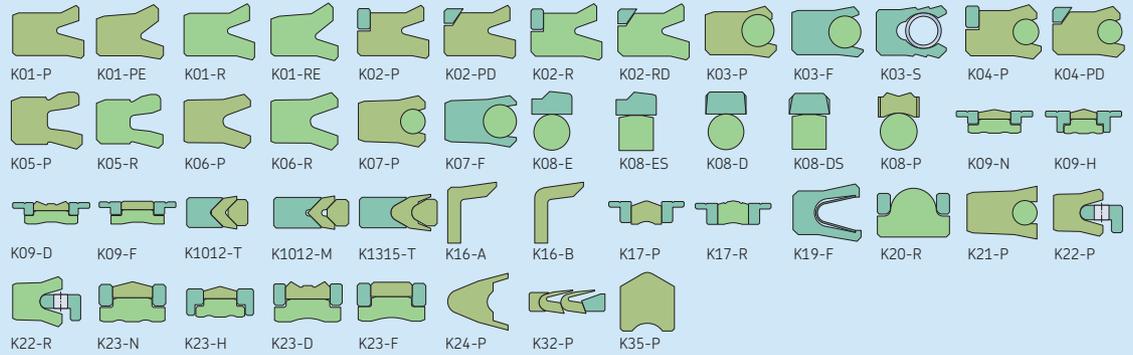


Standard machined seal profiles

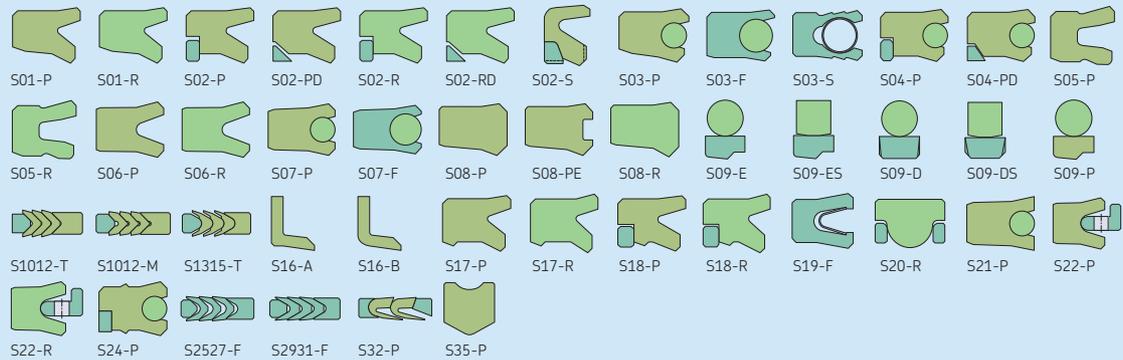
Wipers



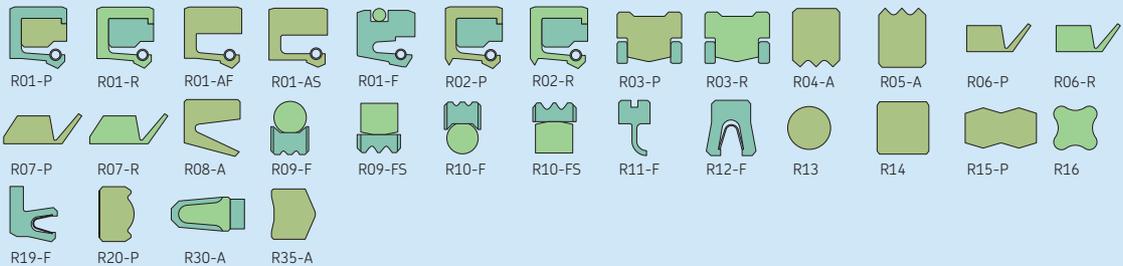
Piston seals



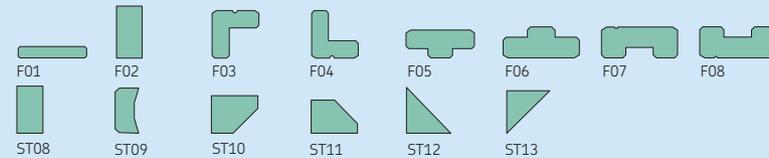
Rod seals



Rotary seals



Guide and backup rings



O-rings and static seals





Materials for the mining, mineral processing and cement industries

The proper selection of sealing materials for a specific application is a key factor with regards to safety compliance. SKF has developed a vast range of high quality sealing materials to meet those demands.

Polyurethanes

Polyurethanes offers outstanding mechanical properties, low compression set, best abrasion resistance and highest strength of the elastomeric sealing materials.

ECOPUR (TPU) offers high compatibility with mineral / synthetic oils and greases.

H-ECOPUR (TPU) is a hydrolysis resistant material. Specially used with water-based hydraulic fluids.

S-ECOPUR (TPU) is a self-lubricated thermoplastic polyurethane elastomer (TPU) with solid lubricants optimized to reduce friction and improve wear resistance. This material is therefore best suited for most severe applications in water hydraulics as well as in non-lubricated pneumatics.

X-ECOPUR (TPU) provides outstanding friction and wear properties as well as high pressure resistance. Therefore the material is well suited for the use as a composite seal, for wipers working in heavy-duty applications as well as for engineered plastic parts.

Elastomers

Elastomers or rubbers are the most frequently used materials for seals and gaskets in low to medium pressure applications with good chemical resistance.

SKF Ecorubber-1 (NBR) is most common for general applications.

SKF Ecorubber-H (HNBR) offers higher temperature and abrasion resistance than NBR.

SKF Ecorubber-2 (FKM / FPM) offers higher temperature, chemical and abrasion resistance and is usually formulated to meet FRAS requirements.

SKF Ecosil (MVQ) offers excellent chemical resistance.

PTFE and its compounds

Where elastomers do not provide sufficient chemical or temperature resistance, top performance SKF Ecoflon (PTFE) compound materials with high chemical and temperature resistance are suitable.

Thermoplastics and special materials

Special hard grade materials with outstanding wear resistance for mechanical applications or anti-extrusion components to control extreme pressure, like SKF Ecopaek (PEEK) or SKF Ecotal (POM) are available.





Sealing materials

Polyurethanes

SKF has developed many high performance sealing materials. In particular, the polyurethanes have outstanding mechanical properties which outperform many other elastomeric sealing materials (like rubbers). Possible application limits are chemical resistance and in some cases, very high temperatures. For further information, please contact SKF competence centres for machined seals.

Material		Colour	Properties
ECOPUR	(TPU/TPE-U, 95 Shore A)	Green	Recommended for hydraulic applications, good chemical resistance
ECOPUR LD	(CPU, 95 Shore A)	Green	Cast polyurethane elastomer (CPU) for large diameter seals with similar properties to ECOPUR
G-ECOPUR	(CPU, 95 Shore A)	Red	Hydrolysis-resistant cast polyurethane elastomer (CPU) with similar properties to H-ECOPUR.
H-ECOPUR	(TPU/TPE-U, 95 Shore A)	Red	Outstanding chemical resistance against water-based fluids
S-ECOPUR	(TPU/TPE-U, 95 Shore A)	Grey/black	Outstanding sliding performance, similar mechanical and chemical properties to H-ECOPUR
T-ECOPUR	(TPU/TPE-U, 95 Shore A)	Blue	Low temperature grade, excellent cold flexibility, limited chemical resistance
X-ECOPUR	(TPU, 57 Shore D)	Dark green	Increased pressure and extrusion resistance, recommended for composite seals, chemical resistance similar to ECOPUR
X-ECOPUR H	(TPU, 60 Shore D)	Dark red	Increased pressure and extrusion resistance, recommended for composite seals, chemical resistance similar to H-ECOPUR
X-ECOPUR S	(TPU, 57 Shore D)	Dark grey	Increased pressure and extrusion resistance, recommended for composite seals, chemical resistance similar to H-ECOPUR, outstanding sliding performance

Elastomers

High quality rubber standard grades with the commonly known features of elastomeric materials, good chemical resistance, but limitations in mechanical properties. For further information, please contact SKF competence centres for machined seals.

Material		Colour	Properties
SKF Ecoflas	(TFE/P, 83 Shore A)	Black	Fluoro-elastomer with outstanding resistance to hot water and steam
SKF Ecorubber-H	(HNBR, 85 Shore A)	Black	Standard grade with good mechanical and chemical properties
SKF Ecorubber-1	(NBR, 85 Shore A)	Black	Standard grade, good chemical resistance
SKF Ecorubber-2	(FKM, FPM, 85 Shore A)	Brown	Standard grade with good chemical resistance
SKF Ecorubber-3	(EPDM, 85 Shore A)	Black	Standard grade with good mechanical properties, recommended for steam injection
SKF Ecosil	(MVQ, 85 Shore A)	Reddish brown	Silicone rubber with high resistance against weathering, ozone and ageing



Thermoplastics and special materials ¹⁾

Thermoplastics and special glassfibre reinforced materials with outstanding mechanical properties. For further information, please contact SKF competence centres for machined seals.

Material		Colour	Properties
SKF Ecomid	(PA)	Black	Standard grade with good mechanical properties (glass filled grades for increased pressure resistance are also available) NOTE: Not to be used in water or moist environments.
SKF Ecopaek	(PEEK)	Cream/black	Exceptional mechanical, chemical and thermal resistance
SKF Ecotal	(POM)	Black	Standard grade with good mechanical properties (glass filled grades for increased pressure resistance are also available)
SKF Ecotex	(fabric reinforced material on polyester resin base)	Light orange	High wear and pressure resistance

PTFE and its compounds ²⁾

Top performance PTFE compound materials with highest chemical and temperature resistance, optimized for sealing applications. For further information, please contact SKF competence centres for machined seals.

Material		Colour	Properties
SKF Ecoflon 1	(PTFE, virgin)	White	High chemical resistance
SKF Ecoflon 2	(PTFE, 15% glass, 5% MOS2)	Grey	Good mechanical properties
SKF Ecoflon 3	(PTFE, 40% bronze)	Bronze	Good tribological properties, high pressure resistance
SKF Ecoflon 4	(PTFE, 25% carbon)	Black	High wear and pressure resistance
SKF Ecoflon 5	(PTFE, modified)	White	Unfilled modified grade to increased pressure and creep resistance

¹⁾ SKF also offers a wide range of individual thermoplastic materials specially designed for guide rings, backup rings, etc..

²⁾ SKF also offers a wide range of organic and inorganic compounds, such as PTFE + glass, PTFE + graphite (steam injection), PTFE + EKONOL, PTFE + PI, PTFE + PEEK, etc..



Material properties

Polyurethanes

Properties	Standard	Unit	ECOPUR	ECOPUR LD	G-ECOPUR cast – hydrolysis resistant	H-ECOPUR hydrolysis resistant	S-ECOPUR solid lubricants	T-ECOPUR low temperature grade	X-ECOPUR hard grade	X-ECOPUR H hard grade hydrolysis resistant	X-ECOPUR S hard grade solid lubricants
			TPU	CPU	CPU	TPU	TPU	TPU	TPU	TPU	TPU
Standard colour			Green	Green	Red	Red	Grey/ black	Blue	Dark green	Dark red	Dark grey
Hardness	DIN ISO 7619	Shore A	95 ±2 ¹⁾	95 ±2 ¹⁾	95 ±2 ¹⁾	95 ±2 ¹⁾	95 ±2 ¹⁾	95 ±2 ¹⁾	97 ±2 ¹⁾	97 ±2 ¹⁾	97 ±2 ¹⁾
Hardness	DIN ISO 7619	Shore D	48 ±3 ¹⁾	48 ±3 ¹⁾	47 ±3 ¹⁾	48 ±3 ¹⁾	48 ±3 ¹⁾	48 ±3 ¹⁾	57 ±3 ¹⁾	60 ±3 ¹⁾	58 ±3 ¹⁾
Density	DIN EN ISO 1183	g/cm ³	1,2	1,19	1,17	1,2	1,23	1,17	1,21	1,22	1,23
100% modulus	DIN 53504	MPa	12	≥ 10	≥ 11	≥ 13	≥ 17	≥ 12	≥ 16	≥ 22	≥ 22
Tensile strength/yield stress	DIN 53504	MPa	≥ 50	≥ 45	≥ 45	≥ 50	≥ 45	≥ 50	≥ 45	≥ 45	≥ 38
Elongation at break	DIN 53504	%	≥ 430	≥ 380	≥ 330	≥ 330	≥ 380	≥ 450	≥ 400	≥ 350	≥ 300
Modulus of elasticity – tensile test	ISO 527-1/2	MPa	–	–	–	–	–	–	–	–	–
Compression set											
70 °C/24h 20% compression	DIN ISO 815	%	≤ 27	≤ 30	≤ 30	≤ 27	≤ 30	≤ 27	≤ 30	≤ 30	≤ 33
100 °C/24h 20% compression	DIN ISO 815	%	≤ 33	≤ 40	≤ 40	≤ 33	≤ 35	45 ³⁾	≤ 35	≤ 35	≤ 39
100 °C/24h	DIN ISO 815	%	–	–	–	–	–	–	–	–	–
175 °C/24h	DIN ISO 815	%	–	–	–	–	–	–	–	–	–
Tear strength	DIN ISO 34-1	N/mm	100	–	–	100	120	80	130	160	160
Abrasion	DIN ISO 4649	mm ³	18	22	18	17	21	15	18	20	29
Minimum service temperature ⁷⁾		°C	–30	–35	–30	–20	–20	–50	–30	–20	–20
Maximum service temperature ⁷⁾		°C	+110	+110	+110	+110	+110	+110	+110	+110	+110

¹⁾ Testing time 3 s only valid for polyurethanes

²⁾ DIN EN ISO 868

³⁾ DIN ISO 815 at –40 °C/24h 20% compression

⁴⁾ ASTM D4894

⁵⁾ ASTM 4745

⁶⁾ ISO 527-1/2

⁷⁾ Minimum and maximum service temperatures are material properties only. Deviations due to varying application parameters are mentioned/stated at each seal profile at the following pages.

Data concerning special materials based on the here mentioned standard grades are available on request.



Elastomers						Thermoplastics						Thermoset			
SKF Ecoflas	SKF Ecorubber-H	SKF Ecorubber-1	SKF Ecorubber-2	SKF Ecorubber-3	SKF Ecosil	SKF Ecoflon 1	SKF Ecoflon 2 +15% GF + 5% MoS2	SKF Ecoflon 3 +4.0% bronze	SKF Ecoflon 4 +25% Carbon	SKF Ecoflon 5 modified	SKF Ecomid	SKF Ecopaek	SKF Ecotal	SKF Ecowear 1000	SKF Ecotex
TFE/P	HNBR	NBR	FPM, FKM	EPDM	MVQ	PTFE virgin	PTFE	PTFE	PTFE	PTFE	PA	PEEK	POM	UHMWPE	-
Black	Black	Black	Brown	Black	Reddish brown	White	Grey	Bronze	Black	White	Black	Cream	Black	White	Light orange
83 ±5	85 ±5	85 ±5	85 ±5	85 ±5	85 ±5	-	-	-	-	-	-	-	-	-	-
						57 ²⁾	62 ²⁾	65 ²⁾	65 ²⁾	65 ²⁾	77 ²⁾	87 ²⁾	82 ²⁾	61 ²⁾	67-77
1,73	1,23	1,31	2,33	1,22	1,52	2,16	2,25	3,05	2,1	2,16	1,15	1,30	1,41	0,93	1,21
8	≥ 10	≥ 11	≥ 5	≥ 8	≥ 5	-	-	-	-	-	-	-	-	-	-
13	≥ 18	≥ 16	≥ 7	≥ 12	≥ 7	27 ⁴⁾	20 ⁵⁾	23 ⁵⁾	15 ⁵⁾	30 ⁴⁾	55 ⁶⁾	100 ⁶⁾	65 ⁶⁾	20 ⁶⁾	55
220	≥ 180	≥ 130	≥ 200	≥ 110	≥ 130	300 ⁴⁾	220 ⁵⁾	240 ⁵⁾	150 ⁵⁾	360 ⁴⁾	100 ⁶⁾	≥ 45 ⁶⁾	25 ⁶⁾	≥ 350 ⁶⁾	-
-	-	-	-	-	-	-	-	-	-	-	1 800 ⁶⁾	3 700 ⁶⁾	2 900 ⁶⁾	600 ⁶⁾	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	≤ 22	≤ 15	-	≤ 15	-	-	-	-	-	-	-	-	-	-	-
29	-	-	≤ 20	-	≤ 15	-	-	-	-	-	-	-	-	-	-
19	24	20	21	15	8	-	-	-	-	-	-	-	-	-	-
110	90	90	150	120	-	-	-	-	-	-	-	-	-	-	-
-10	-25	-30	-20	-50	-60	-200	-200	-200	-200	-200	-40	-100	-50	-200	-40
+200	+150	+100	+200	+150	+200	+260	+260	+260	+260	+260	+110	+260	+100	+90	+120



Pressure fluids – general classification

Seals in the mining, mineral processing and cement industries face a wide range of more or less aggressive working fluids, that may severely attack the sealing materials and ultimately cause seal failure.

Due to increased safety and contamination regulations and standards, more and more combustible fluids, such as mineral oils, are replaced by fire-resistant fluids.

These fire-resistant fluids can be divided into two main groups:

- Water-based fluids
- Synthetic fluids

The water-based fluids can be divided into fluids with high (HWB-fluids) and low (LWB-fluids) water content. The main chemical composition is summarized in **table 1**. Due to the water content of these fluids, the working temperature is limited to 60 °C to avoid equipment damage. For higher temperatures, fire-resistant fluids with a synthetic composition are available (HFD).

As these fluids are toxic major health and safety issues may arise. Please see some details in **table 2** and contact SKF for further details.

Table 1

Composition of water-based fluids

Category	Characterisation	Water content (%)	Non-water ingredients
HFA-E	Oil-in-water emulsion	90–98	Mineral oil, emulsifiers, stabilizers corrosion inhibitors, etc.
HFA-S	Synthetic solutions	90–98	Synthetic fluids, fluids in water antioxidants, corrosion inhibitors, detergents/dispersants
HFB	Water-in-oil emulsion	0–40	Mineral oil, emulsifiers, stabilizers corrosion inhibitors, etc.
HFC	Water-glycol solutions	35–50	Polyalkylene glycols, corrosion inhibitors, various additives

Table 2

Fire-resistant fluids of synthetic composition (HFD)

Category	Characterisation	Toxicity	Notes
HFD-R	Various grades of phosphate esters	medium/high	hazardous
HFD-S	Chlorinated hydrocarbons (mostly PCB)	high	hazardous
HFD-T	Mixtures of phosphate esters and chlorinated hydrocarbons	high	hazardous
HFD-U	Synthetic esters Silicone oils	no/low	biologically degradable



Pressure fluids and sealing materials

Generally fire-resistant working fluids can greatly affect the integrity of sealing materials. Compared to mineral oils these fluids require a much more careful selection of compatible sealing materials.

SKF has many years of experience in sealing systems for these kinds of critical applications and has extensively investigated the compatibility of seals with these fluids. The results of the investigations and general recommendations for suitable sealing materials are summarized in **table 3**.

Table 3

Fluid compatibility of sealing materials

Category	Service temperature (°C)	Resistant elastomers SKF recommendations	Notes
HFA-E	+5 to 60	H-ECOPUR* (specially formulated polyurethane), NBR, HNBR, specially formulated FPM	
HFA-S	+5 to 60	H-ECOPUR* (specially formulated polyurethane), NBR, HNBR, properly formulated FPM and EPDM	Individual tests necessary
HFB	+5 to 60	Specially formulated polyurethanes, NBR, HNBR, specially formulated FPM	–
HFC	–20 to 60	NBR, HNBR, EPDM and MVQ	Specially formulated polyurethanes and FPM have limited stability
HFD-R	>100	FPM (depending on fluid type), EPDM, MVQ (depending on fluid type)	
HFD-S	>100	FPM, MVQ	
HFD-T	>100	FPM, MVQ	
HFD-U	Silicone oils >100	H-ECOPUR* (specially formulated polyurethane) up to 100 °C max. FPM (plastizer-free)	
	Synthetic esters +80	H-ECOPUR* (specially formulated polyurethane), FPM	



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