HL Rod Seal

Low friction – pressure controlled

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

Parker Prädifa

ENGINEERING YOUR SUCCESS.

Profile HL Rod Seal

For a smooth start on Monday morning

Operators of fluid power systems increasingly demand friction-optimised piston and rod seals for hydraulic cylinders. High friction not only means high use of energy, but can also lead to premature seal failure due to wear. Both of these aspects are costly as well as harmful to the environment.

Parker has developed the new HL profile series as a range of friction-optimised sealing solutions featuring a new type of functional principle: the single-acting rod seal has pressure-activated, cascading dynamic sealing edges. This design clearly reduces static and dynamic friction in hydraulic cylinders and increases the efficiency of hydraulic systems. Another new development, the P6030 material, superbly supports this new profile geometry and its innovative action principle. P6030's main advantages are excellent temperature, extrusion and wear resistance.

Previously: the lower the pressure, the more critical the influence of friction

Various parameters influence friction of hydraulic seals. The size of the contact area between the seal and the respective sliding partner is one of the key factors: the larger the contact area of the seal, the higher the amount of static and dynamic friction. The system pressure inside a hydraulic system determines the friction properties required of the seal. For example, friction at lower system pressures or in differential cylinders with low pressure differences is significantly more critical than in cylinders subjected to higher pressure loads.

New: low friction even in low- or no-pressure conditions

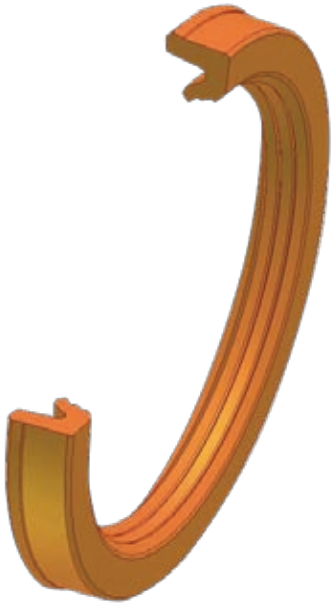
When conventional U-seals are used, a larger portion of the dynamic sealing area will typically contact the piston rod surface even at lower system pressures. By contrast, in the case of the novel functional principle of the HL profile, the cascading sealing edges of the dynamic sealing lips will successively contact the mating surface as system pressure rises. This significantly reduces friction in the pressure-less state and in low-pressure conditions. The small contact area reduces the generation of heat and friction as well, thus enabling higher travel speeds. Depending on the system pressure applied, the individual sealing lips are activated by the deformation of the seal's cross-section. This in turn reduces the amount of drag oil on the rod surface that occurs during the cylinder stroke, and thus increases the sealing effect. Additionally, in case of slow travel speeds, the risk of stick-slip is nearly excluded.

Result: optimum friction, sliding and sealing performance in all pressure conditions

Hence the sealing performance increases with the number of sealing edges and their effects. At the same time, dynamic friction slightly increases as the contact area enlarges. Overall, however, it remains at a very low level. Since only the primary sealing edge is engaged in pressure-less conditions the new functional principle minimises the high break-away friction typically occurring after prolonged down-time. This phenomenon is also known as the "Monday morning effect".
The HL profile with its system pressure controlled, redundant sealing lip system now puts an end to this effect by assuring "smooth" starts at any time, even on Monday mornings!

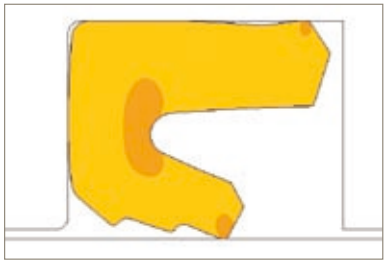
Triple innovation:

Geometry – functional principle - material



Geometry

The novel profile geometry featuring three cascading dynamic sealing lips is automatically controlled by the system pressure. This innovative action principle assures optimum ease of motion and friction properties as well as enhanced extrusion resistance.



0 bar

15 bar

50 bar

Functional principle: stepped pressure activation

The new functional principle causes the individual sealing lips to consecutively contact the mating surface as pressure rises. This results in:

- Extremely low friction at low pressures and in pressure-less conditions
- Low break-away force even after prolonged downtimes
- Good sealing action in all pressure ranges

Material

The P6030 material, which is a new development as well, systematically supports the advantages of the new geometry. P6030 has been specifically designed for low-friction fluid power applications.
In addition to good media resistance, it exhibits increased temperature and wear resistance as well as low compression set.

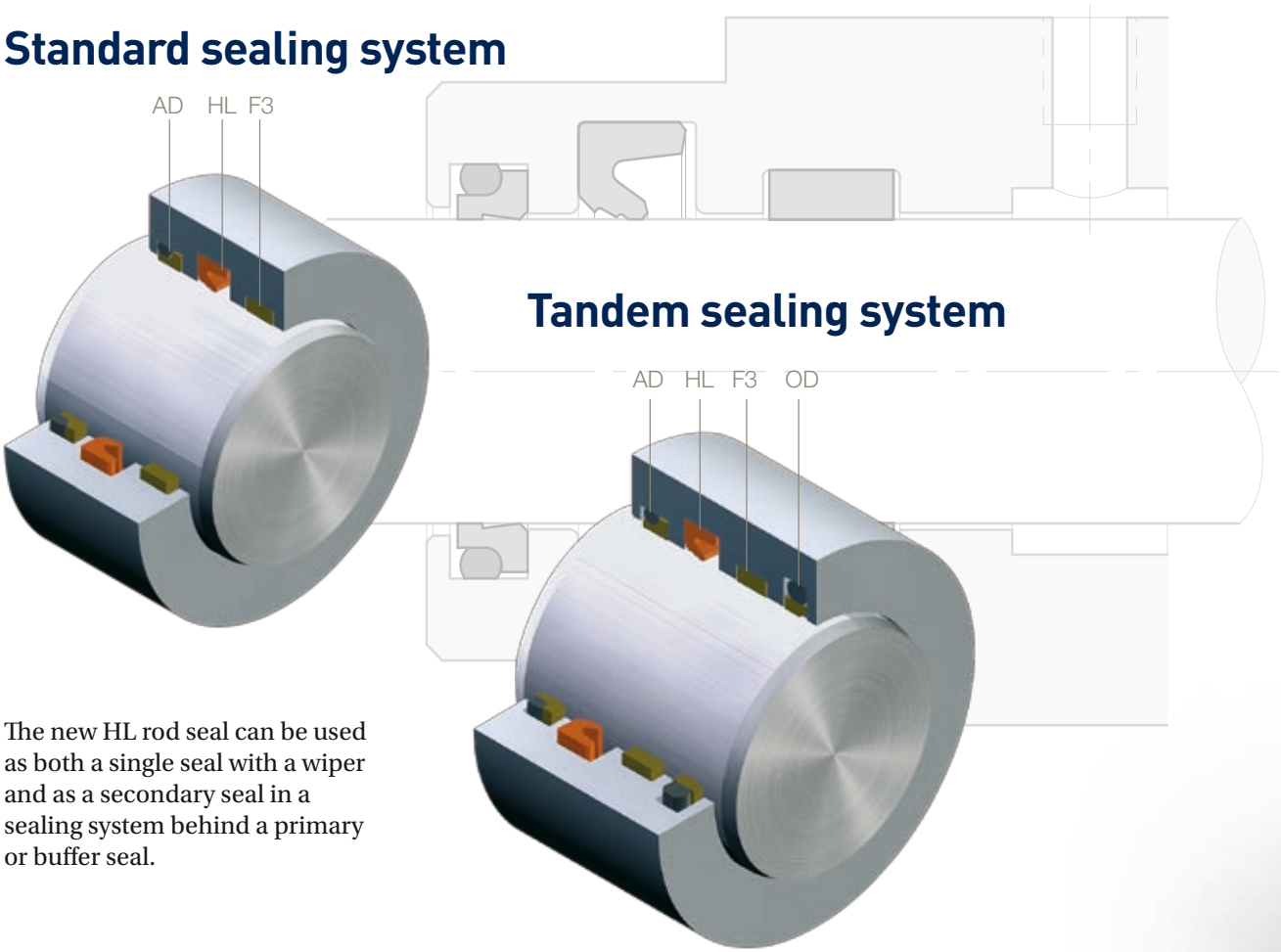
Performance data

Operating pressure [bar]	≤ 250
Operating temperature [°C]	-35 to 110
Sliding speed [m/s]	≤ 1
pv value*	≤ 50
Media	Mineral oil-based hydraulic oils and PAO fluids. Materials for bio-fluids (HEES and HETG) are available on request.

* Definition of pv value: $pv = p\ [bar] \cdot v\ [m/s]$

Installation examples

Standard sealing system



Tandem sealing system

The new HL rod seal can be used as both a single seal with a wiper and as a secondary seal in a sealing system behind a primary or buffer seal.

Properties

- Extremely low friction
- No stick-slip, even in case of low travel speeds
- Optimum sealing function
- High wear resistance
- High extrusion resistance
- High temperature resistance
- Easy fitting
- Short fitting space
- Also ideally suited for use as a secondary seal in a sealing system

Wide application range

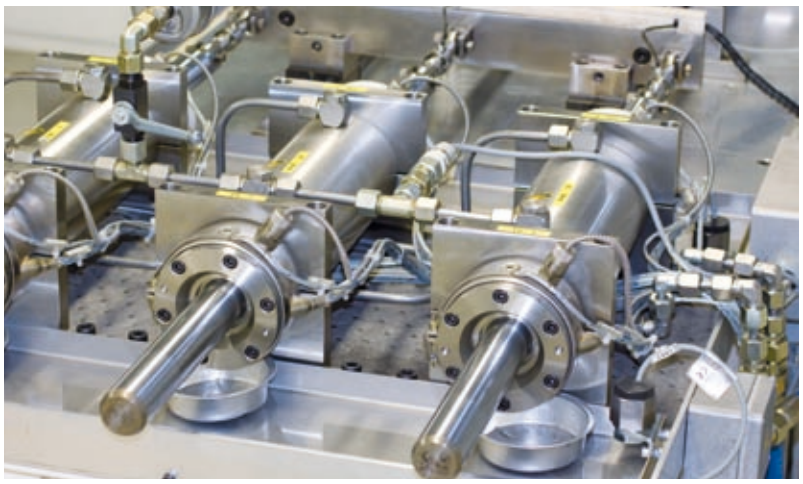
The HL Ultrathan® rod seal is suitable for a wide range of applications requiring minimal friction such as:

- Lifting platforms, loading gates
- Forklift trucks
- Test cylinders
- Automation cylinders
- Cylinders for agricultural equipment
- Door closing mechanisms
- Gas springs
- ...

On the test rig

Endurance test according to ISO 7986

Test conditions	Dimension	Parameters
Operating pressure	bar	0 to 200
Operating temperature	°C	65
Duration	km	500 (1 million cycles)
Rod diameter (hard-chrome-plated rod)	mm	36
Stroke length	mm	250
Sliding speed	m/s	0.15
Medium		HLP 46



The performance properties of the new seal geometry were tested according to in-house as well as international test standards. Specifically, friction and leakage behaviour as well as deformation and wear of the test seals were determined. The investigations were performed using both commercially available hard-chrome-plated rod seal surfaces and alternative surface coatings.

The tests produced the following major results:

- No significant extrusion
- No abrasion on the sealing edge and sealing surface
- No changes to sealing edge contours
- Low plastic deformation of the seal profile
- Low pre-loading loss (< 30 %)

Figure 1: Endurance test rig according to ISO 7986

Wear behaviour

After endurance testing, the sealing surfaces exhibited merely minimal traces of running and wear. The sealing edges retained their original form. Unlike with U-seals, on account of the merely minimal friction there was no discolouration noted in the working areas of the seal.

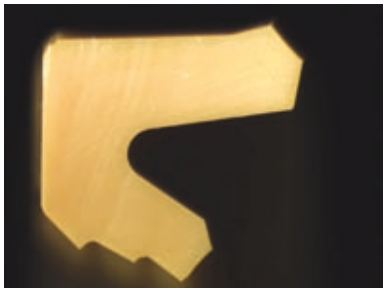


Figure 2: HL in new condition

Extrusion behaviour

The seals exhibited merely minor deformation under the specified testing conditions. There was no significant extrusion noted with any of the dimensions tested.

Figure 3: HL after endurance test

Friction force test according to Parker test standard

Test conditions	Dimension	Parameters
Rod diameter (hard-chrome-plated rod)	mm	36
Rod length	mm	280
Medium		HLP 46
Operating pressure	bar	0 / 5 / 10 / 15 / 20 / 30 / 40 / 50 / 100 / 150 / 200
Operating temperature	°C	30 / 60 / 80
Sliding speed	m/min.	0.1 / 0.5 / 1 / 1.5 / 2 / 2.5 / 3 / 3.5 / 4

The friction force tests under varying pressure, temperature and speed conditions were performed on unused test seals as well as on seals which had been subjected to a prolonged endurance test. The tests revealed that the new HL seal geometry clearly reduces friction compared with conventional U-seals as well as with other – friction-modified - seal versions. This applies to both the low pressure range as well as to higher pressures of up to 200 bar (Figure 4).
At low travel speeds the new seal design exhibits especially significant friction benefits (Figure 5). Particularly with regard to undesirable stick-slip major improvements have been achieved at higher temperatures and speeds across the entire pressure range tested.

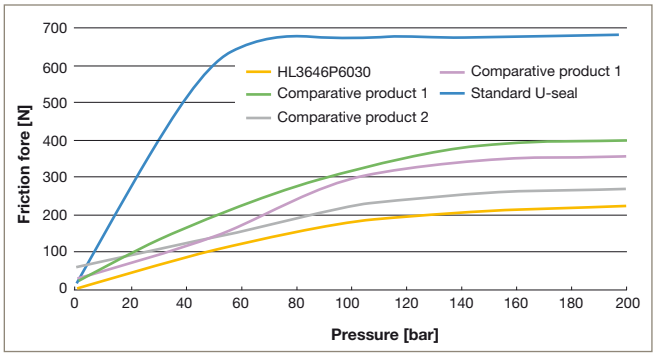


Figure 5: Friction force comparison (pressure-dependent) Groove 36 x 46 x 6.3 – 60 °C – 0.1 m/min

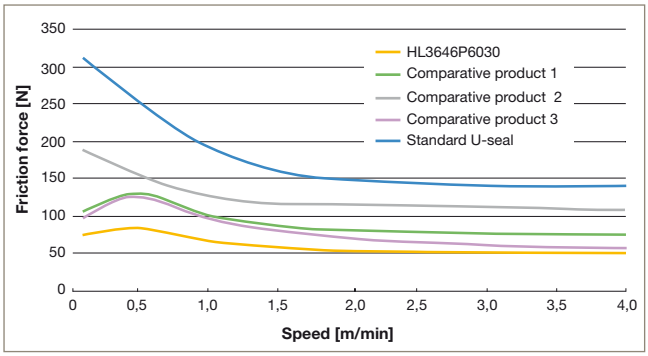


Figure 6: Friction force comparison (speed-dependent) Groove 36 x 46 x 6.3 – 40 bar – 60 °C

The benefit: energy savings

Friction = energy loss

The friction force comparison demonstrates that the friction losses encountered with the HL rod seal compared with a standard U-seal – depending on the specified load – can be reduced by 30 to 70 %. This results in considerable energy savings, thus benefiting budgets as well as the environment.

Energetic comparison between profile HL and a standard U-seal
The maximum energy savings per 1,000 km of "mileage" amount to about 130 kWh, depending on the seal size and piston rod diameter.

This roughly equates to the monthly power consumption of a single household (source: VDEW – Vereinigung Deutscher Elektrizitätswerke e.V.).

The material – P6030

The specialist for low-friction hydraulics

Physical data

Test	Norm	Dimension	Result
Hardness	DIN 53505	Shore A	93 ±5
Spec. weight	DIN	g/cm³	1.2 ±0.02
Modulus 100 %	DIN	N/mm²	> 10
Modulus 300 %	DIN	N/mm²	> 18
Ultimate elongation	DIN	%	> 400
Tensile strength	DIN	N/mm²	> 50
Rebound resilience	DIN	%	> 40
Tear propagation strength	DIN	N/mm	> 80
Low-temperature properties TR10	ASTM D 1329	°C	-33
Compression set 70 h / 70 °C 24 h / 70 °C	DIN ISO 815 7.5.1	%	 ≤ 28 ≤ 25

Properties

- Designed for fluid power application requirements
- Low compression set
- High elastic restoration
- Outstanding extrusion resistance
- High modulus of elasticity and high mechanical strength
- Excellent wear resistance
- Very good tear propagation strength
- Extended temperature range: -35 to 110 °C (short-term 120 °C)
- Good thermo-oxidative stability
- Good media resistance: low volume swelling in mineral oils and PAO
- High consistency of all required properties
- Meets ROHS and ELV Directive 2000/53/EC criteria

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Parker Hannifin GmbH & Co. KG
Packing Division Europe
P.O. Box 1641 · 74383 Bietigheim-Bissingen · Germany
Tel. +49 (0) 7142 351-0
Fax +49 (0) 7142 351-293
www.parker.com/packing-europe
e-mail: packing-europe@parker.com

Parker Prädifa