

**KLÜBER**  
LUBRICATION

## Pneumatics



Seals and lubricants:  
an ideal combination

**Lubrication is our World**

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# Pneumatic drives

Whether in drive units, open-loop or closed-loop control systems: engineers can get quite a lot out of thin air. Acting on cylinders, air pressure and suction can shift, lift or reshift workpieces and tools, start, stop, and direct machinery as well as control the flow and pressure of media. Small wonder pneumatics are very much at home in the fields of industrial handling and automation engineering.

Pneumatic cylinders and valves take up little space and are not only very robust but overload-proof as well. This is due to their high functional reliability and long service life; both are subject to the problem-free operation of seals being in contact with mostly metal pistons and cylinders.

Because friction and wear must be minimized, lubricants that are suitable for a wide variety of operating conditions are of vital importance. Factors such as ambient temperatures, sliding speeds and normal forces must be taken into account by the manufacturers of the highly complex tribological systems that are pneumatic drives.

It's a good thing the manufacturers of seals and lubricants cooperate closely to develop optimized solutions for pneumatic applications; Merkel Freudenberg Fluidtechnic and Klüber Lubrication have been working on the tribological aspects of pneumatic components for several years.

Renowned manufacturers of pneumatic components and university research centers also participated in this cooperative venture, and the result is the special combinations of sealing materials and lubricants outlined in this brochure. These solutions allow the optimized operation of pneumatic systems in all kinds of applications.

# Sealing system

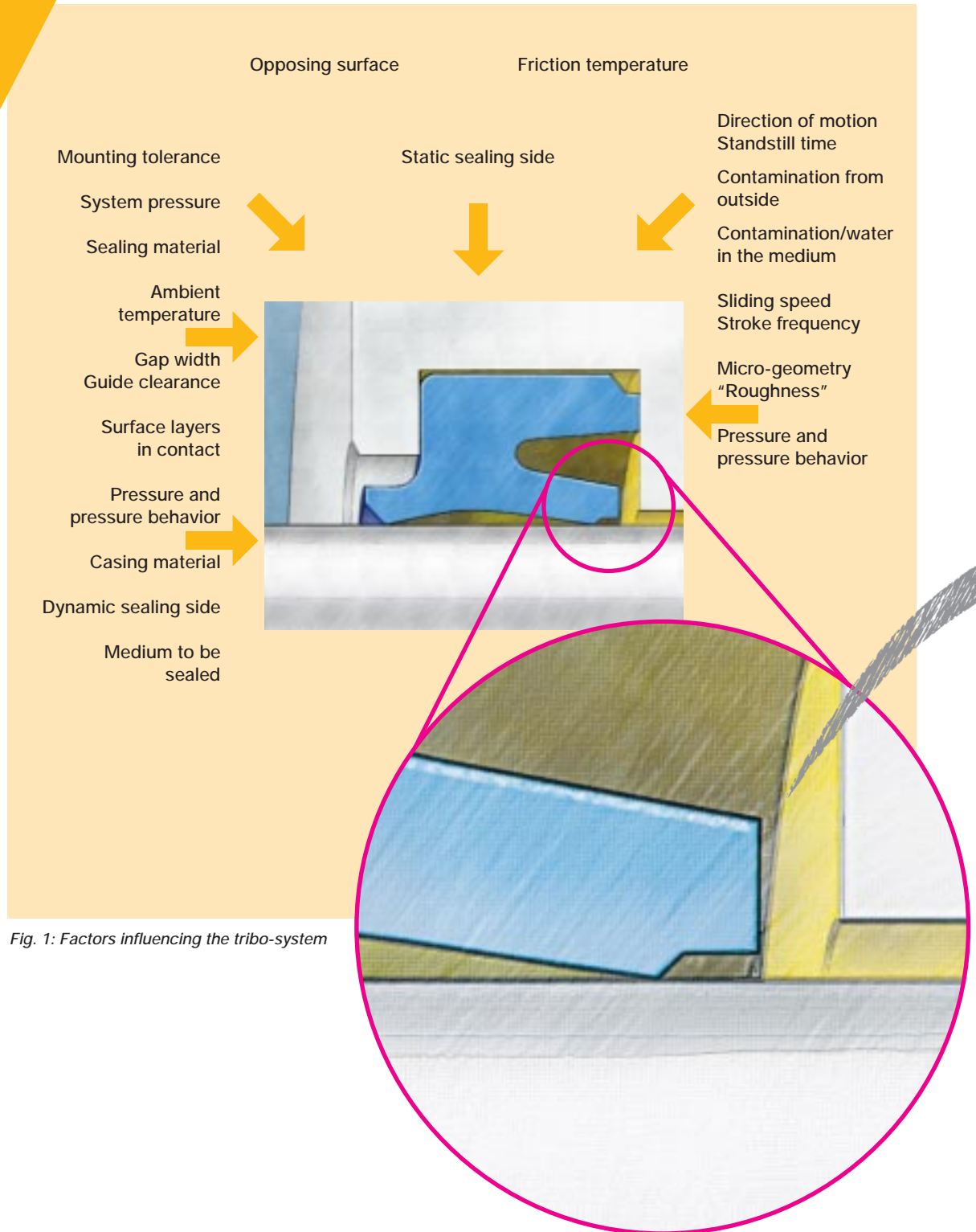


Fig. 1: Factors influencing the tribo-system

## Tribological aspects of the sealing system

In an operating sealing system, friction and service life are interrelated. The nature of this specific relation depends on a number of operating parameters (temperature, pressure and speed), the mounting position, the geometry and material of the seal, its surface finish and the lubricant used (Fig. 1).

Friction describes the energy lost as a consequence of physical energy transport. In linear motion, friction is constituted by the forces resisting this motion, i.e. a friction force. This friction force is the result of the interaction between the opposing bodies and the materials' resistance to deformation when being moved or in an attempt to be moved.

### Adhesive element of friction

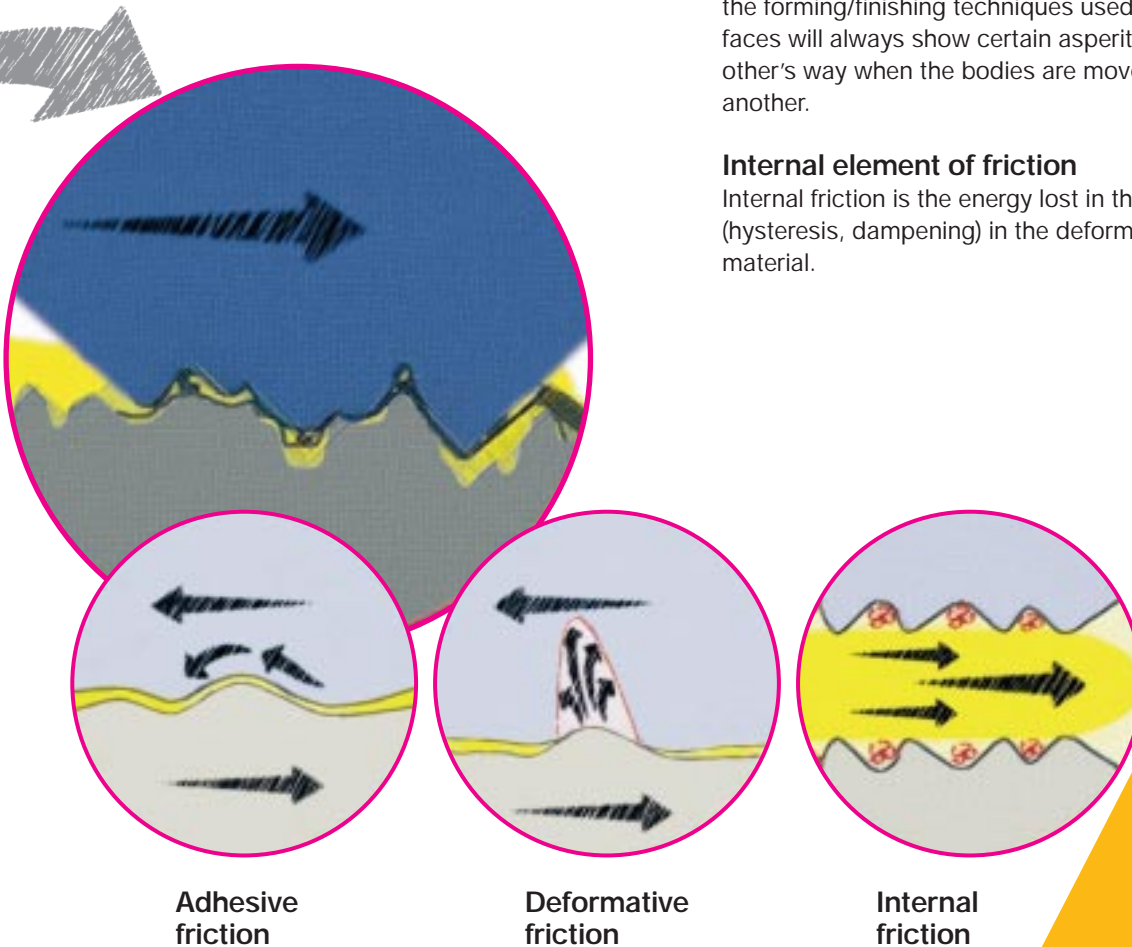
Due to their surface activity and polarity, the two friction bodies attract each other, thus generating a resistance to motion, which constitutes the adhesive element of friction.

### Deformative element of friction

Macro and microgeometric interlocking causes plastic and/or elastic deformation in the friction bodies. Depending on the forming/finishing techniques used, friction body surfaces will always show certain asperities getting in each other's way when the bodies are moved relative to one another.

### Internal element of friction

Internal friction is the energy lost in the form of heat (hysteresis, dampening) in the deformation of any material.



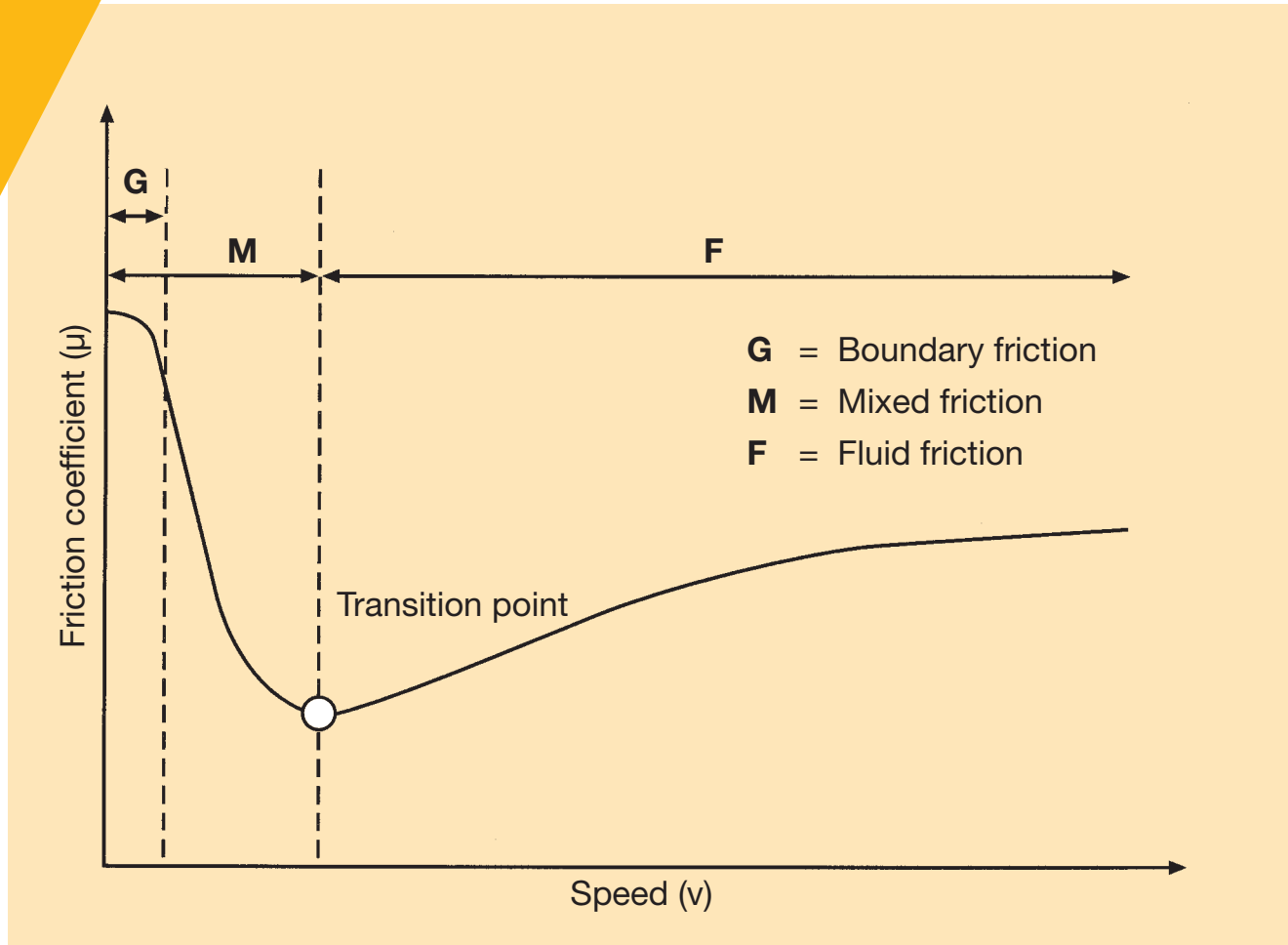
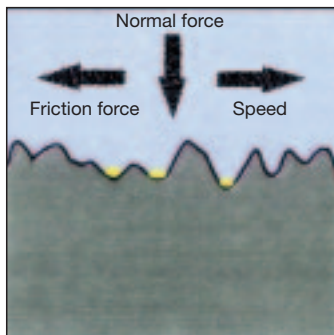
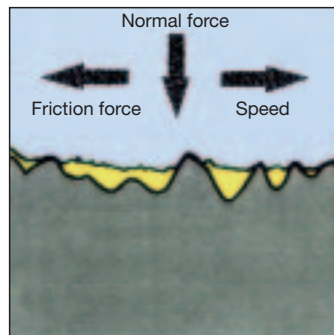


Fig. 2: Stribeck curve: friction force as a function of speed

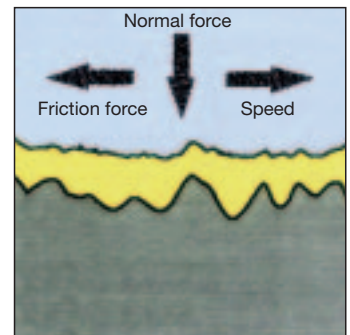
**(G)** Boundary friction



**(M)** Mixed friction



**(F)** Fluid friction



■ Lubricant

■ Sealing material

■ Opposing body

## Friction conditions

The sliding speed of the friction bodies is one of the many factors that cause different friction conditions. The Stribeck curve shows the friction force as a function of speed, which leads to the following friction conditions (Fig. 2):

### **Boundary friction**

When an attempt is made to move the friction bodies relative to one another, adhesive friction builds up due to micro-interlocking. Internal friction also acts as a force resisting relative motion of the interlocked surfaces. No relative motion of the friction bodies occurs in this state.

### **Mixed friction**

There is relative motion between the friction bodies; however, it meets with resistance from micro-interlocking and adhesive friction as well as internal friction. The total friction force is normally lower than that of static friction, as the interlocking portion of the asperities is much smaller and the lubricant becomes effective. The higher the speed, the less asperities can interlock, which results in reduced friction.

### **Fluid friction**

If the sliding speed is high enough, the viscosity of the lubricants leads to pressure building up between the friction bodies, which separates the contact surfaces (grease planing). The degree of friction depends on operating parameters (pressure, temperature and speed) and the element of internal friction within the lubricant.

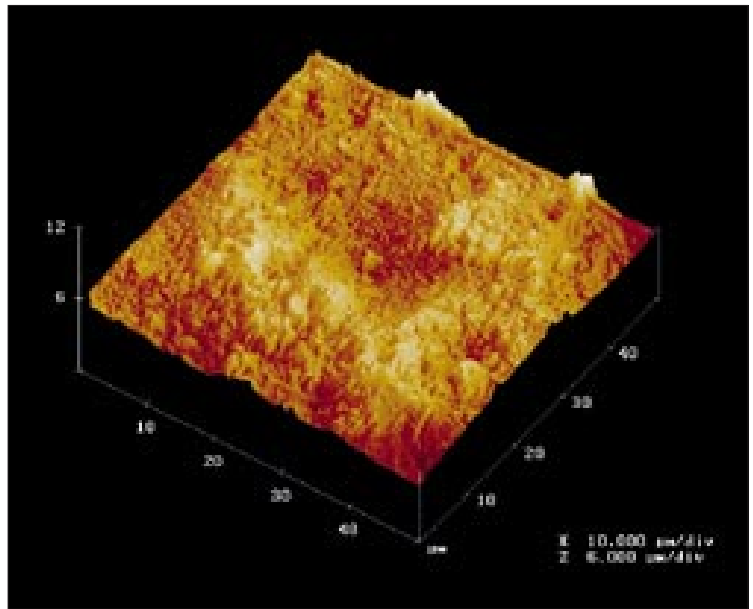


Fig. 3: "ideal"

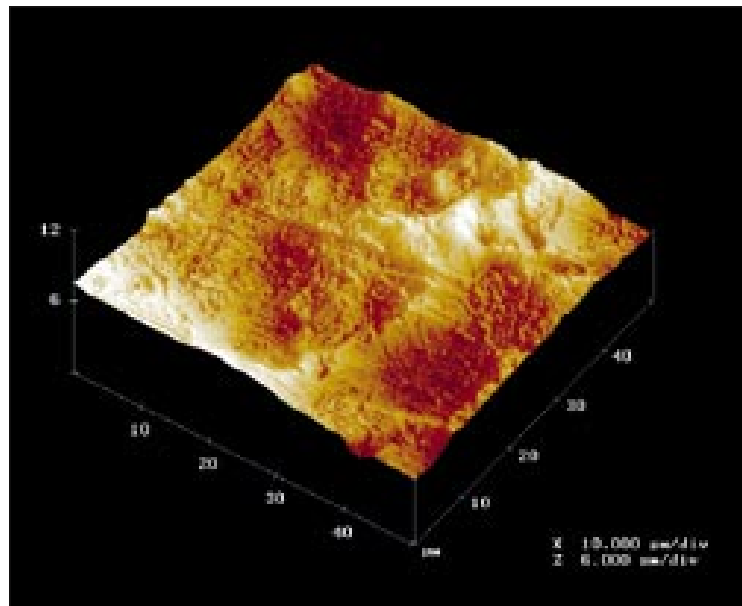


Fig. 4: "too smooth"

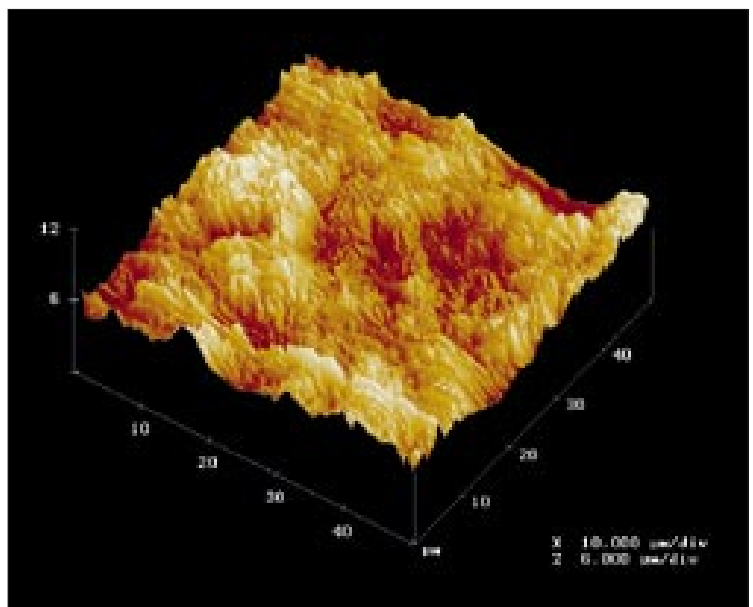


Fig. 5: "too rough"

## Surface finish

The surface finish of the friction bodies should be as identified in the general instructions (*see Simrit Catalogue or [www.simrit.com](http://www.simrit.com)*). When following these recommendations, you should obtain an ideal surface for seal sliding surfaces (Fig. 3).

If a surface is too "smooth" (Fig. 4), it has only very small pockets in which to retain the lubricant. The lubricant is wiped off the seal lip because there is not enough texture to keep the lubricant in place, which results in insufficient lubricating film and increased wear of the seal lip and its opposing body.

A surface that is too rough (Fig. 5), on the other hand, has a direct negative impact on the surface of the seal lips, which is worse when subjected to reciprocating motion.

Both types of surface – too rough or too smooth – lead to shorter service life (leakage) and higher friction (wear).

What is also important is the surface's topography: large asperities scattered at a wide spacing have a negative effect, while small ones close together are beneficial. Therefore, the load-bearing area of the surface needs special attention.

Pneumatic systems are made up of working elements (cylinders and motors) and control elements (valves), and the systems (mechanical elements) they form can be especially reliable and long-lived. To ensure this, utmost cleanliness is mandatory prior to greasing the system and putting it into operation, i.e. all machining residues, used grease and other particles must be carefully removed.

Once this has been achieved, the seals as well as the opposing body can be greased. This ensures even wetting of the friction bodies.

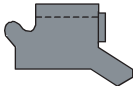
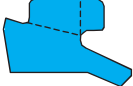
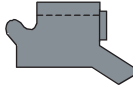

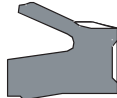
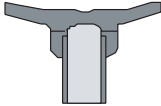

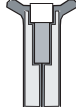

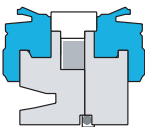
### ***Hints for the greasing of running surfaces in cylinders:***

Use suitable round brushes or automatic greasing pistons. Upon installation, the working piston should be moved up and down its whole stroke path several times. This makes for even distribution of the lubricant and ensures seals are sufficiently wetted when applying the lubricant to the cylinder walls only.

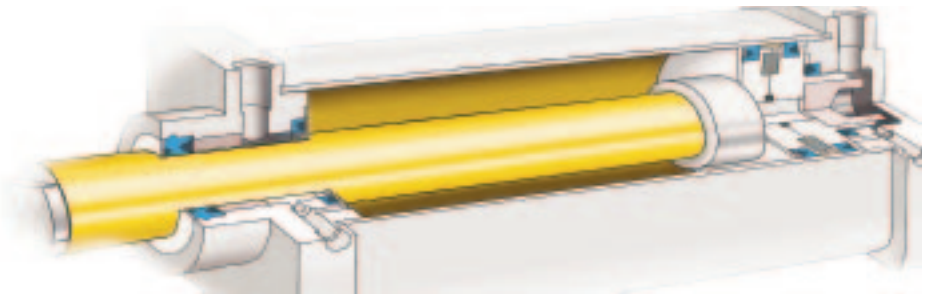
### ***Hints for the greasing of valves:***

Valves can be greased in a similar fashion as cylinders. Depending on the valve's size, excess lubrication of the piston seals will also lead to even lubrication of the friction bodies after a certain number of piston strokes.

# Seals and lubricants for ISO cylinders




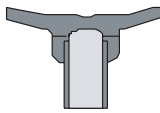


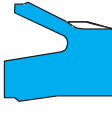
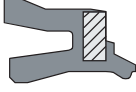
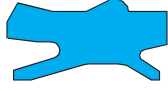
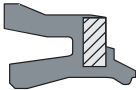
Lubricant			Seal type	Profiled joint
Standard applications	High-temperature applications	Applications in the food-processing industry*		
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Damper seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Damper seal	
	BARRIERTA L55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Damper seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	

\* Lubricant approved acc. to USDA H1.

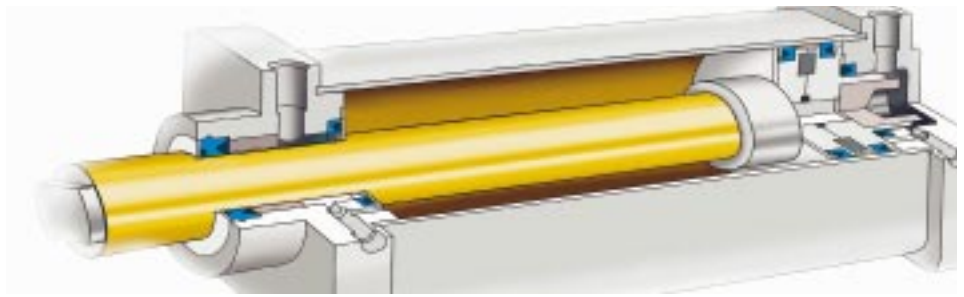


<b>Structural shape</b>	<b>Material</b>	<b>Max. pressure [MPa]</b>	<b>Speed max. [m/s]</b>	<b>Temperature min. to max. [°C]</b>	<b>Nominal dimension [mm]</b>
DIP (Damper ring)	90 NBR 108	1.6	1	-30 to 100	14 to 50
AUDIP (Damper ring)	94 AU 925	2.5	1	-30 to 90	8 to 50
DIP (Damper ring)	75 FPM 595	1.6	1	-5 to 150	on request
NAPN (U-packing)	80 NBR 186349	1	1	-20 to 100	6 to 25
NAPN (U-packing)	80 NBR 186349	1	1	-20 to 100	32 to 320
TDUO P (Complete piston with air relief passages)	72 NBR 708	1.2	1	-20 to 100	25 to 200
TDUO P (Complete piston)	72 NBR 708	1.2	1	-20 to 100	25 bis 140
TDUO PM (Complete piston with magnet and guide tape)	72 NBR 708	1.2	1	-20 to 100	32 to 100
NAP 210 (U-packing)	80 NBR 99079	1.2	1	-25 to 100	8 to 100
Pneuko M (Complete piston)	80 AU 21000	1.2	1	-25 to 80	32 to 100

# Seals and lubricants for ISO cylinders



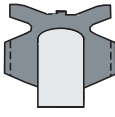



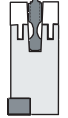
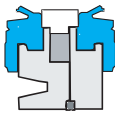


Lubricant			Seal type	Profiled joint
Standard applications	High-temperature applications	Applications in the food-processing industry*		
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	

\* Lubricant approved acc. to USDA H1.

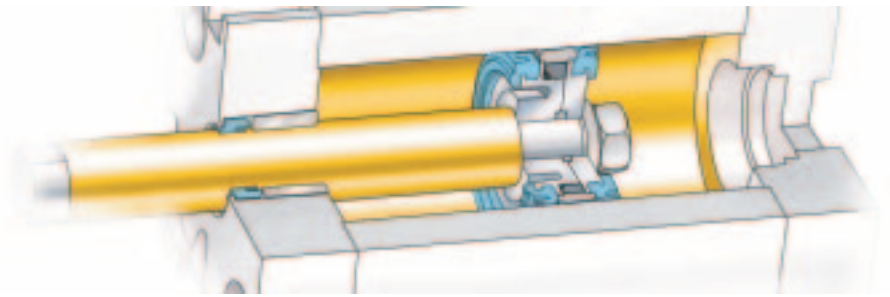


Structural shape	Material	Max. pressure [MPa]	Speed max. [m/s]	Temperature min. to max. [°C]	Nominal dimension [mm]
NAP 310 (U-packing)	80 AU 20994	1.2	1	-35 to 80	8 to 200
NAPN (U-packing)	75 FPM 595	1	1	-5 to 150	on request
Pneuko M (Complete piston)	75 FPM 181327	1.2	1	-5 to 150	32 to 100
TDUO P (Complete piston with air relief passages)	75 FPM 595	1.2	1	-5 to 150	on request
TDUO P (Complete piston)	75 FPM 595	1.2	1	-5 to 150	on request
NAP 210 (U-packing)	75 FPM 99104	1.2	1	-5 to 200	8 to 100
NAP 300 (U-packing)	80 AU 941	1.2	1	-35 to 80	25 to 125
NIPSL (Combi seal)	72 NBR 708	1.2	1	-20 to 100	8 to 50
AUNIPSL (Combi seal)	94 AU 925	1.2	1	-30 to 90	12 to 50
NIPSL (Combi seal)	75 FPM 595	1.2	1	-5 to 150	on request

# Seals and lubricants for short-stroke and compact cylinders

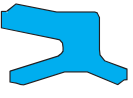
Lubricant			Seal type	Profiled joint
Standard applications	High-temperature applications	Applications in the food-processing industry*		
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Piston seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	

\* Lubricant approved acc. to USDA H1.

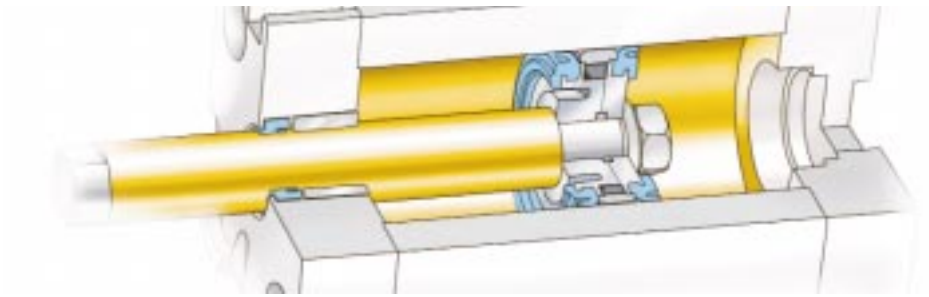


<b>Structural shape</b>	<b>Material</b>	<b>Max. pressure [MPa]</b>	<b>Speed max. [m/s]</b>	<b>Temperature min. to max [°C]</b>	<b>Nominal dimension [mm]</b>
Airzet PK (Compact seal)	80 NBR 186349	1.2	1	-20 to 100	12 to 125
KDN (Compact seal)	72 NBR 708	1	1	-20 to 100	12 to 125
NADUO P (Complete piston)	72 NBR 708	1	1	-20 to 100	8 to 100
NAP 210 (U-packing)	75 FPM 99104	1.2	1	-5 to 200	8 to 100
NAP 210 (U-packing)	80 NBR 99079	1.2	1	-25 to 100	8 to 100
NAP 310 (U-packing)	80 AU 20994	1.2	1	-35 to 80	8 to 200
PNEUKO G (Complete piston)	72 NBR 708	1	1	-20 to 100	12 to 125
PNEUKO M (Complete piston)	80 AU 21000	1.2	1	-25 to 80	32 to 100
PNEUKO M (Complete piston)	75 FPM 181327	1.2	1	-5 to 150	32 to 100
Airzet PR (Compact seal)	80 NBR 186349	1.2	1	-20 to 100	6 to 50

# Seals and lubricants for short-stroke and compact cylinders





Lubricant			Seal type	Profiled joint
Standard applications	High-temperature applications	Applications in the food-processing industry*		
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
POLYLUB GLY 151		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
Klübersynth AR 34-402		Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	
	BARRIERTA L 55/1	Klübersynth UH1 14-151 PARALIQ GTE 703	Rod seal	

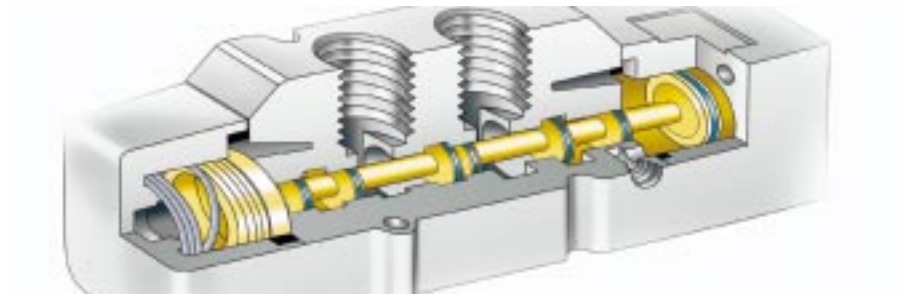
\* Lubricant approved acc. to USDA H1.



Structural shape	Material	Max. pressure [MPa]	Speed max. [m/s]	Temperature min. to max [°C]	Nominal dimension [mm]
NIPSL 200 (Combi seal)	80 NBR 4005	1	1	-20 to 100	4 to 16
NIPSL 210 (Combi seal)	75 FPM 181327	1	1	-5 to 150	4 to 32
NIPSL 300 (Combi seal)	90 AU 924	1	1	-30 to 90	4 to 16
NIPSL 310 (Combi seal)	85 AU 942	1	1	-30 to 80	4 to 32
NIPSL 320 (Combi seal)	94 AU 925	1.2	1	-30 to 90	10 to 32
NIPSL SF (Combi seal)	90 NBR 108	1	1	-20 to 100	4 to 10
NIPSL SF (Combi seal)	75 FPM 595	1	1	-5 to 150	on request

# Seals and lubricants for valves

Valve type	Lubricant	Profiled joint*
Directional control valve	PETAMO GHY 133N UNISILKON L 641	
Directional control valve	PETAMO GHY 133N UNISILKON L 641	
Directional control valve	PETAMO GHY 133N UNISILKON L 641	
Seat valve	PETAMO GHY 133N UNISILKON L 641	



Structural shape	Material	Max. press. [MPa]	Temperature min. to max. [°C]
Special designs	80 NBR 186349	1.2	-30 to 100
Special designs	80 HNBR 181572	1.2	-15 to 120
Special designs	AU*	1.2	-35 to 80
NAP 310	AU*	1.2	-35 to 80
KDN NAP 210 Airzet	NBR*	1.2	-30 to 100
Special designs	AU*	1.2	-35 to 80

*\* on request*

# Product data

## Lubrication of pneumatic cylinders

Lubricant	Base oil/ thickener	Service temperature range <sup>1)</sup> [°C] approx.	Density at 20°C [g/cm <sup>3</sup> ] approx.	Base oil viscosity DIN 51562, part 1 [mm <sup>2</sup> /s]	
				40°C approx.	100°C approx.
<b>Klübersynth AR 34-402</b>	Synth. hydrocarbon oil/special calcium soap	-30 to 130	0.90	400	40
<b>POLYLUB GLY 151</b>	Mineral oil/synth. hydrocarbon oil/ spec. lithium soap	-50 to 130	0.85	150	18.5
<b>BARRIERTA L 55/1</b>	PFPE/ PTFE	-40 to 260	1.95	415	40
<b>Klübersynth UH1 14-151</b>	Synth. hydrocarbon oil/aluminium complex soap	-40 to 120	0.92	150	22
<b>PARALIQ GTE 703</b>	Silicone oil/PTFE	-50 to 150	1.31	1000	360

## Lubrication of pneumatic valves

<b>PETAMO GHY 133N</b>	Mineral oil/synth. hydrocarbon oil/ polyurea	-30 to 160	0.88	150	18
<b>UNISILKON L 641</b>	Silicone oil/PTFE	-40 to 160	1.25	75 000	30 000

<sup>1)</sup> Service temperatures are guide values which depend on the lubricant's composition, viscosity or viscosity depending on the mechano-dynamical loads, time, pressure

<b>Worked penetration</b> DIN ISO 2137 [0.1 mm]	<b>Consistency</b> NLGI grade DIN 51 818	<b>Indications</b>
265 to 295	2	Adhesive lubricating grease for wide piston speed ranges; reduces stick-slip tendency at very low piston speeds; low breakaway torques even after longer periods of standstill
310 to 340	1	Smooth running grease, particularly for low temperatures
310 to 340	1	Adhesive lubricating grease for high temperatures; excellent resistance to most chemicals; compatible with most elastomers and plastics
310 to 340	1	NSF H1 food-grade lubricant; good water resistance and corrosion protection
220 to 250	3	NSF H1 food-grade lubricant; wide service temperature range; resistant to hot and cold water and compatible with EPDM
265 to 295	2	Adhesive lubricating grease for a wide service temperature range; reduces static and dynamic friction; good water resistance and corrosion protection
300 to 320	–	NSF H1 grease, very adhesive; particularly suitable for applications with high reciprocating frequency and high air throughput at low temperatures

*the intended use and the application method. Lubricants change their consistency, apparent dynamic and temperature. These changes in product characteristics may affect the function of a component.*

## **Satisfaction is in the air!**

We will do anything we can to make sure you get the most out of pneumatics. We not only supply the right lubricant for your pneumatic system but, if requested, we can assist you in the development of new pneumatic elements right from the start. You are welcome to use our friction test facilities, and we will perform component tests for you.

It is our foremost goal to offer lubrication solutions for our customers that provide optimal operational and economical benefits. For this reason, the products from Klüber Lubrication and Merkel Freudenberg Fluidtechnic are available worldwide to ensure that your pneumatics systems always work to their fullest capability.

## **Your partner for pneumatics:**

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The data in this technical brochure is based on our general experience and knowledge at the time of printing and is intended to give information of possible applications to a reader with technical experience. It constitutes neither an assurance of product properties nor does it release the user from the obligation of performing preliminary tests with the selected product. We recommend contacting our Technical Consulting Staff to discuss your specific application. If required and possible we will be pleased to provide a sample for testing.

Klüber products are continually improved. Therefore, Klüber Lubrication reserves the right to change all the technical data in this technical brochure at any time without notice.

## **We are where you are.**

Klüber Lubrication – the world market leader in speciality lubricants

- subsidiaries in over 30 countries
- more than 1,700 staff
- products available worldwide

Klüber Lubrication offers expert tribological solutions.

Through our worldwide presence, we meet customers' needs reliably and on time.

We supply tailor-made speciality lubricants to customers from nearly all branches of industry and around the world – oils, greases, bonded coatings, pastes and many more. Over 75 years of experience, industry-specific know-how, and exceptional test facilities all help to optimise our solutions.



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