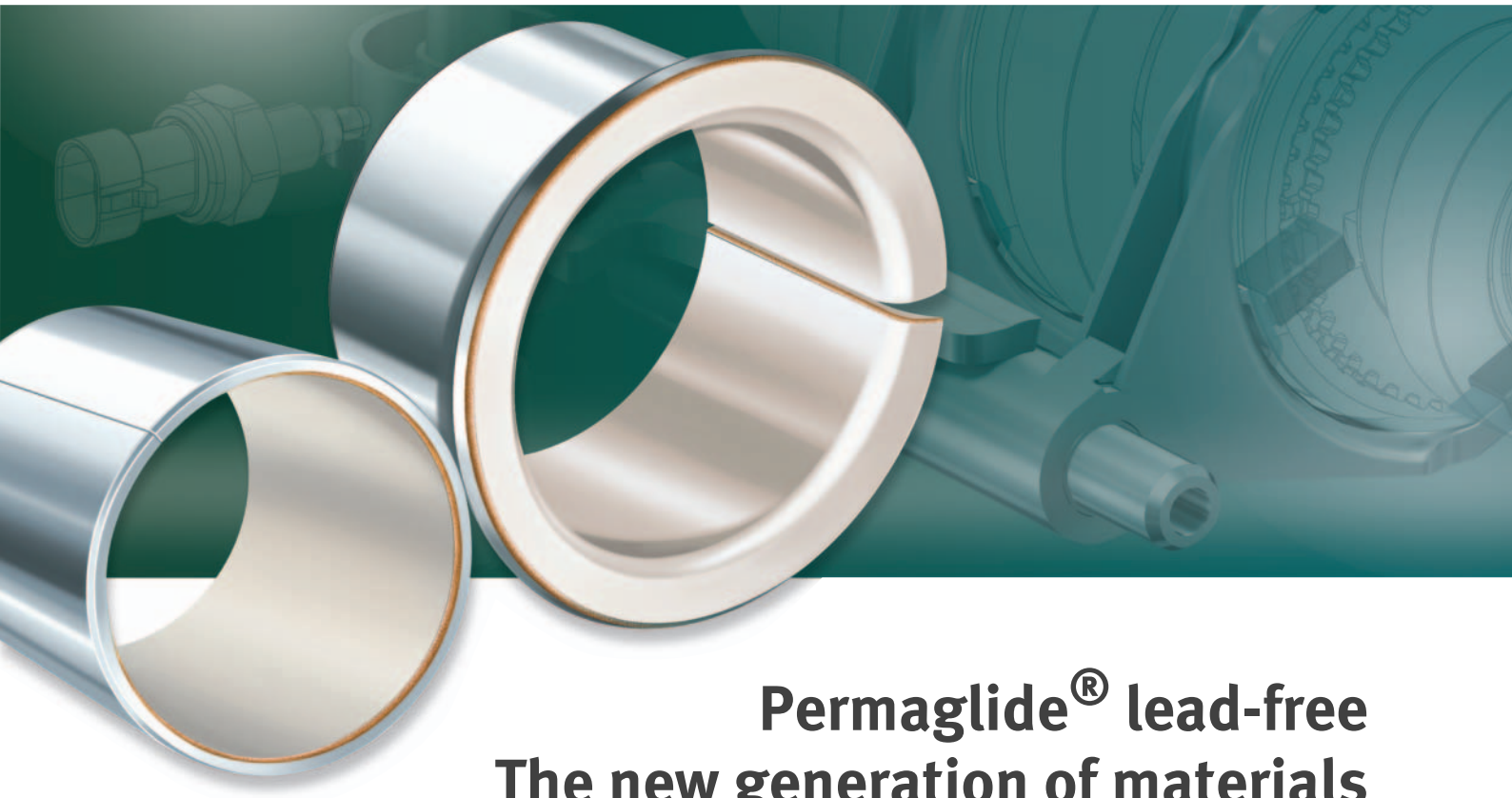

Permaglide® lead-free
The new generation of materials

Technical Product Information

SCHAEFFLER GROUP

Permaglide® Lead-free

The lead-free generation

High performance, environmentally friendly and compliant with environmental guidelines – this is the new generation of lead-free Permaglide® materials. Permaglide® P14 and P141 (with zinc sulphide) are the lead-free alternatives to lead-containing Permaglide® P10 and P11.

P14 has been developed for dry running, but can also be used in mixed friction and hydrodynamic applications.
Permaglide® P141 is intended for oil lubricated applications, but can also be used dry.

By replacing lead with zinc sulphide, these materials comply with Directive 2000/53/EC (End Of Life Vehicles Directive) and 2002/95/EC (RoHS). Bearings made from these new materials have shown very high performance in several applications and tests.

A comparison of characteristics is shown in Table 1.

End Of Life Vehicles Directive

Article 4 of Directive 2000/53/EC states that new vehicles may no longer contain certain substances:

- Member States shall ensure that materials and components of vehicles put on the market after 1 July 2003 do not contain lead, mercury, cadmium or hexavalent chromium other than in cases listed in Annex II under the conditions specified therein.

According to Annex II (dated 27 June 2002), bearings and bearing shells containing lead may continue to be used. Appendix II will be reviewed on a regular basis.

RoHS

Directive 2002/95/EC prohibits the use of lead in electrical and electronic devices as listed in 2002/96/EC (WEEE).

Table 1 · Comparison of characteristics

Technical data			P10[1]	P14[2]	P141[2]	Unit
Maximum pv value for dry running		pv	1,8	1,8	2	$N/mm^2 \cdot m/s$
Permissible specific bearing load	Static	p_{max}	250	250	250	N/mm^2
	Very low sliding speed	p_{max}	140	140	140	N/mm^2
	Rotating, oscillating	p_{max}	56	56	56	N/mm^2
Permissible sliding speed	Dry	v_{max}	2	2	2	m/s
	With oil lubrication	v_{max}	>3	>3	>5	m/s
Permissible operating temperature		ϑ	–200 to +280	–200 to +280	–60 to +260	°C

1) With lead.
2) Lead-free.

Permaglide® is a registered trademark
and product of KS Gleitlager GmbH, St. Leon-Rot.

P14 (Figure 1)

Plain bearings made from P14 have the following structure:

- Running-in layer ①:
  - polytetrafluoroethylene (PTFE) and zinc sulphide (ZnS), 0,01 mm to 0,03 mm thick
- Sliding layer ②:
  - porous bronze layer filled with PTFE/ZnS, 0,20 mm to 0,35 mm thick
- Steel backing ③
- Surface protection for steel backing ④:
  - tin, approx. 0,002 mm thick.

P143

This material is similar to P14, but is attached to a bronze backing, which is especially useful in applications that require greater corrosion resistance, increased thermal conductivity or antimagnetic properites. Plain bearings made from P143 are available by agreement.

P141 (Figure 2)

Plain bearings made from P141 have the following structure:

- Running-in layer ①:
  - polytetrafluoroethylene (PTFE) and zinc sulphide (ZnS) with wear-inhibiting additives ②, 0,01 mm to 0,03 mm thick
- Sliding layer ③:
  - porous bronze layer filled with PTFE/ZnS and wear-inhibiting additives, 0,20 mm to 0,35 mm thick
- Steel backing ④
- Surface protection for steel backing ⑤:
  - tin, approx. 0,002 mm thick.

P144

This material is similar to P141, but is attached to a bronze backing, which is especially useful in applications that require greater corrosion resistance, increased thermal conductivity or antimagnetic properites. Plain bearings made from P144 are available by agreement.

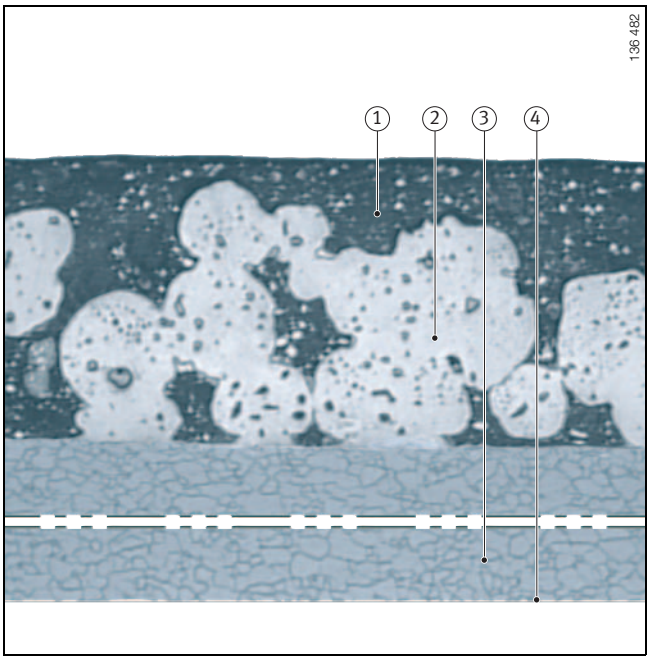

Figure 1 · Structure of P14

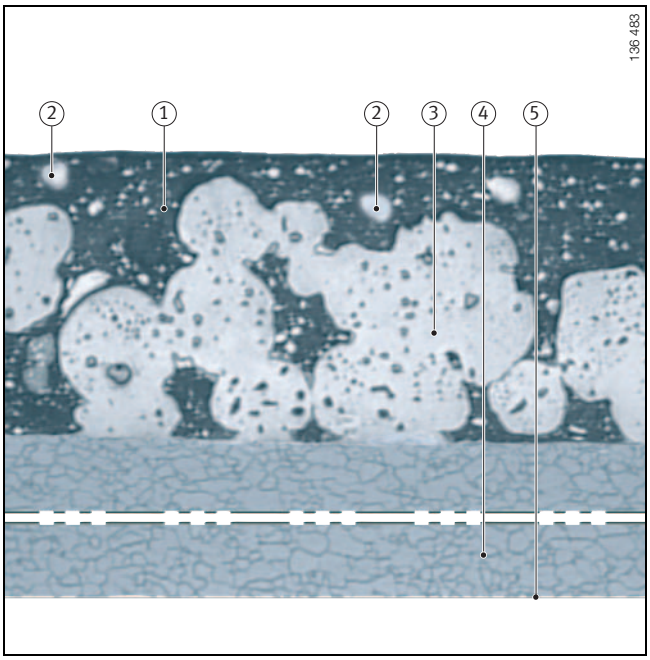

Figure 2 · Structure of P141

Dry Running Performance

Permissible operating range (Figure 3)

Figure 3 shows the permissible operating range for load and speed. At sliding speeds between 0,02 m/s and 0,8 m/s, the lead-free materials Permaglide® P14 and P141 can support higher loads than the lead-containing material P10.

At sliding speeds above 0,8 m/s P10 can support higher loads due to better heat dissipation.

Wear under dry running (Figure 4)

Compared with the material Permaglide® P10, the wear of P14 is reduced under the test conditions stated below. The wear-inhibiting additives in P141 reduce the wear further.

Friction (Figure 5)

In comparison with Permaglide® P10, the friction of both P14 and P141 is somewhat lower.

Test I – conditions

The values for wear and friction were determined under the following test conditions:

- Rotation
- Point load
- pv value
  - 0,84 N/mm^2 · m/s
- Sliding speed
  - v = **0,42 m/s**
- Specific load
  - p = **2 N/mm^2**
- Room temperature
- Shaft material
  - X155CrVMo121 (high carbon chromium, vandium, molybdenum steel)
- Shaft hardness
  - 50 HRC to 60 HRC
- Surface roughness of the shaft
  - R_z1,5.

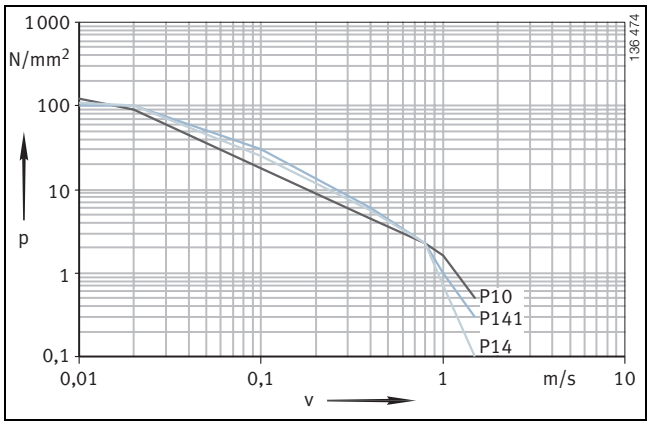

Figure 3 · Permissible operating range

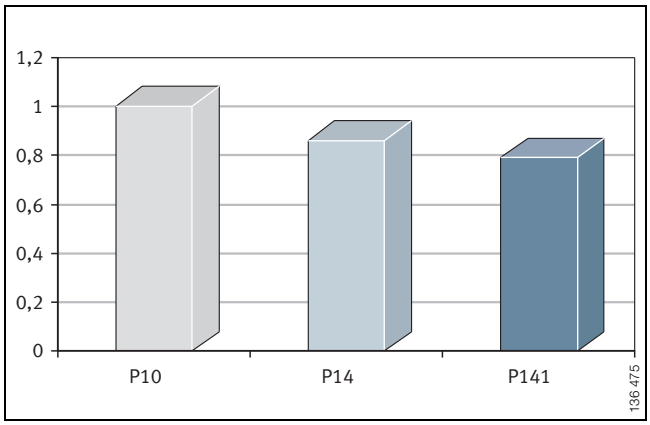

Figure 4 · Test I – Relative wear

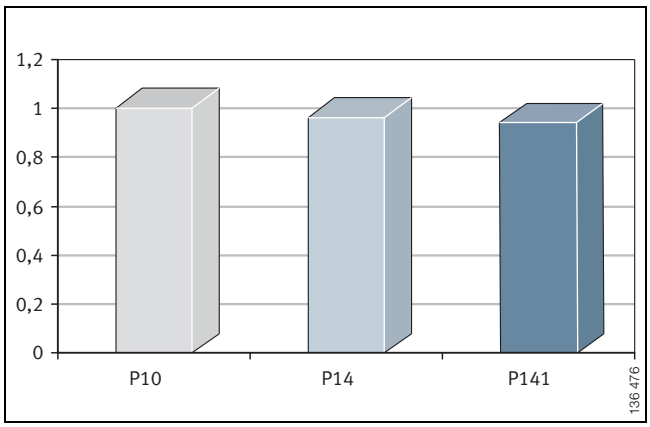

Figure 5 · Test I – Relative friction

Mean temperature curve (Figure 6)

The mean temperature curve for the lead-free material P14 is higher than for P10. The values illustrate the better thermal conductivity of P10. At higher sliding speeds, this effect is more pronounced.

Wear (Figure 7)

The pv value in Test II is the same as in Test I but with double the speed and half the load. The increased wear resistance of the lead-free materials is even more pronounced under these conditions.

Friction (Figure 8)

In Test II the friction shows similar behaviour to that of Test I. For both Permaglide® P14 and P141, a lower frictional torque was measured than for P10.

Test II – conditions

The values for wear and friction were determined under the following test conditions:

- Rotation
- Point load
- pv value
  – 0,84 N/mm^2 · m/s
- Sliding speed
  – v = **0,84 m/s**
- Specific load
  – p = **1 N/mm^2**
- Room temperature
- Shaft material
  – X155CrVMo121
  (high carbon chromium, vandium, moybdenum steel)
- Shaft hardness
  – 50 HRC to 60 HRC
- Surface roughness of the shaft
  – R_z1,5.

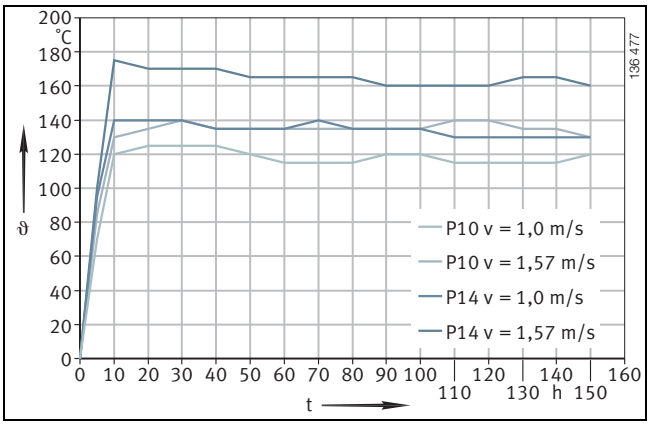

Figure 6 · Mean temperature curve

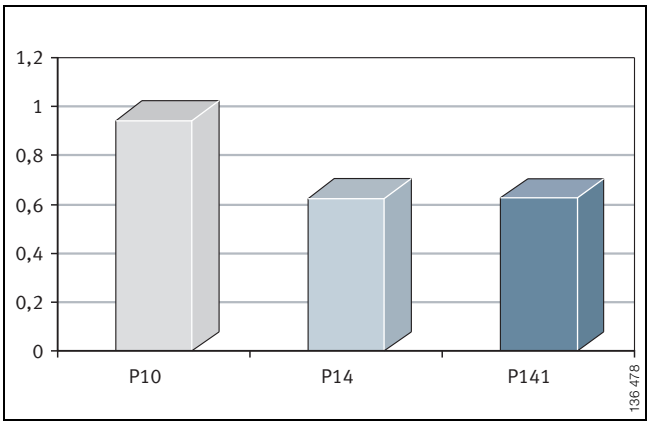

Figure 7 · Test II – Relative wear

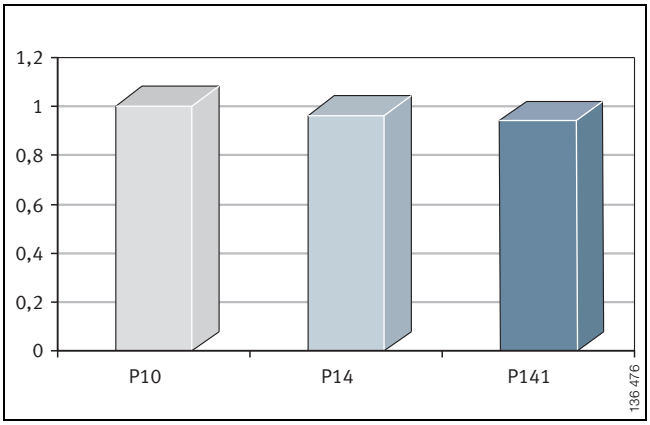

Figure 8 · Test II – Relative Friction

Wear (Figure 9)

In the axial motion described in Test III, oil lubricated P14 and P141 show significantly less wear during mixed friction operation.

Friction (Figure 10)

The friction values for P10, P14 and P141 are very similar under the mixed friction conditions of Test III.

Test III – conditions

The values for wear and friction were determined under the following test conditions:

- Axial motion
- Specific load
  - p = **5 N/mm**^{2}
- Stroke 1
  - travel 80 mm
  - frequency 1 Hz
  - thus v = 0,16 m/s
- Stroke 2
  - travel 8 mm
  - frequency 12 Hz
  - thus v = 0,192 m/s
- Temperature
  - +90 °C
- Test duration
  - 2 million load cycles
- Oil type
  - DEA 1579A (universal shock absorber oil).

Swelling tendency (Figure 11)

The swelling resistance of Permaglide® is proven in numerous media such as petroleum, diesel, kerosene and Biodiesel (RME) at temperatures up to +150 °C. The swelling tendency of the lead-free materials is significantly lower.

Test IV – conditions

The values for swelling tendency were determined under the following test conditions:

- Temperature
  - +150 °C
- Test duration
  - 528 h
- Oil type
  - Shell ATF3403 M115
- Initial sample thickness
  - 1,5 mm.

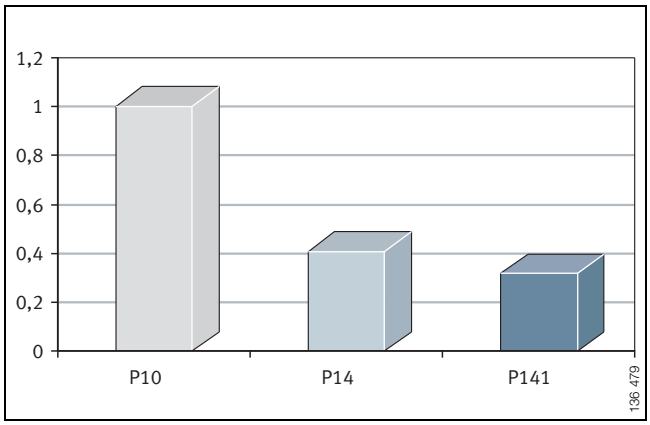

Figure 9 · Test III – Relative wear

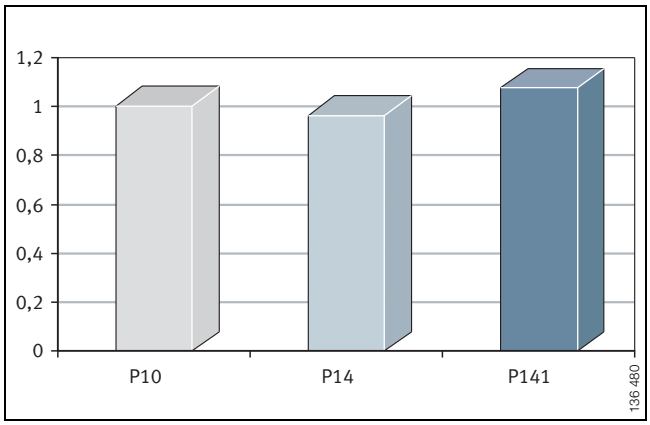

Figure 10 · Test III – Relative friction

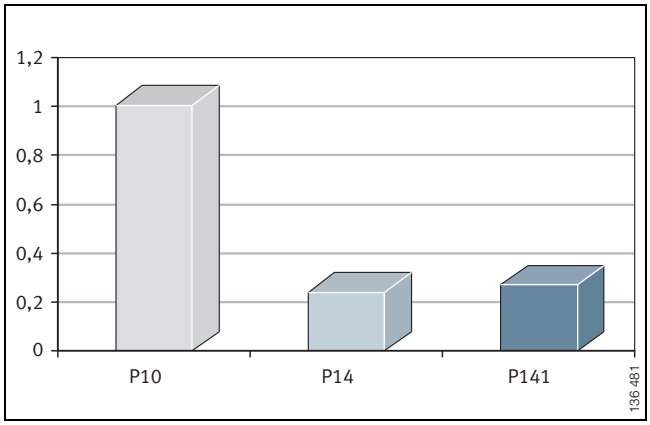

Figure 11 · Test IV – Swelling tendency

Application examples

Gear Pump – operating conditions

- Displacement: 120 cm^3
- Flow Volume: 3 l/s
- Pressure (p_{max}): 150 bar
- Speed (n_{max}): 2 000 rpm.

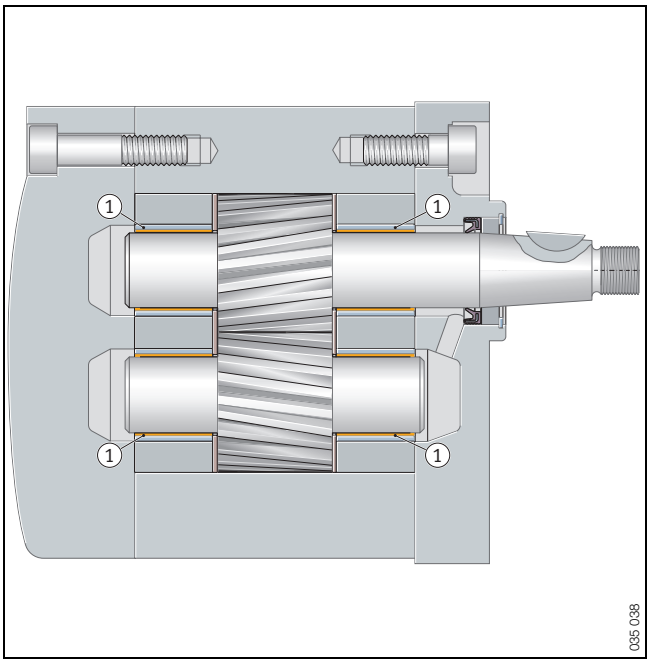

Figure 12 · Gear pump containing bushings ① made from P141 with rotary motion and hydrodynamic conditions

Electromagnet – operating data

- Nominal voltage: 24 V
- Nominal power: 14 W
- Continuous operation
- Adjustable stroke: 3 mm
- Complete stroke: 6 mm.

For additional Permaglide® application examples please request Publication ABP.

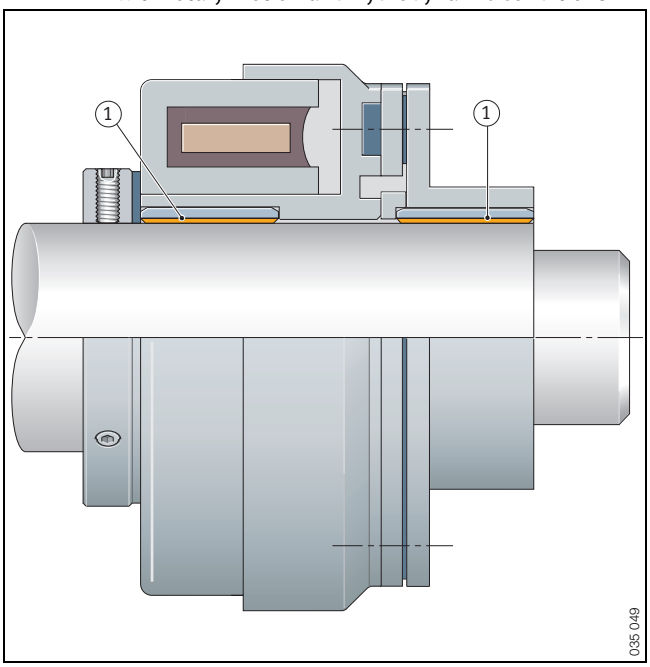

Figure 13 · Linear motion application of P14 bushings ① in an electromagnet

Sach-Nr. 027-499-421/TPI 113 GB-D ○ · Printed in Germany

INA-Schaeffler KG

Industriestrasse 1–3
91074 Herzogenaurach (Germany)
Internet www.ina.com
E-Mail Info@de.ina.com

In Germany:
Phone 0180 5003872
Fax 0180 5003873

From Other Countries:
Phone +49 9132 82-0
Fax +49 9132 82-4950

Every care has been taken to ensure the correctness of the information contained in this publication but no liability can be accepted for any errors or omissions.
We reserve the right to make changes in the interest of technical progress.
© by INA · 2005, September
This publication or parts thereof may not be reproduced without our permission.

TPI 113