KOENIG **Expander**®

Technical Information

Profile Projector – Measuring Instrument for in-process control of production.

Engineering: Design and development with state-of-the-art CAD-Design.

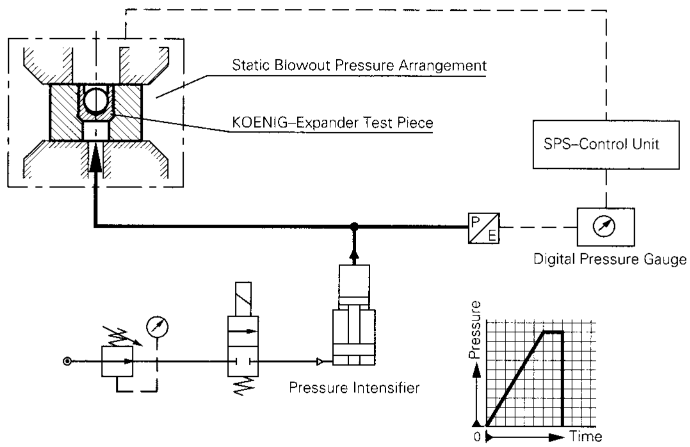
Contents *Page*

NOTES

Pressure Performance Tests–KOENIG-Expander

Test (A) Pressure Test To Failure

In Test (A) the KOENIG-Expander is subject to increasing static pressure until plug blowout occurs. These tests are done by KVT for functional testing during manufacturing runs. Each production lot (Batch No.) undergoes these tests.



Test (B) Temperature/Pressure Cycling

In Test (B) the KOENIG-Expander is subject to a long term test simulating practical conditions. This determines the pressure which can be applied (lower limit) without plug blowout, with intermittent pressure and varying temperature.

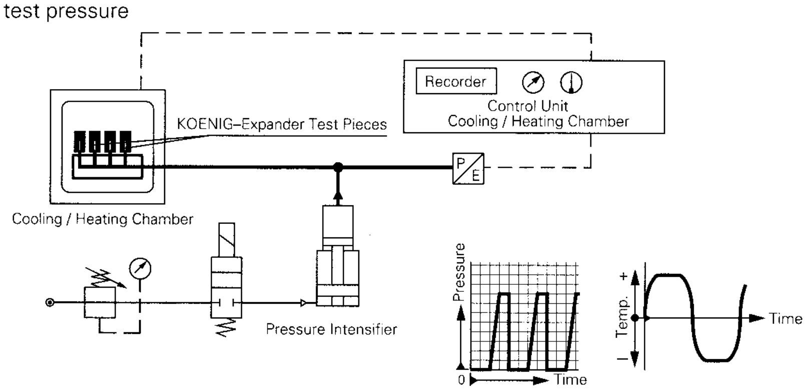
Conditions

Temperature : 2 hours at 100 °C, 2 hours at –40 °C
Series LK and LP, in some base materials, 2 hours at +150ºC, 2 hours at -40ºC.
temperature change: between 30 and 45 minutes.

Pressure : intermittent
2 minutes at 0 bar, 3 minutes at test pressure

Duration : 170 h (Long term test)

Drill Hole : Tolerances, roundness, and roughness per data sheets, plain surface
Distance from edge per data sheets



KOENIG Expander®

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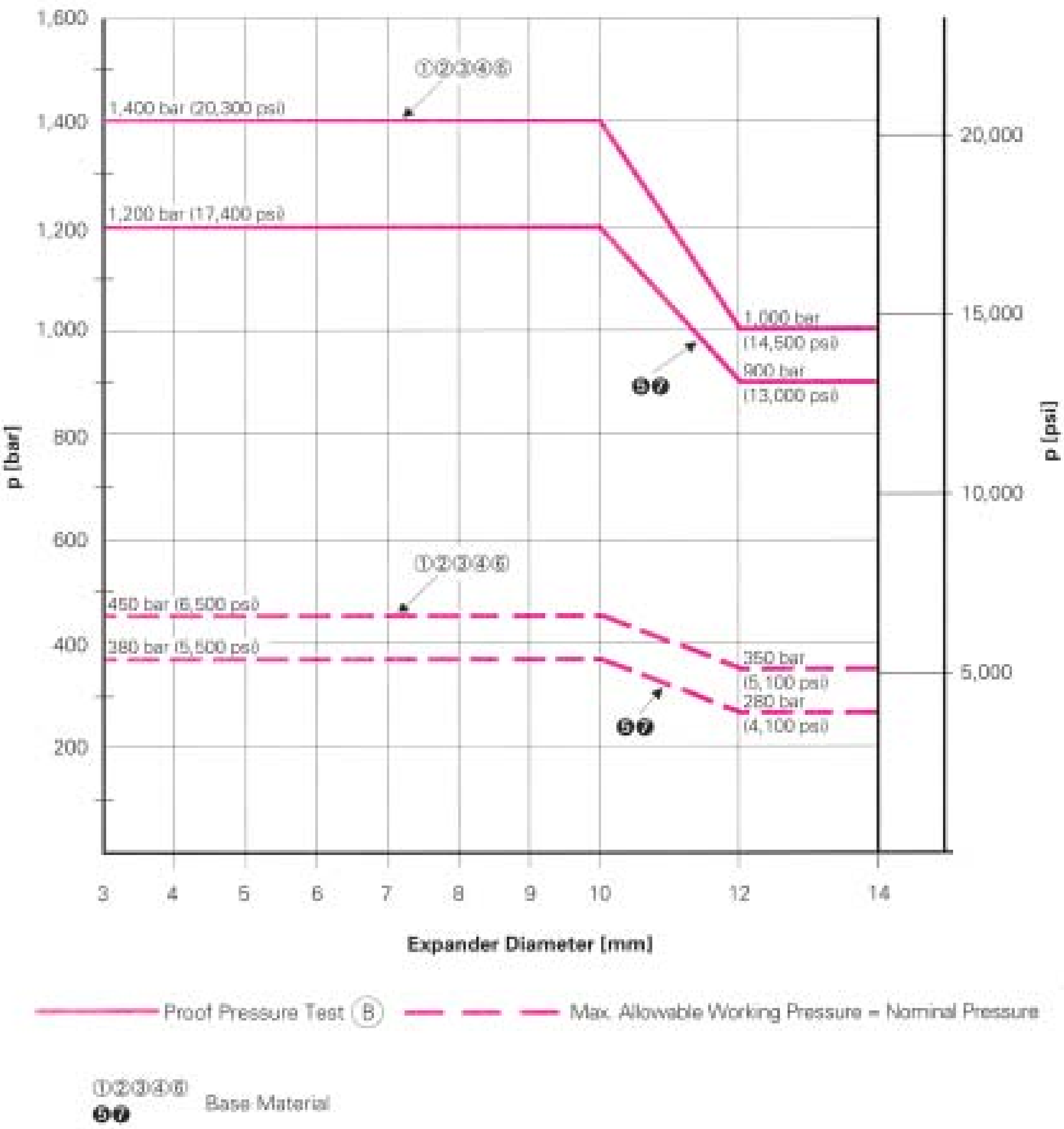
Pressure Performance MB 600

Sleeve Material: X 10 CrNiS 18 9
DIN 1. 4305

Tensile Strength Rm = 640 N/mm²
Hardness HB = 220



Pressure Performance MB 600

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) [N/mm^2]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm^2]	Hardness (min.) HB	Drilled Hole	
						Tolerance [mm]	Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	+ 0.1 0	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		anchorage in base metal
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
❺	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
❼	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

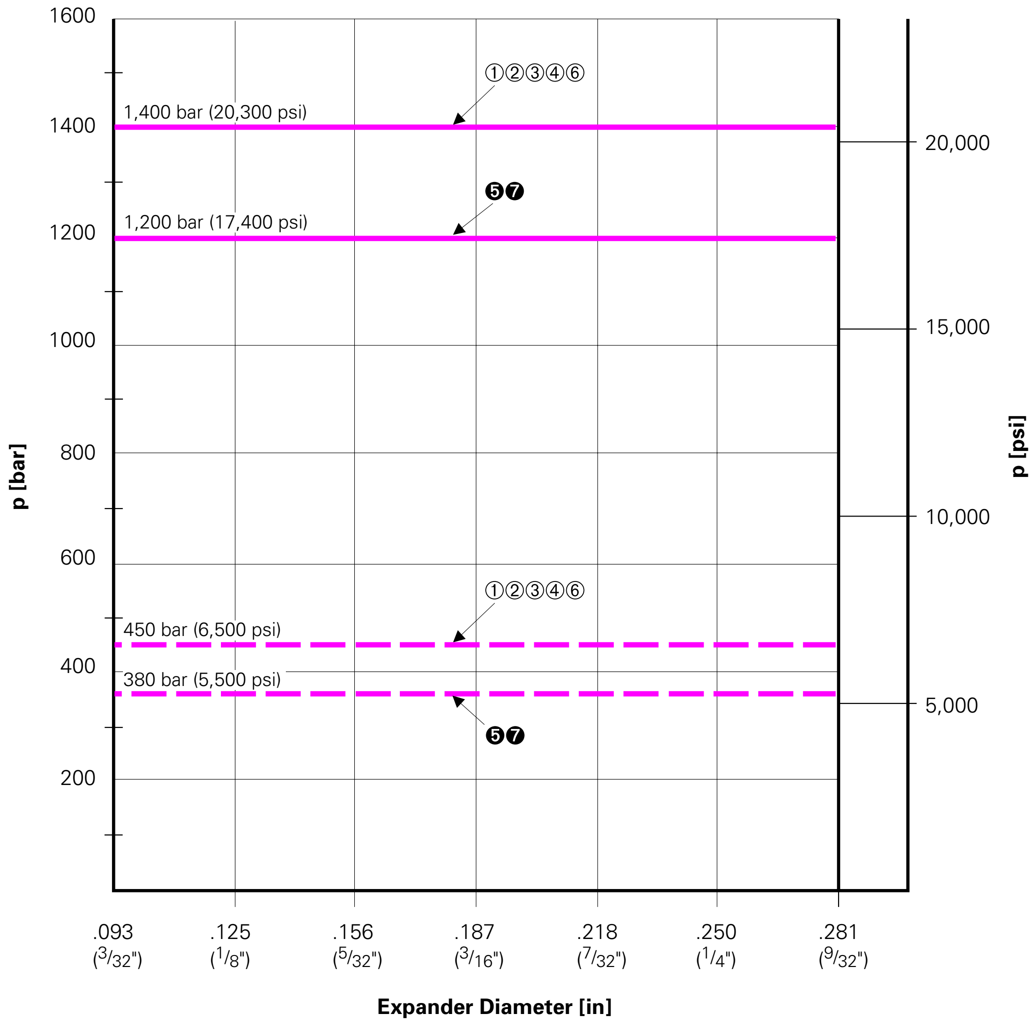
- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance MB 600, Inch-Version

Sleeve Material: X 10 CrNiS 18 9 DIN 1.4305 — **Tensile Strength Rm = 640 N/mm^2 Hardness HB = 220**



Proof Pressure Test (B) — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑥ ❺❼ Base Material

Pressure Performance MB 600, Inch-Version

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) [N/mm^2]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm^2]	Hardness (min.) HB	Drilled Hole Tolerance [in.]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	ø .093 $^{+0.002}_{0}$ from ø .125 $^{+0.004}_{0}$	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		anchorage in base metal
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
❺	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
❼	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

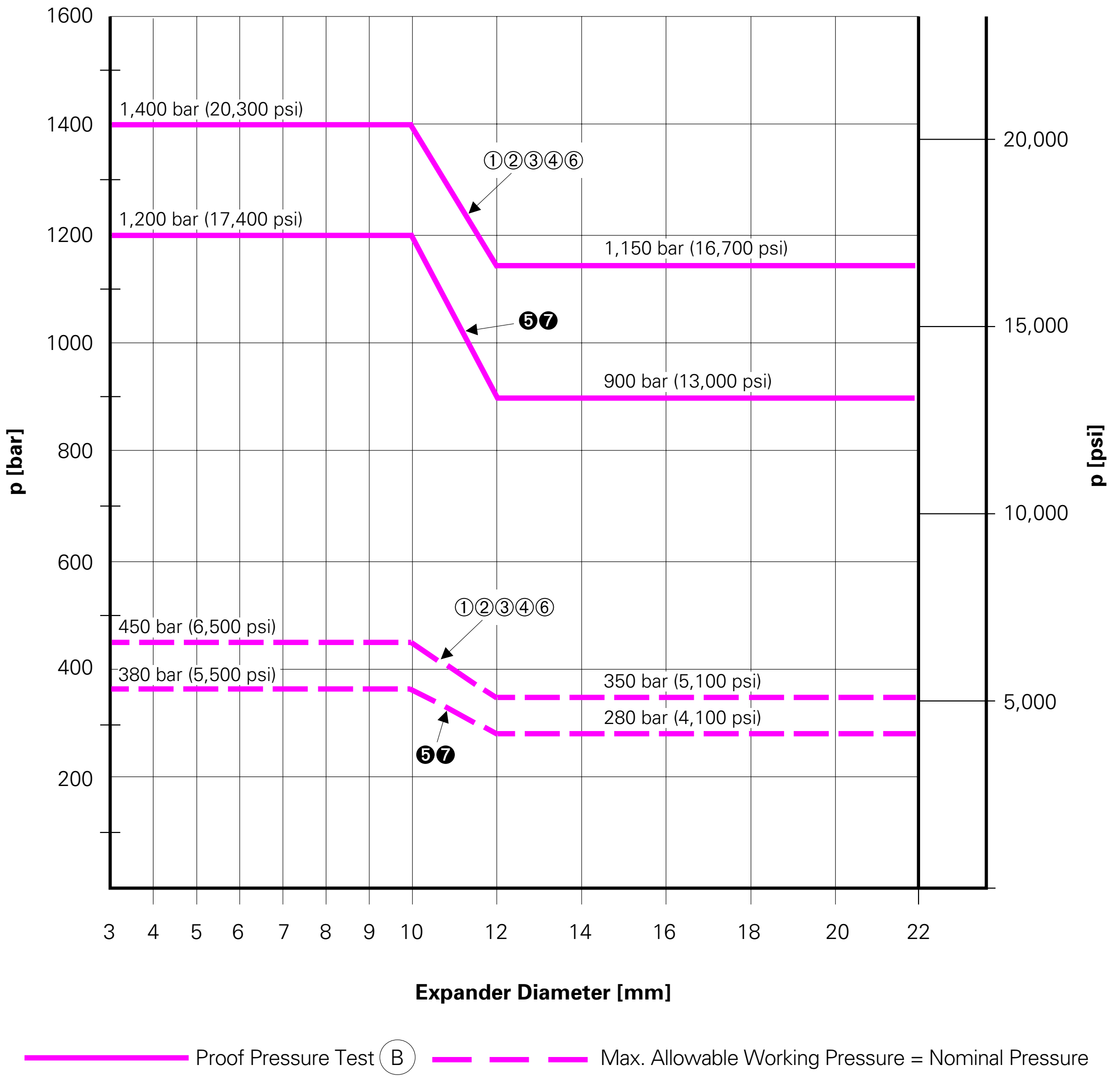
Security Range

The security range (the difference between working pressure and Test (B) pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test (A) and Test (B) pressure are reduced about 20% after this point.

Pressure Performance MB 700

Sleeve Material: Stainless Steel, AISI 303 DIN 1.4305

Tensile Strength Rm = 640 N/mm²
Hardness HB = 220



①②③④⑥
❺❼ Base Material

Pressure Performance MB 700

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

<table>
<tr><th colspan="2" rowspan="2">Base Material of the Installation</th><th rowspan="2">Tensile Strength (avg.) [N/mm²]</th><th rowspan="2">Elongation (min.) [%]</th><th rowspan="2">Ultimate Strength (avg.) Rp 0.2 [N/mm²]</th><th rowspan="2">Hardness (min.) HB</th><th colspan="2">Drilled Hole</th></tr>
<tr><th>Tolerance [mm]</th><th>Roughness R_z [µm]</th></tr>
<tr><td>①</td><td>High Strength St.
ETG-100
AISI 1144</td><td>1000</td><td>6</td><td>865</td><td>280</td><td rowspan="7">+ 0.1
0</td><td rowspan="2">10 to 30</td></tr>
<tr><td>②</td><td>Free Machining Case Hard. Stl.
C15 Pb
DIN 1.0403</td><td>560</td><td>6</td><td>300</td><td>180</td></tr>
<tr><td>③</td><td>Cast Iron
GG-25
DIN 1691</td><td>250</td><td>–</td><td>–</td><td>160</td><td rowspan="5">anchorage
in
base metal</td></tr>
<tr><td>④</td><td>Ductile Cast Iron
GGG-50
DIN 1693</td><td>500</td><td>7</td><td>320</td><td>170</td></tr>
<tr><td>❺</td><td>Aluminum Alloy
Al Mg Si Pb
DIN 3.0615
AA6262</td><td>340</td><td>8</td><td>300</td><td>90</td></tr>
<tr><td>⑥</td><td>Aluminum Alloy
Al Cu Mg 2
DIN 3.1354
AA2024</td><td>480</td><td>8</td><td>380</td><td>120</td></tr>
<tr><td>❼</td><td>Cast Al Alloy
G-Al Si 7 Mg
3.2371
AA356-T6</td><td>300</td><td>4</td><td>250</td><td>80</td></tr>
</table>

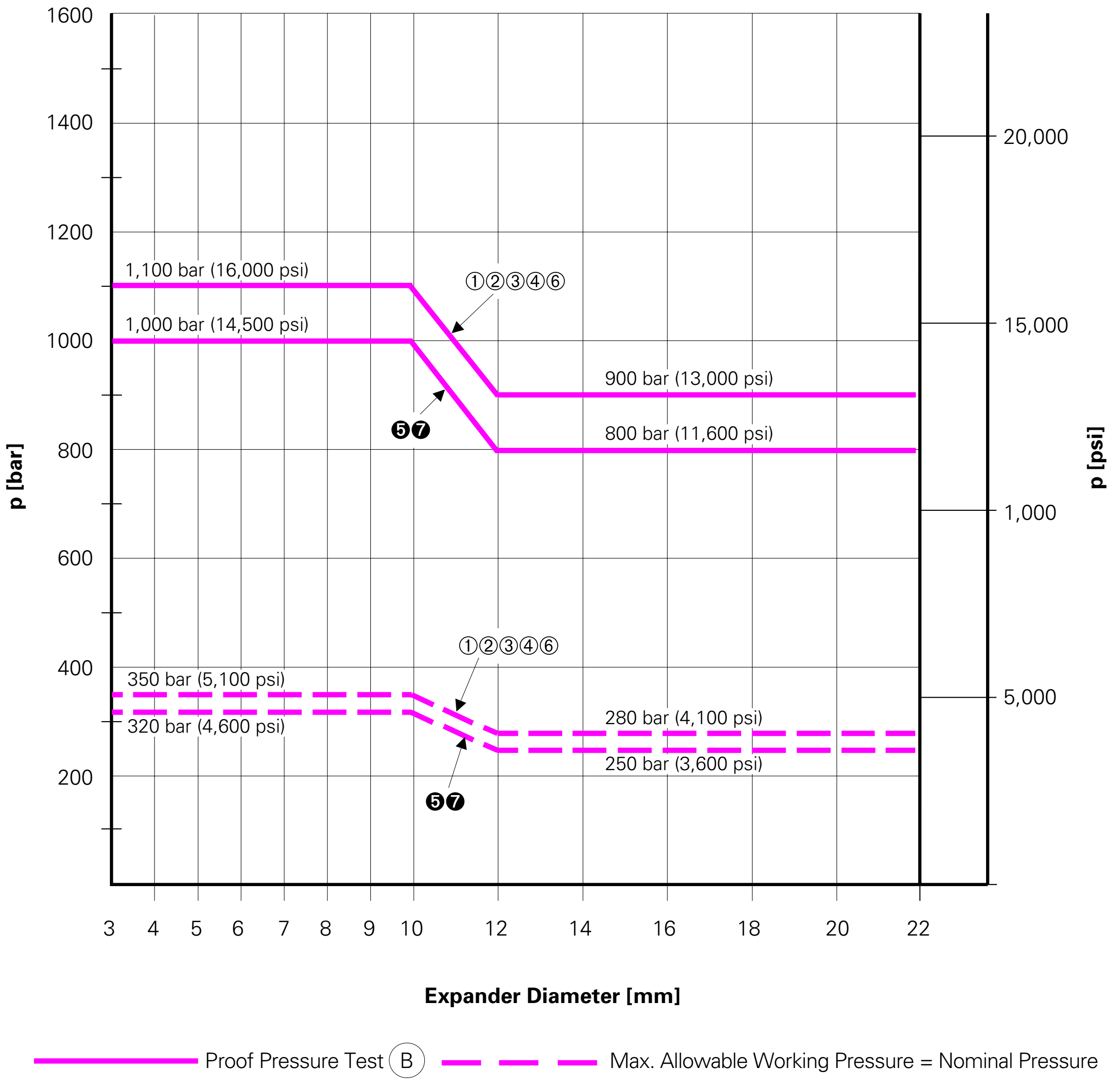
- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance MB 800

Sleeve Material: Case Hardening Steel DIN 1.0403 **Tensile Strength Rm = 500 N/mm^2** **Hardnesss H = 180**



①②③④⑥ ❺❼ Base Material

Pressure Performance MB 800

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) Rm [N/mm^2]	Elongation (min.) [%]	Ultimate Stength (avg.) Rp 0.2 [N/mm^2]	Hardness (min.) HB	Drilled Hole Tolerance [mm]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	+ 0.1 0	10 to 30
②	Free Machining CasehHard. St. C15Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
❺	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		anchorage in base metal
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
❼	Cast Al Alloy G-Al Si 7 Mg DIN 3.2371 AA356-T6	300	4	250	80		

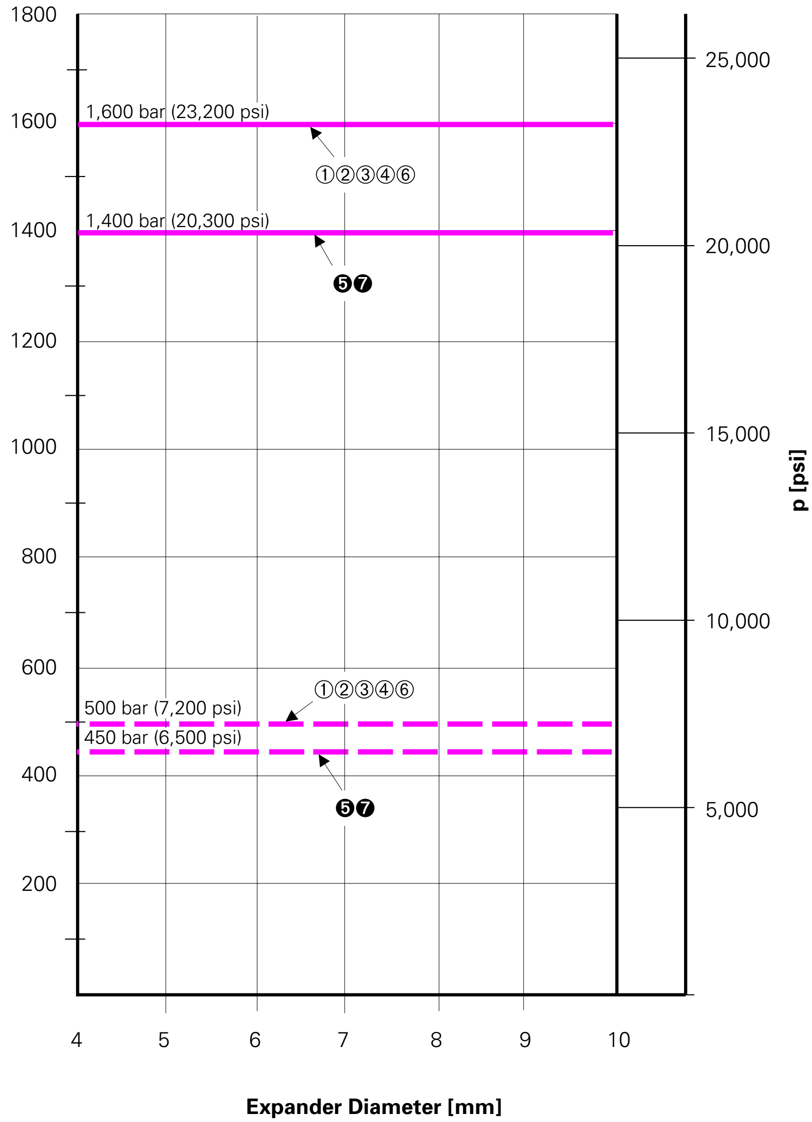
- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance Sidex-SK

Sleeve Material : Case Hardening Steel DIN 1.0403 **Tensile Strength Rm = 500 N/mm²** **Hardness HB = 180**



Proof Pressure Test Ⓑ — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑥ ❺❼ Base Material

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Pressure Performance Sidex-SK

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) [N/mm²]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm²]	Hardness (min.) HB	Drilled Hole Tolerance [mm]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	+ 0.12 / 0	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
❺	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		anchorage in base metal
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
❼	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- If pressure is applied to both sides of the Sidex-SK plug, allowable working pressure on the insertion side is reduced by 50%.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

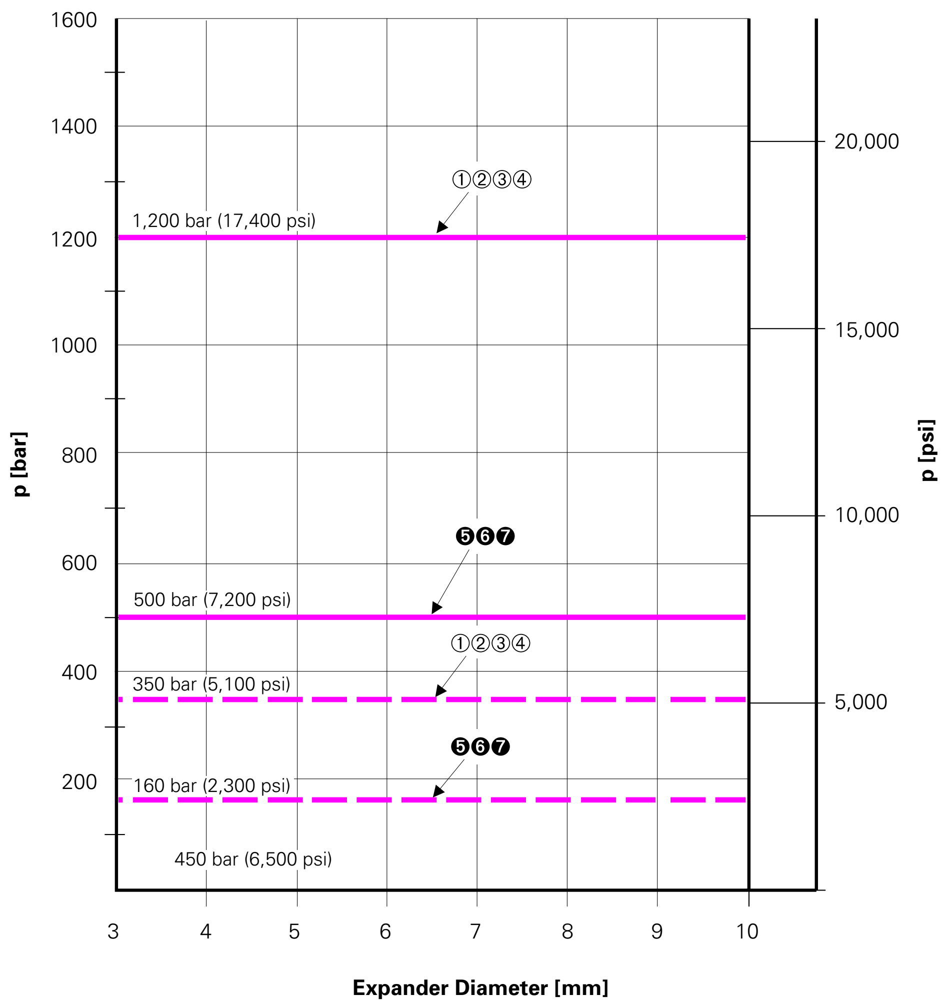
Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance HK 55

Sleeve Material : Case Hardening Steel, soft annealed DIN 1.0403

Tensile Strength Rm = 350 N/mm²
Hardness HB = 100



Proof Pressure Test (B) — — — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑥ ❺❼ Base Material

Pressure Performance HK 55

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

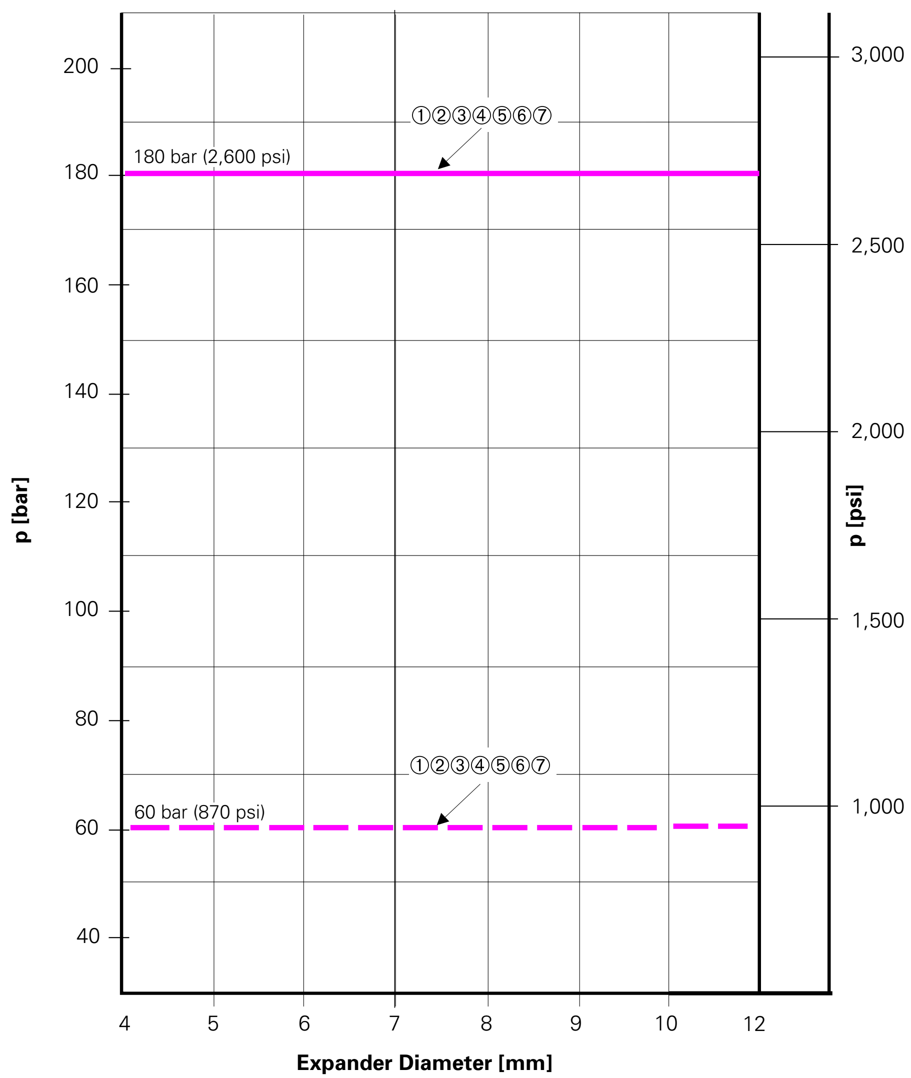
	Base Material of the Installation	Tensile Strength (avg.) [N/mm^2]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm^2]	Hardness (min.) HB	Drilled Hole Tolerance [mm]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	+ 0.1 0	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
❺	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		roughness anchoring not effective * anchorage in base metal not possible
❻	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
❼	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- If HK plugs are used to keep channels separate, allowable working pressure on the insertion side is reduced by 50%.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance LK 600



Proof Pressure Test Ⓑ — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑤⑥⑦ Base Material

①②③④⑤ Temperature range for Proof Pressure Test Ⓑ : -40ºC to +150ºC

⑥⑦ Temperature range for Proof Pressure Test Ⓑ : -40ºC to +100ºC

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Pressure Performance LK 600

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) [N/mm²]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm²]	Hardness (min.) HB	Drilled Hole	
						Tolerance [mm]	Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	+ 0.12 0	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		anchorage in base metal
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
⑤	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
⑦	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Series LK are not suitable for pressure load applied on the insertion side of plug.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test (B) pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test (A) and Test (B) pressure are reduced about 20% after this point.

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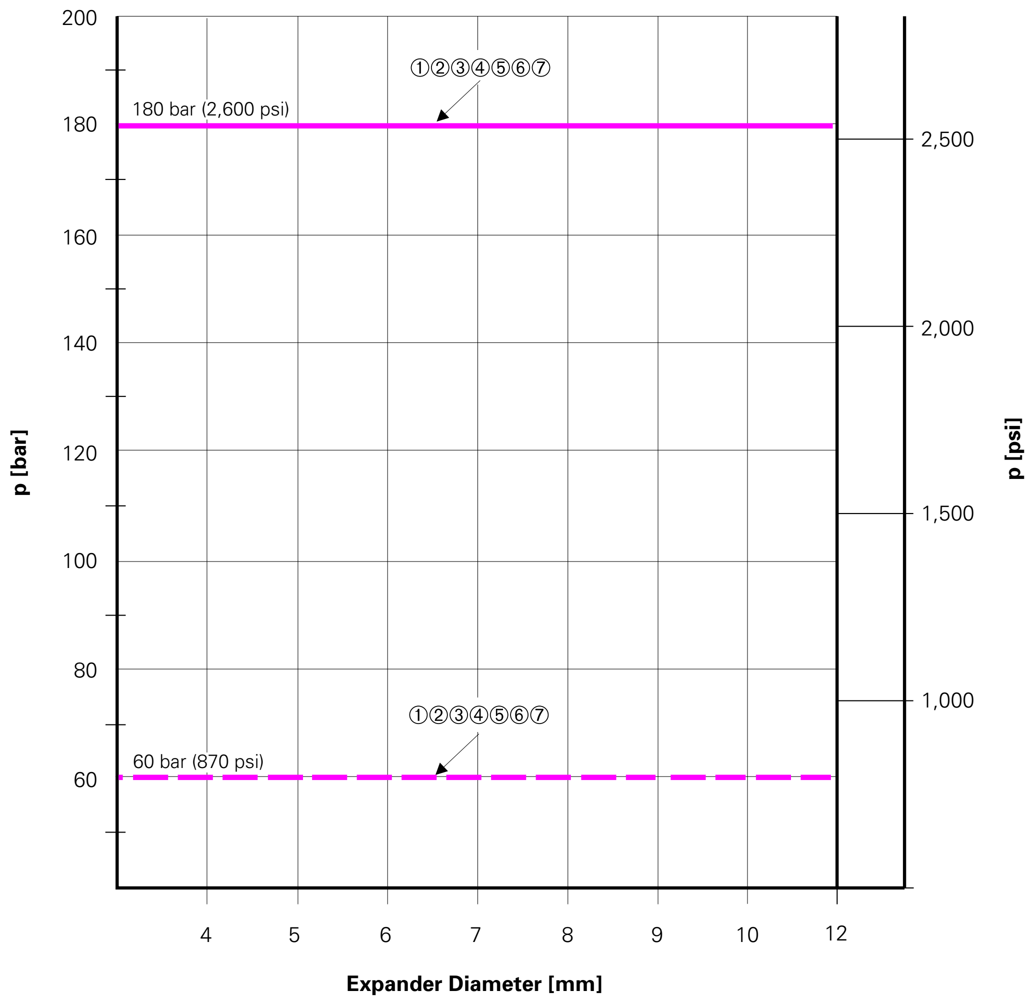
Pressure Performance LK 950



Proof Pressure Test (B) — — — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑤⑥⑦
Base Material

①②③④⑤ Temperature range for Proof Pressure Test (B) : -40ºC to +150ºC

⑥⑦ Temperature range for Proof Pressure Test (B) : -40ºC to +100ºC

Pressure Performance LK 950

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

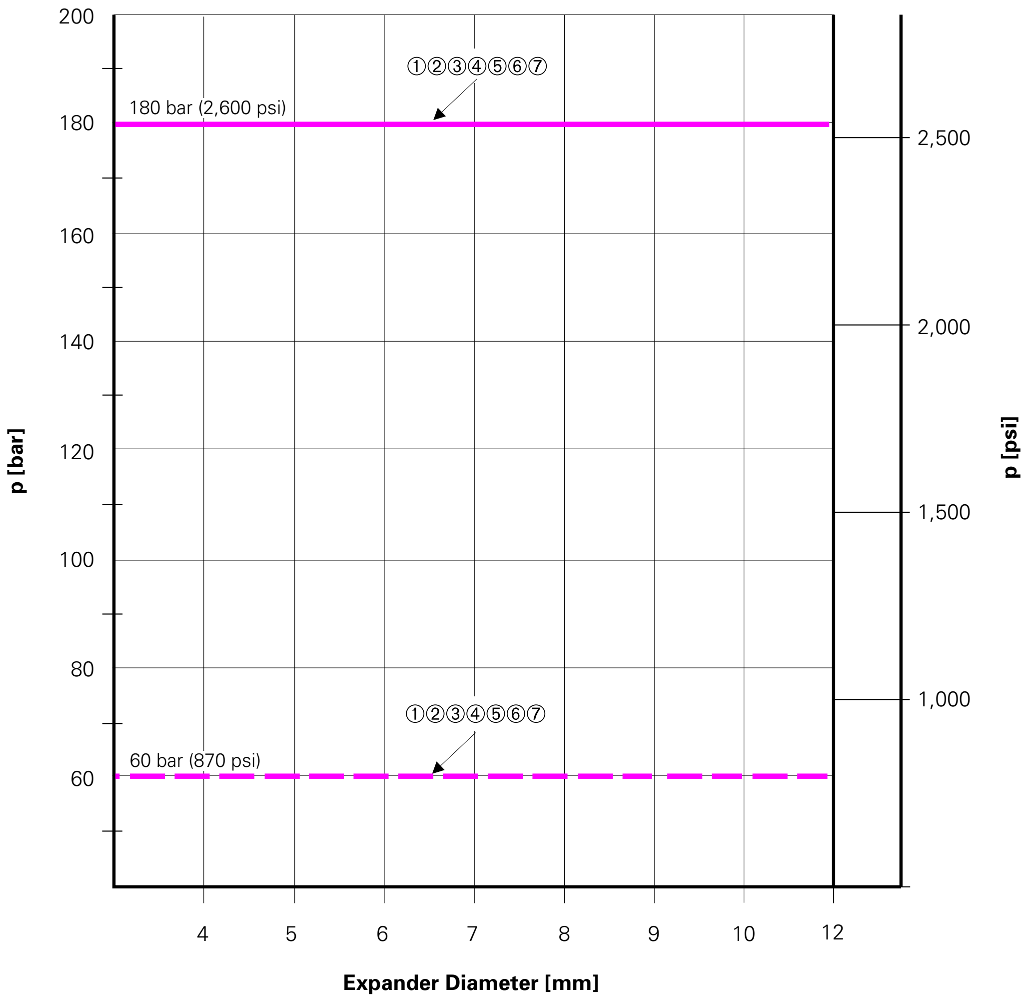
	Base Material of the Installation	Tensile Strength (avg.) [N/mm^2]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm^2]	Hardness (min.) HB	Drilled Hole Tolerance [mm]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	Diameter 4 to 12mm + 0.12 0	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
⑤	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		Partial Anchorage
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		10 to 30
⑦	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		Anchorage in base material

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Series LK are not suitable for pressure load applied on the insertion side of plug.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Pressure Performance LP 900



Proof Pressure Test Ⓑ — Max. Allowable Working Pressure = Nominal Pressure

①②③④⑤⑥⑦ Base Material

①②③④⑤ Temperature range for Proof Pressure Test Ⓑ : -40ºC to +150ºC

⑥⑦ Temperature range for Proof Pressure Test Ⓑ : -40ºC to +100ºC

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Pressure Performance LP 900

Installation Requirements

The working pressure specifications on the preceding page are obtainable under the following conditions.

	Base Material of the Installation	Tensile Strength (avg.) [N/mm²]	Elongation (min.) [%]	Ultimate Strength (avg.) Rp 0.2 [N/mm²]	Hardness (min.) HB	Drilled Hole Tolerance [mm]	Drilled Hole Roughness R_z [µm]
①	High Strength St. ETG-100 AISI 1144	1000	6	865	280	Diameter 3 to 12 mm (see data sheet)	10 to 30
②	Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180		
③	Cast Iron GG-25 DIN 1691	250	–	–	160		
④	Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170		
⑤	Aluminum Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90		anchorage in base metal
⑥	Aluminum Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120		
⑦	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6	300	4	250	80		

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Applications for other non-ferrous metals and non-metallic materials upon request.
- Factors which may lower the working pressure capability are:
  - anchorage principle
  - bore roughness requirements
  - design guidelines
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 µm is needed to achieve indicated working pressures.

Security Range

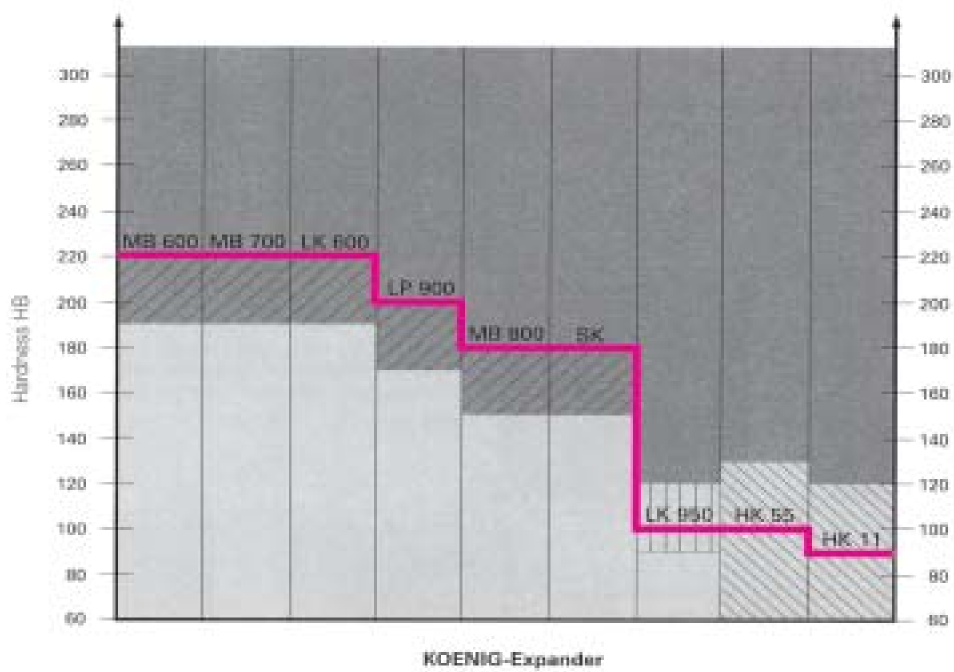
The security range (the difference between working pressure and Test Ⓑ pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test Ⓐ and Test Ⓑ pressure are reduced about 20% after this point.

Anchorage Principle

The required bore roughness is directly related to the hardness and the mechanical characteristics of the base material. Depending on the combination of sealing plug and base material, anchorage takes place either by the groove profile of the expander sleeve biting into the base material or on anchorage to the surface roughness of the bore.

NOTE: When selecting a KOENIG Expander the bore roughness must always be adjusted according to the hardness of the base material.

Anchorage principle related to base material



Hard base material: To achieve the allowable working pressure, anchorage to the bore roughness of the base material is required. **Roughness R_z = 10 to 30 μm.**

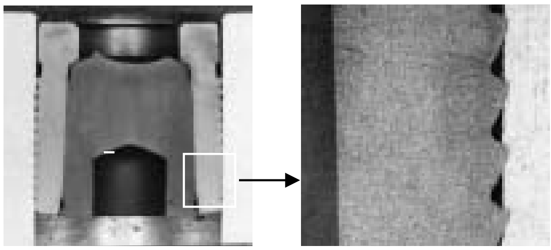
Soft base material: Anchorage to the bore of the base material occurs automatically due to the serrations on the sleeve of the KOENIG-Expander.

Soft base material: Anchorage is not possible with the HK 55 and HK 11 Series. Such combinations are not allowed **for high pressure applications**.

Transition zone: To achieve the allowable working pressure, anchorage to the bore roughness of the base material is required. **Roughness R_z = 10 to 30 μm.**

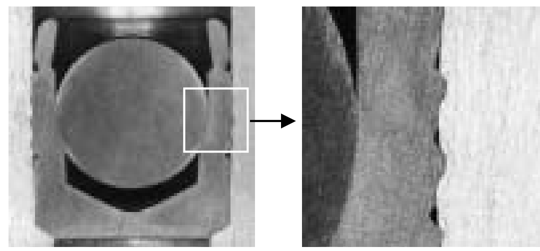
Transition zone: To provide for the allowable pressure rating, the serration of the sleeve, anchors into the base material.

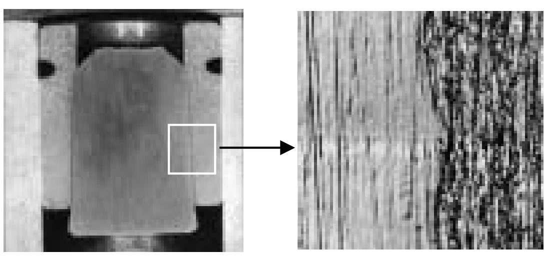
Anchorage Principle



Anchorage due to plug sleeve serrations
KOENIG Expander **Series SK**
in aluminum alloy HB=90

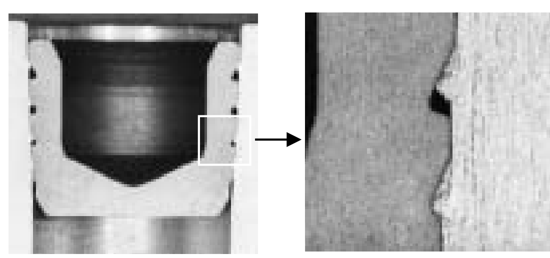
Anchorage due to plug sleeve serrations
KOENIG Expander **Series MB 800**
in aluminum alloy HB = 90

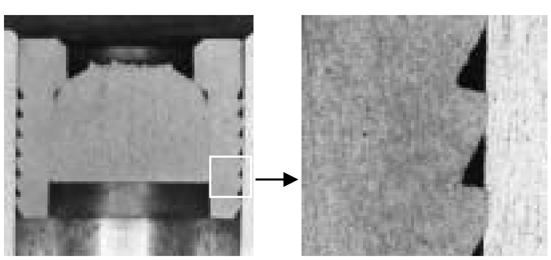




Anchorage due to bore roughness
KOENIG Expander **Series HK 55**
in gray cast iron HB = 160

Anchorage due to plug sleeve serrations
KOENIG Expander **Series LP 900**
in aluminum alloy HB = 90





Anchorage due to plug sleeve serrations
KOENIG Expander **Series LK 950**
in aluminum alloy HB = 90

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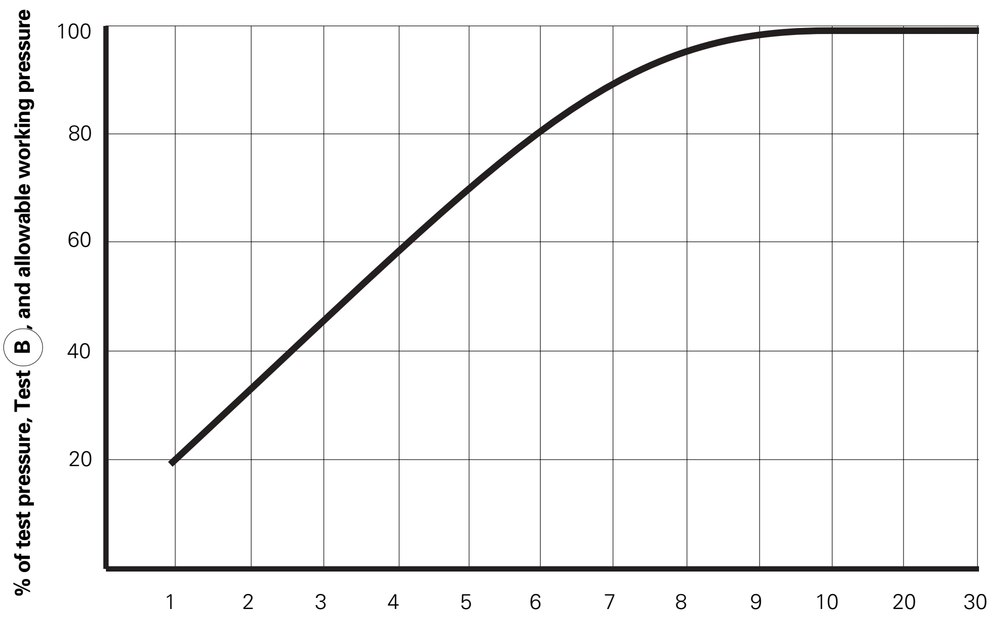
Bore Roughness Requirements

When installing KOENIG-Expanders in hard base material no positive anchoring is possible. So, to attain suitable working pressures and anchorage, it is necessary to have a bore roughness of Rz=10-30 µm. At a roughness greater than Rz=10-30 µm leakage might occur.

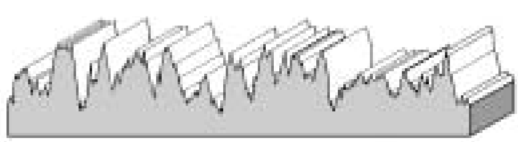
Pressure performance correlation to bore roughness.



Roughness R_Z [µm]
(Approximate)

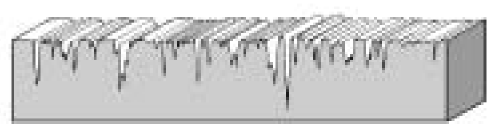
Roughness Profile

Required roughness profile



The ideal bore roughness for anchorage is attained by drilling with a twist drill or core drill.

Undesirable roughness profile

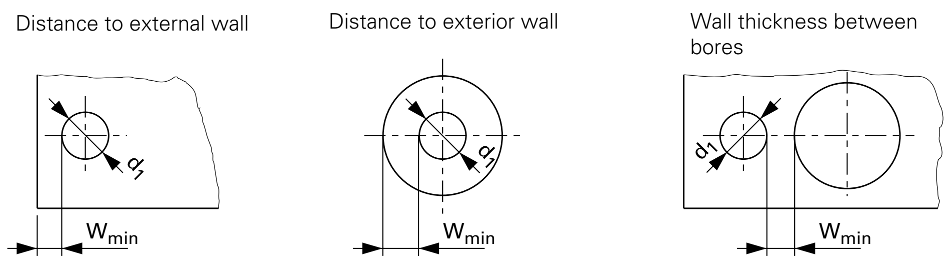


By reaming, a one-sided, smooth roughness profile is created. This is not desirable.

Design Guidelines

Wall thickness/distance from edge

As the radial expansion of the KOENIG Expander sleeve occurs, the base material in which it will be anchored plastically deforms. The resultant strength, as well as the hydraulic pressure and temperature service conditions depending on the expander type and characteristics of the base material, require minimum wall thickness, or distance from edge.



The guideline values for minimum wall thickness and distance from edge (Wmin) express these influencing factors. At these minimum values, only slight deformation on the exterior profile of the base material of less than 20 µm is likely. This does not affect the function of the KOENIG Expander. Below the guideline values (Wmin) the possibility of overloading the base material exists, which can adversely influence the function of the KOENIG Expander. In such cases tests must be conducted.

Guideline values W_{min} for wall thickness and distance from edge

At KOENIG Expander diameters **$d_1 \geq$ 4mm: $W_{min} = f_{min} \cdot d_1$**
$d_1 <$ 4mm: $W_{min} = f_{min} \cdot d_1 + 0.5$ mm

		①	②	③	④	⑤	⑥	⑦
Base Material	Description	ETG 100	C 15Pb	GG-25	GGG-50	AlCuMg2	AlMgSiPb	G-AlSi7Mg
	Avg. tensile strength [N/mm^2]	1000	560	250	500	480	340	300
	Min. elongation A5 [%]	6	6	–	7	8	8	4
	Avg. ultimate strength $R_{P\,0.2}$ [N/mm^2]	865	300	–	320	380	300	250
KOENIG Expander Series		Factor $f_{min.}$						
MB 600		0.6	0.8	1.0	0.8	0.8	1.0	1.0
MB 600, Inch-Version		0.6	0.8	1.0	0.8	0.8	1.0	1.0
MB 700		0.6	0.8	1.0	0.8	0.8	1.0	1.0
MB 800		0.5	0.6	1.0	0.6	0.6	1.0	1.0
SK		0.5	0.6	1.0	0.6	0.6	1.0	1.0
HK 55		0.4	0.5	0.8	0.5	0.5	0.8	0.8
HK 11		0.4	0.5	0.8	0.5	0.5	0.8	0.8
LP 900		0.3	0.3	0.5	0.3	0.4	0.5	0.5
LK 600		on demand						
LK 950		on demand						

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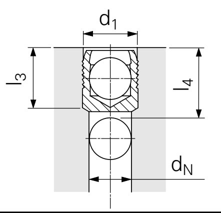
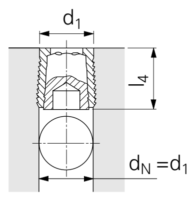
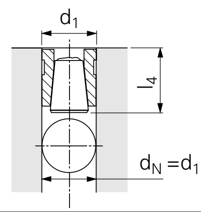
Design Guidelines

Required Installation Lengths

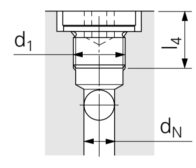
Dimensions in MM







Comparison



d_N	MB			Sidex-SK		HK				Threaded Plugs	
						HK 55		HK 11		DIN 908	
	d_1	l_3 min	l_4 min*	d_1	l_4 max	d_1	l_4 max	d_1	l_4 max	d_1	l_4 max
2.0	3.0	3.4	5.0								
3.0	4.0	3.8	5.5			3.0	7.0	3.0	6.5		
4.0	5.0	5.3	7.0	4.0	6.5	4.0	8.0	4.0	8.0		
5.0	6.0	6.3	8.5	5.0	7.5	5.0	9.5	5.0	10.0	M 8x1	11.5
6,0	7.0	7.3	9.5	6.0	8.0	6.0	10.0	6.0	10.0	M 8x1	11.5
7.0	8.0	8.3	11.0	7.0	9.0	7.0	11.0	7.0	10.5	M10x1	12.0
8.0	9.0	9.8	12.5	8.0	10.5	8.0	11.5	8.0	13.5	M10x1	12.0
9.0	10.0	10.8	13.5	9.0	11.0	9.0	13.0	9.0	13.0	M12x1.5	16.0
10.0	12.0	12.8	16.0	10.0	12.5	10.0	13.5	10.0	15.5	M12x1.5	16.0
12.0	14.0	14.5	18.0					12.0	15.0	M14x1.5	16.5
14.0	16.0	16.5	20.0							M16x1.5	16.5
16.0	18.0	18.5	22.5							M18x1.5	17.5
18.0	20.0	21.5	25.5							M20x1.5	19.5
20.0	22.0	24.5	28.5							M22x1.5	19.5

d_N = given nominal bore/system bore size

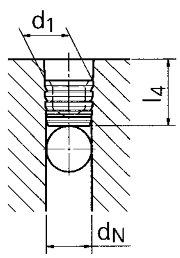
* Installation Lengths MB Series

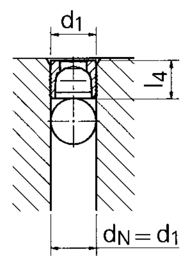
The required installation length (l_4) min. for MB plugs is for base materials with hardness greater than HB=90. For softer materials, deeper installation is required.

Design Guidelines

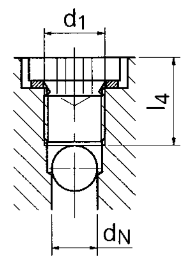
Required Installation Lengths

Dimensions in MM





Comparison



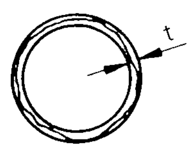
d_N	LP Series		LK Series		Threaded Plugs DIN 908	
	d_1	l_4 max	d_1	l_4 max	d_1	l_4 max
4.0	4.40	7.0	4.0	4.0		
5.0	5.40	8.0	5.0	4.8	M8x1	11.5
6.0	6.40	8.5	6.0	5.3	M8x1	11.5
7.0	7.40	8.5	7.0	5.8	M10x1	12.0
8.0	8.45	9.5	8.0	6.8	M10x1	12.0
9.0	9.60	10.0	9.0	6.8	M12x1.5	16.0
10.0	10.65	11.0	10.0	6.8	M12x1.5	16.0
12.0	12.75	12.0	12.0	7.8	M14x1.5	16.5

$\mathbf{d_N}$ = given nominal bore / system bore size

Design Guidelines

Roundness Tolerance

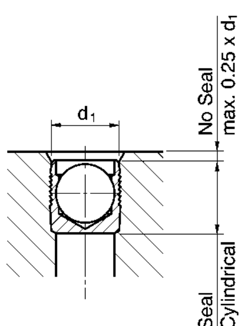
To assure reliable functioning of the KOENIG-Expander with regard to pressure performance and to assure leak tight sealing, a **roundness tolerance of t=0.05 mm** must be held.



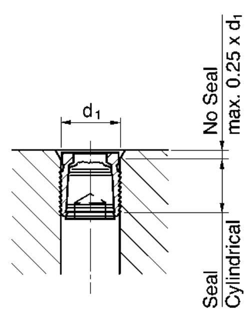
By using a double lipped twist drill, the called out hole and roundness tolerances are reached. Better tolerances, particularly for larger diameter holes, can be held by using a triple lipped twist drill.

Conicity of the Bore

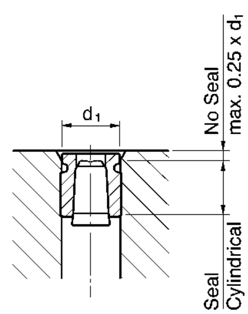
Within the **effective sealing area** of the KOENIG Expander, the bore must be according to the dimensional sheets. The bore lead in can be beveled up to a depth of **0.25 x d_1 (LK: 0.15 x d_1)** because this area has no significant effect on the sealing function.



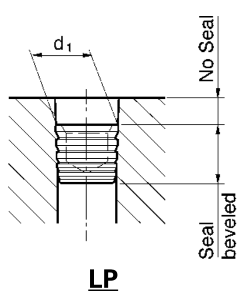
MB



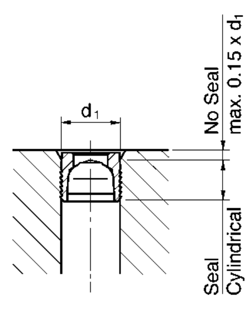
SK



HK



LP



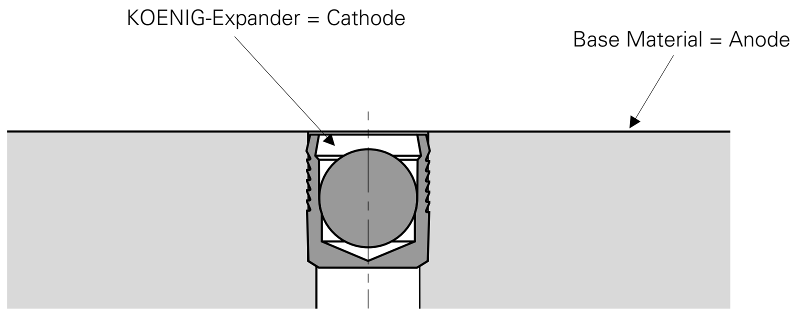
LK

Galvanic Corrosion

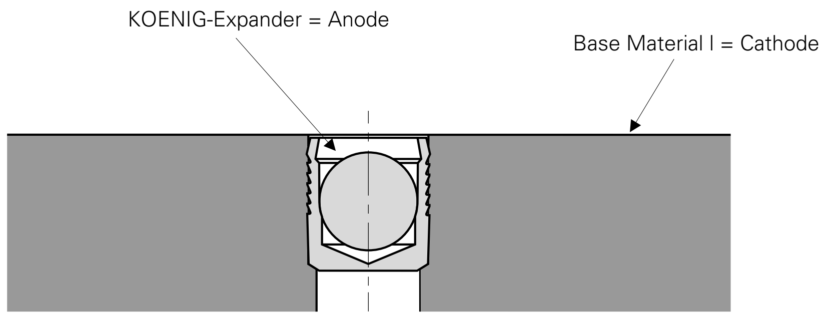
In choosing a KOENIG Expander you must consider that the material of the sealing plug and the material of the production piece can show different electrical potentials. In the presence of an electrolyte (e.g. 5% Water-NaCl solution), this potential difference causes electrochemical attack on the least noble of the metals in contact - galvanic corrosion. In this case, either the base material or its surface protection will become the anode and will be transferred to the pure metal of the cathode. The corrosion speed or the current density will be determined by the relative surface area or volume of the anode and cathode as illustrated below.

Cathode

Anode



Large Anode Area → Low Current Density at the Anode → **Slow Corrosion**



Small Anode Area → High Current Density at the Anode → **Fast Corrosion**

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Galvanic Corrosion

Effect of Galvanic Corrosion

The following table shows the expected galvanic corrosion behavior of KOENIG Expanders in common base materials allowing for the relative surface areas of both metals, which influences the speed of corrosion.

Base Material	KOENIG Expander Series								
	MB 600	MB 700	MB 800	SK	HK 55	HK 11	LP 900	LK 600	LK 950
Steel, carbon/low alloy, plain	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Steel, carbon/low alloy, Zn plated, chromate	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Steel, carbon/low alloy, phosphatized	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Nitrided or case hardening steel	behavior depends on the method used								
Stainless steel, DIN 1.4305, AISI 303	Not accelerated	Not accelerated	Accelerated	Accelerated	Accelerated	Accelerated	Accelerated	Not accelerated	Accelerated
Stainless steel, DIN 1.4005, AISI 416	Not accelerated	Not accelerated	Accelerated	Accelerated	Accelerated	Accelerated	Accelerated	Not accelerated	Accelerated
Cast iron, GG, DIN 1691, plain	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Cast iron, GG, DIN 1691, Zn plated, chromate	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Cast iron, GG DIN 1691, phosphatized	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Ductile cast iron, GGG DIN 1693, plain	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Ductile cast iron, GGG DIN 1693, Zn plated, chromate	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Ductile cast iron, GGG DIN 1693 phosphatized	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Marked acceleration	Lightly accelerated	Lightly accelerated	Lightly accelerated
Aluminum alloy, Ws-Nr. 3.3211, AA 6061	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Aluminum alloy, Ws-Nr. 3.0615, ~AA 6262	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Aluminum alloy, Ws-Nr. 3.1354, AA 2024	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Aluminum alloy, Ws-Nr. 3.4365, AA 7075	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Cast aluminum alloy, Ws-Nr. 3.2371, AA 356-T6	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Cast aluminum alloy, Ws-Nr. 3.2373	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated
Cast aluminum alloy, Ws-Nr. 3.2381	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated	Not accelerated	Lightly accelerated	Lightly accelerated	Lightly accelerated

Key to the galvanic corrosion behavior of KOENIG-Expanders in the presence of an electrolytic medium installed in base materials per the above table:

- Not accelerated
- Lightly accelerated
- Accelerated
- Marked acceleration

Suggestions to prevent galvanic corrosion

- Chose materials with no or low potential difference.
- Use corrosion reducing designs, i.e. if possible prevent the accumulation of fluids on the outer surface of the workpiece.
- By using suitable surface coatings, corrosion attack can be considerably reduced.

Salt spray testing per DIN 50021 can be done in our lab.

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Hardness Conversion Table for Hardenable Carbon and Low Alloy Steel.

Taken from DIN 50150-Issued 12/76

Tensile Strength 2) N/mm²	Vickers-Hardness (F ≥ 98 n)	Brinell-Hardness 1) $(0{,}102 \cdot \frac{F}{D^2} = 30 \frac{N}{mm^2})$	Rockwell Hardness HRB	HRC	HRA
255	80	76			
270	85	80.7	41		
285	90	85.5	48		
305	95	90.2	52		
320	100	95	56.2		
335	105	99.8			
350	110	105	62.3		
370	115	109			
385	120	114	66.7		
400	125	119			
415	130	124	71.2		
430	135	128			
450	140	133	75		
465	145	138			
480	150	143	78.7		
495	155	147			
510	160	152	81.7		
530	165	156			
545	170	162	85		
560	175	166			
575	180	171	87.1		
595	185	176			
610	190	181	89.5		
625	195	185			
640	200	190	91.5		
660	205	195	92.5		
675	210	199	93.5		
690	215	204	94		
705	220	209	95		
720	225	214	96		
740	230	219	96.7		
755	235	223			
770	240	228	98.1	20.3	60.7
785	245	233		21.3	61.2
800	250	238	99.5	22.2	61.6
820	255	242		23.1	62
835	260	247	(101)	24	62.4
850	265	252		24.8	62.7
865	270	257	(102)	25.6	63.1
880	275	261		26.4	63.5
900	280	268	(104)	27.1	63.8
915	285	271		27.8	64.2
930	290	276	(105)	28.5	64.5
950	295	280		29.2	64.8
965	300	285		29.8	65.2
995	310	295		31	65.8
1030	320	304		32.2	66.4
1060	330	314		33.3	67
1095	340	323		34.3	67.6
1125	350	333		35.5	68.1

Tensile Strength 2) N/mm²	Vickers-Hardness (F ≥ 98 n)	Brinell-Hardness 1) $(0{,}102 \cdot \frac{F}{D^2} = 30 \frac{N}{mm^2})$	Rockwell Hardness HRB	HRC	HRA
1155	360	342		36.6	68.7
1190	370	352		37.7	69.2
1220	380	361		38.8	69.8
1255	390	371		39.8	70.3
1290	400	380		40.8	70.8
1320	410	390		41.8	71.4
1350	420	399		42.7	71.8
1385	430	409		43.6	72.3
1420	440	418		44.5	72.8
1455	450	428		45.3	73.3
1485	460	437		46.1	73.6
1520	470	447		46.9	74.1
1555	480	(456)		47.7	74.5
1595	490	(466)		48.4	74.9
1630	500	(475)		49.1	75.3
1665	510	(485)		49.8	75.7
1700	520	(494)		50.5	76.1
1740	530	(504)		51.1	76.4
1775	540	(513)		51.7	76.7
1810	550	(523)		52.3	77
1845	560	(532)		53	77.4
1880	570	(542)		53.6	77.8
1920	580	(551)		54.1	78
1955	590	(561)		54.7	78.4
1995	600	(570)		55.2	78.6
2030	610	(580)		55.7	78.9
2070	620	(589)		56.3	79.2
2105	630	(599)		56.8	79.5
2145	640	(608)		57.3	79.8
2180	650	(618)		57.8	80
	660			58.3	80.3
	670			58.8	80.6
	680			59.2	80.8
	690			59.7	81.1
	700			60.1	81.3
	720			61	81.8
	740			61.8	82.2
	760			62.5	82.6
	780			63.3	83
	800			64	83.4
	820			64.7	83.8
	840			65.3	84.1
	860			65.9	84,4
	880			66.4	84.7
	900			67	85
	920			67.5	85.3
	940			68	85.6

Numbers in brackets indicate hardness values, which are outside the definition area of the standard hardness test, but actually often used as approximate values.
But the Brinell values in brackets are only used when measured with a hard metal ball.
1) Calculated as: HB = 0.95 HV
2) The tensile strength values shown in the table are only to be used as approximate values. To get the exact tensile strength values a tensile test must be performed.

SI-Units

The following table gives an overview of the SI units used in this catalog.
NOTE: Units listed in previous conversion tables, are no longer valid according to the international unit system (SI).

Measurement	Symbol	SI-Unit (Name)	Other Valid Units	Relationship Between SI-Units
Length	l	m (Meter)		
Area	A	m^2 (Sq. meter)	a (Are), ha (Hectare)	1 a = 100 m^2
Volume	V	m^3 (Cubic meter)	l (Liter)	1 l = 1 dm^3
Time	t	s (Second)	min (Minute), h (Hour), d (Day)	1 min = 60 s 1 h = 3600 s
Speed	v	m/s	km/h	1 km/h = 0.2778 m/s
Frequency	f	Hz (Hertz)	1/s	1 Hz = 1/s
Revolutions	n	1/s	1/min	
Weight	m	kg (Kilogramm)	g (Gram), t (Ton)	1 t = 1000 kg
Tightness	ϱ	kg/m^3		
Force	F	N (Newton)		1 kg m/s^2
Torque	M	Nm		
Pressure	P	Pa (Pascal)	bar (Bar) mm Hg (Millimeters of mercury)	1 Pa = 1 N/m^2 1 bar = 10^5 Pa 1 mm Hg = 1.3332 · 10^2 Pa
Mech. Tensile Strength	σ,τ R	N/mm^2	Pa	1 N/mm^2 = 10^6 Pa
Volumetric Flow	$\mathring{V}$	m^3/s		
Temperature	T	K (Kelvin)	°C	°C = K - 273.15 ΔT °C = ΔT K

Conversion Table
Former units in comparison and relationship to the SI system

Units of Force

	N	kp. kgf	dyn
1 N	1	0.102	10^5
1 kp. 1 kgf	9.81	1	$9.81 \cdot 10^5$
1 dyn	10^{-5}	$1.02 \cdot 10^6$	1

Mechanical Tensile Strength:

	Pa	N/mm^2	kp/mm^2
1Pa=1N/m^2	1	10^{-6}	$1.02 \cdot 10^{-7}$
1 N/mm^2	10^6	1	0.102
1 kp/mm^2	$9.81 \cdot 10^6$	9.81	1

Units

Pressure Units for Fluid Power:

	Pa (N/m²)	bar (daN/cm²)	N/mm² (M Pa)	daN/mm²	kp/cm²) (at, atü)	kp/mm²
1 Pa (1 N/m²)	1	10^{-5}	10^{-6}	10^{-7}	$1.02 \cdot 10^{-5}$	$1.02 \cdot 10^{-7}$
1 bar (1 daN/cm²)	10^{5}	1	0.1	10^{-2}	1.02	$1.02 \cdot 10^{-2}$
1 N/mm² (1 MPa)	10^{6}	10	1	0.1	10.2	0.102
1 daN/mm²	10^{7}	100	10	1	102	1.02
1 kp/cm² (1 at, 1 atü)	$9.81 \cdot 10^{4}$	0.981	$9.81 \cdot 10^{-2}$	$9.81 \cdot 10^{-3}$	1	10^{-2}
1 kp/mm²	$9.81 \cdot 10^{6}$	98.1	9.81	0.981	100	1

SI-Unit or per standard approved units.

SI-Prefixes (decimal multipliers for SI units):

Factor	Symbol	Name
0,000,001 = 10^{-6}	µ	Micro
0,001 = 10^{-3}	m	Milli
0,01 = 10^{-2}	c	Centi
0,1 = 10^{-1}	d	Deci
1 = 10^{0}	–	–
10 = 10^{1}	da	Deca
100 = 10^{2}	h	Hecta
1,000 = 10^{3}	k	Kilo
1,000,000 = 10^{6}	M	Mega

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American and British Measure Units

Conversion of commonly used American (US) and British (UK) units to SI Units

Measurement	Name	Symbol	Conversion	
Length	mil		1 mil	= 25.4 µm
	inch	in	1 in = 1000 mils	= 25.4 mm
	foot	ft	1 ft = 12 in	= 0.3048 m
Area	square inch	sq in (in^2)	1 sq in	= 6.4516 cm^2
	square foot	sq ft (ft^2)	1 sq ft = 144 sq in	= 929.03 cm^2
Volume	cubic inch	cu in (in^3)	1 cu in	= 16.3871 cm^3
	cubic foot	cu ft (ft^3)	1 cu ft	= 28.3168 dm^3
	US gallon	gal	1 US gal	= 3.785 dm^3 = 3.785 l
Weight	ounce	oz	1 oz	= 28.3495 g
	pound	lb	1 lb	= 0.453592 kg
Force	pound-force	lbf	1 lbf	= 4.44822 N
	ounce-force	ozf	1 ozf	= 0.278014 N
	UK ton-force	UK tonf	1 UK tonf	= 9964.02 N
	US ton-force	US tonf	1 US tonf	= 8896.44 N
Pressure	pound-force per square inch	lbf/in^2, psi	1 lbf/in^2 = 1 psi	= 6.89476 kPa = 0.0689476 bar
Temperature	Degrees Fahrenheit	°F	°C	= (°F -32) · $^5/_9$

NOTES

Quality Assurance KOENIG-Expander

Quality Assurance per ISO 9001, ISO 14001, and QS-9000 (4th Qtr. 2001) is very important to us. Koenig (KVT) / Sherex is committed to a system of "Total Quality Management" (TQM) to constantly improve our quality of service to our customers.

Clear specifications
In cooperation with our suppliers

Exact instructions and procedures
For all employees

Controls
For inspection

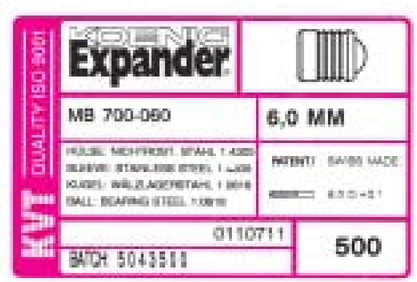
Process control
In production and assembly

Quality control
Through statistical techniques such as SPC, Norm charts, etc.

Design control
In development, projects, and revisions.

Employee training
Through regular internal auditing and implementation of Quality Circles

NOTE: All KOENIG-Expanders are labeled on their package with a Batch Number identification. This Batch Number guarantees traceability of all pertinent quality characteristics from production and procurement.



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