Needle roller and cage assemblies for crank pins and piston pins
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**Product overview**
Needle roller and cage assemblies for crank pins and piston pins ........................................................ 2

**Features**
Needle roller and cage assemblies for crank pins ...................... 3
Needle roller and cage assemblies for piston pins ..................... 3
Special designs ........................................................................ 3

**Design and safety guidelines**
Guidance of the connecting rod................................................. 4
Design of adjacent parts ........................................................... 5
Preferred enveloping circle diameter of needle roller and cage assemblies ............................................ 5
Calculation of rolling bearings in crank mechanisms............... 6
Design brief for crank mechanism bearing arrangements .......... 7

**Accuracy**
Geometrical tolerances ............................................................. 8
Radial internal clearance........................................................... 10
Sort plan for crank pin bearing arrangements ......................... 10
Sort plan for piston pin bearing arrangements .......................... 11

**Ordering example, ordering designation**
................................................................................................ 11

**Dimension tables**
Needle roller and cage assemblies for crank pins ...................... 12
Needle roller and cage assemblies for piston pins ..................... 13
Product overview  Needle roller and cage assemblies for crank pins and piston pins

For crank pins  KZK

For piston pins  KBK
Needle roller and cage assemblies for crank pins and piston pins

**Features**

Needle roller and cage assemblies for connecting rod bearing arrangements are used in the crank mechanisms of 2 and 4 stroke engines as well as in compressors for supporting crank pins and piston pins. They consist of cages equipped with needle rollers, support high centrifugal and acceleration forces and are suitable for high speeds.

They require very little radial space since the radial section height only corresponds to the diameter of the needle rollers. They give bearing arrangements with high runout accuracy which is, however, influenced by the geometrical accuracy of the raceways. The radial internal clearance is dependent on the needle sort as well as the shaft and housing tolerances and can be adjusted by means of the needle roller sort.

Needle roller and cage assemblies for crank pins

Needle roller and cage assemblies for crank pins are externally guided, which means that the connecting rod bore guides the cage radially with defined clearance. The radial movement of the cage in relation to the connecting rod bore and the rolling elements is as small as possible.

The cages are made from quenched and tempered steel, have good wear resistance, exhibit high strength and their large guidance surfaces are designed for optimum lubrication.

Needle roller and cage assemblies for piston pins

Needle roller and cage assemblies for piston pins are internally guided, which means that the piston pin guides the cage radially with defined clearance. Due to their small radial internal clearance, tilting of the connecting rod is reduced to a minimum. The needle roller and cage assemblies support high frequency oscillating loads and are available for the majority of piston pin diameters in various widths, in accordance with the piston boss spacing.

The steel cages are case hardened or quenched and tempered, exhibit good wear resistance and have high strength.

Further information

For further information on needle roller and cage assemblies:
- Catalogue HR 1, Rolling Bearings.

Special designs

Depending on the performance requirements, variants are possible in relation to:
- material
- heat treatment
- coating
- cage profile
- needle roller profile.

Further information

For further information on coatings:
- TPI 186, Higher Performance Capacity Through the Use of Coatings.
Needle roller and cage assemblies for crank pins and piston pins

Design and safety guidelines

Guidance of the connecting rod

Crank end guidance

Depending on which parts of the crank mechanism are guided laterally by the connecting rod, a distinction is drawn between crank end guidance and piston end guidance.

The connecting rod and needle roller and cage assembly KZK are guided axially between the crank webs, Figure 1. The connecting rod eye at the crank end must have lubrication pockets and slots to allow the supply of lubricant.

Free lateral movement of the connecting rod and needle roller and cage assembly KBK between the piston bosses must be ensured taking account of all tolerances.

Piston end guidance

The connecting rod and needle roller and cage assembly KBK are guided axially between the piston bosses, Figure 2.

Free lateral movement of the piston rod and needle roller and cage assembly KZK between the crank webs must be ensured taking account of all tolerances.

In order to ensure good radial guidance of the needle roller and cage assembly KZK, the large connecting rod eye must be matched to the width of the needle roller and cage assembly KZK.

Figure 1
Crank end guidance: Lateral guidance of the connecting rod between the crank webs

Figure 2
Piston end guidance: Lateral guidance of the connecting rod
Design of adjacent parts

The bores and pins for the needle roller and cage assemblies must be produced as rolling bearing raceways. A roughness Rz 1 (Ra 0.2) must be ensured.

The raceways must be hardened, ground and, depending on the application, honed. The rolling elements and guidance surfaces of the cage must also be supported over their entire length by the raceways.

A minimum case hardening depth of 0.5 mm and a minimum surface hardness of 700 HV must be observed for all raceways and thrust surfaces. In addition, the lateral thrust surfaces should be precision machined (maximum Ra 0.2 recommended) and wear resistant (thrust washers should be fitted if necessary).

For lubrication of the needle roller and cage assemblies, holes or lubrication pockets should be provided, with additional lubrication slots for the crank end guidance.

Proven materials for adjacent parts

<table>
<thead>
<tr>
<th>Adjacent part</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>Connecting rod</td>
<td>16MnCr5, 15CrNi6</td>
</tr>
<tr>
<td>Crank pin</td>
<td>15Cr3, 17Cr3, 15CrNi6</td>
</tr>
<tr>
<td>Piston pin</td>
<td>Ck15, 15Cr3, 17Cr3</td>
</tr>
</tbody>
</table>

Preferred enveloping circle diameter of needle roller and cage assemblies

The dimensions of the needle roller and cage assemblies KZK and KBK are determined by factors including the capacity of the cylinder. The preferred enveloping circle diameters $F_w$ of needle roller and cage assemblies for proven diameters of crank pins and piston pins are given for 2 stroke engines, see table. Other enveloping circle diameters may be available if sufficient quantities are required.

Proven enveloping circle diameters for 2 stroke engines

<table>
<thead>
<tr>
<th>Capacity per cylinder cm$^3$</th>
<th>Enveloping circle diameter $F_w$ for KZK mm</th>
<th>Crank pin mm</th>
<th>Enveloping circle diameter $F_w$ for KBK mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>over</td>
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<td>--</td>
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<td>300</td>
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</tbody>
</table>

In order to design needle roller and cage assemblies for a specific engine, the technical data of the engine must be taken into consideration. The design brief for crank mechanism bearing arrangements must therefore be completed. The design brief is available online, see link, page 7.
Needle roller and cage assemblies for crank pins and piston pins

Calculation of rolling bearings in crank mechanisms
The basic rating life and adjusted reference rating life are available for the calculation of rolling bearings in crank mechanisms. We recommend calculating the adjusted reference rating life in preference.

Fatigue theory as a principle
The rating life calculation standardised in ISO 281 is based on Lundberg and Palmgren’s fatigue theory, which always gives a final rating life.
However, modern, high-quality bearings can exceed by a considerable margin the values calculated in accordance with standard ISO 281 under favourable operating conditions. Ioannides and Harris have developed a further model of fatigue in rolling contact that expands on the Lundberg and Palmgren theory and gives a better description of the performance capability of modern bearings.

Basic rating life
Our calculation method can be used to calculate the basic rating life \( L_{10} \) of the bearings (needle roller and cage assemblies for crank pins and piston pins, main bearings) in the crank mechanism of internal combustion engines on the basis of DIN ISO 281. In comparison with the standardised calculation to DIN ISO 281, it additionally takes into consideration the influence of internal load distribution in the bearing on the rating life. The calculation method takes account of dynamic loading (gas forces and inertia, external forces acting on the crankshaft) and the movement functions in crank mechanisms.

Simplifications underlying the calculation model are as follows:

- the crankshaft is only subjected to propulsion units of identical load and geometry, articulated connecting rods are not taken into consideration
- statically determinate crankshaft bearing arrangement with two bearings
- no account taken of lubrication influences
- no account taken of geometrical imperfections and deformations of the surrounding parts.

Adjusted reference rating life
It is also possible to calculate the adjusted reference rating life \( L_{nmr} \) in accordance with DIN ISO 281, Appendix 4. This calculation method additionally incorporates the fatigue limit load of the material, the lubrication conditions and the type and size of contamination. Further data is required in this case. Please contact Schaeffler.

Further information
For detailed information on the calculation methods:
- Catalogue HR 1, Rolling Bearings.
Design brief for crank mechanism bearing arrangements

In order to be able to support you in designing needle roller and cage assemblies for a specific engine, the relevant technical data of the engine is required. The design brief used to record this data is available online via the following link.

http://bit.ly/2qSVKWX
Needle roller and cage assemblies for crank pins and piston pins

Accuracy
Geometrical tolerances

The geometrical tolerances of the raceways must be observed, see tables, Figure 3 and Figure 4, page 9.

Permissible geometrical tolerance values for crank pin bearing arrangements

<table>
<thead>
<tr>
<th>Nominal diameter of the crank pin $d_B$ mm</th>
<th>Tolerance $t$ of cylindricity for $d_B$ (crank pin) $\mu$m</th>
<th>$D_B$ (connecting rod bore) $\mu$m</th>
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<tr>
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</table>

Figure 3
Geometrical tolerances for crank pin bearing arrangements

1. Crank end guidance
Permissible geometrical tolerance values for piston pin bearing arrangements

<table>
<thead>
<tr>
<th>Nominal diameter of the piston pin</th>
<th>Tolerance ( t ) of cylindricity for ( d_A ) (piston pin)</th>
<th>Tolerance ( t ) of cylindricity for ( D_A ) (connecting rod bore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( d_A ) mm</td>
<td>( d_A ) ( \mu m )</td>
<td>( D_A ) ( \mu m )</td>
</tr>
<tr>
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<td>incl.</td>
<td>( \mu m )</td>
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</table>

Figure 4
Geometrical tolerances for piston pin bearing arrangements

\( \text{\#2 Piston end guidance} \)
### Needle roller and cage assemblies for crank pins and piston pins

#### Radial internal clearance
The radial internal clearance can be set using the appropriate needle roller sort; sort plans can be used for this purpose, see tables.

Example of determination of the radial internal clearance using the mean value of the needle roller sort:
- needle roller sort 0 –2, mean value –1.

#### Crank pin bearing arrangements
The radial internal clearance is dependent on the speed, rigidity and accuracy of the crankshaft parts.

Minimum values for radial internal clearance must be achieved, see table, page 11.

Do not exceed the tolerance range of 0,015 mm.

For very high speeds (for example in racing engines), please contact Schaeffler.

#### Piston pin bearing arrangements
The radial internal clearance must be at least 0,002 mm and must not exceed 0,012 mm.

#### Sort plan for crank pin bearing arrangements
Conditions:
- bore tolerance G6 for 18 mm to 30 mm in three groups
- pin tolerance h5 for 14 mm to 18 mm in three groups
- needle roller sort 0 –2 to –5 –7
- radial internal clearance 17 μm to 26 μm.

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<td>Crank pin deviation</td>
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<td>–6</td>
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<td>Needle roller sort</td>
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<td>Needle roller sort</td>
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<td>0 –2; –1 –3</td>
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<td>Radial internal clearance</td>
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<td>19 to 27</td>
<td>23 to 30</td>
<td></td>
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</tbody>
</table>
Sort plan for piston pin bearing arrangements

Conditions:
- bore tolerance K6 for 10 mm to 18 mm in three groups
- pin tolerance 0 –6 in three groups
- needle roller sort 0 –2 to –5 –7
- radial internal clearance 3 μm to 12 μm.

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<th>Characteristics</th>
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<td>Needle roller sort</td>
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<td>Radial internal clearance</td>
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<td>Piston pin deviation</td>
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Radial internal clearance, minimum values

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<th>Nominal dimension</th>
<th>Crank pin bearing arrangement</th>
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<td>d_B mm over incl.</td>
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</table>

Ordering example, ordering designation

Needle roller and cage assembly KZK for:
- crank pin 16 mm
- connecting rod bore 22 mm
- width 12 mm
- needle roller sorts (sort pair coded blue) –2 –4 and –3 –5
- copper plated cage.

Ordering designation KZK16×22×12 SORT–2–4/–3–5–CU
Needle roller and cage assemblies for crank pins

### Dimension table: Dimensions in mm

<table>
<thead>
<tr>
<th>Dimensions</th>
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<th>Fatigue limit load</th>
<th>Mass m</th>
<th>Designation 1/2)</th>
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<td>25 500</td>
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Other dimensions available by agreement.

1) The needle roller and cage assemblies are available by agreement only (subject to availability).
2) Production is dependent on economically viable quantities.

For a precise ordering designation, please contact Schaeffler.
Needle roller and cage assemblies for piston pins

**Dimension table** - Dimensions in mm

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Basic load ratings</th>
<th>Fatigue limit load</th>
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**Other dimensions available by agreement.**

1) The needle roller and cage assemblies are available by agreement only (subject to availability). Production is dependent on economically viable quantities.

2) The designation describes the dimensions only.

For a precise ordering designation, please contact Schaeffler.