

6. NEEDLE ROLLER BEARINGS AND RELATED BEARINGS



ROLLING BEARINGS

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INTRODUCTION:

6. Needle bearings and related bearings

Introduction

Needle bearings represent a variant of cylindrical roller bearings, in which the roller length is at least six times its diameter. As far as the structure, size and variety of types as well as application possibilities are concerned they represent unquestionably the largest group of rolling bearings. Each variant has individual features, but generally needle bearings demonstrate high load capacity at relatively small sizes. It helps obtain a compact bearing-closed pairs construction, and wide variety of sizes and types makes it possible for designers to use new technological solutions. The contact line of tracks and needles is modified (needles are profiled on their ends), what not only eliminates harmful end stresses but also enables minimal misalignment between the shaft and the bearing mounting. Bearings are equipped with steel cages or cages made of steel sheet. In smaller-sized bearings cages made of polyamide strengthened with glass fiber are also in use.

6.1. Single-row and double-row needle roller bearings with an open-end ring or without ring in the uncovered and sealed version

6.1.1. Dimension series

- **NA48.. NA49.. NA59.. NA69.. NA40.. NA22..**
- with inner ring
- **RNA48.. RNA49.. RNA59.. RNA69.. RNA40.. RNA22..**
- without inner ring (versions with rubber seals – RS or 2RS designation behind the symbol)
- **NKI.. NKIS..** - with inner ring (S means seal)
- **NK.. NKS..** - without inner ring (S means seal)



Fig.23 Single-row, massive needle roller bearing

6.1.2. Structure and dimensions

The bearing consists of the outer ring, which is functionally connected with the cage containing needles and the detachable inner ring. Bearings with outside diameter above 19 mm have a ring groove and a lubricating hole on the outer ring. NA69-series, 55mm in diameter and above, has two rows of needles. For sealed versions the inner ring has been slightly lengthened, what substantially improves parameters of the bearing tightness.



Fig.24 Double-row, massive needle roller bearing

As far as the structure is concerned both series differ from each other in nothing, but NA-series dimensions are consistent with ISO standards, whereas NKI-series dimensions are not standardized but in practice are widely accepted. The latter comprise in their designation, one by one, the inner diameter size in mm, the "r"-mark and the width size in mm, e.g. NKI 28/20, but for series without the inner ring one provides (in spite of the inner diameter) the rated diameter of the inscribed circle of the cage with needles – Fw, e.g. NK 25/25.

6.1.3. Features and application

Among other needle bearings these series are characterized by a high load capacity at high rotational parameters. Needle bearings with inner ring are applied as often as needle bearings without it, but the bearings without the inner ring can be applied under the condition that, surface-hardening (at least 60HRC) and grinding is applied to the tracks on the shafts. Important feature of these bearings is

the possibility of axial shift, especially of bearings without inner ring or with specially extended ring. On account of the features mentioned above the application of these bearings is very wide, especially wherever bearing-closed pairs are required to have small cross-section and little dead weight. NA-series bearings in the sealed version have slightly extended inner ring.

6.2. Needle roller bearings without lips on the outer ring

6.2.1. Dimension series

- **NAO..** - both single-row and double-row with inner ring
- **RNAO..** - both single-row and double-row with inner ring.

6.2.2. Structure and dimensions

In terms of structure they correspond to the NA- and NKI-series bearings, but their outer ring has no lips and as a result is detachable – an open-end ring. Narrow bearings with one row of needles in contrast to wider bearings with two rows do not have a groove or a lubricating hole on the outer ring. Dimensioning of the NAO-series with inner ring consists in providing three dimensions in mm behind the symbol:

d – inside diameter,

D – outside diameter,

B – width, divided by the “x” sign.

Designation of the RNAO-series without inner ring provides the rated diameter of the inscribed circle of the cage with needles (Fw) in spite of the size of the inside diameter d.



Fig.25 Massive NAO-series needle roller bearing, inner and outer ring are open-end rings

6.2.3. Features and application

The open-end outer ring represents the key feature of these bearings, what in turn enables an easy axial shift in relation to both rings. Double detachability enables individual assembly of all elements. These bearings are above all applied in the printing industry, textile industry, aircraft industry as well as machine-building industry – machine tools.

6.3. Adjustable needle roller bearings

6.3.1. Dimension series

- **PNA..** - with inner ring
- **RPNA..** - without inner ring.

6.3.2. Structure and dimensions

In appearance and dimensions these bearings correspond to the NKI-series but their internal structure is quite different. There is a special spherical ring – having a decisive effect on adjusting possibilities of the bearing – between the outer ring, which has neither a groove nor a lubricating hole, and the cage with needles.

Dimensioning rules are the same as in case of NKI- and NK-series bearings.

6.3.3. Features and application

Thanks to this structure the PNA- and RPNA-series bearings obtain features of adjustable bearings additionally to features that are typical for needle bearings.

The possibility of the shaft axis displacement in relation to the housing axis is in the range between 0° and 3°. The PNA- and RPNA-series bearings as typical adjustable bearings, make also possible the compensation of errors of alignment and feature considerable resistance to shaft deflection. These bearings are implemented especially in construction solutions where on the one hand the size of the housing of the bearing and its load carrying capacity require the use of the needle bearing and on the other hand the operating conditions show the necessity for application of the adjustable bearing.

The PNA- and RPNA-series bearings as the adjustable bearings are very often assembled in bearing mountings.

6.4. Thin-walled needle roller bearings without inner ring, open-end bearings and closed-end bearings

6.4.1. Dimension series

- **HK..** - open-end bearings
- **BK..** - closed-end bearings.

6.4.2. Structure and dimensions

The most diversified group of needle bearings as far as dimensions are concerned is represented by thin-walled



Fig.26 Thin-walled needle roller bearing, open-end version



Fig.27 Thin-walled needle roller bearing, closed-end version

needle roller bearings. In contrast to other needle bearings, the thin-walled needle roller bearings have a very thin outer ring, stamped from steel sheet. The bearings in the basic-make have no inner ring. They are usually single-row bearings, except for wide 1622, 2030, 2538, 3038 bearings, which comprise two adjacent rows of needles and the lubricating hole in the outer ring (other bearings can have this hole, too). Open-end bearings are opened from both sides and closed-end bearings are closed from one side and are suited to be mounted on shaft ends. The outer ring stamped from hardened steel sheet, cage and needles form the inseparable whole. Special versions with contact seal made of polyurethane or synthetic rubber are also produced – RS or 2RS marking behind the bearing symbol. Dimensions of HK- and BK-series bearings are standardized and consistent with ISO standards. In their designation the dimensions in mm are provided in the following order: d-inside diameter, B-width, and for bearings with other dimensions one puts D-outside diameter between “d” and “B”, e.g. HK1210-standardized dimensions d=12mm B=10mm, HK071108-not standardized dimensions d=7mm D=11mm B=8mm

6.4.3. Features and application

The key feature of thin-walled needle roller bearings is a very small cross-sectional height and high ability to accommodate loads. They are used above all wherever the holes in the bearing mounting cannot be used as tracks for needle roller and cage assemblies and at the same time one wants to obtain economical and compact place for bearing system. Thin-walled needle roller bearings must be tightly seated in a hole of the bearing mounting and if one gives up mounting faces, snap rings and the like for axial positioning, bearing mounting holes can be made easily and economically. The bottom of the closed-end bearing is designed to enable small axial leading forces to be carried. If the shaft cannot be hardened or grinded, inner rings (IR) are also applied to these bearings.

6.5. One-way needle clutches

6.5.1. Dimension series

- HF..

6.5.2. Basic features

A special variant of needle roller bearings where rotation on its own axis is possible only in one direction. Such bearings enable rotation only in one direction, rotation of needles in the other direction is prevented by special locking pawls. In

terms of appearance and size they resemble the HK-series thin-walled needle roller bearings very much. Both cages and blocking elements can be made of steel or plastics – TN marking behind the bearing symbol.

6.6. Needle roller and cage assemblies

6.6.1. Dimension series

- K.. - single-row
- KK.. - double-row
- KBK.. - single-row for crankshafts
- KZK.. - single-row for piston pins.



Fig.28 Single-row needle roller and cage assembly

6.6.2. Structure and dimensions

The only element of needle roller and cage assembly is the cage itself with one or two rows of needles. Symbolic representation is very simple and comes down to providing dimensions in mm:

d - inside diameter,
D - outside diameter,
B - width, all separated with the “x” mark.

6.6.3. Features and application

They guarantee the smallest cross-section of the bearing – closed pairs at high load capacity from among all needle bearings. They interact directly with other machine elements but it requires keeping proper diameter tolerances



Fig.29 Double-row needle roller and cage assembly

for outer track and inner track as well as for their hardness, shape accuracy and placement. The cages of needle roller and cage assemblies are normally made of steel but several types, especially of smaller sizes are available with cages made of polyamide – TN mark behind the bearing sym-

bol. Construction of cages depends on main dimensions ratio, whereas they can be lightweight models with tender structure through to solid variants. Needle roller and cage assemblies implemented in connecting-rods construction are specially designed. In traditional needle roller and cage assemblies rolling elements are placed centrally in relation to the cage circumference, whereas in the KBK assemblies the needles are placed outside from this circumference, and in the KZK assemblies inside it.

Because of their specific features, very simple construction at low prices, needle roller and cage assemblies are applied in all branches of modern industry.

6.7. Needle roller bearings combined with other bearings

6.7.1. Dimension series

- **NX..** – combined with a ball bearing, without inner ring
- **NX..Z** – as NX.., but a closed (inseparable) version
- **NKIA..** – combined with a ball bearing with the inner ring composed of two parts or one part
- **NKIB..** – as NKIA.., but this time a double-direction version with the inner ring composed of two parts
- **NKX..** – combined with a thrust ball bearing
- **NKX..Z** – as NKX.., but a closed (inseparable) version
- **NKXR..** – combined with a thrust cylindrical bearing
- **NKXR..Z** – as NKXR.. but this time a closed (inseparable) version

6.7.2. Main features

- Combined bearings, unique in their construction, combine the features of bearing type they are composed of.

- Such solution allows to meet at the same time high requirements regarding load carrying capacity of the bearing-closed pairs, guiding precision and rotational parameters.
- On the whole, they guarantee the maximum economizing on the space the housing of the bearing takes.

They are relatively expensive, but obtaining the same results with other bearing types is often impossible or increases the cost of making a bearing-closed pair.

6.8. Inner rings of needle and cylindrical roller bearings

6.8.1. Dimension series

- **IR..**

6.8.2. Main features

Because of the structure of needle and cylindrical roller bearings (detachability) the inner rings are also manufactured separately in many sizes and types, thus giving many possibilities for constructional solutions. Depending on needs the rings can be made longer or shorter with or without chamfered ends and requirements regarding precision and clearance are met by choosing the appropriate diameters. Dimensioning of rings comes down to providing actual dimensions in mm:

d – inside diameter

D – outside diameter

B – length (width) separated by the “X” sign.