SCHAEFFLER

Tandem Axial Bearings for Extruder Gearboxes Series T.AR

Technical Product Information

Foreword

Expertise in extruder gearboxes

The Schaeffler Group has extensive knowledge in the field of drive technology. For decades, Schaeffler has been a development partner for extruder gearboxes and a leading supplier of rolling bearings for arrangements in extruder gearboxes.

In addition to the tandem axial bearings of series T.AR, we offer the full product portfolio of rolling bearings for extruder gearboxes, see Catalogue HR 1, Rolling Bearings:

- axial spherical roller bearings of series 292, 293 and 294
- axial cylindrical roller bearings of series 811, 812, 893 and 894
- four point contact bearings of series QJ10, QJ2 and QJ3.

The following are available for commonly used radial bearing arrangements:

- needle roller bearings
- full complement cylindrical roller bearings SL
- cylindrical roller bearings with cage.

Tandem axial bearings T.AR

Tandem axial bearings T.AR

Area of application

Tandem axial bearings of series T.AR were developed specifically for extruder gearboxes. The bearings are mainly used in the gearboxes of twin screw extruders, but also of single screw extruders.

Typical areas of application are:

- smaller extruders for pelletising in the feed and food industry
- extruders in the plastics industry, for example in injection moulding and profile extrusion
- large extruders for the production of plastic granulate in the petrochemical industry.

Requirements

Tandem axial bearings of series T.AR are highly suitable for use in extruders as they meet the following requirements:

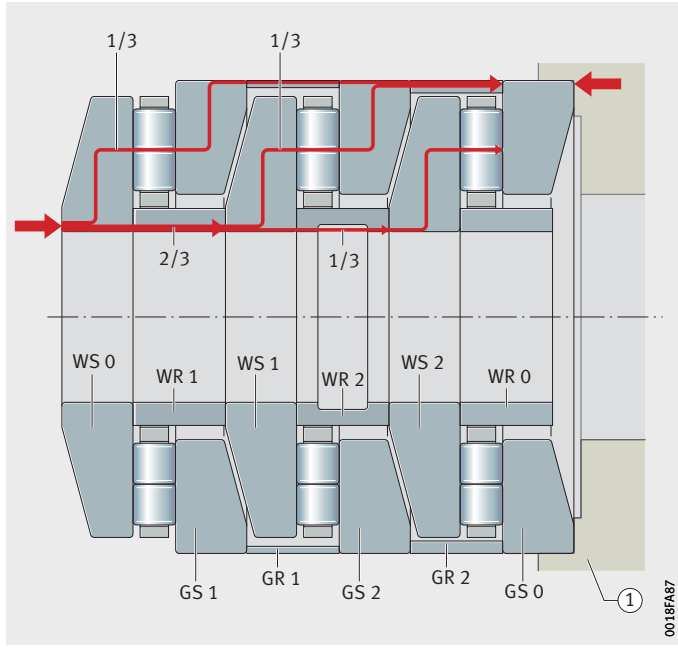
- accommodation of high back pressures exerted on the output shafts by the extruder screws
- smaller radial design envelope required. Due to the process, this is limited by the narrow centre distance in twin screw extruders
- maximum load carrying capacity due to full utilisation of the axial design envelope
- long operating life
- low frictional torque
- low speeds of counter-rotating extruders.

Design

A tandem axial bearing of series T.AR is an axial bearing for supporting load in one direction. It consists of an assembly of two to eight axial cylindrical roller bearings arranged in line, with sleeves in between. This elastic system of sleeves distributes the force uniformly over the individual axial cylindrical roller bearings.
The rolling elements are proven cylindrical rollers from catalogue series. The cylindrical rollers are guided by cages. The cages are made from brass, aluminium or polyamide. Bearing washers and sleeves are made from hardened steel. For the high-performance variant, bearing washers made from high performance steel are used. Speeds, the permissible temperature range and the design details of the T.AR tandem axial bearing can be found in the quotation drawing.

Uniform loading

Uniform loading of each axial cylindrical roller bearing is achieved through the matched geometries of the sleeves and bearing washers.

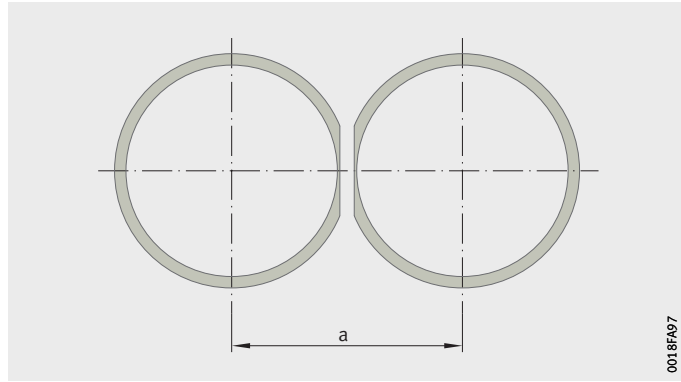


① Housing

Figure 1
Structure and power flow

Variants

To enable the smallest possible centre distance, variants are available with sleeves which have a flattened diameter on one side.



a = centre distance

Figure 2
Sleeves with flattened areas

For unfavourable operating conditions, such as low speeds of counter-rotating twin screw extruders, variants are available with Durotect B or the PVD coating system Triondur.

Performance-enhanced variant

The technical advancement permits gear teeth of increased operational strength. At the same time, there is a rise in extruder output and, as a result, performance density is increased. In many extruder gearboxes, tandem axial bearings of series T.AR are the components subjected to the highest loads. For this reason, performance-enhanced variants (high-performance, HP) have been developed.

The performance-enhanced variants have the same dimensions as the standard T.AR designs and, as a result, are mutually interchangeable.

Available bearings

Designation	Dimension d mm		Basic load ratings dyn. C_a kN		stat. C_0 kN		Load $F_{a\,max}$ kN	
	from	to	from	to	from	to	from	to
T2AR	8	420	62	20 200	114	84 000	40	4 900
T2AR HP			81	26 260				
T3AR	5	565	565	29 000	106,5	126 000	20	7 150
T3AR HP			735	37 700				
T4AR	5	73	73	27 000	142	118 000	40	9 075
T4AR HP			95	35 100				
T6AR	5	165	165	6 200	342	26 000	90	2 792
T6AR HP			215	8 060				
T8AR	6	292	292	15 250	592	61 600	132	8 070
T8AR HP			380	19 825				

HP = high-performance variant.

Bearings with inside diameters of 5 mm to 565 mm are available.

The performance-enhanced variants are made from high performance steel.

Cromadur

The development of Cromadur was based on a tried and tested steel with through hardening suitability. With knowledge gains in rolling bearing design came the definition of higher quality requirements and modified material requirements. A special heat treatment achieves increased toughness and the basic dynamic load rating C_a is around 30% higher than that of the standard design.

Mancrodur

Mancrodur is a case hardening steel developed by Schaeffler, which is particularly suitable for carbonitriding heat treatment. The case hardening steel has a tough core. The nitrided surface layer with a finer structure formation and increased residual compressive stress results in a significantly increased overrolling resistance. As with Cromadur, the basic dynamic load rating C_a of the bearings produced from this material increases by 30% compared with bearings of the standard design. Mancrodur is used for bearings with larger washer cross sections.

Advantages

The increased basic dynamic load rating offers considerable advantages.

With an identical bearing load, a 2,4-fold increase in the fatigue life of the bearings is achieved, allowing bearing changeover intervals to be doubled. In many cases, system downtimes specifically planned for bearing changeovers are not necessary. Alternatively, a 30% higher bearing load can be permitted. Operation can take place under increased thrust screw force and with increased drive power, with the fatigue life of the bearings unchanged.

The development of new, higher-performance extruders does not require a redesign of the gearbox. Alternatively, gearboxes can be downsized to economise on the footprint, weight and costs.

Performance-enhanced radial bearings

In addition to tandem axial bearings, radial bearings subjected to high loads can also be produced from high performance steel. Many bearings commonly used in extruders are already available as special bearings in high-performance variants or can be offered by agreement.

Design of bearing arrangements

When designing the axial bearing arrangement of a gearbox with tandem axial bearings of series T.AR, there are a number of factors that must be considered during construction.

Preload

Tandem axial bearings of series T.AR must be subjected to a preload of 1% of the basic dynamic load rating. A minimum load is thus achieved and slippage damage, which would occur in load-free operation, is avoided. Furthermore, it is ensured that the deflection is in the linear range of the characteristic curve. The positioning relative to the second shaft (worm shaft) is simplified.

Load

The loads that usually occur during operation of the extruder form the basis of the design of tandem axial bearings of series T.AR. The maximum axial load $F_{a\ max}$ is specified on the quotation drawings for tandem axial bearings. This load must not be exceeded during operation.

Deflection

For twin screw extruders, the process gap between the intermeshing screws must be guaranteed over the entire operating range. The deflection of the tandem axial bearing of series T.AR must be observed in conjunction with the second axial bearing and matched to this. This is particularly important when bearings of different designs are used on the two output shafts. Schaeffler Application Engineering can assist here with the calculation of spring curves.

Radial guidance

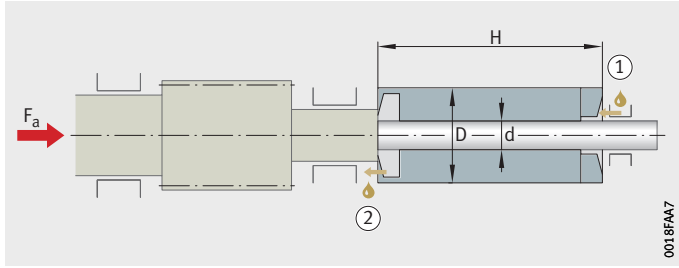
The output shafts are radially guided by radial bearings, such as needle roller bearings or single row full complement cylindrical roller bearings of series SL.

Mounting fit

For tandem axial bearings of series T.AR, a mounting fit of f6 is recommended for the shaft and F7 for the housing bore. To achieve a uniform load distribution, the bearings must be tilt-free after fitting. Tight geometrical tolerances of the adjacent construction must also be observed. A Schaeffler application engineer can prepare a mounting recommendation for each specific case.

Lubrication

To ensure heat dissipation and adequate lubrication, tandem axial bearings of series T.AR are operated with circulating oil lubrication. The lubrication system is usually equipped with an oil filter and oil cooling facility.



① Oil feed
② Oil outlet

Figure 3
Design of the lubrication system

For a long bearing life without wear-induced failure, a separating EHD lubricant film is required. Oil viscosity, oil temperature and speeds for the load spectrum must be taken into account, in order to set an adequate viscosity ratio (κ).
The specifications in Catalogue HR 1, Rolling Bearings, apply.
An oil with anti-wear additives should be used under unfavourable operating conditions. Schaeffler offers T.AR variants where anti-wear protection is achieved through the use of coating systems Durotect B and Triondur C. Schaeffler application engineers can advise you on selecting the most suitable bearings for the prevailing lubrication conditions.

Ordering designation

The ordering designation for a tandem axial bearing of series T.AR is a special bearing number followed by a short material designation. The ordering designation can be found on the quotation drawing, on the packaging and on the bearings.

F-81661.T8AR (example)

F-81661 is the special bearing number,
T8AR is the short material designation.

The short material designation indicates the number of axial cylindrical roller bearings arranged in line (in this example, 8).

Mounting

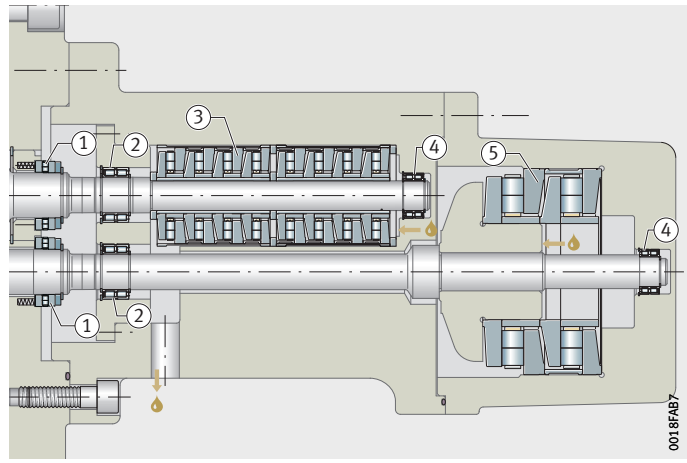
The components must be mounted in a defined order. The fitter will find a corresponding mounting instruction in the packaging.

The bearing components are matched to each other with a high degree of precision and, as a result, are not interchangeable in most cases. If an exact arrangement must be observed when fitting, the relevant bearing components are marked accordingly.

Application example

Counter-rotating twin screw extruders are used to produce plastic granulate from natural gas.

The largest of these systems enable production outputs of up to 100 t of granulate per hour. Production stoppages are extremely costly. As a result, operational reliability and system availability are a top priority for these systems.



① 81128
② SL185026
③ T8AR
④ SL185024
⑤ T2AR

Figure 4
Large gearbox for counter-rotating twin screw extruder

Schaeffler products used:

- INA series 81128
  Axial cylindrical roller bearing
- INA series SL185026
  Semi-locating bearing,
  double row full complement cylindrical roller set
- INA series T8AR
  Tandem axial bearing of series T.AR,
  performance-enhanced variant in Mancrodur
- INA series SL185024
  Semi-locating bearing,
  double row full complement cylindrical roller set
- INA series T2AR
  Tandem axial bearing of series T.AR,
  performance-enhanced variant in Mancrodur.

Tandem axial bearings T.AR

Gearbox solution

To enable the high output of the extruder, the gearboxes must transmit high power levels and torques up to 500 kNm. With a high power density, the torque must be branched uniformly to the less rigid output shafts while avoiding bending moments. In the example shown here, the high back pressure forces on the output shafts are accommodated in the axial bearing pot of the transfer gearbox. The high reduction takes places in the reduction unit of the gearbox. Sophisticated distributor units enable the close spacing of the extruder screws required by the process.

Bearing solution

Due to the short distance between the shafts, the axial bearing of the shorter output shaft is designed in the version T8AR. A larger radial design envelope is available for the outlying tandem axial bearing. As a result, a bearing of design T2AR can be used. The requisite bearing preload is applied via axial cylindrical roller bearings of series 811.

Full complement cylindrical roller bearings of series SL1850 guide the output shafts radially in the bearing pot. The most heavily loaded bearings in the extruder are the tandem axial bearings of series T.AR. During operation, the load is so high that the limits for fatigue strength are exceeded. In order to replace the bearings, the system has to be shut down. If performance-enhanced tandem axial bearings of series T.AR with a 2,4-fold bearing life are used, the bearings can be replaced during main maintenance work on the system, thus avoiding any additional system downtime.

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