alzen® 305

White bronze alloy without lead with reduced CO_2-footprint

voestalpine Camtec GmbH
www.voestalpine.com/camtec

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ONE STEP AHEAD.

CONTENTS

1.	The alloy without lead	4
2.	Chemical reference analysis	5
3.	Industries & applications	6 - 7
4.	Mechanical & physical properties	8 - 10
5.	Temperature behaviour	11
6.	Substitutable materials	12
7.	Requirements	13
8.	Delivery programme	14
9.	Semi-finished product tolerances	15
10.	Recommended oversize	17
11.	Bearing design & fit selection	18 - 19
12.	Machining instructions	20 - 21
13.	Lubricant selection	22
14.	Run-in characteristics	23
15.	Order data	24
16.	Technical service	26
17.	voestalpine Camtec	27
18.	Foreign representations	28

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Zinc-based alloys change their technical values depending on the type of stress (mechanical, tribological, thermal, chemical, etc.). These changes can influence the function. We always recommend an individual consultation and provide samples for testing on request and where possible.

1

THE ALLOY WITHOUT LEAD

For the reduction of your CO_2 footprint

alzen® 305 is a zinc-based alloy (ZnAlCu) developed by voestalpine without the addition of lead, which is primarily suitable for use as a bearing material and also offers other possibilities and advantages.

Compared to lead-containing red castings, this alternative is characterised by comparable mechanical and tribological properties, significantly lower density and a good price-performance ratio.

Advantages:

» **High load capacity**
- Favourable behaviour due to solid solution strengthening and phase hardening of the ZnAlCu alloy

» **Excellent emergency running behaviour & good wear resistanced**
- Favourable behaviour due to the multiphase structure and the formation of zinc and aluminium oxides on the component surface

» **Good embeddability of foreign bodies**
- Favourable behaviour due to an even distribution of hard, load-bearing and soft, embeddable phases

» **No lead as an alloying element**
- No information obligation according to REACH Regulation, Article 33

» **Low density**
- Price advantage, low freight costs, lightweight applications

» **Excellent sliding properties with low coefficients of friction**
- Extensive avoidance of the „stick-slip effect“

» **Very good wettability & lubricant distribution**

» **Higher thermal conductivity than standard leaded red bronze alloys**
- E.g. CuSn12-C/Gbz12, CuSn7Zn4Pb7/RG7, etc.

» **Good damping capacity**

» **High processing speeds possible**
- Similar to aluminium alloys such as EN AW-5083

» **Low sensitivity to edge pressure**
- Comparable to Gbz12

» **Lower CO_2-footprint compared to conventional gunmetal alloys**
- Low melting point, energy requirement, processing and transport costs

CHEMICAL REFERENCE ANALYSIS

Composition in weight percent

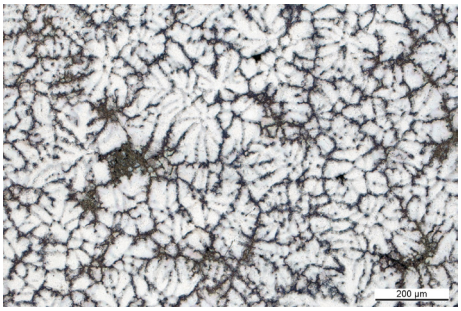
Material abbreviation	Abbreviation	Al	Cu	Zn [1)]
ZnAl32Cu4	alzen® 305	32	4	Rest

[1)] incl. trace elements

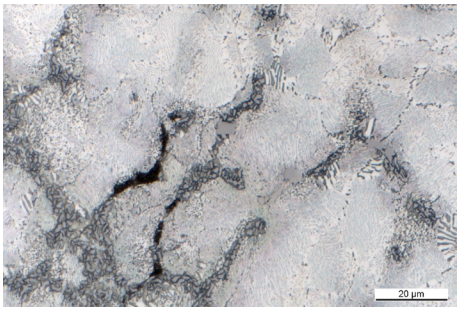
Microstructure

The cast structure of alzen® 305 shows aluminium-rich dendrites surrounded by eutectoid zinc-rich phases and metastable copper-rich precipitates. Subsequent heat treatment stabilises the phase fractions and achieves the desired adjustment of the strength properties (A5↑, hardness↓).

Light microscope image

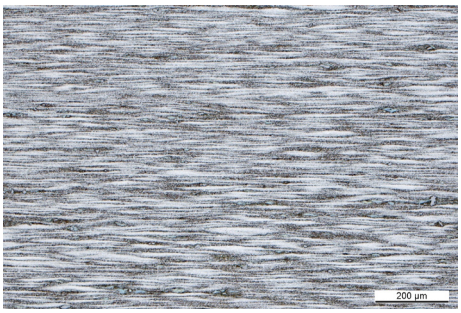


alzen® 305, mould casting,
position C, scale 200 µm



alzen® 305, mould casting,
position C, scale 20 µm

After the rolling process, the dendritic structure is rolled flat, resulting in a more homogeneous microstructure than the cast alloy. This uniformity has a positive effect on the results of the mechanical test (A5↑, hardness curve = constant).



alzen® 305K sample, wrought material,
position C, scale 200 µm

alzen® 305K sample, wrought material,
position C, scale 20 µm

3

INDUSTRIES & APPLICATIONS

Recognised companies from demanding sectors of the **metal and electronics industry** rely on alzen® 305.

» **Mechanical and plant engineering**
- Machine tools
- Conveying systems
- Drive technology
- Agricultural machinery
- Mining, construction machinery
- Pumps and compressors
- Cooling and air technology
- Fittings
- Food processing machinery
- Textile machinery
- Ovens
- Machines for the paper industry
- Metal production and rolling mill equipment

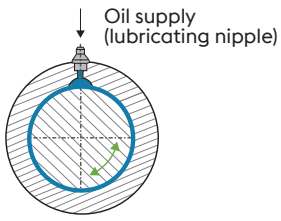
» **Metal industry**

» **Rail vehicle manufacturing**

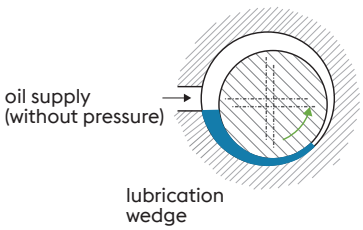
The alloy is used for various tribological applications. The spectrum ranges from sliding elements such as plates, guideways, thrust washers, bushings and bearing segments to hydraulic components such as sealing rings and other customised special parts.

lubrication types of Plain bearing

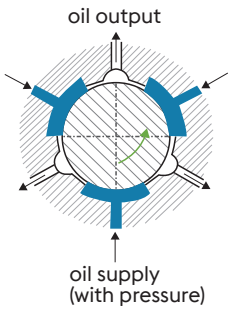
Basic or initial lubrication



Hydrodynamic lubrication



Hydrostatic lubrication

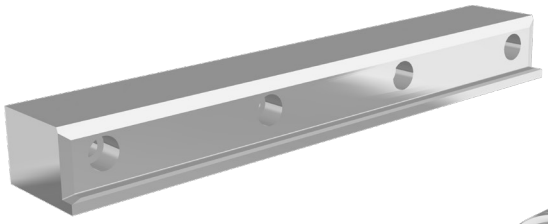


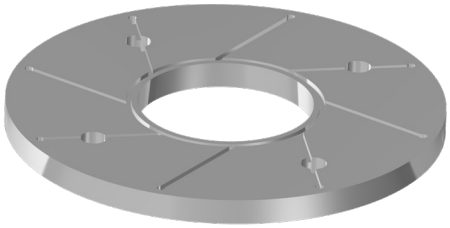
TYPES OF PLAIN BEARING MOVEMENT

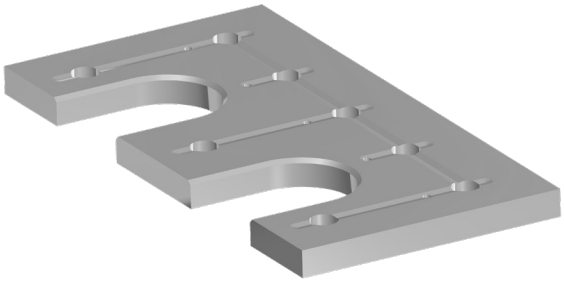
» Linear movement
- Sliding plates, sliding bars, prismatic guides

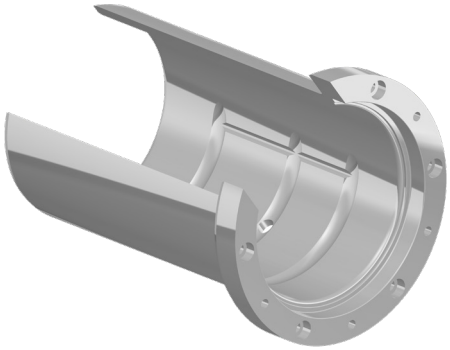
» Rotational movement
- Radial: bushes with and without flange, bearing shells
- Axial: thrust washers, support shells, sealing rings, segment plates

COMPONENT DESIGNS









Click here to go directly to the components

Discover all current components on our website:
www.voestalpine.com/camtec/en/alzen-r

4

MECHANICAL & PHYSICAL PROPERTIES

	Wrought alloy	Casting material	Casting material	Casting material
Material properties [1]	alzen® 305K [5]	alzen® 305	CuSn12-C-GM (GBz12) [6]	CuSn7Zn4Pb7-C-GM (RG7) [6]
Density ρ in kg/dm³	4,6	4,6	8,7 [7]	8,8 [7]
Young's modulus [2] E in N/mm²	62.000	70.000	97.000 [7]	101.000 [7]
Yield strength [2] $R_{p0,2}$ in N/mm²	215	215	150 [6]	120 [6]
Tensile strength [2] R_m in N/mm²	290	290	270 [6]	230 [6]
Elongation at break [2] A_5 in %	8	5	5 [6]	12 [6]
Offset yield strength [2] $R_{dp0,2}$ in N/mm²	240	240	150 - 160 [7]	120 - 160 [7]
Compressive strength [2] $R_{dm3,0}$ in N/mm²	330	330	-	-
Hardness [3] in HBW10/1000	90	115	80 [6]	60 [6]
Coefficient of thermal expansion α in 10^{-6} K^{-1}	26	26	17,8 [7]	18,0 [7]
Thermal conductivity λ in W/(m*K)	100 - 113	100 - 113	55 [7]	64 [7]
Coefficient of static friction [4] μ_{RH}	0,12 - 0,2	0,12 - 0,2	-	-
Coefficient of mixed friction [4] μ_{RH}	0,02 - 0,05	0,02 - 0,05	-	-

[1]) The values listed are reference values and do not represent design limits.

[2]) Average values analysed on cast samples at room temperature, may vary depending on component size: Strength values are temperature-dependent.

[3]) Maximum values tested on cast samples at room temperature, may vary depending on component size.

[4]) According to ASTM G77 under lubricated conditions at v=0.5m/s, varies depending on additional lubrication, load, sliding speed and ambient conditions.

[5]) The values have been determined on the standard sheet thickness d = 15 mm, may vary depending on the sheet thickness.

[6]) Reference values taken from EN 1982:2017.

[7]) Reference values taken from the Deutsches Kupferinstitut.

TECHNICAL DETAILS

alzen® 305 is used for tribological applications due to its good sliding properties. The information on the recommended sliding speed and surface pressure relates to the **condition of mixed friction** and therefore represents lower values than for wear-free liquid friction.

	Wrought alloy	Casting material	Casting material	Casting material
Material properties [1]	alzen® 305K [3]	alzen® 305	CuSn12-C-GM (GBz12)	CuSn7Zn4Pb7-C-GM (RG7)
pv-value [2] N/mm² * m/s	1,5	1,5	1,3	1,0
Sliding speed v in m/s	0,2 - 1,0	0,2 - 1,0	0,4	0,4
Dynamic surface pressure p_{dyn} N/mm²	10	10	vergleichbar	vergleichbar
Static surface pressure p_{stat} in N/mm²	40	40	vergleichbar	vergleichbar
Max. temperature short term T_{max} in °C	120	120	-	-
Min. temperature T_{min} in °C	0	0	-	-
Min. hardness of the counter body HB_{min} in HBW10/1000	225	225	200	200
Roughness of counter body Rz / Ra in µm	6,3 / 0,8	6,3 / 0,8	6,3 / 0,8	6,3 / 0,8

[1] The values listed are reference values and do not represent design limits.

[2] According to ASTM G77 under lubricated conditions at v=0.5m/s, varies depending on additional lubrication, load, sliding speed and ambient conditions.

[3] The values were determined on the standard sheet thickness d = 15 mm and may vary depending on the wall thickness.

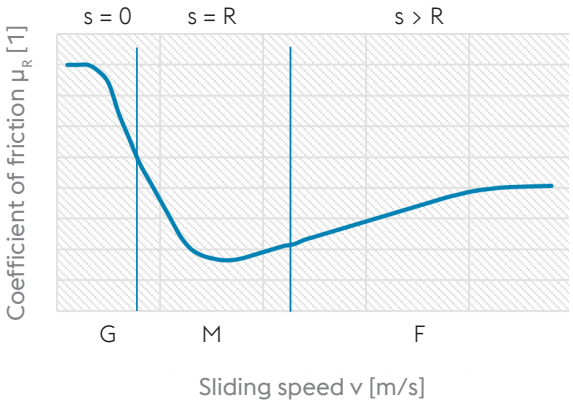
On this page you will find important technical data and key figures on alzen®. If you have any further questions, our experienced team of experts will be pleased to help: Contact us at **engineering.camtec@voestalpine.com**

Despite the presence of a multiphase structure and the formation of different oxide layers (aluminium oxide - hard and wear-resistant, zinc oxide - soft with dissipating hexagonal crystal structure), the material is not self-lubricating **under continuous load,** which is why a **separating layer with a lubricant is re-quired.** Continuous operation in the area of the dry friction ***G*** is not permitted.

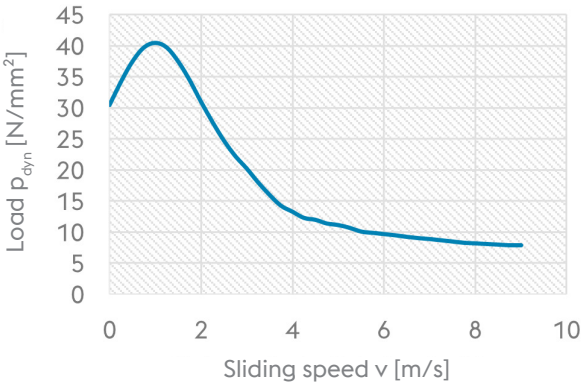
With manual oil or grease lubrication and adequate lubricant selection, a mixed friction range ***M*** with low wear can be expected. The gap ***s*** between the sliding element and the counterpart corresponds approximately to the roughness ***R***. The guide values for the surface pressure and sliding speed can be found in the table on page 9.

In general, under hydrodynamic and static lubrication, the sliding speed can be increased depending on the viscosity η of the lubricant and fluid friction ***F*** is present (see figure on the left). The gap ***s*** between the sliding element and the counterpart is greater than the roughness ***R***, there is no wear. **In view of the surface pressure, a doubling of the diagram values can be achieved under hydrostatic lubrication (see figure on the right).**

Schematic representation of the Stribeck curve



Load capacity limits for alzen® 305 with drip oil lubrication and hydrodynamic condition

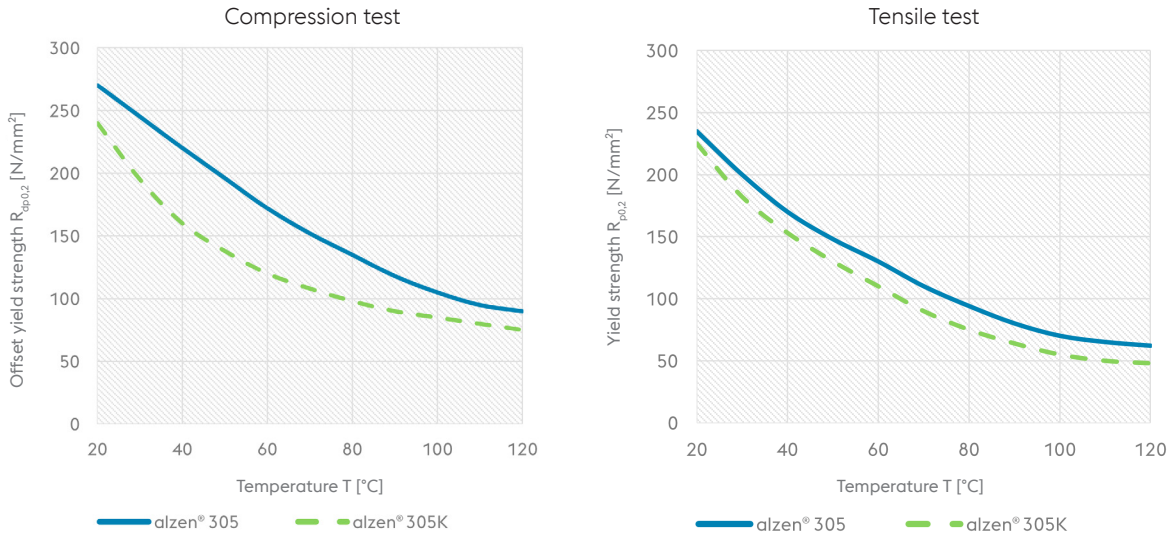


G .... Dry friction
M..... Mixed friction range
F ..... Fluid friction
s..... Gap between sliding surfaces
R..... Roughness

TEMPERATURE BEHAVIOUR

The casting behaviour favoured by the melting temperature (T_M = 500 °C) leads to reduced mechanical material properties at elevated temperatures. As the thermal load increases, the tensile strength, yield strength and hardness decrease, while the break elongation increases. Permanent temperatures above 80 °C are not recommended regarding to the decreasing strength values of alzen® and the service life of the lubricant.

Heat resistance data for alzen® 305 and alzen® 305K



6

Substitutable materials

From a tribological point of view, the materials listed can be replaced by alzen® 305 or alzen® 305K. A precise examination of the load situation, lubrication conditions and fit design is necessary before any change of material. The customer is not exempt from testing the selected product in advance.

- CuSn12-C-GM / (GBz12)
- CuSn7Zn4Pb7-C-GM / (SAE660, RG7)
- CuSn7Pb15-C-GM / (SAE67)
- CuSn10Pb10-C-GM / (SAE64)
- CuSn14-C-GM / (B14)

According to the current EU directive (REACH / Article 33), these materials contain substances of very high concern (SVHC) and are therefore required to provide information.

Further information on the REACH Regulation can be found here:

REQUIREMENTS

Chemical composition

If the performance of a chemical analysis is requested, the permissible deviations must comply with the agreements between the customer and voestalpine Camtec GmbH. The sampling location must be specified.

Mechanical properties

If special properties apply to certain areas or to the entire component, e.g. yield strength, tensile strength, hardness, these properties must be agreed by the time the order is placed. In such cases, the location, the shape of the sample, the sampling conditions and the acceptance criteria must also be specified.

External and internal properties

External and/or internal quality requirements, if applicable, must be agreed and specify the following subjects:

- the non-destructive testing method to be used (VT, PT, UT, ...)
- the scope of the inspection (area and/or frequency)
- the acceptance criteria

In those areas where non-destructive testing has been agreed, the required surface condition must be ensured by applying a suitable method (VT, PT). Indications of imperfections must be specified in accordance with the relevant non-destructive testing standards. If minor surface imperfections do not impair the application or if the surface of the casting corresponds to the initial sample, they do not need to be removed. Examples of minor surface imperfections are small sand or slag spots, small cold welding spots, small scabs, small blowholes, accumulations of small pores, casting material residues, unevenness or burrs.

Pores and blowholes with dimensions < 1.5 mm are not accepted as a cause for complaint. The results of a surface test (PT) must be assessed in accordance with DIN ISO 4368-3 and approved up to classification „E“. Acceptance criteria for class „E“:

- no circular indication with a > 8 mm
- no linear indication with a > 7 mm
- no linear indication with l > 16 mm
- a maximum of twenty indications, with a total area of max. 250 mm^2
- total area of the indications max. 250 mm^2/dm^2

Unacceptable external imperfections can be repaired as specified in EN 1559-6 if the component application is not negatively affected as a result. A corresponding procedure may be agreed between the customer and voestalpine Camtec GmbH. If there is no agreement, repairs can be carried out with suitable metal kits (DIAMANT Polymer Solutions, Aluminium A powder Art. No. 0005B or PM Aluminium AA Hardener Art. No. 1560A).

Cf. Austrian Standards Institute, ÖNORM1559-1

8

DELIVERY PROGRAMME

alzen® 305 | Casting material

Mould casting small

» Diameter: 35 - 116 mm
» Lengths: 280 - 500 mm

Mould casting large

» Diameter: 60 - 570 mm
» Lengths: up to 580 mm
» Block dimensions: on request

Sand casting / composite material

» Size range: on request

Delivery times

» Semi-finished products: approx. 8 weeks
» Finished parts: approx. 12 weeks

alzen® 305K | Wrought alloy

Raw sheets

Max. dimensions s x L x W [mm]

s	L	W
12	1300	1650
15	1300	1650
20	1300	1650
25	1300	1650
30	1300	1650
35	1800	1650
40	1800	1650
45	1800	1650

Rolled-in bearing segments

» Max. thickness finished parts: 31 mm
» Max. thickness raw parts: 45 mm
» Size range: on request

Delivery times

» Semi-finished products: approx. 8 weeks
» Finished parts: approx. 12 weeks

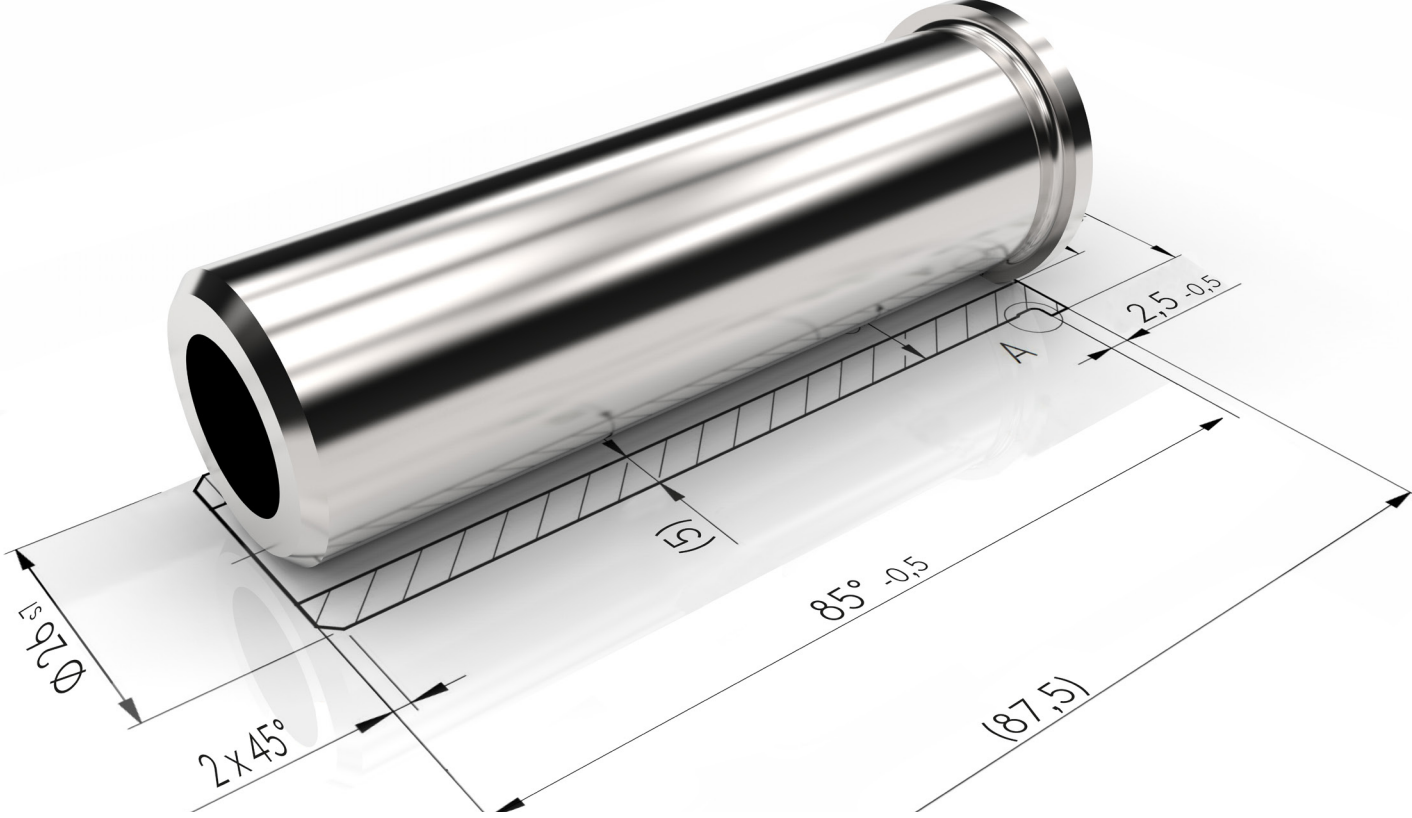
Packaging and surface protection

If no special agreements have been made by the time of acceptance of the order, the choice of packaging and/or surface protection for transport and storage is the responsibility of voestalpine Camtec GmbH.

Standard packaging

» Castings < 20 kg: cardboard
» Castings ≥ 20 kg: wooden boxes
» Metal sheets: disposable pallets incl. edge protection

To prevent oxidation of finished components, it is recommended that alzen® 305 finished parts are stored in a dry environment. Additional protection is provided by corrosion inhibitors such as ENSIS® RPO 600.



SEMI-FINISHED PRODUCT TOLERANCES

alzen® 305 | Casting material

The shrinkage dimension must be considered when specifying the dimensions of raw parts. To prevent complaints, we also recommend providing the finished dimensions.

» Shrinkage: 1,2 %

alzen® 305K | Wrought alloy

» Lateral tolerance: +0/+4 mm

» Thickness tolerance: -0,5/+1,9 mm

» Flatness tolerance: 2 mm/m

» Tolerances for rolled bearing segments: on request

RECOMMENDED OVERSIZE

The following dimensions must be considered when ordering unmachined parts.

alzen® 305 | Casting material

Mould casting small

» Ø 35 - 90 mm: min. +5 mm on inner and outer diameter

Mould casting large

» Outer diameter < 325 mm: min. +10 mm
» Inner diameter (core) < 251 mm: min. +10 mm
» Outer diameter ≥ 325 mm: min. +20 mm
» Inner diameter (core) ≥ 251 mm: min. +15 mm

alzen® 305K | Wrought alloy

Raw sheets

» Lateral oversize: min. +5 mm
» Thickness oversize: min. +5 mm
» Oversize of rolled bearing segments: on request

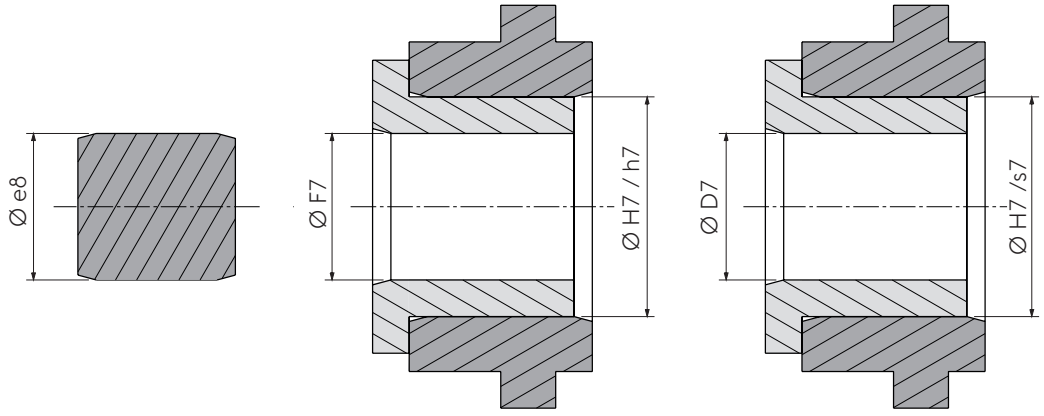
11

BEARING DESIGN & FIT SELECTION

Fitting systems according to DIN EN ISO 286-1

	alzen® 305	finish-machined	not finish-machined
Close fit [1])	G7/g6	G7/g6	E7/g6
Standard fit [1])	F7/f7	F7/f7	E8/f7
Easy fit [1])	F7/e8*	F7/e8	D7/e8**
Loose fit [1])	E7/d9	E7/d9	D8/d9
	The bush is fitted into the housing (fit H7 / h7) and fixed with screws / clamps.	**The bushing is pressed into the housing (fit H7 / s7). Pressing in reduces the inside diameter of the bushing by 80 % of the dimension that is added to the outside diameter to achieve a secure press fit.**	

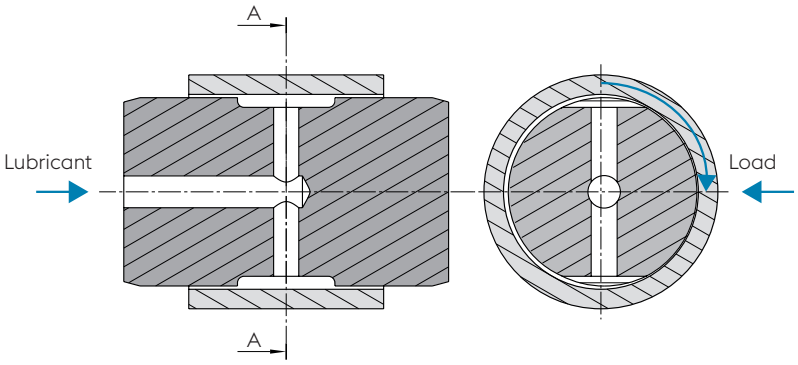
[1]) Data without guarantee



Shaft | Clearance fit* | Fixing with press fit**

For the design of bearings made of alzen® 305 up to an inside diameter of 200 mm it is recommended to follow the DIN ISO 4379 standard. DIN ISO 12128 illustrates the illustrates the standardised design of lubrication holes, grooves and pockets. **To avoid excessive edge pressure, the bearing length should not be more than 1.5 times the shaft diameter. The appropriate and economical wall thickness is in the range of 5 - 10 % of the diameter.** The lubrication system is selected according to the type and load of the plain bearing. Two basic cases have been selected from the various possibilities on page 19.

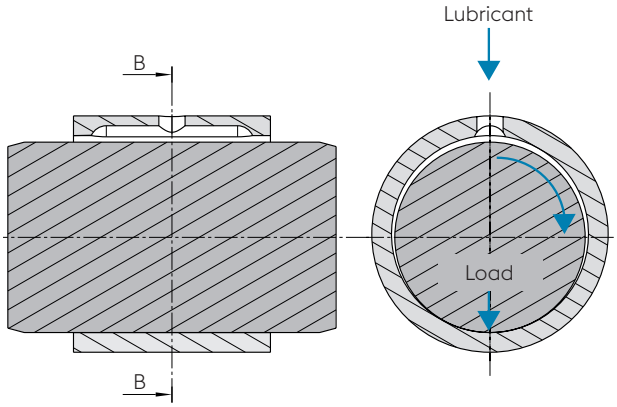
Case 1 | The bushing is turning, the bolt is stationary



Lubrication is provided by the fixed bolt. The bearing bush rotates and must support the entire circumference. The bearing surface of the bush should not be interrupted by anything. The lubrication grooves must be in the pin.

As a result, the support of the bushing is fully used and the maximum load can be absorbed. The bushing only turns on a certain area of the bolt (loaded zone). If the lubrication grooves are fitted to the bolt in the non-loaded zone, the lubricant is drawn into the load-bearing zone and a lubricating film is formed.

Case 2 | The shaft is turning, the bushing is fixed



The lubricant is fed through the bushing. The shaft is supported around its entire circumference, so no lubrication grooves must be machined into the shaft.

These must be fitted in the bearing bush outside the load-bearing zone. If possible, the design should be large enough to accommodate lubricant reserves. The formation of the lubrication wedge should be improved by rounding off all edges.

12

MACHINING INSTRUCTIONS

A particular advantage of alzen® 305 compared to Cu-based bearing metals is its more efficient machinability due to higher cutting speeds:

Cutting parameters for turning (guide values)

Machining	Cutting speed v_c [m/min]	Feed rate f [mm/U]	Cutting depth a_p [mm]	Working depth a_e [mm]	Cooling
Roughing	0,4 - 0,5	0,4 - 0,5	5	3	Cooling lubricant
Finishing	0,1 - 0,15	0,1 - 0,15	0,5	0,5	Cooling lubricant

Cutting parameters for milling (guide values)

Machining	Cutting speed v_c [m/min]	Feed rate f [mm/U]	Cutting depth a_p [mm]	Working depth a_e [mm]	Cooling
Roughing / Face milling	300 - 400	0,4 - 0,8	5	5	Cooling lubricant
Roughing / Roll milling	200 - 300	0,5 - 0,8	5	5	Cooling lubricant
Finishing / Face milling	300 - 400	0,4 - 0,8	0,5	0,5	Cooling lubricant
Finishing / Roll milling	200 - 300	0,5 - 0,8	0,5	0,5	Cooling lubricant

Metalworking oils and water-miscible cooling lubricants for machining

Castrol	Houghton	Kluthe
Syntilo Hysol Alusol	Dromus B	Hakuform A

Cutting with water jet or laser cutting system (guide values)

Sheet thickness [mm]	12	15	20	25	30	35	40	45
Feed rate [mm/min] Water jet cutting	750	575	390	265	235	190	155	120
Feed rate [mm/min] Laser cutting / N_2 [1)]	2220	1380	900	-	-	-	-	-
Feed rate [mm/min] Laser cutting / Compressed air [1)]	1200	900	540	-	-	-	-	-

[1)] Recommended laser cutting system: Salvagnini Laser L5

Saw cut (guide values)

Cuttings height [mm]	Band saw blade	Band speed [m/min]	Feed rate [mm/s]	Lubrication
<100	HISI 224 Bimetallic band	90 - 130	0,3 - 2,0	Cutting oil / Minimum quantity lubrication
>100		85 - 110		
>500		80 - 100		

13

LUBRICANT SELECTION

The following table lists commercially available oils (kinematic viscosity at 40 °C between 32 - 930 mm^2/s) and soft to medium-strength greases (NLGI 1-3) which are recommended for lubrication.

		Klüber [1)]	BP	Castrol	Mobil	OMV	Shell	Total
Oils	Plain bearing oils Machine oils Machine bed oils	Klübersynth GEM 4 N, Klübersynth GH 6 N	Energol CS, Maccurat oils	Magna SW 68, Magna CF 220	Vactra	-	Tonna	-
	Gear oils	-	-	ATF Dex II Multivehicle, Transmax Dex III Multi-vehicle	ATF-Serie	ATF-Serie	Spirax S-Serie	-
Fats	Multi-purpose greases	Klüberplex SK 12, Klüberlub BE 71-501	Energrease	Spheerol EPL	Nebula EP Beacon EP	-	Gadus S-Serie	Ceran XM 720

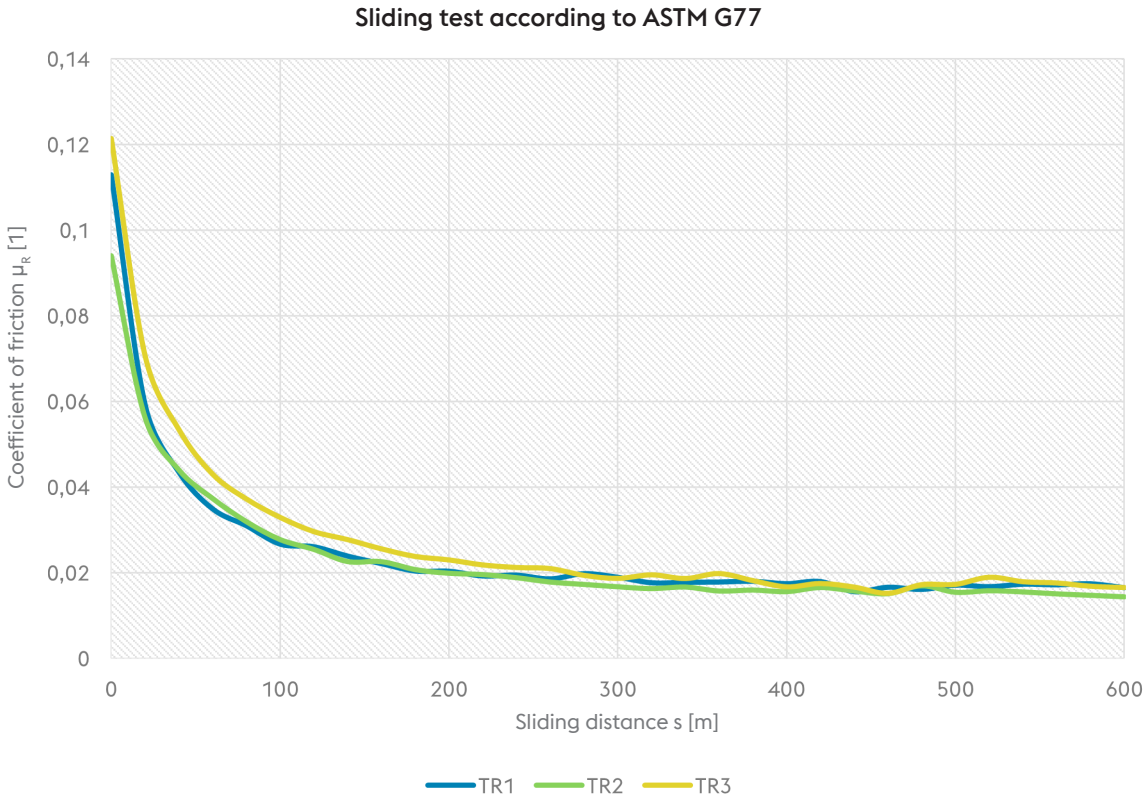
[1)] Recommended lubricant supplier

For plain bearings in the mixed friction range (v=0.1 m/s to 1 m/s), high-viscosity oils or greases tend to be recommended, while low-viscosity oils are used for hydrodynamic (v>1 m/s) and static applications in order to reduce internal friction and the associated heat input.

RUN-IN CHARACTERISTICS

Block on disc

This test shows the coefficient of friction μ_R as a function of the sliding distance ***s*** of three identical samples. After an initial running-in characteristics, a constant steady state with low friction occurred (mixed fluid friction). After finishing the test series, no visible signs of wear were detected on the hardened 42CrMo4 (58±2HRC SHD500=1.5 1) counter body.



Frictional characteristic alzen® 305, casting material, v=0,5 m/s,
F_N = 50 N, $p_{(s = 800\ m)}$ = 3 N/mm², lubricant: HD46

15

ORDER DATA

The following information is required to prepare a offer and process the order:

- Component name / identification
- Order quantity incl. coordination of possible follow-up orders (framework agreement)
- Delivery schedule
- Material category (alzen® 305, alzen® 305K)
- Relevant drawings (raw and finished dimensions, tolerances, etc.), 3D data (step), standards and technical specifications
- Information regarding the external and internal casting properties
- Information regarding machining, such as the relevant position and clamping point
- Information on initial sample and product approval, tests, etc.
- Information on packaging and transport
- Any special requirements that must be agreed at the time of acceptance of the order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16

TECHNICAL SERVICE

In addition to the production of semi-finished and finished parts, voestalpine Camtec GmbH also offers the testing of prototypes on internal and external test benches to enable the examination of operating behaviour under application-specific conditions.

INTERNAL TEST BENCHES

» **63t-eccentric press:**
- Max. press force: 630 kN
- Stroke frequency: 10 – 30min^{-1}
- Max. installation height: 360 mm
- Max. table top: 840 x 900 mm
- Data acquisition:
  Force signal (piezo sensors, strain gauges)
  Position detection (ind. proximity sensor)
  Temperature signal (PT-100)
  Distance X/Y/Z (laser triangulation)
  Wear sensor (PCB)

» **Wear plate tribometer:**
- Surface pressure: 0,2 – 2,5 N/mm^2
- Sliding speed: 0,1 m/s – 0,9 m/s
- Stroke length: 170 mm
- Sliding plate dimension: 80 x 125 x 20 mm (ID: 19808)
- Data acquisition:
  Normal force (load cell)
  Longitudinal force (strain gauges)
  Wear sensor (PCB)
  Temperature measurement (PT-100)
  Friction coefficient
  Stroke rate
  Distance
  Test duration

TESTING OPTIONS AND CERTIFICATES

To fulfil the highest quality requirements, components can be measured and checked conventionally and via a 3D measuring machine. A 2.1 certificate is optionally included in the scope of supply. If additional measures such as the non-destructive testing of components (UT, PT, ...), the provide of a 2.2 or 3.1 certificate are required, additional costs will ocur.

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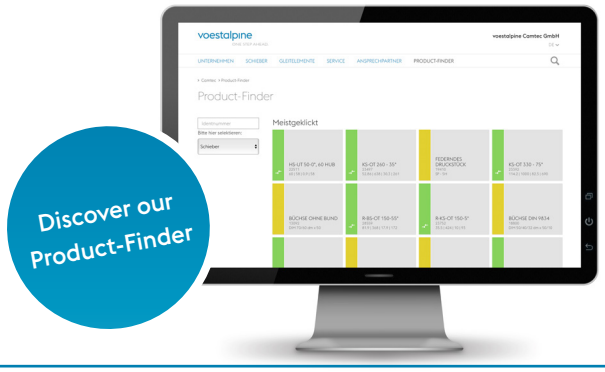
Click here to go directly to the Product-Finder



FOREIGN REPRESENTATIONS

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voestalpine Camtec is a leading global company with many years of experience in the manufacture of cam units, maintenance-free sliding elements and non-ferrous metal alloys.

Our global team is at your service worldwide:
Find the right contact person online at www.voestalpine.com/camtec
or contact us at **sales.camtec@voestalpine.com**

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