Project: Long-time gas nitrified St52 shafts

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Task: Evaluation of wear tests with various plain bearings against long-time gas nitrified St52 shafts

Test description and results:

The wear of various plain bearing materials against long-time gas nitrified St52 shafts should be assessed. The test parameters are listed in the following table Test Parameters.

Test parameter

	Parameters
Plain bearing	iglidur G; alloyed brass; rolled metal with gliding layer (for dry operation)
Shaft	S355J2C (St52-3K) cold drawn; with a subsequent long-time gas nitriding
Motion type	Pivoting; pivot angle 60°
Load	30 MPa →For a socket with Di = 20; L= 20 → 12,000 N
Surface Speed	0.01 m/s (~ 2s per cycle)
Run time	up to 200,000 cycles
Travel distance	up to 4.2 km
Test temperature	23 °C
Environment	Dry; except for the brass bearing An initial lubrication was performed there with Rivolta SKD 3602.

The wear tests were carried out on the heavy duty test stands (diagram 1).

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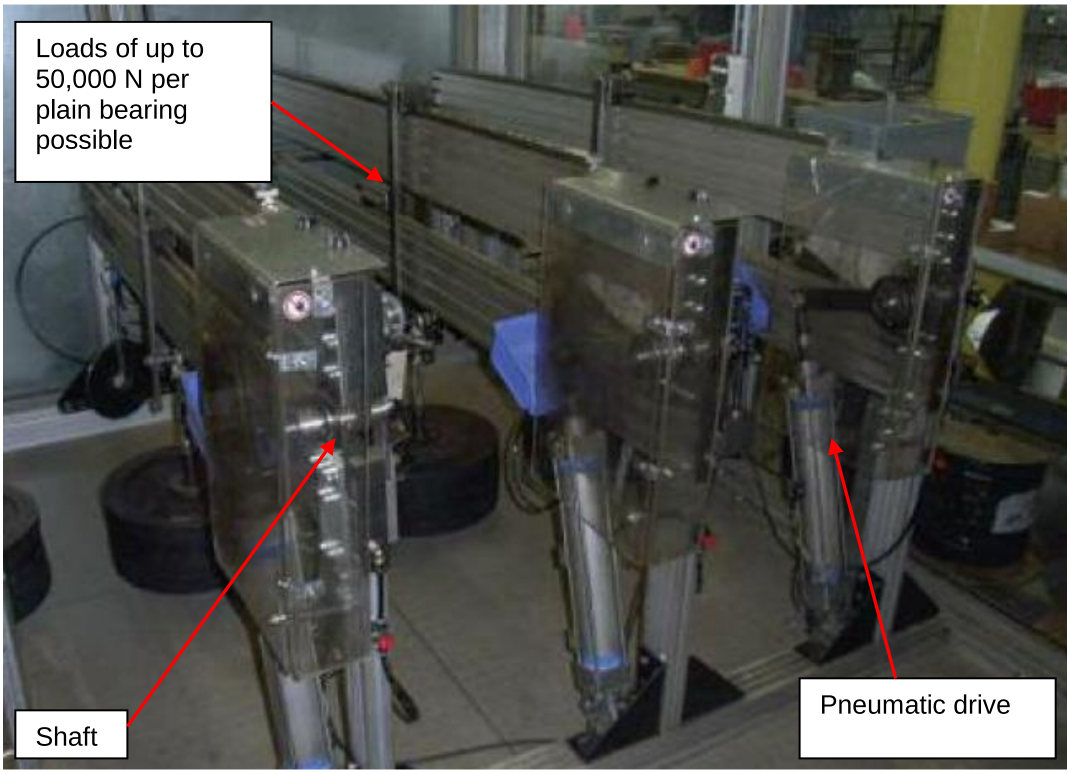

Heavy duty test stand for pivoting 1

To evaluate the wear, the inner diameter of the pressed-in plain bearing is measured in the load direction before and after the test. Together with the past cycles, shaft diameter and pivot angle, the wear rate (number of wear microns on a 1 km distance) can be determined.
The results of the experiments are shown in the following Table 1 and Graph 1.

Table 1: Results of wear tests; reduction of wall thickness

Plain bearing	Shaft	Reduction of wall thickness					
		D1 before [mm]	D1 after [mm]	"Wear" [µm]	No. of cycles [-]	Dist-ance [km]	"Wear rate" [µm/km]
iglidur® G	St52 gas nitrified	20.23	20.50	270	200000	4.2	64
iglidur® G	St52 gas nitrified	20.26	20.47	210	137642	2.9	73
Brass with initial lubrication	St52 gas nitrified	20.15	20.70	550	146565	3.1	179
Brass with initial lubrication	St52 gas nitrified	20.15	20.60	450	83403	1.7	258
Brass with initial lubrication	St52 gas nitrified	20.10	20.20	100	50000 run time shortened	1.0	96

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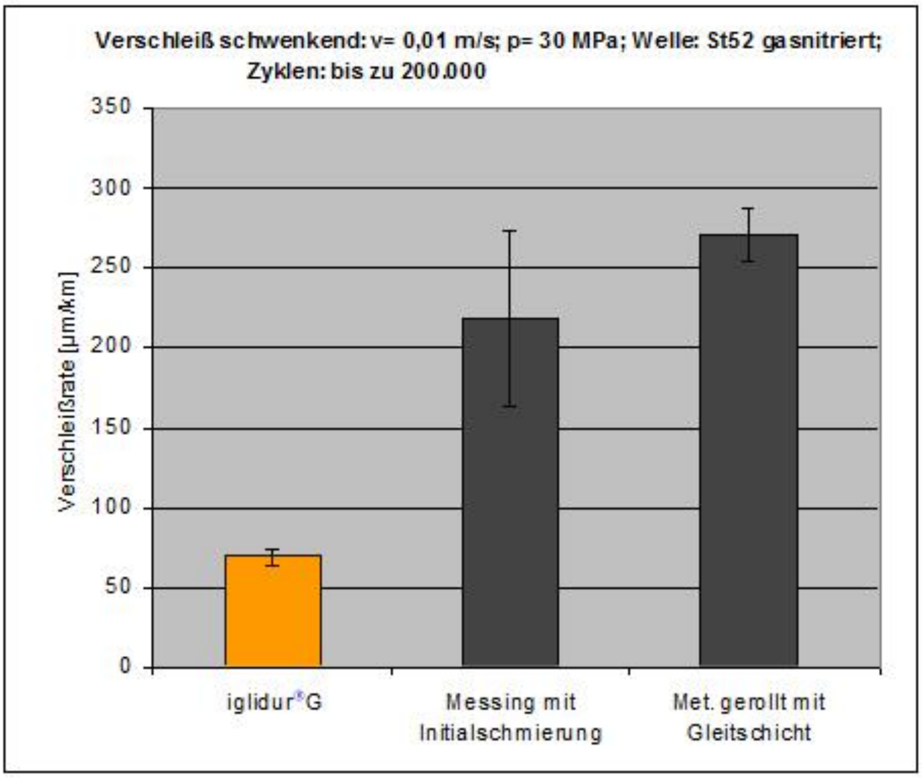
Rolled metal with gliding layer	St52 gas nitrified	20.12	20.47	350	59030	1.2	283
Rolled metal with gliding layer	St52 gas nitrified	20.12	20.46	340	62667	1.3	259

Note:
D1= Inner diameter
Grease used for initial lubrication = Rivolta SKD 3602
Wear= The wear measured here consists of abrasion and deformation of the plain bearing
Wear rate= Indicates the extent of wear (µm) of the plain bearing on a 1 km distance.

Graph 1: Results of the wear tests



In the wear tests the iglidur® G material had the lowest wear.

In addition, the tested shafts and plain bearings were visually assessed (diagram 2-6).

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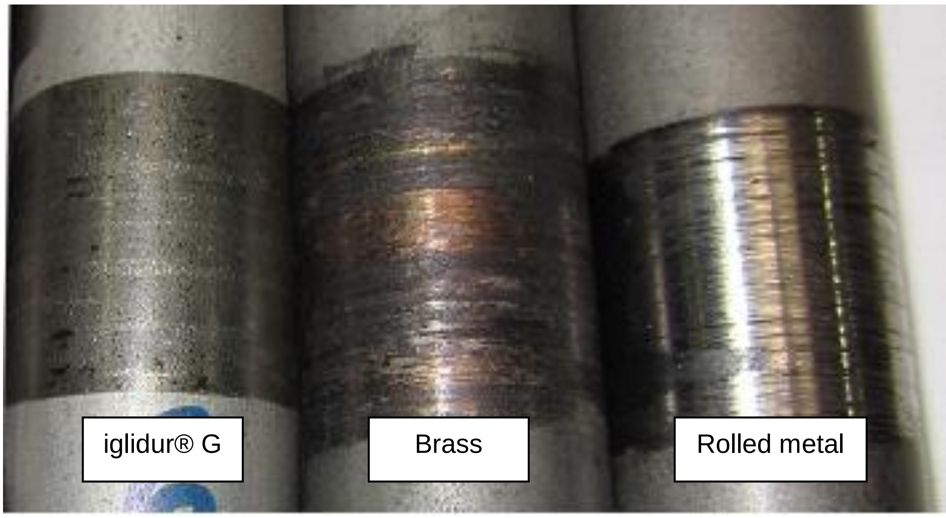

Diagram 2: Shafts in wear tests 1

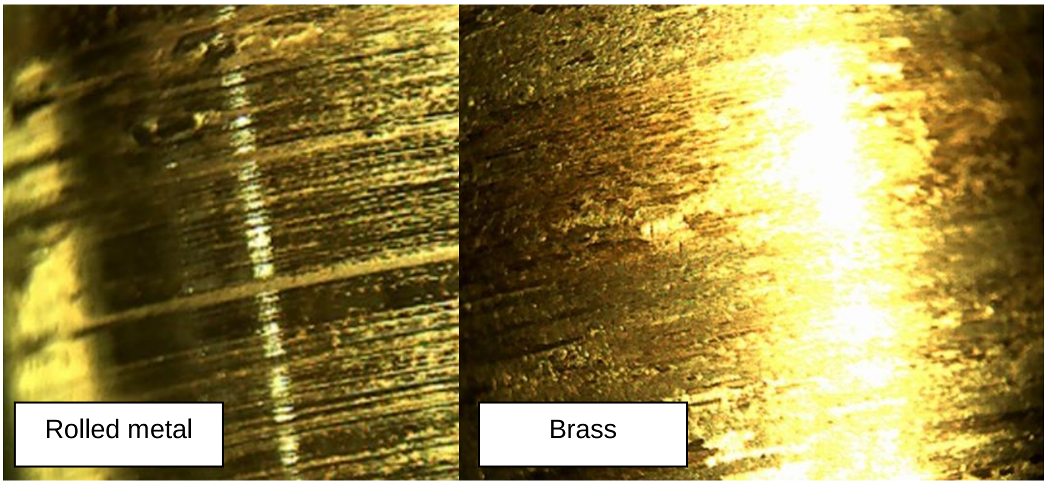

Diagram 3.: Shafts under the microscope 1

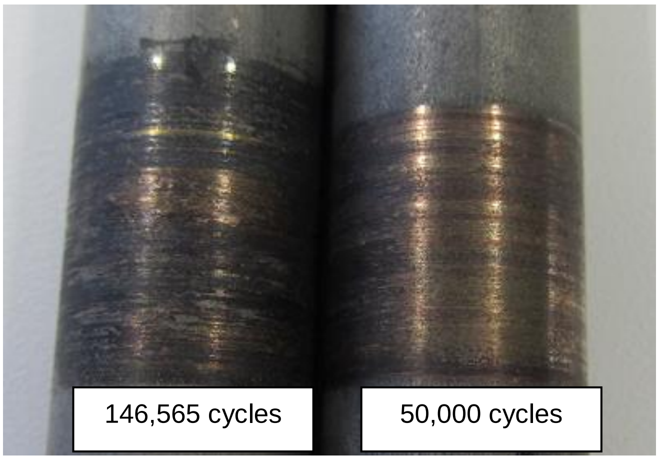

Diagram 4: Shafts in the wear tests with brass plain bearings

Diagram 5: Brass plain bearings in the wear tests

Diagram 5: Rolled metal plain bearings in the wear test

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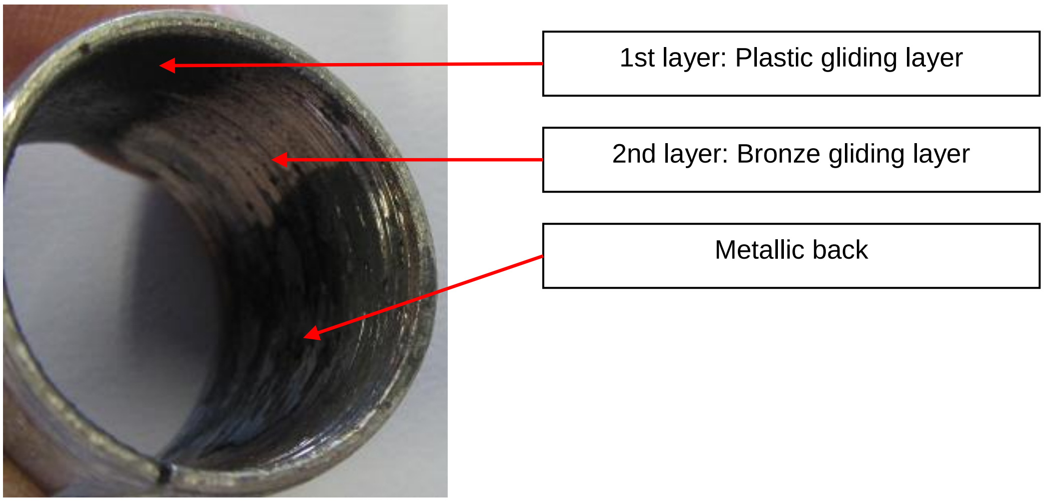

Diagram 6: iglidur® G plain bearing in the wear test

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Conclusion / Optimisation proposal:
The findings from these experiments are summarised in Table 4.

Table 4: Summary

	Wear rate [µm/km]	Anomalies on the plain bearing	Anomalies on the shaft
iglidur® G	69 ±6	Normal running tracks, Worn out	Normal running tracks; Cavities filled with plain bearing material
Brass with initial lubrication	219 ±55	Strong running tracks; disruption; Considerably worn out	High transfer of brass on to the shaft
Rolled metal with gliding layer	271 ±17	Gliding layers worn; Steel back "exposed"; Considerably worn out	High shaft wear; seizure between plain bearings and shaft

In addition, it should be noted:

- The high wear in competitor's plain bearings is likely to be attributed to an insufficient lubrication. Because:
  - In the case of the rolled metal plain bearing, the gliding layer is already worn after 60,000 cycles.
  - In the case of the brass plain bearing, the initial lubrication does not appear to be sufficient for 200,000 cycles. The wear is considerably lower with a shorter running time (50,000 cycles).
- The (competitor's) plain bearings are sometimes considerably worn out, which means the wear is composed of abrasion and deformation.
  - The cause of the strong flow of the competitor's plain bearings is unknown. Possibly, the high shear stress has a decisive influence here due to the increased coefficient of friction (high coefficient of friction due to the insufficient lubrication).
- The iglidur® G plain bearings "work" differently. Because:
  - For the iglidur G plain bearing, the cavities on the shaft surface are filled. As a result, the solid lubricants could be distributed more easily between the shaft and the plain bearing.

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