PTFE Based Lead Free Metal-Polymer Plain Bearing Materials for Dry Applications

Technical Information

GGB

1 Introduction

This brochure describes the range of self-lubricated, PTFE based metal-polymer plain bearings specifically developed by GGB for operation in dry applications.

PTFE based metal-polymer plain bearing materials are used extensively in a wide range of industrial and automotive applications, where they provide improved friction and wear performance relative to conventional bimetal bearing alloys. The materials offer excellent performance under a diverse range of loads and speeds, with or without lubrication. Where no external lubricant is available and the bearing operates dry, the material must provide a sufficiently low wear rate to meet the life requirement of the application.

GGB's longest serving product, DU™, was originally developed as a self-lubricated dry bearing and for almost 50 years has remained the industry standard. Although the PTFE lining of DU contains lead, it has in recent years been GGB's environmental policy to eliminate the use of lead from its products. As a result of an extensive development program, GGB is now able to offer a range of alternative lead-free, PTFE based metal-polymer dry bearings that are ELV compliant and capable of meeting the most stringent performance requirements.

Each of these new materials comply with the European Parliament's End of Life Vehicles directive (ref: 2000/53/EC) on the elimination of hazardous materials in the construction of passenger cars and light trucks.

Although these materials are designed for operation in the absence of a lubricant, it should be noted that they also perform exceptionally well in lubricated applications.

2 Materials

Structure and Composition

GGB PTFE based metal-polymer materials share a common structure of a steel backing to which is bonded a porous bronze interlayer impregnated and overlaid with a filled PTFE bearing layer.

Microsection

PTFE Lining Compositions

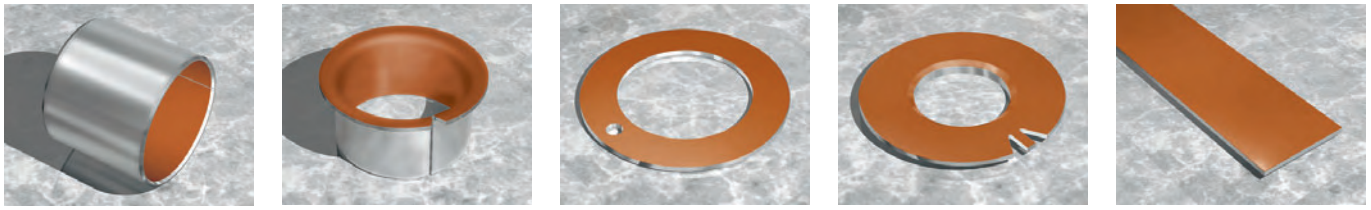
Material	DP4™	DH™	DP20™
Lining Composition	PTFE + CaF_2 + aramid fibre	PTFE + glass fibre + aramid fibre	PTFE + thermoplastic polymer

Physical and Mechanical Properties

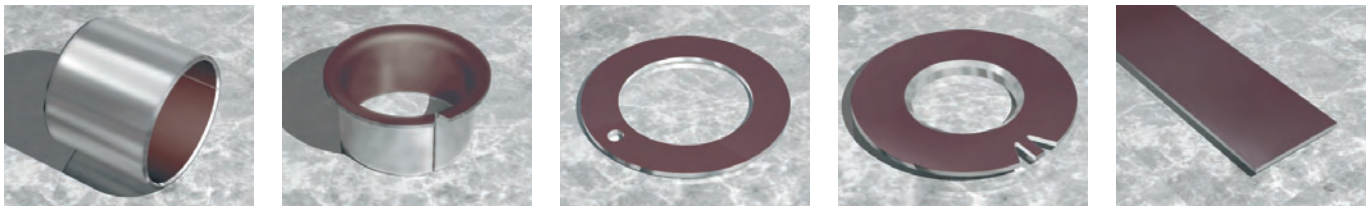
Physical Properties	Units	Values DP4	DH	DP20
Coefficient of thermal expansion - parallel to surface - normal to surface	1/10⁶ K	 11 30	 11 30	 11 30
Maximum operating temperature T_{max}	°C	280	280	200
Minimum operating temperature T_{min}	°C	-200	-200	-200
Mechanical Properties				
Compressive yield strength	N/mm²	350	350	350
Max. load - static - dynamic	N/mm²	250 140	250 140	250 140

Basic Forms

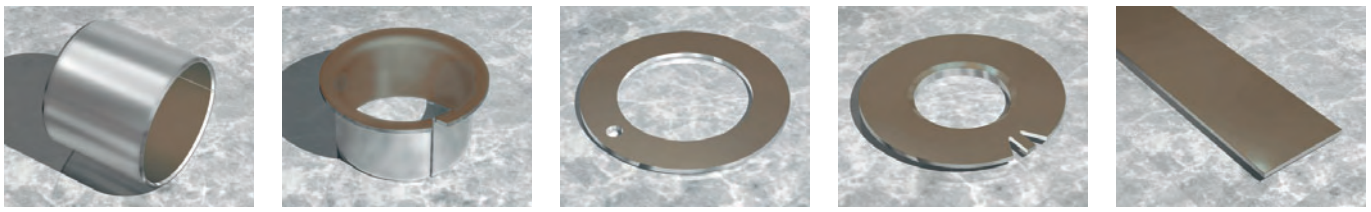
All materials are available in a variety of forms such as cylindrical and flanged wrapped bushes, thrust washers, strip material, and as special parts manufactured to customers' requirements.



DP4 Cylindrical bushes | Flanged bushes | Thrust washers | Flanged washers | Strips



DH



DP20

Patent Information

DH: US Patent No. 6,296,392
European Patent No. 956458 and others apply

DP4: US Patent No. 5,911,514
European Patent No. 708892 and others apply

DP20: US Patent No. 5,665,825
European Patent No. 683807 and others apply, including Brazil, China

Trademark Information

DU™, DP4™, DH™ and DP20™ are trademarks of GGB

Performance Factors

Each application, depending on the equipment design, usage, lubrication and operating conditions, places individual demands on the bearing material properties required for satisfactory performance. The following indicates some of the factors that can influence bearing life and compares the major performance characteristics of each of the materials.

Dry Wear Resistance

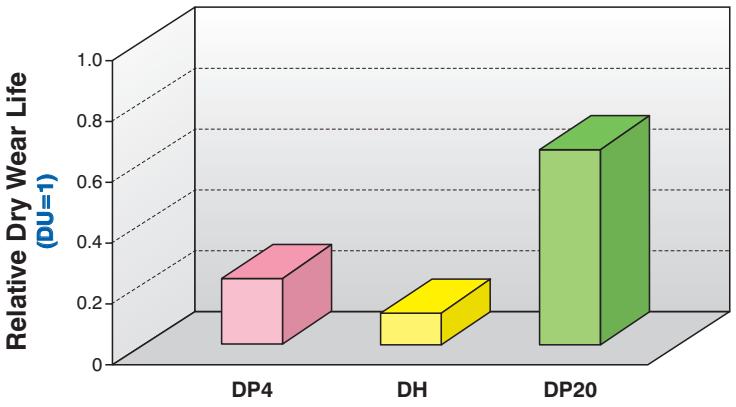
The tribo-chemistry of the dry wear mechanism of the lead containing DU material is fundamental to its wide operating spectrum and resulting commercial acceptance. The dry wear mechanism of the lead free PTFE based metal-polymer bearing materials however, is significantly different and as a result the relative performance of the materials depends upon the actual operating conditions.

The wear rate under dry conditions depends on the specific load ($\bar{p}$), sliding speed (U), the $\bar{p}U$ factor and the type of motion i.e. continuous or intermittent, rotating or oscillating.

The relative performance of each material under a range of standard GGB test rig conditions is highlighted below.

Continuous Rotation

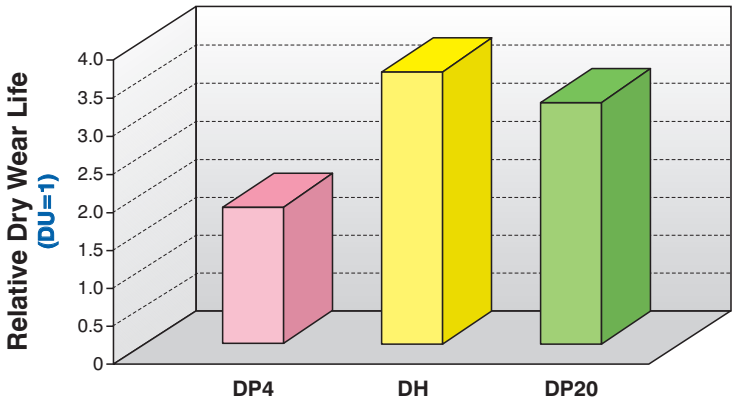
Under the test conditions quoted DP20 shows the best dry wear performance of all the lead-free PTFE base metal-polymer materials tested.



Test Conditions:
Load: 0.9 MPa Speed: 0.78 m/s PV: 0.7 MPa x m/s Shaft Roughness: 0.15 µm Ra

Oscillating Movement

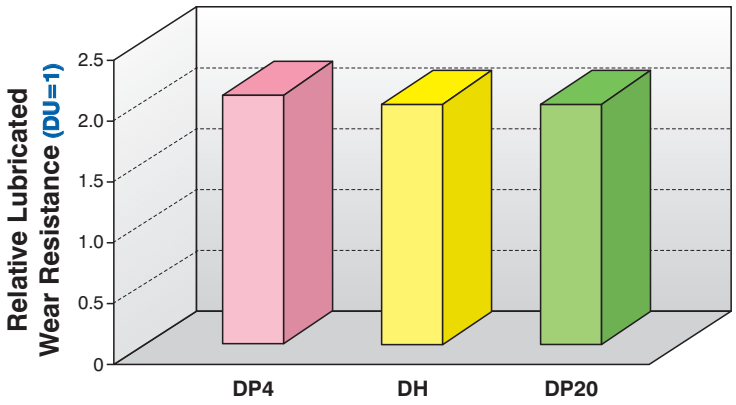
The lead free materials generally exhibit superior performance under oscillating conditions, particularly in conditions of high amplitude, low frequency oscillation, as indicated. However, it should be noted that bearing performance under high frequency, low amplitude modes of operation, such as those associated with vibration or fretting type wear, is highly influenced by the specific conditions of operation.



Test Conditions:
Load: 13 MPa Frequency: 0.4 Hz Angle of Oscillation: 36° Shaft Roughness: 0.15 µm Ra

Boundary Lubricated Wear Resistance

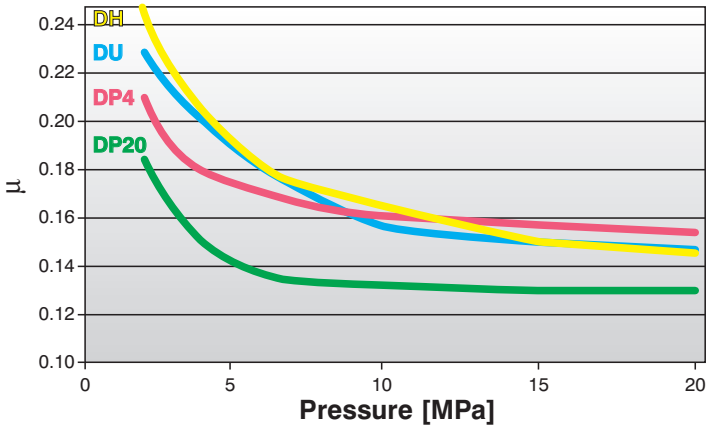
For a long service life, a low wear rate is necessary particularly under severe mixed film or boundary lubricated conditions where the generated lubricant films are of the same order, or less than, the surface roughness of the mating surface.



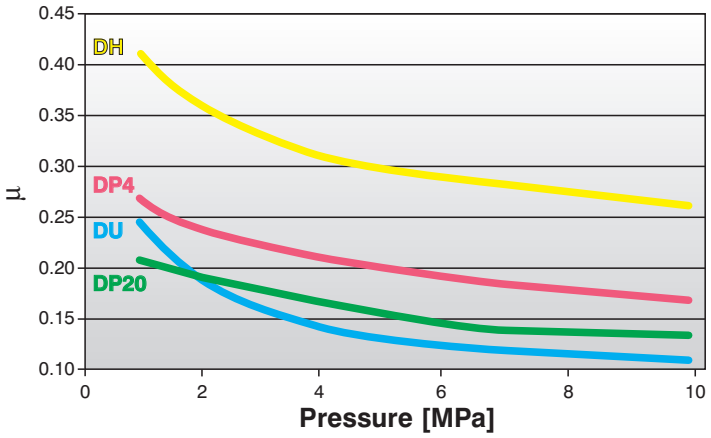
Test Conditions:
Speed: 0.11 m/s Load: 12 - 40 MPa Lubricant: BP Bartran HV

Dry Friction

A low and constant static and dynamic friction is generally desirable in most applications. None of the materials show stick-slip effects, however, actual friction values depend on many design and operating factors.



Dry friction under low speed conditions:
Speed: 0.04 m/s



Dry friction under high speed conditions:
Speed: 0.7 m/s

Calibrating / Burnishing

In some applications it is necessary to calibrate or burnish the assembled bush bore in order to control the assembled bearing clearance. The physical properties of the PTFE bearing surface determine the ability of the bearing material to withstand this process.

All of GGB's metal polymer bearings are capable of being calibrated within reasonable limits of tool interference.

Overview & Selection Guide

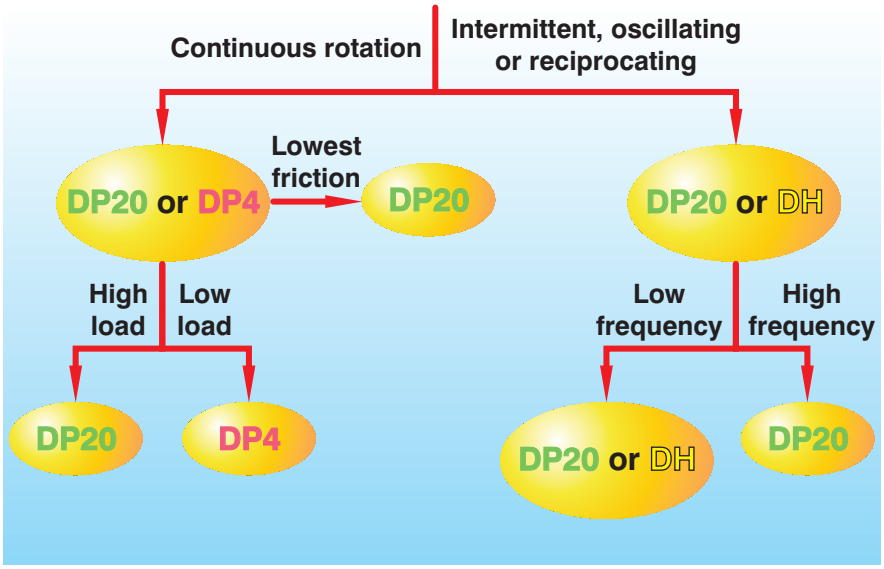
Product selection may be simplified using the following table and flow-chart which summarises and compares the relative strengths of each of the lead free self-lubricating materials.

Performance Comparison

Material	High speed, continuous rotation	Low frequency oscillation	High frequency oscillation	Dry friction	Burnish-ability
DP20	1	1	1	1	2
DH	4	1	3	2	2
DP4	2	3	3	2	2

Ranking: 1 excellent | 2 good | 3 satisfactory | 4 not recommended

Material Selection Guide for Dry Applications



Product Information

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