The right perspective

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D Glide Materials Information

Introduction

D Glide is the family name of a range of composite bearing materials produced by DRIE-D bv located in The Netherlands.

The main properties they share are:
-They can be used maintenance free
- High allowable loads (on par with or higher than metal plain bearings)
- Elastic (e-modulus ~ 1% of steel)
- Low friction values (under 0.1 is achievable)
- Very low wear rates
- Dimensionally stable (dry and in water)
- Good chemical resistance
- No hazardous components (like asbestos or phenolic resins)
- Counter face friendly
- Electrically insulating

Applications

When taking the above short summary into consideration it is easy to see applications where D Glide bearings are a better choice than metal bearings for example:
- When lubrication is not possible or unwanted
- In water (experience up to 3.000 metres deep)
- Where the elasticity of the materials may be required (misalignments, shock loads, vibrations)
- Longer bearing life including linear motions
- When low friction values are needed
- Corrosion may occur
- Where shaft wear is occurring

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Summary of D Glide Materials

The basic D Glide range consists of 3 major families D Glide P, X and F with F being the major types being produced today. Within this range for most applications the optimal bearing material can be found. It is also possible to quickly and efficiently produce special types of D Glide to optimally meet the requirements of specific applications. All D Glide varieties can be machined with common equipment. Machining instructions are available, only harmless dust and fibres will be released. If the bearings are used without lubrication, it is advisable to use a corrosion resistant counter face material for optimum results. All D Glide materials are available in sheet and hollow tube except D Glide X which is available only in hollow tube.

D Glide P is the originally developed base material of the range. The maximum loads are high, friction is low as are the wear rates and demands on the counter face materials. It is also available in a 'no-creep' version. D Glide P normally is coloured blue but can also be produced in different colors when requested. It is the most inexpensive material in the D Glide family and it probably offers the best price performance ratio of any composite material available today.

D Glide F is in most aspects the superlative of D Glide P. It allows higher loads and a higher temperature than P. More importantly friction is lower allowing higher PV values and the wear resistance is even better. Also D Glide F is available in a 'no-creep' version. Both research and experiences in real applications have shown that the family of D Glide F is one of the least wearing materials of its kind.

D Glide X is the youngest and strongest variety of the D Glide family. This material has been developed for applications where up to now no bearing material gives satisfactory results. Besides the very high strength the resistance against abrasive wear is unequalled. Also D Glide X is probably the only homogeneous composite bearing material that does not creep. D Glide X is one of the strongest and, in dirty conditions, the most wear resistant plain bearing material in existence and the only one to have non-creeping qualities.

Properties	Unit	D Glide P	D Glide F	D Glide X
Compressive strength	(MPa)	325	350	430
Shear strength	(MPa)	95	105	120
Stiffness under compression	(MPa)	2000	1600	3600
Density	(103	1.25	1.35	1.60
Water absorption	(%)	0.15	0.30	0.15
Coefficient of thermal expansion	(10-	65	50	60
Chemical resistance	(-)	Good	Good	Excellent
Color	(-)	Blue	Yellow	Black
Maximum temperature	(°C)	130	150	220
Minimum temperature	(°C)	<-200	<-200	<-200
Advised maximum working	(°C)	80	100	150
Typical friction value	(-)	0.05 – 0.12	0.04 - 0.10	0.04 - 0.12
General wear resistance	(-)	Very good	Excellent	Excellent
Resistance against abrasive wear	(-)	Good	Very good	Excellent
Minimal hardness counter face	(HB)	170	170	200
Ideal hardness counter face	(HB)	190	190	240
Desired roughness counter face	(Ra,	<1.6	<1.6	<1.6

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D Glide P

- Base material of the range
- **Main components**:

- Terylene cloth, polyester resin with PTFE friction modifier

- **Main properties:**

- Breaking strength > 300 Mpa
- Negligible water swell
- Typical real friction values: ±0.1
- PV-values limited

- **Applications in general:**

- Oscillating motions
- Wet applications

- **Current Applications:**

- Joints and hinges offshore equipment (ref. www.huisman-itrec.com)
- Hinges agricultural equipment (ref. www.wifo.nl)
- Rudder bearings
- Hydraulic cylinder wear rings (ref. www.eaton.com)
- Deck hatches (ref. www.rodenstaal.nl)
- Slide blocks and pads
- Joints and hinges
- Sockets / connections wire ropes (Kranbau Köthen)
- Truck trailers (ref. www.nooteboom.nl)

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D Glide F

- Improved version of D Glide P
- **Main components:**

-Terylene cloth, high temp resin (250 °C), PTFE friction modifier

- **Main properties:**

- Breaking strength > 300 Mpa
- Negligible water swell
- Typical real friction values: ±0.1
- Higher PV-values than D Glide P

- **Applications in general:**

- Oscillating and rotating motions
- Wet and dry applications

- **Current Applications:**

- Sheaves and rollers
- Hydro-power gates, linkages and pumps
- Rail applications (QLD, European Rail)
- Spherical and non-spherical bushes
- Pump bearings (KSB, Weir and Ebs-Ray)
- General offshore applications (ref. www.rolls-royce.com)
- Civil applications (bridges, locks, gates, ref www.hollandia.tvo.nl)
- Wind power

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D Glide X

- Special carbon fibre based material
- **Main components:**

- Carbon fibre (FW), high temperature resin (250 °C), PTFE friction modifier

- **Main properties:**

- High temperatures
- Extremely strong
- Stiffer than any other composites manufactured
- Slightly brittle
- Good conductivity (heat and electricity)
- No creep
- High PV-values
- Not available in sheet form

- **Applications in general:**

- High temp
- High PV applications
- Enduring loads

- **Current applications:**

- Hot glue rollers
- Rail
- Hydro-forming equipment

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D Glide FT

D Glide FT is from the family of D Glide F with a special high PTFE content sliding layer. With respect to friction values and wear rates there is no material that comes even close to PTFE but mechanical properties of PTFE are poor. For this reason most D Glide materials contain PTFE homogeneously dispersed in the material but the percentage that can be included this way is limited. To increase the percentage of PTFE in the contact surface Drie-D has developed D Glide FT. The sliding layer does not have the full strength of normal D Glide F but with limited layer thicknesses this is hardly significant for the bearing as a whole. As the sliding layer is not as tough as normal D Glide F the resistance against abrasive wear is slightly reduced. One major advantage of D Glide FT is that if the PTFE sliding layer wears through there is still a fully functional D Glide F bearing to be used as a back up.

Property	**Unit**	
Compressive strength	(MPa)	300
Shear strength	(MPa)	95
Stiffness under compression	(MPa)	1600
Density	(103	1.35
Water absorption, submerged	(%)	0.3
Coefficient of thermal expansion	(10-6/°C)	50
Chemical resistance	(-)	Good
Colour	(-)	Yellow
Maximum temperature	(°C)	150
Minimum temperature	(°C)	<-200
Advised maximum working temp	(°C)	100
Typical friction value, dry	(-)	0.04 – 0.08
General wear resistance	(-)	Excellent
Resistance against abrasive wear	(-)	Average

- **Applications in general:**

- All applications where friction value of D Glide F is too high

- **Current applications:**

- Rollers
- Slide and wear pads
- Sheaves
- Railway spherical bushes

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D Glide FS

D Glide FS is a special variety of the D Glide F material. The bearing properties are identical to those of D Glide F, but due to a different combination of fibres the mechanical properties are different. D Glide FS has been developed for high load applications where using D Glide F or P creep may occur. The stiffness of D Glide FS is approximately twice as high as of D Glide F but can be adjusted upwards and downwards when desired. In practice this means that the material is suited to be loaded for a long period of time with much higher pressures than would be acceptable for almost any other composite plain bearing material besides D Glide X.

Property	**Unit**	
Compressive strength	(MPa)	350
Shear strength	(MPa)	105
Stiffness under compression	(MPa)	3000 – 6000
Density	(103	1.35
Water absorption	(%)	0.30
Coefficient of thermal expansion	(10-6/°C)	50
Chemical resistance	(-)	good
Colour	(-)	Yellow
Maximum temperature	(°C)	150
Minimum temperature	(°C)	<-200
Advised maximum working temp	(°C)	100
Typical friction value	(-)	0.04 – 0.10
General wear resistance	(-)	Excellent
Resistance against abrasive wear	(-)	Very good

- **General applications:**

- All applications with very high loads
- Applications requiring a higher stiffness than D Glide F

- **Current applications:**

- Sheave blocks
- Amusement rides (Maurer)
- Highly loaded hinges (offshore)

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D Glide FC

D Glide FC is a variety of D Glide F with which it shares the main mechanical properties. As with all other D Glide material it is designed to be used without lubrication or any other kind of maintenance. D Glide FC has been developed to further reduce wear rates, especially in less than ideal circumstances. This includes many linear applications where the counter face conditions are not as well controlled as is usually the case in rotating motions. D Glide FC is less sensitive to the intrusion of foreign particles (for example sand or rust) in the contact surface. This gives the material a very constant long term behavior, low wear rates with low and constant friction values even when contamination is introduced. When used in abrasive circumstances some extra care is required in choosing the counter face material. Especially in rotating applications a minimum hardness of HB 220 is advised.

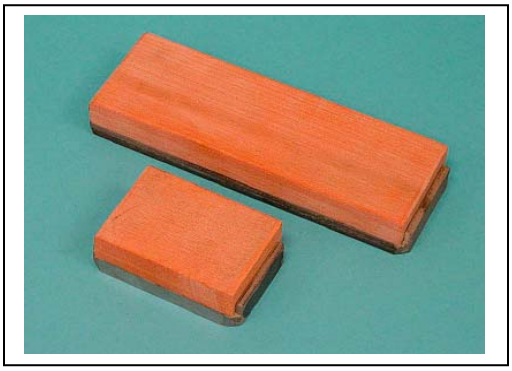
Property	Unit	
Compressive strength	(MPa)	350
Shear strength	(MPa)	105
Stiffness under compression	(MPa)	1600
Density	(103 kg/m3)	1.35
Water absorption	(%)	0.30
Coefficient of thermal expansion	(10-6/°C)	50
Chemical resistance	(-)	good
Colour	(-)	Pink / Orange
Maximum temperature	(°C)	150
Minimum temperature	(°C)	<-200
Advised maximum working temp	(°C)	100
Typical friction value	(-)	0.04 – 0.10
General wear resistance	(-)	Excellent
Resistance against abrasive	(-)	Very good

- **General Applications:**

- Linear and sliding motions
- Wear blocks / strips and plates
- Slurry pump bushings

- **Current Applications:**

- Container (straddle) carriers
- Formula one wear planks
- Slurry pump sleeves (Weir)
- Screw conveyor hanger bearings



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D Glide U

D Glide U can be seen as an improved version of D Glide F. It shares the good running properties of D Glide F but thanks to the use of different fibres, the resistance against abrasive wear is even better. Also maximum strength and stiffness are slightly higher than of D Glide F. Creep is an unknown phenomenon for D Glide U. Perhaps the most significant improvement over D Glide F is the much higher allowable temperature, better temperature stability and the fact that properties hardly change with increasing temperatures.

Properties	**Unit**	
Compressive strength	(MPa)	390
Shear strength	(MPa)	110
Stiffness under compression	(MPa)	2200
Density	(103 kg/m3)	1.4
Water absorption, submerged	(%)	0.3
Coefficient of thermal expansion	(10-6/°C)	35
Chemical resistance	(-)	Good
Colour	(-)	Yellow
Maximum temperature	(°C)	250
Minimum temperature	(°C)	<-200
Advised maximum working temp	(°C)	180
Typical friction value, dry	(-)	0.06 – 0.12
General wear resistance	(-)	Very good
Resistance against abrasive wear	(-)	Excellent

- **General Applications:**

- Used where D Glide F is unable to withstand the high continuous temperatures

- **Current applications:**

- Steel foundry and aluminium smelting hooks
- Heavily contaminated pumps
- Hot steel rollers

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Design guidelines

The main concern when designing anything is that the product should perform its function and should achieve its desired life. The same of course applies to D Glide bearings. To be able to make statements about this we need to look at the 'failure mechanisms' i.e. the causes for possible failure. For a D Glide bearing there are four: overloading, creep, overheating and wear. Further some guidelines are given for the dimensions of D Glide bearings and other relevant design aspects.

Overloading

When pressures are mentioned this is the average pressure, for bushings this means the load divided by inner diameter times bearing length. Local peak pressures ('Hertz stresses') of course are higher, how much higher depends on the bearing design. All data provided is based on the average pressures.
Long term average pressure values of up to 60 MPa dynamic and 120 MPa static are allowed. Higher values are often possible; however in these cases please consult Modern Engineering. If the loads don't go beyond these limits deformation is then elastic; there will be no permanent effects on the bearing.

Creep

Creep is defined as permanent (plastic) deformation caused by long term stress. Almost all plastics and a number of metals are sensitive to creep. Whether or not creep can occur depends on many factors like wall thickness relative to bearing diameter and length, temperature, installation method, other design features and so on. For an average bearing, in average conditions, for D Glide P and F, creep may start to occur at long term pressures of over 50 MPa, for D Glide U this is 75 MPa and for the no creep version of D Glide P and F this is 100 MPa.
Again, in case of any doubts please consult Modern Engineering.

Overheating

Wherever sliding takes place heat is generated and too much heat can damage a D Glide bearing. There unfortunately is no easy way to calculate contact temperatures but there is an easy way to assess the amount of heat going into a bearing. The amount of heat has a direct relation with the contact pressure (p, MPa) and sliding velocity (v, m/s), commonly known as PV value. Because this says nothing about how well heat can flow away there are no fixed threshold values, instead 3 area's are defined: Green - permanent motion will not lead to overheating, Orange - overheating could occur further investigation is required and Red - don't bother, bearings will melt.

Hereunder the values:

	Green	Orange	Red
D Glide P	**< 0.3**	**0.3 - 2**	**> 2**
D Glide F / FC	**< 0.5**	**0.5 – 3**	**> 3**
D Glide FT	**< 0.7**	**0.7 – 4**	**> 4**
D Glide U	**< 0.8**	**0.8 - 5**	**> 5**

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Wear

It is virtually impossible to make general statements about wear; actual wear rates are simply influenced by too many factors. Lifetime calculations are possible but detailed information about the application then is required. To provide some feeling about wear rates / life times hereunder some comparisons with other bearing materials in the same conditions. In various applications D Glide F has proven to outlast self-lubricating bronze bearings by a factor between 2 and 5 and compared with normal bearing bronze running without lubrication, differences in wear as high as a factor 100 or more are not uncommon. In abrasive conditions D Glide FC has proven to be one the most wear resistant bearing materials available, it is used successfully as replacement for hardened steel bearings in grabs and dredging equipment and has even been used as wear plank under Formula 1 racing cars.
If wear is a concern please always consult Modern Engineering.

Bearings dimensions

A good value for the wall thickness is between 10% and 5% of shaft diameter, larger and smaller wall thicknesses are allowed. Larger wall thicknesses reduce the load capability and increase the sensitivity to creep. At smaller wall thicknesses the interference fit between bushing and bore might become a point of concern. Of course the elasticity of a bearing and the amount of misalignment it can accept is directly related to the wall thickness.

Direction of the load

With composite materials the mechanical properties depend on the fibre orientation, all properties apply to loads perpendicular to the fibre orientation (bushings -> radial loads, thrust washers -> axial loads). Parallel to the fibres the load capability is about 30% but also depends on design details. Wear rates and other dynamic behavior are not influenced by orientation of the load.

Counter faces

Good counter faces for D Glide must meet 3 basic requirements, the roughness is not higher than Ra 1.6µ, the hardness minimally is HB 180, preferably HB 220 or more and they should not corrode in the environment they are used in. All materials that meet these requirements can be used.

Conclusion

Designing good D Glide bearings is not difficult; the main rule is to use common sense. The data provided here is purely indicative and consultation with Modern Engineering and Drie-D is recommended. In case of any questions or doubts, Modern Engineering is always available for advice and support.