
**Hydro Power/
Water Control**

Lubron®

TF

**Self-Lubricating Woven
PTFE Bearings**

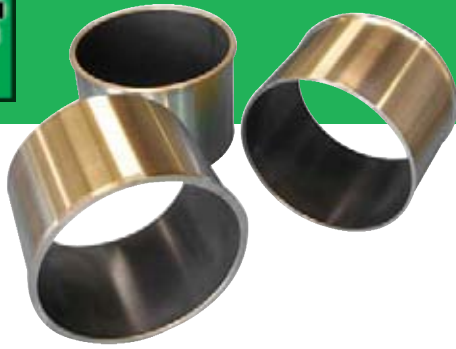


Lubron Bearing Systems

Bearings to move the world.



Lubron TF Self-Lubricating Woven PTFE Bearings



LUBRON® TF bearings are designed to provide the lowest possible coefficient of friction for moderate to high load applications. Consisting of a woven PTFE fabric liner permanently bonded to a metallic substrate, LUBRON TF bearings are completely maintenance-free and can operate wet or dry.

BENEFITS

LUBRON TF self-lubricating bearings feature the following advantages:

- Extremely low friction
- High wear resistance
- Long service life
- Static loads up to 60 ksi
- Dynamic loads up to 20 ksi
- Minimal permanent set
- Tight running clearances
- Excellent dimensional stability
- Negligible water swell
- Simple installation
- No oil or grease lubrication

LUBRON TF bearings also have a unique mechanical locking system to prevent delamination, a common problem with other types of bearing liner systems.

SUPERIOR CONSTRUCTION

LUBRON TF's proprietary construction provides full support of the individual PTFE fibers and ensures a rigid bond of the fabric to the bearing substrate, two basic requirements that DuPont specifies for the successful use of Teflon® as a bearing surface. In addition to having low tangential shear stress and high wear resistance, LUBRON TF's high strength adhesives and unique mechanical locking systems eliminate any possibility of delamination of the bearing liner during installation or actual service.

Teflon® is a registered trademark DuPont



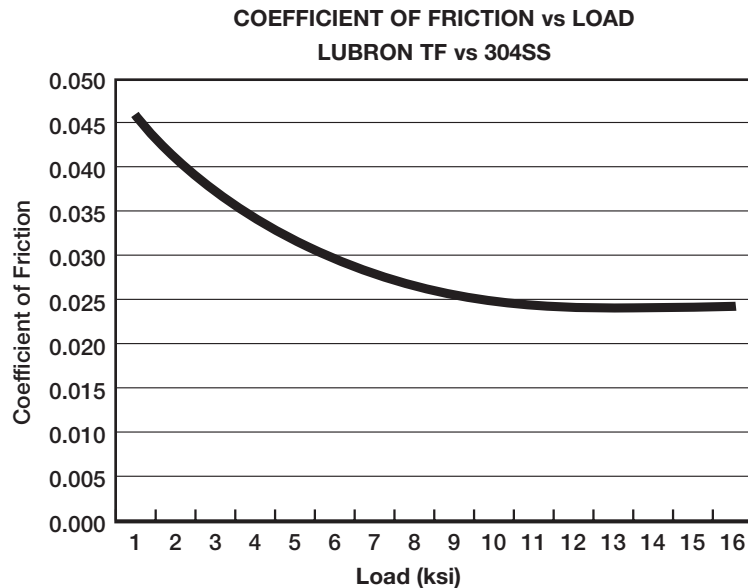
LUBRON TF self-lubricating bearings have been performing flawlessly in a variety of rigorous operating conditions for more than two decades. LUBRON TF bearings provide dependable maintenance-free service in applications where oil and grease lubrication is not desirable.



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HIGH LOAD CAPACITY

LUBRON TF bearings are generally designed to accommodate loads from 1.5 ksi (10 N/mm²) to 10 ksi (69 N/mm²), and can withstand loads in excess of 60 ksi (415 N/mm²) without cold flow. Cold flow is minimized by the effective entrapment of PTFE fibers and glass fibers with high strength bonding resins.



LOW FRICTION

The coefficient of friction for PTFE fibers is the lowest of all known fibers. Static coefficient of friction is only slightly higher than dynamic, minimizing stick-slip. LUBRON TF bearings typically have a coefficient of friction of less than 0.06, depending on the load, velocity, temperature, finish and hardness of the mating surface. In tests performed by Powertech Laboratories for the U.S. Corps of Engineers, LUBRON TF bearings exhibited a maximum coefficient of friction of 0.06 (wet) and 0.07 (dry).

Coefficient of friction and wear tests performed by Powertech Laboratories consisted of applying a 3300 psi (23 MPa) load for 120 hours, simulating two years of normal operation for a typical hydroelectric turbine. Bronze bearings tested for comparison were either water lubricated (wet) or grease lubricated (dry). Coefficient of friction decreases as bearing loads increase. This characteristic allows using the smallest bearing sizes to obtain the least amount of friction.



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LOW WEAR RATE

LUBRON TF bearings have a very low rate of wear, which is defined in terms of volumetric loss of material over time. Volumetric wear is approximately proportional to the unit load multiplied by the distance traveled, and is generally expressed as follows:

$$W = KPVT$$

where W = wear depth, in (cm)

K = proportionality constant,
in³-min/ft-lb-hr (cm³-min/m-kg-hr)

P = bearing pressure, psi (kg/cm²)

V = surface velocity, ft/min (m/min)

T = elapsed time, hr

K values for LUBRON TF bearings have been derived from independent testing, and can be used to determine the amount of wear that will occur over a period of time. For most applications, a value of $K = 9.1 \times 10^{-10}$ in³-min/ft-lb-hr is appropriate, which would be equivalent to 0.00045 inches of wear after 100,000 inches of travel at 3.5 ksi (24 Mpa).

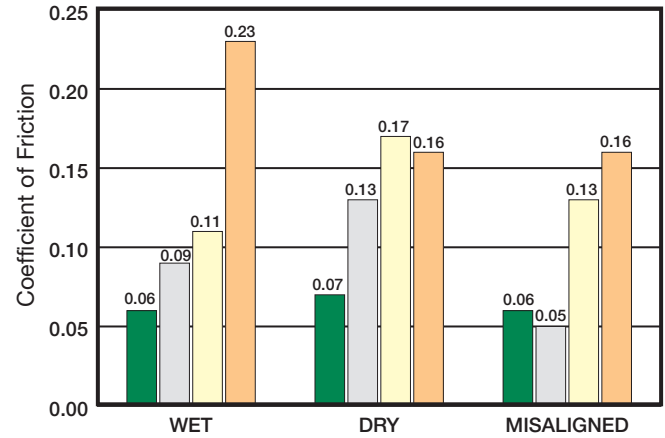
LUBRON's TF low coefficient of friction and abrasion resistance helps minimize wear and prolong bearing life. In 300 hours of extended testing a Powertech Laboratories, LUBRON TF bearings exhibited a wear rate of 0.04 mils per hundred hours at 3300 psi.

In actual applications, wear can be affected by a combination of many factors. By minimizing PV, deformation due to shaft misalignment, vibration and excessive heat, LUBRON TF bearings will achieve long service life.

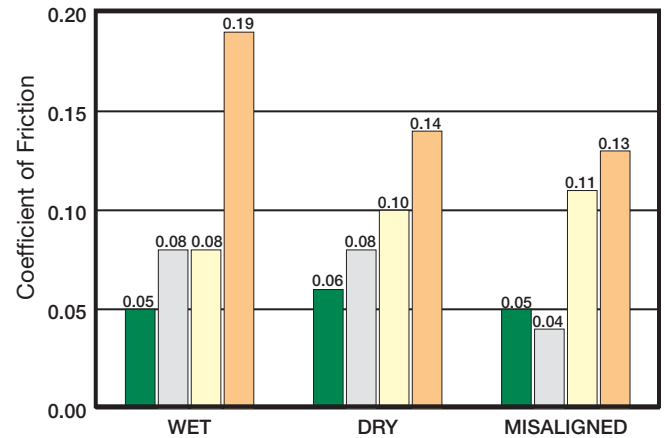
PERFORMANCE CRITERIA

The overall performance of LUBRON TF bearings is directly influenced by a variety of operating factors which include bearing load, velocity, PV and temperature. The following table lists typical property values applicable for a broad range of conditions.

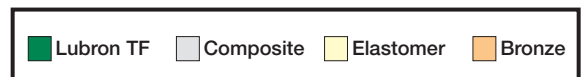
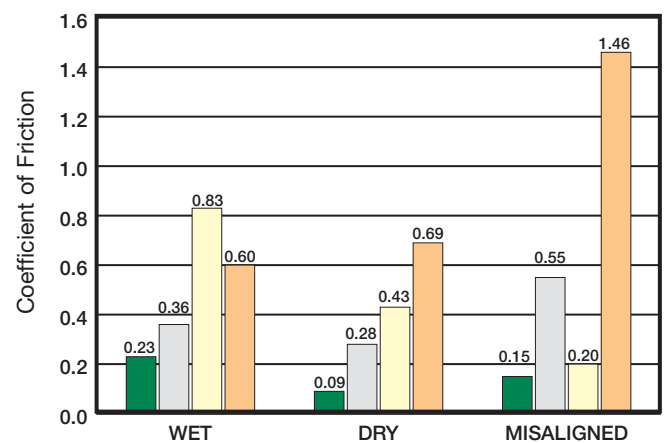
STATIC COEFFICIENT OF FRICTION



DYNAMIC COEFFICIENT OF FRICTION



WEAR RATE (MILS PER 100 HOURS)





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TABLE 2

Properties	Value	
Maximum Static Pressure	60	415 N/mm ²
Maximum Dynamic Pressure	20	140 N/mm ²
Maximum Velocity	30 ft/min	10 m/min
Maximum PV	60 x ft/min	130 N/mm ² x m/min
Temperature Range	- 200°F to +400°F	- 130°C to +200°C
Static Coefficient of Friction (Wet/Dry)	0.06 to 0.07	0.06 to 0.07
Dynamic Coefficient of Friction (Wet/Dry)	0.05 to 0.06	0.05 to 0.06
Minimum Shear Strength (% of total radial load)	25	25
Maximum Swell in Water (% of wall thickness)	<0.1	<0.1

MATERIAL SELECTION

LUBRON TF bearings are typically furnished with bronze or stainless steel substrates. The following table is intended to aid in the selection of a suitable substrate material for a specific application under consideration.

In most applications, the greatest economy and size reduction can be achieved by combining the high strength capability of LUBRON TF fabric liners with the high load capability of Alloy 863 Manganese Bronze.

TABLE 3

Alloy Number	Generic Description	ASTM Specification	Maximum Recommended Bearing Load	Maximum Recommended PV
932	High Leaded Tin Bronze	B584-C93200	1500 psi 10.3 N/mm ²	2,400 psi-ft/min 50N/mm ² -m/min
954	Aluminum Bronze	B148-C95400	4000 psi 27.5 N/mm ²	48,000 psi-ft/min 100N/mm ² -m/min
863	Manganese Bronze	B584-C86300	8,000 psi 55 N/mm ²	60,000 psi-ft/min 130N/mm ² -m/min
304	Stainless Steel	A351-CF8	10,000 psi 69 N/mm ²	60,000 psi-ft/min 130N/mm ² -m/min
17-4	Stainless Steel	A747-CB7CU-1	20,000 psi 138 N/mm ²	72,000 psi-ft/min 150N/mm ² -m/min



Lubron TF Self-Lubricating Woven PTFE Bearings

SHAPES

LUBRON TF bearings are available in many different configurations depending on the application. Most common shapes include sleeve bushings, flange bushings, thrust washers, plates and self-aligning spherical bearings.

Bushings

One-piece sleeve bushings are used extensively to accommodate all types of rotary and linear motion. Sleeve or journal bushings are employed when the shaft load is essentially perpendicular to the axis of the shaft (radial loads).

Flange Bushings

Flange bushings combine the features of sleeve bushings and washers into one unit. Flange bushings are used when the shaft load has both an axial and a perpendicular component. The flanges may be lubricated for thrust load applications, or provided without lubrication when required to function only as a spacer.

Washers

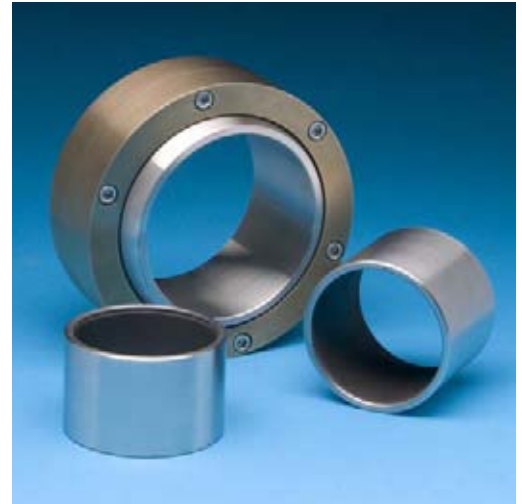
Washers are used to accommodate end thrust when the shaft load is in the direction of the axis of the shaft. Used alone or in conjunction with sleeve bushings, LUBRON TF washers can be lubricated on one or both sides.

Spherical Bearings

Self-aligning spherical bearing assemblies are designed primarily to accommodate radial loads and some misalignment. Misalignment may be caused by structural or shaft deflections under load. LUBRON TF spherical bearings consist of an inner component (gimbal) with a cylindrical inside diameter for shaft rotation and a spherical convex outside diameter, and a two-piece outer component (race) with a mating spherical concave inside diameter and a cylindrical concave outside diameter for mounting in a housing. Either component can be lubricated. Stainless steel roller wheels are also available from Lubron Bearing Systems in combination with self-aligning spherical bearings.

Plates

Bearing plates are used to accommodate longitudinal and transverse movement under vertical and horizontal loads. LUBRON TF bearing plates are generally fastened with machine screws or retained with welded bars.





Lubron TF Self-Lubricating Woven PTFE Bearings

SIZING

LUBRON TF bearings are finished machined to meet the exacting requirements of each application and are available in both inch and metric sizes. Nominal sizes for inside and outside diameters are dependent on the bearing load, shaft diameter, required wall thickness and size of the housing bore. Bearing length is usually determined by the amount of projected area required to accommodate the radial load, and can be calculated by dividing the shaft load by the desired bearing pressure multiplied by the inside diameter. Flange and washer thickness generally correspond to the bushing wall thickness. Machining tolerances for most LUBRON TF bearings range from $\pm .001''$ (.025 mm) to $\pm .002''$ (.050 mm) for the inside diameters, and $\pm .0005''$ (.012 mm) to $\pm .001''$ (.025 mm) for the outside diameters.



As a general rule, close running fits are recommended for oscillating motion when minimum starting torque is less important than elimination of free play.

For constant rotation, a free-running fit is normally recommended. A running clearance of 0.0015 inch per inch (0.038 mm per mm) of bore is usually satisfactory.

The following iso-tolerance guide can be used for most hydroelectric applications:

Shaft Diameter	$\leq 3''\text{Ø}$ ($\leq 75\text{ mmØ}$)	e6
	$> 3''\text{Ø}$ ($> 75\text{ mmØ}$)	d6
Inside Diameter	$\leq 3''\text{Ø}$ ($\leq 75\text{ mmØ}$)	G8
	$> 3''\text{Ø}$ ($> 75\text{ mmØ}$)	G8
Outside Diameter	$\leq 3''\text{Ø}$ ($\leq 75\text{ mmØ}$)	r7
	$> 3''\text{Ø}$ ($> 75\text{ mmØ}$)	r7
Housing Bore	$\leq 3''\text{Ø}$ ($\leq 75\text{ mmØ}$)	H7
	$> 3''\text{Ø}$ ($> 75\text{ mmØ}$)	H7

These recommended tolerances are for installed sizes. Allowance for shrinkage of the bushing inside diameter of at least 100% of the press or shrink fit interference must be made to ensure adequate running clearance.

As running clearance and press fit tolerances vary with each application, please contact Lubron Bearing Systems for specific design recommendations.



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MATING SURFACES

For maximum wear resistance and service life, shafts should be corrosion resistant and polished to a surface finish not exceeding 32 microinch (0.8 micrometer). Austenitic (Types 304 & 316) and precipitation-hardened (17-4 PH) stainless steels are generally used for smaller diameters. For larger shaft sizes, stainless steel sleeves or weld overlay is recommended. Best performance is obtained with the hardest available mating surface.

SEALS

Seals are recommended for applications subject to ingress of foreign debris. LUBRON TF bearings can be furnished with seals, or recommendations offered for their specification.

INSTALLATION

LUBRON TF bearings are supplied fully machined and ready for installation. Even though LUBRON TF bearings are very durable, care must be taken to ensure the lubricated bearing surface is not damaged during installation. The bearings may be hydraulically press fit into the housing, or shrunk fit with refrigeration or dry ice. If the use of liquid nitrogen is necessary, please contact Lubron Bearing Systems for instructions.

QUALITY ASSURANCE

All LUBRON TF bearings are manufactured and inspected in strict accordance with the requirements of ISO 9002. Every phase of manufacture is planned, performed, checked and certified in writing by Quality Control. Non-destructive testing is performed upon request by certified independent testing laboratories.

TESTING

Prototype and full size production testing can be performed in-house or by an independent testing laboratory to simulate load, movement, temperature and other environmental conditions present during actual operations.

ENGINEERING SUPPORT

We offer a variety of engineering services from selection of bearing materials to in-house testing of prototype and full size bearings. Bearing design, AutoCAD® drawing preparation, testing, consulting and on-site engineering services are available upon request.



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ORDERING INFORMATION

The following information is helpful in properly recommending the most suitable bearing for a specific application:

- Type of application
- Wet or dry environment
- Maximum operating load
- Minimum operating load
- Type of rotation
- Speed of rotation
- Size & tolerance of shaft diameter
- Size & tolerance of housing bore
- Shaft material & surface finish
- Seal requirement
- Delivery requirement

STANDARD SPECIFICATION FOR LUBRON TF SELF-LUBRICATING BUSHINGS:

Self-lubricating bronze bushings shall be equal to “LUBRON TF” as manufactured by Lubron Bearing Systems, Huntington Beach, California, USA. The bushings shall be composed of a supporting metal and a solid lubricant suitable for long-term maintenance-free operation. The bushings shall be one-piece construction with a permanent self-lubricating bearing surface on the inside diameter. The supporting metal shall be high strength Manganese Bronze, Copper Alloy UNS C86300, manufactured in strict accordance with ASTM B22-C86300, ASTM B271-C86300, ASTM B505-C86300 and ASTM B584-C86300.

The solid lubricant shall consist of a LUBRON TF woven PTFE fabric liner permanently bonded to the bronze metal substrate. The fabric liner shall consist of unbleached 100% virgin PTFE oriented multifilament fibers fully encapsulated with high strength epoxy resin adhesives. The woven PTFE liner shall be capable of bearing loads up to 60 ksi.

The self-lubricating bushings shall be furnished completely finish machined to the sizes and tolerances as specified on the drawings. The bearing manufacturer shall recommend the housing and shaft tolerances to assure proper interference fit and running clearance of the bushings. The self-lubricating bushings shall have a design bearing load capacity of at least 8 ksi (55 MPa) for surface speeds up to 10 fpm (0.5 m/s). The static and dynamic coefficients of friction shall not exceed 0.06 when subjected to loads up to 8 ksi.



Lubron TF Self-Lubricating Woven PTFE Bearings

LUBRON Self-Lubricating Bearings for Hydro Applications

LUBRON AQ

LUBRON AQ bearings are constructed of high strength bronze alloys permanently embedded with PTFE solid lubricants, and are unequalled for toughness and durability. Specified and approved by engineering design firms and water power authorities worldwide, LUBRON AQ bearings are the proven choice for hydro pump-turbine and dam gate applications.

LUBRON HP

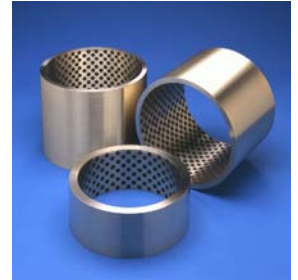
LUBRON HP bearings are specifically designed for smaller hydro turbine wicket gates and control linkage, and employ a variety of bronze alloys permanently embedded with PTFE solid lubricants. LUBRON HP bearings eliminate larger running clearances required for water swell, and are especially suitable for small oscillating movements and long periods of dwell.

LUBRON TF

LUBRON TF bearings are constructed of woven PTFE fabric liners permanently bonded and mechanically locked to rigid bronze or stainless steel backings. Capable of very low friction and high wear resistance, LUBRON TF bearings offer exceptional performance for hydro turbine wicket gate, control linkage, butterfly valve and dam gate applications.

LUBRON TX

LUBRON TX bearings consists of synthetic fiber reinforced PTFE polyester materials capable of high loads and low friction. LUBRON TX bearings have excellent dimensional stability in water, and are ideally suited for many hydro turbine applications. LUBRON TX bearings can be machined on-site, and are a lower cost alternative to many other self-lubricating bearings.



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