



High-Performance Engineered Bushings and Sleeve Bearings



Bushings Applications



Overview

Engineered Bushings

For more than 50 years, HEF has designed and developed high performance bushings, rings and joints for demanding applications in industries such as construction, mining, railroad, and agriculture. HEF bushings are recognized worldwide for their excellent **frictional and anti-seizure properties**, and their ability to withstand high loads.

HEF bushings are also industry's choice for applications requiring **extended intervals between lubrication**. Our extensive tribology laboratories give our customers a major advantage in determining precisely what bushings will best meet stringent performance and cost requirements.

Three factors combine to give our engineered bushings exceptional serviceability for the high-load/low rotational speed applications that are our specialty. Those factors are:

- **Advanced base materials**
- **Patented surface treatments**
- **Patented surface topographies & textures: cross-hatching & surface cavities**

Cross-hatching involves a network of grooves on the inner surface of the bushing. For a lubricated joint, a grease reservoir is built-up in the interconnecting channels, allowing lubrication intervals to increase by as much as 100%.

Debris present in the contact zone often exhibits very high hardness, leading to premature joint wear in many industrial situations. Cross-hatching allows effective evacuation of unwanted particles and debris.

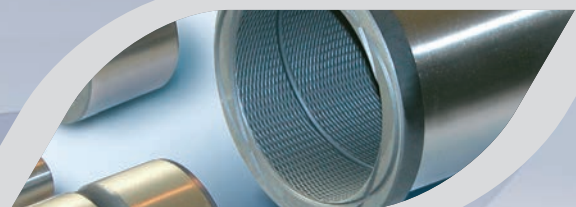
Surface cavities provide a lubricant reserve, allowing the joint to be operated maintenance-free, or with very long lubrication intervals. Grease is not evacuated and is retained at the contact points. For high sliding speeds, surface cavities allow the onset of a local hydrodynamic friction mode; contact pressure is then borne by the local grease bearings.

HEF offers several patented bushing designs, in a broad range of sizes, as well as carburized and ground sleeve bearings. To determine the best design for a particular application, designers should first consider the **constraints of the work environment, including abrasion, loading, corrosion and maintenance requirements**.

When selecting the appropriate bushing for each application, the **pressure-velocity (PV) factor** is particularly important. For joints operating under dry or greased conditions, the thermal energy generated by friction is proportional to the pressure (P), the sliding velocity (V) and the friction coefficient (F) between the sliding surfaces.

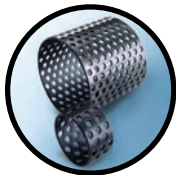
Given a pair of materials, there is a maximum PV beyond which surfaces can no longer absorb the generated friction, leading to seizure or melting of mating surfaces. Each of the HEF bushing designs has its own PV curves, which are indispensable for determining the appropriate bushing for particular applications and operating conditions.

In addition to bushings and bearings, HEF supplies a broad range of other friction components, including pins, shafts and sleeves; slides and pads, washers, rollers, screws and nuts.



Product Portfolio

Engineered Steel Bushings and Sleeve Bearings



Application	Max. Pressure (N/mm ²)	Max. Sliding Speed (M/S)	Reduced Maintenance	Abrasion Resistance	Corrosion Resistance	Max. Temperature	Resistance to Shocks and Vibrations	Misalignment
PEL®-T								
• High load • High speed • Reduced maintenance • Suitable for high contact pressure and abrasion	100	8	•••	••	••	250°C 480°F	••	•
PEL®-BH, BH 2, BH-HG								
• High load • High surface hardness • Shock, pressure and abrasion-resistant	200	1.5	•••	••	••	250°C 480°F	•••	•
PEL®-PEL, HP								
• High load • Shock loads	100	0.5	•••	••	••	250°C 480°F	•••	•
FAM®								
• Abrasion • Shock loads • Maintenance-free • High temperature	50	0.5	•••	•••	•	380°C 720°F	•••	•
COD 11®								
• Corrosion-resistant	60	0.2	•	•	•••	350°C 660°F	•••	•
Tesco								
• High load • Abrasion-resistant • High temperature	100	0.5	•	•••	••	500°C 930°F	•••	•
PEL®-BH & FAM Spherical Plain Bearing								
• High load • High surface hardness • Shock, pressure and abrasion-resistant • Reduced maintenance	See Prod Sheet	See Prod Sheet	•••	••	••	250°C 480°F (PEL-BH) 380°C 270°F (FAM)	•••	•••

••• Particularly Adapted, •• Well Adapted, • Suitable

Hardened Steel Bushings

Hardened steel bushings are excellent for low speed / high load, or pivot applications. These bushings are commonly used to protect a housing from premature wear caused by friction with a pin. These bushings are made of **high carbon steel** and through-hardened to 56-62 HRC. Hardened steel sleeve bearings require **daily** or **weekly greasing**.

HEF hardened steel bushings can be designed according to customer needs with different kinds of **internal grooves for lubricant distribution** and facilitating **removal of abrasive particles**. Flanged bushings or washers can also be manufactured with the same technology.

	Dyn. Load (N/mm ²)	Max Speed (m/s)	Max Temp (°C)	Abrasion Resistance	Shock Resistance	Corrosion Resistance	Low-Maintenance Resistance
Carburized / hardened steel	100	0.5	+200	...	•	–	–

Advantages	Applications
✓ Wear resistance ✓ Low cost ✓ High load capacity	✓ Earth moving equipment ✓ Mining equipment ✓ General purpose industrial equipment

Polymer Bushings

HEF polymer bushings are the result of intensive R&D in the field of **self-lubricated and zero-maintenance bearings**. These polymer bushings have a woven structure made of PTFE and epoxy resin. This provides tensile strength that is vastly superior to injection molded polymer bushings — and is significantly more resistant to high loads, seizure and galling. These bushings are well-suited for rotation and oscillation applications, and high speeds. High-load polymer bushings from HEF are **chemically inert and have low water absorption**. Their maximum working temperature is 320°F (160°C).

H-Liner M bushings are manufactured with a homogeneous woven polymer material on the complete wall thickness. This product is re-machinable and also available as flanged bushings, washers and slides. They are widely used when low water absorption or misalignment resistance is required.

H-Liner S bushings are manufactured from a high strength composite fiberglass backing with a woven liner inside. **H-Liner S1** bushings are made from high strength composite fiberglass backing and an improved wear-resistant liner.

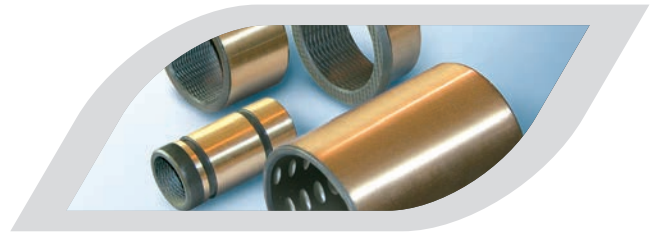
	Dyn. Load (N/mm ²)	Max Speed (m/s)	Max Temp (°C)	Low- Maintenance	Wear Resistance	Low Water Absorption
H-Liner M	80	0.5	+350°C	...	••	...
H-Liner S	100	0.5	+160°C	...	••	•
H-Liner S1	140	0.5	+160°C	...	•••	•

Advantages	✓ Maintenance free ✓ Weight reduction ✓ Noise reduction ✓ Good chemical resistance ✓ Corrosion resistance ✓ Insulating material ✓ Misalignment accommodation
Applications	✓ Off shore / Oil & Gas ✓ Hydropower energy ✓ Conveyor rollers ✓ Harbor ✓ Handling equipment ✓ Recycling industries ✓ Railways

Engineered Bushings

Industries where HEF sleeve bearings are prevalent:

- Construction equipment
- Material handling equipment
- Mining
- Steel
- Transportation
- Power generation: Hydro, Renewable



Some Typical Applications of HEF Sleeve Bearings

Application	Problem Solved by HEF Bushings
Arm, bucket and cylinder joints of wheel loaders	Seizure and wear
Joints of front loaders for agricultural tractors: cylinder, bucket, fork, etc.	Abrasive wear of the bushings and corrosion of the pin
The heaviest loaded joints on excavators (boom foot, boom cylinder foot, pivot, stick nose) and the joints of the bucket linkage	Wear and seizure after only hundreds of hours of usage
Front axle joints on agricultural tractors	Scuffing of the joints due to an irregular greasing and gradual wear
Several plow joints: jacks, mold board joints, front furrow width and plow alignment joints	Abrasive wear of polymer/ bronze bushings or seizure of the steel bearing
Joints of various parts of the shoe-brake linkage from cylinder to wheel rim, for underground cars and freight trains	Seizure and wear
Bushings of rod end cylinder for hydraulic hammer used in mining applications	Scuffing and wear after several hundred hours of operation
Joints on front axles of trucks	Ball bearings failure due to vibrations and breakages due to shock loads. Replaced by HEF bushings
Ladle trunnion bushing	Oxidation and slag abrasion. Scuffing due to friction under high load. Grease failure due to high temperature (250°C)
Caster run-out table bearing	Burning /coking of bearing grease in the lines, leading to seizure of bearings
Ore carrier clamshell bucket bushing	Abrasion wear and breaking of the outer ring
Pivot joint arm on container stacker for port handling	Cost of the spherical plain bearing. Corrosion and fretting corrosion of the pin which could lead to dismantling problems
Miscellaneous hydro energy applications: Segment & Wagon gate rollers , valve trunnions , Francis, Kaplan & Pelton turbine components	Lubrication intervals, seizure and wear.

Bushings Applications





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