Better than metal

Composites give off-highway OEMs another option for pneumatic and low-pressure hydraulic parts.

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PolyLube fiber series bushings feature a more open liner architecture enabling the wear surface to accommodate contaminates and debris.

Designers of pneumatics and low-pressure hydraulics often grapple with the dual challenges of reducing friction and weight. For traditional metal cylinders and bushings, these properties can limit design and performance options.

Recent advances in composite self-lubricated bushings and linerless cylinders could help. PolySlide and PolyLube composites, for example, can give hydraulic parts longer service life and are lighter, stronger, and more economical than their metal counterparts.

LINERLESS COMPOSITE CYLINDERS

PolySlide linerless cylinders offer features not commonly available with traditional metallic cylinders for fluid-power pneumatic and low-pressure hydraulic applications.

The advanced composite helps improve properties between bore surfaces and piston seals. For example, seals wear less and there'll be little impingement between surfaces. Composites don't corrode and they resist fatigue while offering a high strength-to-weight ratio.

Linerless-composite cylinders come in several forms, ranging from interchangeable tubing to complete cylinder assemblies. Cylinder assemblies also include nonmetallic/self-lubricating rod-end bushings and composite piston rods to further boost performance and cut weight.

Additionally, a patent-pending bore surface helps reduce friction, the most common cause of seal wear in metal cylinders. Two types of friction often oppose each other in the design of the bore surface:

Interlocking friction results from shear forces encountered from the interlocking of irregularities between contacting surfaces during sliding motion. Metallic cylinder surfaces that are bored or honed will have microscopic rough edges that penetrate and shear the softer seal material, thereby reducing its life. Metallic

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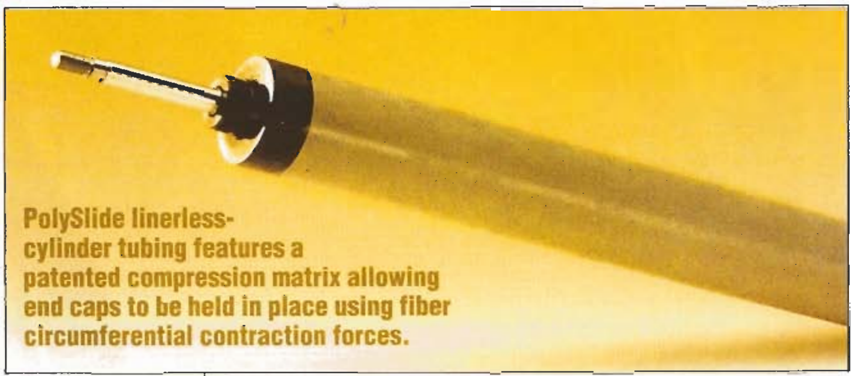
PolySlide linerless-cylinder tubing features a patented compression matrix allowing end caps to be held in place using fiber circumferential contraction forces.

cylinders use a lower bore-surface finish spec (i.e., a smoother surface) to reduce the interlocking friction and extend seal life.

Adhesion friction is the physical attraction of two smooth surfaces brought into close contact with each other. More contact means more adhesion between the surfaces. A smooth surface reduces the gap between surfaces, resulting in higher adhesion. Friction between seal and bore surfaces rises considerably as the bore finish drops from 16 to 6 Ra. So a higher-bore surface finish will reduce the seal adhesion friction and make seals last longer.

Designers of metallic cylinders must optimize surface finish to balance the effects of these two types of friction. Interlocking friction is the largest contributor to seal wear. Therefore, metallic cylinders must have smooth surface finishes. In linerless-composite cylinders, however, the two types of friction don't interact as badly.

The bore of the PolySlide linerless-composite cylinder is molded, not machined. The material at the molded surface of the bore is microscopically round in nature. Both the material and molding process dramatically reduce interlocking friction when compared to metal cylinders.

The material composition of the sliding surfaces also helps prevent friction. Lubricants incorporated in the material serve to lower surface tension at the bore surface with respect to the seals. The bore surface also has a 50 to 60 R_c hardness rating that helps minimize wear and extends piston seal life.

SELF-LUBED COMPOSITE BUSHINGS

Cylinders can last even longer through use of self-lubed composite bushings. They replace metallic rod guide bushings used in knuckles, sheaves, hydraulic cylinder clevises, and boom pivots.

Woven-lined bushings are for high-load, low-speed applications that would traditionally need grease. The bushings have self-lubricating liners that never need grease. Teflon and other materials in the woven liner provide long service life under high pressures. Typical design pressures for this bushing are 55 to 69 MPa. Woven liners also let bushings operate in moderately contaminated environments without the need for seals.

The mechanism that lets woven-lined bushings operate over the entire life of most off-highway equipment is called "film transfer." Liners transfer some of the Teflon at the surface to the shaft during break-in periods. Bushing surfaces have microscopic peaks and valleys. During the break-in period of the Polylube composite bushings, the peaks on the surface will be sheared off and the valleys will fill with the transferred Teflon. Once the transfer completes, the coefficient of friction stabilizes to approximately 0.08 to 0.10 and wear will be nearly eliminated.

Metallic bushings, in contrast, have no liner and rely on the operator to periodically grease the bushing. When bushings go ungreased, contamination can get trapped between the bushing and the shaft. This can score the bushing ID and the shaft, causing wear and eventual failure.

The wear surface used by other composite-bushing manufacturers is filament wound and can be easily recognized by the overlapping bands on the ID. This type of liner has problems with grease and contamination because of its construction. Grease can cause hydraulic cracking. It enters voids between filaments and forces them apart. Contamination acts in a similar manner.

The end result is a breakdown in the integrity of the liner, causing the liner to form a "bird's nest." The disrupted liner will then wear at a much faster rate and ultimately fail.

PTFE-FILLED TAPE BUSHINGS

Polytetrafluoroethylene (PTFE) is a fluorocarbon-based, low-friction polymer that stands up well to chemicals, temperature extremes, and weathering. It also has good electrical and thermal-insulation properties.

PTFE-filled tape bushings typically serve as rod-guide bushings. Tape bushings transfer a film of PTFE to the shaft and can virtually eliminate wear. PTFE-based rod-guide bushings outperform those made from bronze that can score the shaft over time, eventually wearing the rod wiper seal.

The PTFE film that transfers to the shaft tends to enhance sealing. The bushing and seal have a symbiotic relationship in the cylinder. The seal keeps the contamination out of the bushing and the bushing keeps the load off the seal. The PTFE-filled tape bushing keeps the shaft in good condition with minimal radial wear and thus extends the life of the entire system.

PTFE-filled tape bushings take many forms in rod-guide applications. They are available with seal grooves, flanges, and holes. Their coefficient of friction can be under 0.08 and their load capacity can reach 55 MPa.

Additionally, the compressive strength of the PTFE-filled tape bushing lets it handle side loads better than its traditional metal counterparts.

PolyLube and PolySlide composites have a density of 2.05 gm/cm^3 and thus weigh substantially less than metal competitors. Aluminum is about 30% heavier, while steel is four times as heavy. Cylinders that use composite bushings also glean weight savings. The density of composite bushings is about 1.9 gm/cm^3 (bronze bushings are about five times heavier). And, depending on the application, pultruded composite rods can replace traditional steel rods that weigh approximately four times as much. **MD**

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