Lubed-for-Life Using Microporous Polymeric Lubricants

By Alan J. Heckler, Ph.D., PhyMet Inc.

The traditional method for lubricating ball and roller bearings is with grease and oils. These lubricants can be messy, causing significant housekeeping problems and requiring periodic maintenance to replenish the lubricant. Microporous polymeric lubricants (MPL) can significantly reduce or eliminate these problems.

Characteristics of MPLs

MPLs are comprised of two major components, a polymer containing a continuous microporous network and oil contained within these pores. The type of oil incorporated into the polymer can be tailored to the requirements of the application. Examples include FDA/USDA-approved food-grade lubricants to eliminate product contamination and improve housekeeping and safety, or oils with an extreme pressure (EP) additive for high-load applications. Other additives can also be used to alter the lubricant's properties. Examples include oil property enhancers such as corrosion and oxidation inhibitors and coefficient-of-friction modifiers and lubricating solids such as molybdenum disulfide, graphite and Teflon. The oil content in the polymer can be controlled during processing and the MPL can contain more than 50 percent by weight.

The microporous polymer acts like a sponge releasing and absorbing the oil. The oil is released from the polymer through capillary action to its surface and is transferred to any surface it contacts to provide the necessary lubrication. As the quantity of oil on the surface decreases, the MPL releases more oil. If excess oil becomes present, it is reabsorbed by the porous polymer. For example, as the temperature of the MPL-filled bearing increases, more oil is typically released by the MPL, however, this is reabsorbed by the MPL as the bearing temperature decreases. Because of this, MPLs reduce or eliminate the need for relubrication, therefore minimizing or eliminating maintenance and housekeeping.

Continued on Page 50

"The MPL provides a continuous source of lubrication. Because it is solid, the MPL can help seal the bearing and reduce foreign contamination of the bearing. Thus it is useful in applications where bearings are exposed to dust or dirt."

Continued from Page 48

Applications

A major application of MPLs is the lubrication of ball and roller bearings providing an extended source of lubrication. It is inserted into the space between rolling elements and the race of the bearings (Figure 1). The MPL provides a continuous source of lubrication. Because it is solid, the MPL can help seal the bearing and reduce foreign contamination of the bearing. Thus it is useful in applications where bearings are exposed to dust or dirt. Reducing the incursion of debris into the bearing can significantly extend the bearing's life.

MPLs can also be produced in various solid profiles by casting, extruding and injection molding (Figure 2). While they are not designed as load-bearing materials, these solid profiles offer a unique method of delivering lubrication, especially for difficult-to-reach locations. Solid profiles have been used to lubricate railroad and crane wheel flanges, chains, ball screws, linear bearing rails and as lubricating plugs in bushings and sleeves. One special application is the Lubri-sprocket® shown in Figure 3, where it is being used as an idler sprocket to lubricate chains.

Figure 1. Bearings Filled with MPL

Production Methods

MPLs are made by mixing proprietary polymers, oils and special additives. The mixture is packed into the bearing and thermally processed. Several trimming and cleaning operations are required before shipping. Alternately, the mixture can be extruded into cross-sectional shapes or injection molded into specific parts. Because MPLs require thermal processing, the bearings must be processed in the manufacturer's facility where the MPL is incorporated into the bearing. Therefore, it is not possible to put oil-filled polymer lubricants in a bearing at an existing field operation. This means that MPL-filled bearings must be purchased already filled or sent to the manufacturer to be filled. Nearly any type of bearing can be lubricated with MPLs, including ball, roller, needle, tapered, spherical and cam followers.

Possible Product Advantages

The main advantages of MPLs vs. a grease or oil include:

1. Cost savings due to the reduction of required maintenance with oils and greases.
2. Protection of bearings from dust and dirt.
3. Bearing life extension.
4. The ability to provide lubrication for difficult-to-reach locations such as overhead cranes.
5. Release of oil to bearing surfaces on demand.
6. Improved plant housekeeping and safety conditions.
7. The availability of standard solid profiles such as rounds, rectangles and trapezoids. These shapes can be used to reduce sliding friction or in conjunction with spring-loaded applicators for use in overhead cranes, locomotives and railroad wheel flanges.
8. The production of complicated lubrication shapes for use in applications such as ball screws and linear bearings.

Possible Product Limitations

While the benefits of MicroPoly® are numerous, there are some limitations. The temperature limitations are listed in Table 2.

If these temperatures are exceeded, the polymer softens and can be ejected from the bearing. In addition, MPLs do not dissipate heat rapidly, and as a result, there are rotational speed limitations based on the bearing type and size. Maximum rotational speeds (rpm) at room temperature have been determined for each type of bearing and can be calculated by the following formula using the data in Table 3.

While MPLs generally resist contamination better than greased bearings, this does not make the bearing waterproof and will not prevent corrosion of the bearing. Direct contact with solvents, cleaners and/or acids is not recommended. Repeated exposure will deplete the oil from MPLs, making them less effective.

Because the bearing cavity is filled with the MPLs, the rotational torque is increased compared to grease filled bearings, especially on start-up. This is usually not a problem in most industrial applications.

Examples of Successful Applications

1. Conveyor chain roller and ball bearings, which were exposed to higher-than-room temperatures and sand contamination, had

Continued on Page 52

Table 1.

	Hand Grease	Automatic Grease	Automatic Oil	MPL
Lower Preventive Maintenance Cost	-	Ignoring Significant Capital Costs	Ignoring Significant Capital Costs	X
Particulate Exclusion	-	-	-	Some
Application to Hard-to-Reach Areas	-	X	X	X
Lubrication Applied as Needed	Not Automatic	X	X	X
Reduced Housekeeping	-	-	-	X
No External Application Equipment	Need Grease Gun	-	-	X

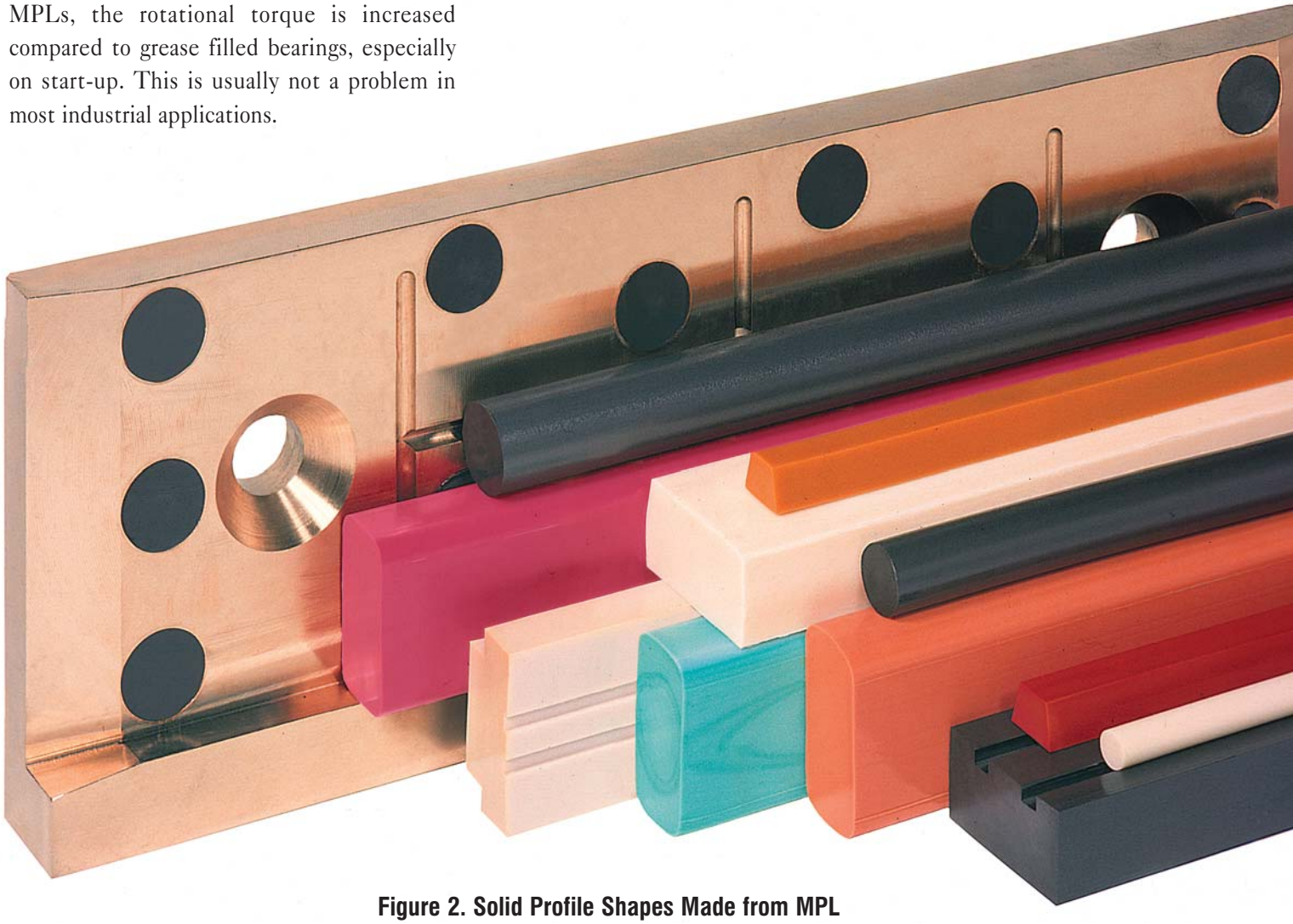

Figure 2. Solid Profile Shapes Made from MPL

Continued from Page 51

Figure 3. Lubri-sprocket® Used to Lubricate Chains

Table 2. Temperature Limitations

Product ID *	Upper Temperature Limit	Lower Temperature Limit
MPI-0800	200°F	10°F
MPI-0840	200°F	25°F
MPI-0779	225°F	-40°F
MPI-2371	225°F	-20°F
MPI-2000	350°F	10°F
MPI-2400	350°F	10°F
MPF-2308	200°F	10°F
MPF-0779	225°F	-40°F
MPF-2371	225°F	-20°F

* MPI: Industrial Products, MPF: Food-grade products. The 4-digit suffix represents the viscosity of the oil in SUS units at 100°F.

Table 3. Ndm Values

NdM Value

Maximum rpm = 1/2 (bore + outer diameter) in mm.

Bearing Type	Ndm Value
Single Row Deep Groove Ball	300,000
Ball with Plastic Cage	40,000
Double Row Deep Groove Ball	150,000
Angular Contact Ball	150,000
Self-Aligning Ball	150,000
Cylindrical Roller	150,000
Spherical Roller	85,000
Tapered Roller and Roller Thrust	45,000

inconsistent bearing life and failed prematurely. Because of the location, the bearings could not be relubricated, complicating the bearing life further, causing excessive downtime and high maintenance costs. The use of a microporous polymeric lubricant in this application increased the bearing life six to seven years and substantially improved uptime and reduced maintenance costs.

2. Tapered roller bearings used in the front spindles of a tow motor routinely failed in three to six months due to heavy loads and poor maintenance. The use of an MPL in this application increased the life to three and a half years and resulted in a cost savings of more than $325,000 for a fleet of 47 vehicles.

3. Coal dust contamination caused tapered roller bearings to seize, resulting in potential coal dust fires. The bearing life was nine months. Bearings filled with an MPL have extended the life to 10 years and substantially reduced maintenance and downtime and resulted in an annual cost savings of $250,000.

4. In an overhead conveyor system on a crank shaft grinding line, the wheels were lubricated by spraying with oil. The oil dripped on to the floor, creating a safety hazard and housekeeping problem. The bearing life was six to nine months. With the use of an MPL, the life of the bearings was increased to three years and completely eliminated the safety and housekeeping problems.

5. Tapered roller bearings used in an apparatus to turn billets in a steel rolling mill failed after approximately two months. The estimated ambient temperature is 300°F to 400°F. The bearing life was not increased with a regular MPL. However, bearings filled with high-temperature MPL have been in service for nine months without failure.

6. Tapered roller thrust bearings used in truck axle/king pins were failing due to severe road conditions, dirt, water and road salt. The bearings were difficult to maintain and did not meet warranty life requirements. With the use of MPLs, no maintenance is required and warranty claims were eliminated.