MicroPoly
The solid idea for lubrication

MICROPOROUS POLYMERIC LUBRICANTS

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INTRODUCTION

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. Solid lubricants can significantly reduce or eliminate these problems. One type of solid lubricant is a microporous polymeric lubricant (MPL). MPL's have been available for approximately 30 years but have been actively marketed for the past 20 years. PhyMet, Inc. markets a series of proprietary MPL's under the product name MicroPoly®.

CHARACTERISTICS OF MICROPOLY

MicroPoly is made up of two major components, a polymer containing a continuous microporous network and oil that is 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 or NSF approved oils for use in food processing or oils with an EP (Extreme Pressure) additive for high load applications. Also, other additives can be used to alter the lubricant's properties. Examples include, oil modifiers such as corrosion and oxidation inhibitors, coefficient of friction modifiers additives and lubricating solids such as molybdenum disulfide, graphite and Teflon. The oil content in the polymer can be controlled during processing and the MicroPoly can contain over 50% by weight.

The microporous polymer acts much like a sponge releasing and absorbing the oil. The oil is released from the polymer through capillary action to its surface and, thereby, transferred to any surface it contacts to provide the necessary lubrication. As the oil on the desired lubricating surface decreases, MicroPoly releases more oil. If excess oil becomes present, the oil is re-absorbed by the porous polymer. For example, as the MicroPoly filled bearing's temperature increases more oil is typically released by the MicroPoly, however, this is reabsorbed by the MicroPoly as the bearing temperature decreases. Because of this property, MicroPoly reduces or eliminates the need for re-lubrication and, therefore, minimizes or eliminates maintenance and housekeeping.

APPLICATIONS

A major application of MicroPoly is the lubrication of ball and roller bearings. It is inserted into the space between rolling elements and the races of the bearings. (See Figure 1)

FIGURE 1: EXAMPLES OF BEARINGS FILLED WITH MPL

MicroPoly provides a continuous source of lubrication. Since it is solid, the MicroPoly can help seal the bearing and, therefore, 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.

MicroPoly can also be produced in various solid profiles by casting, extruding and injection molding. (See Figure 2)

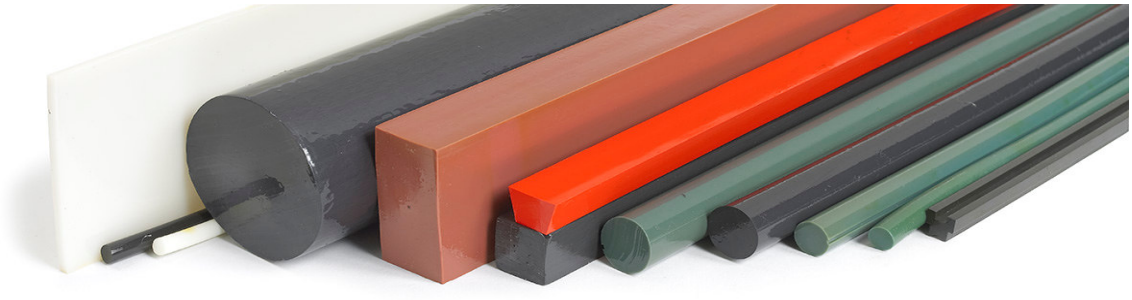

FIGURE 2: SOLID PROFILE SHAPES MADE FROM MPL

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, to cite just a few examples**.**

One special application is the Chain Lubrication System shown in Figure 3. The applicator uses grooved MicroPoly blocks to lubricate chains.

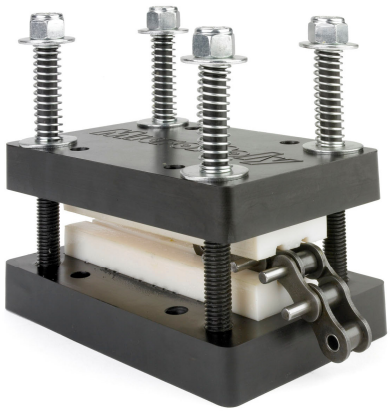

FIGURE 3: CHAIN LUBRICATION SYSTEM USED TO LUBRICATE CHAINS

MicroPoly is also available in formulations that meet FDA/USDA and NSF requirements. The absence of grease in food processing plants eliminates product contamination and improves housekeeping and safety.

PRODUCTION METHODS

MicroPoly is made by mixing proprietary polymers, oils and special additives. The mixture is packed into the bearing and subsequently 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. Since MicroPoly requires thermal processing, the bearings must be processed in PhyMet's facility where the MicroPoly is incorporated into the bearing. Therefore, it is not possible to put MicroPoly in a bearing at an existing field operation. This means that MicroPoly filled bearings must be purchased already filled from a distributor or sent to PhyMet, Inc. to be filled. Nearly any type of bearing can be lubricated with MicroPoly, including ball, roller, needle, tapered, spherical, and cam followers.

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PhyMet's Research department has developed a series of new products, which have extended the range of application. MicroPoly grades are now available for use at higher temperatures, in food handling or heavily loaded bearings. Table 1 gives a list of currently available products and their specific useful range of applications.

TABLE 1: MICROPOLY® PRODUCT LINE

Product ID	Industrial Applications	H-1 Food Processing	H-2 Food Processing	Wash Down Applications	Upper Temp Limit	Lower Temp Limit	Available as Solid Profiles	*E.P. Additive
MPI-0800	X			X	200 °F	10 °F	X	
MPI-0779	X			X	225 °F	-50 °F	X	X
MPI-2000	X				350 °F	10 °F		X
MPI-2400	X			X	350 °F	10 °F		X
MPI-S700	X				250 °F	-50 °F		X
MPF-0779	X		X	X	225 °F	-40 °F	X	X
MPF-0690	X	X	X	X	200 °F	-50 °F	X	X

MPI: Industrial Products MPF: Food Grade Products.
The 4-digit suffix represents the viscosity of the oil in SUS units at 100° F.
***E.P. = Extreme Pressure**

PRODUCT ADVANTAGES

The main advantages of MicroPoly are:

1. Cost savings due to the reduction of required maintenance with oils and greases
2. Protection of bearings from dust and dirt
3. Extension of the life of bearings
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 application such as ball screws and linear bearings

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PRODUCT LIMITATIONS

While the benefits of MicroPoly are numerous, there are some limitations. The application temperature limitations are listed in Table 1. If these temperatures are exceeded the polymer softens and can be ejected from the bearing. Also MicroPoly does 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 2

The exception is MPI-S700 which was developed to operate at higher speeds. Call PhyMet's Technical Service staff to discuss your high speed applications (937 743 8061).

$$\text{Maximum rpm} = \frac{\text{Ndm Value}}{\frac{1}{2}(\text{Bore} + \text{O.D.}) \text{ in mm.}}$$

TABLE 2: NDM VALUES

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

While MicroPoly is generally more contamination resistant than greased bearings, it does not make the bearing waterproof and will not prevent corrosion of the bearing. Also direct contact with solvents, cleaners and/or acids is not recommended. Repeated exposure will deplete the oil from MicroPoly making them less effective.

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

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EXAMPLES OF SUCCESSFUL APPLICATIONS

1. Conveyor chain roller and ball bearings, which were exposed to higher than room temperatures and sand contamination, had inconsistent bearing life and failed prematurely. Because of the location, the bearings could not be re-lubricated, complicating the bearing life further, causing excessive downtime and high maintenance costs. The use of MicroPoly in this application increased the bearing life 6 to 7 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 3 to 6 months due to heavy loads and poor maintenance. The use of MicroPoly in this application increased the life to 3.5 years and resulted in a cost savings of over $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 9 months. Bearings filled with MicroPoly 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 crankshaft 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 6 to 9 months. With the use of MicroPoly, the life of the bearings was increased to 3 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 2 months. The estimated ambient temperature is 300 to 400° F. The bearing life was not increased with regular MicroPoly, MPI-0800. However, bearings filled with the high temperature MicroPoly, MPI-2000, have been in service for 9 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 MicroPoly, no maintenance is required and warranty claims were eliminated.