## BEARING TECHNICAL INFORMATION

This report will provide the bearing designer with some fundamental engineering information to design Northex™ UHMW - PE bearings for rotating shafts when the loading is acting normal to the bearing surface or 90° from the shaft axis.

Bearing characteristics are given in limiting pressure velocity curves (P.V. curves) where the pressure term is in pounds per square inch and the velocity is in feet per minute shaft surface speed. In this case, "limiting" means that the mathematical product of the pressure exerted on the bearing by the shaft and the velocity of the shaft must not exceed the recommended PV value. If they do, the bearings will wear excessively or have very short service lives.

## BEARING OPERATION

It is important to note that the PV Values for Northex™ UHMW - PE bearings are to be used as design guidelines only and cannot be used directly for operational bearing design. A bearing designed too close to the limiting PV value may fail for a variety of reasons beyond the designer's control. Some of these factors are room temperature changes, contamination in the bearing, shaft corrosion and any factors that could affect the coefficient of friction between the shaft and the bearing causing the bearing to overheat and fail.

While Northex™ UHMW - PE has a high coefficient of thermal expansion which would cause the bearing to change dimensions, in practical applications, the thermal expansion and contraction do not cause serious problems.

## BEARING DESIGN GUIDELINES

Some general guidelines for bearing design recommendations can be offered, however they are not as rigid as those that can be advanced for metal bearing designs. The primary reasons for this are the poorer dimensional stability of plastics and their higher coefficient of thermal expansion.

In general, the bearing inside diameter should be about .001 inches over the true shaft diameter for shafts one inch in diameter and less. Larger shafts will require greater clearances. The bearing length should be approximately equal to the shaft diameter unless the load is high and then more bearing surface is required to resist creep. The wall thickness should be as thin as possible to permit easy heat dissipation. About 10% of the shaft diameter is recommended for bearing thickness when conditions are not too close to the PV limit. Close to the limit, a thinner bearing wall will be required to facilitate heat removal. If the bearing is to be subjected to impact or shock loads, a heavier wall may be required.

## CALCULATIONS OF PV VALUES

The terms of the rotating shaft bearing pressure velocity (PV) values are pounds per square inch times feet per minute.

The pressure in pounds per square inch can be calculated by dividing the load in pounds on the bearing shaft by the diameter of the shaft times the length of the bearing. The load is the weight of the rotating part being supported by the bearings divided by two if the bearings are used to support it. There are other possible mechanical loads exerted on the bearing by springs or levers. It is important to consider all loads when calculating the pressure value.

The velocity (V) in feet per minute is calculated from the following equation:

$$V = \frac{D \times p \times RPM}{12} = \text{feet per minute}$$

V = Velocity per minute

D = Shaft diameter in inches

p = 3.1412

RPM = Shaft speed in revolutions per minute

# UHMW - Load Bearing Properties



| DEFORMATION UNDER COMPRESSION % | | | | | | | PERMANENT DEFORMATION AFTER REMOVAL OF LOAD | |
|---|---|---|---|---|---|---|---|---|
| | | INITIAL LOADING | | | | | | |
| TEMP° F | COMPRESSION - PSI | 10 MIN. | 100 MIN. | 1000 MIN. | 1 DAY | 56 DAYS | AFTER 1 MIN. | AFTER 24 HRS. |
| 68° | 282 | 1.5 | 1.7 | 1.8 | 1.9 | 2.4 | 0.9 | 0.6 |
| | 570 | 2.4 | 2.5 | 2.7 | 3.0 | 4.0 | 1.8 | 1.2 |
| | 850 | 3.0 | 4.0 | 4.5 | 5.0 | 5.1 | 2.7 | 1.8 |
| | 1140 | 4.0 | 5.0 | 6.0 | 7.0 | 7.5 | 3.6 | 2.4 |
| | 1420 | 5.0 | 6.5 | 7.5 | 8.0 | 9.0 | 4.5 | 2.9 |
| | 1700 | 7.0 | 7.5 | 8.0 | 10.0 | 11.0 | 5.4 | 3.5 |
| 122° | 282 | 1.6 | 1.8 | 2.0 | 2.5 | 2.6 | 1.3 | 0.8 |
| | 570 | 2.6 | 3.0 | 3.5 | 4.0 | 5.0 | 2.7 | 1.5 |
| | 850 | 4.5 | 5.0 | 5.5 | 6.0 | 7.5 | 4.1 | 2.3 |
| | 1140 | 6.0 | 7.0 | 8.0 | 9.0 | 11.0 | 5.5 | 3.1 |
| | 1420 | 7.5 | 9.0 | 10.0 | 11.0 | 14.0 | 6.9 | 3.9 |
| | 1700 | 9.0 | 11.0 | 12.0 | 13.0 | 16.0 | 8.2 | 4.7 |
| 176° | 282 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 1.6 | 1.1 |
| | 570 | 5.0 | 5.5 | 6.0 | 6.5 | 8.0 | 3.2 | 2.3 |
| | 850 | 7.5 | 8.0 | 9.0 | 10.0 | 12.0 | 4.8 | 3.5 |
| | 1140 | 10.0 | 11.0 | 12.5 | 14.0 | 15.5 | 6.4 | 4.6 |
| | 1420 | 12.5 | 14.0 | 15.5 | 17.0 | 20.0 | 8.1 | 5.8 |
| | 1700 | 15.0 | 17.0 | 18.0 | 20.5 | 24.0 | 9.7 | 6.9 |

**PV CURVES EXPLANATION**

Following are four charts (Figures 1, 2, 3 and 4) giving Northex™UHMW - PE PV values for a variety of operating conditions:

1. The Effects of Environmental Temperature
2. The Effects of Lubricants
3. The Effects of Operating Times in Intermittent Use
4. The Effects of Down Time Between Operations in Intermittent Use

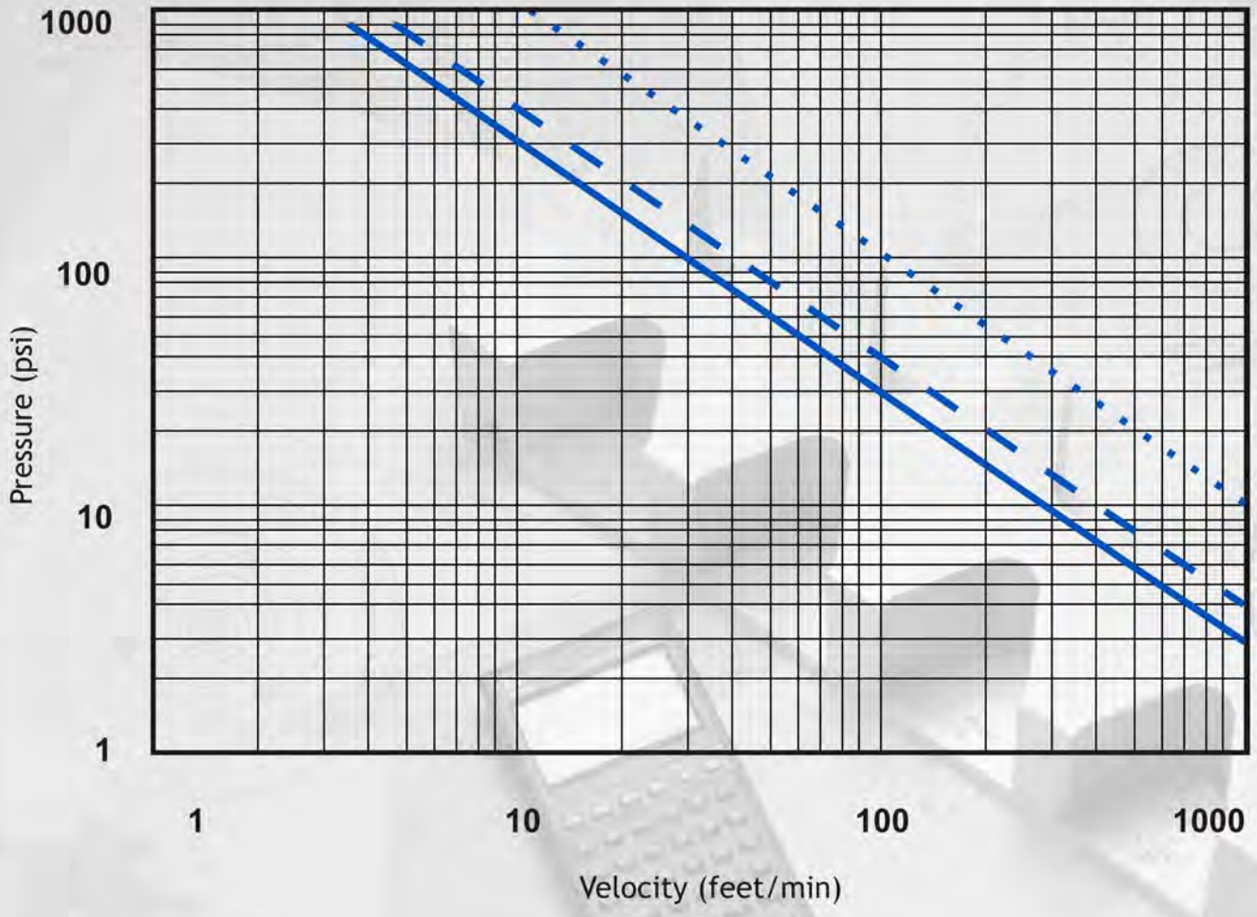
Figure 1 is the basic chart for Northex™UHMW - PE bearings. It describes the normal unlubricated bearing behaviour at three operating temperatures: 0° F, room temperature (70°F) and 140°F. These are environment temperatures and not the temperature of the operating bearing surface. The bearing has higher PV values at lower temperatures or lower values at higher temperatures because the mechanism for performance degradation is overheating of the bearing surface.

Figure 2 describes the effects of lubrication on the PV values. Lubrication reduces the coefficient of friction between the bearing and the shaft, thus reducing the tendency to overheat and wear out. The best lubrication for UHMW is water. Petroleum lubricants tend to make UHMW swell. These results were generated at 70°F.

Figure 3 shows the advantageous effects of using bearings in intermittent operations when the heating time is shortened and the cooling time reduces the temperature of the bearing surface. Bearing cooling is not as efficient as the heating. This is demonstrated by the fact that longer operating times reduce the longevity of the bearings. However, all intermittent operations provide longer bearing life over those experienced in continuous operations.

Figure 4 shows the benefits of longer down or cooling times to the performance of the UHMW bearing. The longer down or cooling times permit the bearing to be designed for significantly higher PV values.

## Effects of Temperature on PV Values

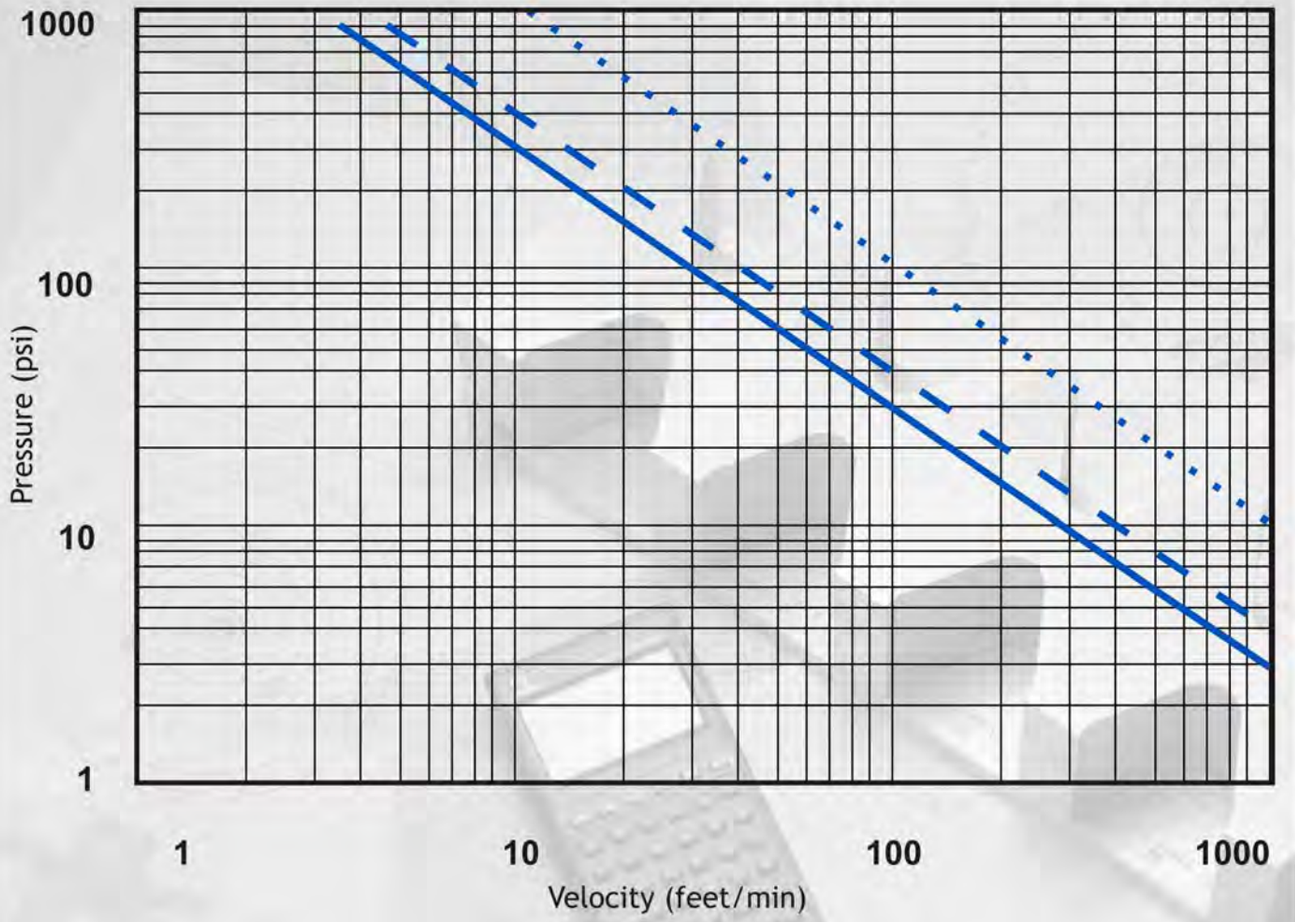



Continuous Operation

- 0 °F
- 70 °F
- 140 °F

Figure 1 is the basic chart for Northex™ UHMW - PE bearings. It describes the normal unlubricated bearing behaviour at three operating temperatures: 0° F, room temperature (70°F) and 140°F. These are environment temperatures and not the temperature of the operating bearing surface. The bearing has higher PV values at lower temperatures or lower values at higher temperatures because the mechanism for performance degradation is overheating of the bearing surface.

## Effects of Lubrication on PV Values




Constant Temperature
70° F

. . . . . Submerged Lubrication

– – Intermittent Lubrication

——— No Lubrication

Figure 2 describes the effects of lubrication on the PV values. Lubrication reduces the coefficient of friction between the bearing and the shaft, thus reducing the tendency to overheat and wear out. The best lubrication for UHMW is water. Petroleum lubricants tend to make UHMW swell. These results were generated at 70°F.

## Effects of Operating Time in Intermittent Operation on PV Values

**Northex™ UHMW - PE Bearing**
**Figure 3.**

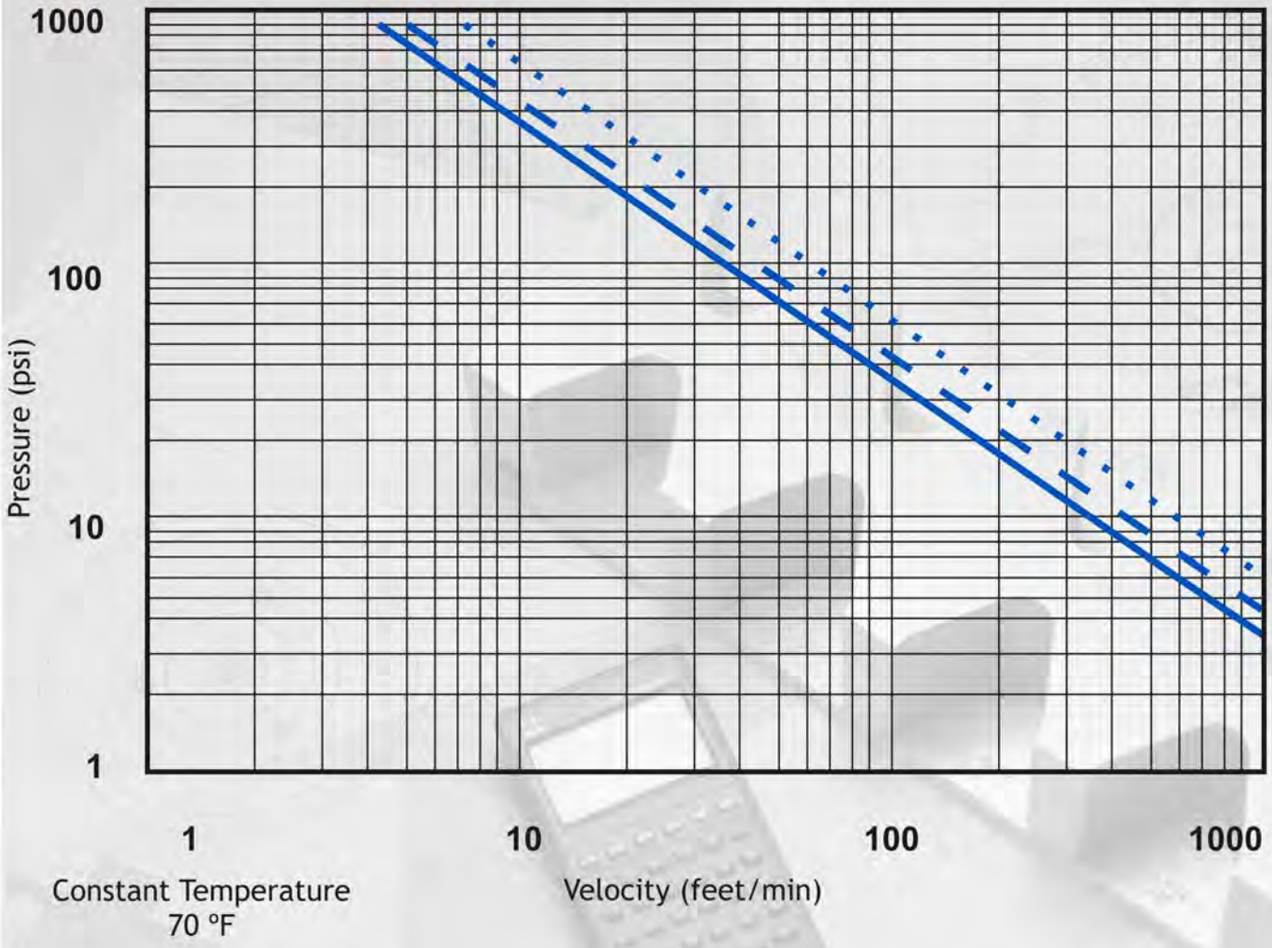
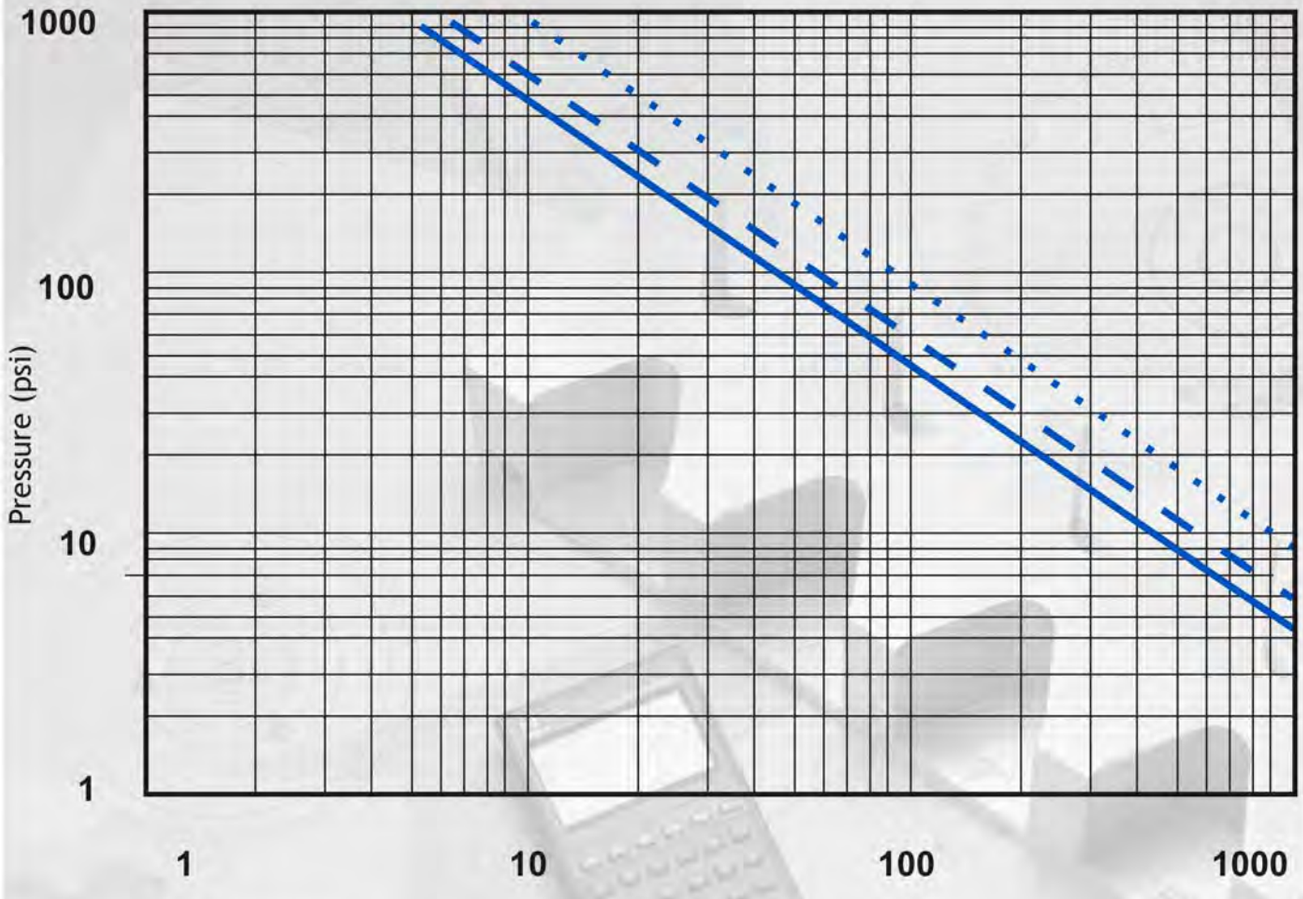



Figure 3 shows the advantageous effects of using bearings in intermittent operations when the heating time is shortened and the cooling time reduces the temperature of the bearing surface. Bearing cooling is not as efficient as the heating. This is demonstrated by the fact that longer operating times reduce the longevity of the bearings. However, all intermittent operations provide longer bearing life over those experienced in continuous operations.

## Effects of Operating Off Time in Intermittent Operation on PV Values




Constant Temperature
70 °F

On- Time 1 min.

Off Time 4 min.

Off Time 3 min.

Off Time 1 min.

Figure 4 shows the benefits of longer down or cooling times to the performance of the UHMW bearing. The longer down or cooling times permit the bearing to be designed for significantly higher PV values.