CAST NYLONS LIMITED

Technical Bulletin #107

- Bearing Design -

Guidelines for Bearing Design

Nylon materials intended for bearing applications with or without lubrication must be designed with consideration of the individual physical characteristics and operating conditions of each actual requirement. The design data below is provided as an introduction to nylon bearing design. It is suggested that actual field testing be conducted under proper environmental conditions.

PV Value

The frictional build-up of heat is a major consideration in the design of nylon bearings. The two significant factors that affect heat generation are unit pressure (P) and surface velocity (V). Pressure velocity (PV), therefore, is the product of unit pressure and surface velocity.

Surface velocity for sleeve-type bearings can be computed using the following:

$$V = .262 \times rpm \times D$$

Rpm represents shaft revolutions per minute, and D is the shaft diameter in inches.

Pressure can be computed for flat bearing units by dividing the total load in pounds by contact area expressed in square inches:

$$P = \text{Total Load} / \text{Contact Area}$$

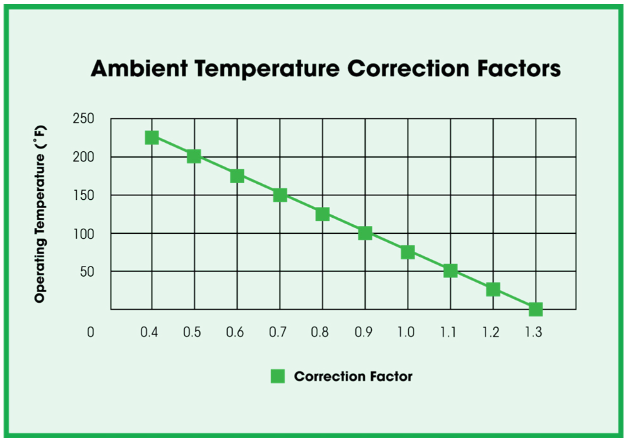
Now that the PV has been determined for the application, it must be checked against the PV limits for NYCAST materials as listed in the following chart:

Product	Unlubricated	Continuously Lubricated
NYCAST 6PA Natural **NYCAST XHA Blue** **NYCAST 6PA MoS_2**	3,600	14,000
NYCAST CP	3,600	14,000
NYCAST NYLOIL	16,000	16,000
NYCAST RX/GX	16,000	16,000

Note: Max. P for dynamic bearings is 2,000 psi
Max. V for dynamic bearings is 400 fpm

Ambient Temperature Correction

When the ambient temperature is higher or lower than 75°F, the PV capabilities change. The following graph indicates the relationship between ambient temperatures and the necessary PV modifications. From the graph on the next page, establish the Ambient Temperature Correction Factor for the bearing operating environment temperature and multiply this value by the limiting PV for the material being used. The value obtained is the actual limiting PV value for the application in question. For a Nycast Nyloil bearing operating at 150°F environment, the temperature correction factor would be 0.7, multiplying 16,000 x 0.7 produces a new limiting PV value of 11,200.



Basic Nylon Bearing Design

Nominal Wall Thickness

In the design of new equipment, the engineer has some latitude in establishing nominal wall thickness. For bearings that will be subjected to severe impact, maximum walls are suggested, while minimum walls can be used for bearings that operate near the material's maximum recommended PV.

Nominal wall thickness is the difference between shaft diameter and housing I.D. divided by 2.

Bearing Shape

The ratio of bearing length to shaft diameter has an important effect on the coefficient of friction. For a bearing with a ratio of one (bearing length equal to shaft diameter), the coefficient is generally lowest. As the bearing length increases to two or three times the diameter of the shaft, the probability of localized heating increases due to slight shaft vibration and out-of-roundness.

Clearance

Because the clearances required for nylon bearings are larger than those normally required for metal bearings, attention to proper clearances is one of the most important factors in bearing design. Most premature nylon bearing failures occur because of insufficient initial clearance that results in seizure on the shaft and even melting of the bearing. Because of the self-dampering nature of nylon materials, the increased clearances required do not result in shaft vibration or scoring of the bearing.

Total running clearance can be calculated by adding the basic shaft allowance (C_1), the wall thickness allowance (C_2), the press fit allowance (C_3), and, if applicable the moisture expansion allowance (C_4). The running clearance is then added to the shaft diameter to obtain an actual I.D. for the bearing. For press fit bearings, the O.D. should be machined to the nominal I.D. of the housing plus the press fit allowance (C_3).

Machining Tolerance

Proper running clearances for bearing I.D. and O.D. can be assured by holding tight machining tolerances. It is recommended that I.D.s be machined to plus best commercial tolerance, minus 0.00 inches. O.D.s should be machined to plus or minus best commercial tolerance.

Lubrication

Except where dry applications are required (as in some food and textile machinery), lubrication should always be used. The lubrication of the nylon bearing results in a higher PV limit on sliding parts when compared to dry operation. Any general purpose grease or oil can be used, providing that they do not contain acids. Acid containing lubrications cause a swelling of the nylon material, which decreases the clearance and can cause seizure on the shaft. An initial start-up application of grease or oil will facilitate bedding-in and increase both bearing performance and life, even if no further lubricant is provided during operation.

C_1 Shaft Allowance

Shaft Diameter (in.)	1	2	3	4	5	6	7	8	9	10	11	12
C_1	.005	.009	.012	.014	.017	.019	.021	.024	.026	.028	.030	.032

Shaft allowance, C_1 is the normal running clearance required on the bearing I.D.

C_2 Wall Thickness Allowance

Material	Average Bearing Temp.	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"	1"	1-1/4"	1-1/2"
All NYCAST Materials (Operation in normal surroundings at 50% RH)	75°F	.002	.004	.006	.007	.009	.011	.015	.019	.022
	100°F	.002	.004	.006	.008	.010	.012	.016	.020	.024
	125°F	.002	.004	.007	.009	.011	.013	.018	.022	.027
	150°F	.002	.005	.007	.009	.012	.014	.019	.024	.028
	175°F	.002	.005	.007	.010	.013	.015	.021	.026	.031
	200°F	.003	.006	.008	.011	.014	.016	.023	.028	.034
	225°F	.003	.006	.009	.012	.015	.017	.024	.030	.036
	250°F	.003	.006	.009	.013	.016	.018	.026	.032	.039

(Data given is for bearings with ends free to expand. When ends retained, increase values by 50%)
C_2 is the clearance required in the bearing I.D. to allow for expansion of the bearing wall during operation.

C_3 Press Fit Allowance

Housing I.D. (in.)	0	1	2	3	4	5	6	7	8	9	10	11	12
C_3	.002	.004	.006	.009	.010	.012	.013	.014	.015	.016	.017	.018	.019

Press fit allowance, C_3 is added to bearing I.D. when bearing is pressed into housing.
When NYCAST materials are pressed into a housing the bearing experiences close-in.
C_3 added to the bearing I.D. allows for this close-in.

C_4 Moisture Expansion Allowance (submerged/water lubricated applications only)

Bearing Wall Thickness (in.)	1/8"	3/16"	1/4"	3/8"	1/2"	3/4"	1" and up
C_4	.012	.017	.021	.026	.030	.032	.033

Figures shown represent maximum bearing I.D. closure as a result of bearing wall expansion at full moisture saturation and must be added to the bearing I.D. for correct clearance.