Engineering Property - Frictional Characteristics

Friction of Die-Thane polymers against non-lubricated surfaces decreases with increasing hardness as shown in Figure 1.

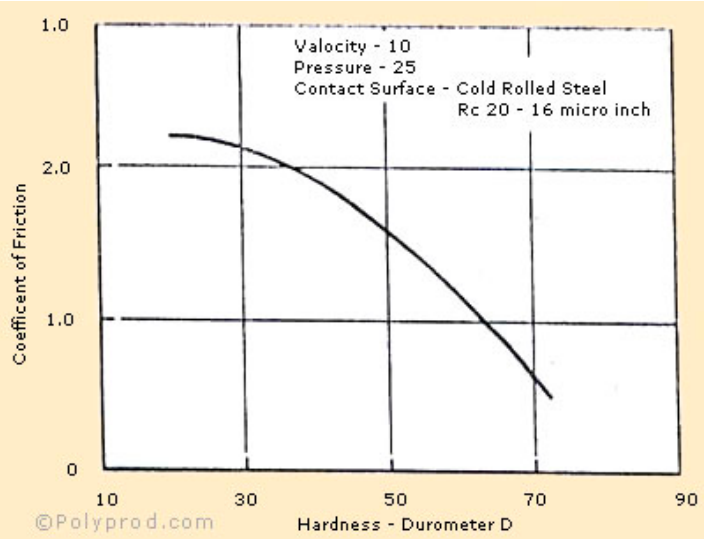

FIGURE 1 COEFFICENT OF FRICTION AT VARIOUS HARDNESS

Since harder polymers have the lowest coefficient of friction, these materials have been used where sliding resistance is important.

Of all Die-Thane Urethane rubbers, P-675 has the lowest, unlubricated coefficient of friction. This characteristic, coupled with its superior abrasion resistance and load-carrying ability, is an important reason why 75 is used for bearings and bushings. Since the hardness of compounds of P-675 approaches some plastics, comparison of P-675 with various plastics is shown in Table I.

Effect on Additives on Frictional Properties

Additives may be used to alter the frictional properties of Die-Thane polymers. With P-675 urethane rubber, powdered TEFLON® TFE fluorocarbon resin and TEFLON® TFE fluorocarbon fiber flock significantly reduce the coefficient of friction of this elastomer. The frictional due to these additives is shown in Figure 2, on the following page. P-675 without additives is used as a control.

TABLE I

COMPARISION OF P-675 WITH PLASTICS				
	Die-Thane P-675	Nylon 66 2.5% Water	Acetal	Cast Phenolic Unfilled
Specific Gravity	1.20	1.14	1.42	1.30
Hardness, Rockwell	R90	R108	R120	M110
Tensile Strength, psi	9,000	11,200	10,000	7,000
Elongation at Break, %	210	200	15	-
Modulus of Elasticity in Tension, 103 psi	52	260	410	700
Flexural Modulus (Instron), 103 psi	81	175	410	-
Compressive Modulus, 103 psi	68.75	-	-	-
Impact Resistance, ft.lb./ in.Notched Izod, 75°F	15	2.0	1.4	0.3
Head Deflection Temp., % at 66 psi/at 264 psi	365/135	300/150	338/255	260/--
Taber abrasion, cs-17, 1000 g, mg loss/1000 rev.	5	7	20	-
Water Absorption, 24 Hrs. At 75°F, %	1.2	0.4	0.25	0.4

Engineering Property - Frictional Characteristics

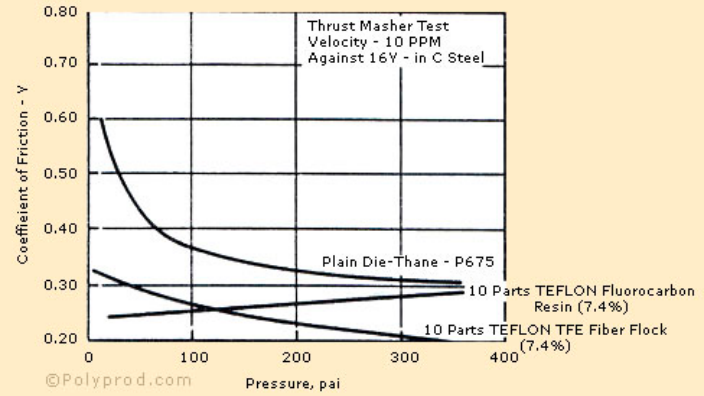

FIGURE 2 DIE-THANE P-675 EFFECT OF ADDITIVES ON COEFFICIENT OF FRICTION

The additives mentioned above will affect other physical properties of Die-Thane P-675. Changes presented on Table II.

TABLE II

DIE-THANE P-675 - EFFECT OF LUBRICANT ADDITIVES ON PHYSICAL PROPERTIES			
	Die-Thane P-675	+TEFLON® Powder 10 Parts	+TEFLON® Fiber Flock 10 Parts
100% Modulus, psi	4650	4100	4100
Tensile Strength, psi	9000	5000	5200
Elongation@Break,%	210	115	125
Durometer D Hardness	73	72	72
ASTM D-470 Tear, lbs./in.	110	105	95
Nat'l Bureau of Stds. Abrasion Index, %	400	500	890
Compression Set, Method A 1350 psi, 22 Hrs. @ 158°F	10	8	4

Materials Used:

1. TEFLON® Powder - Rilube #63, Modern Industrial Plastics, Dayton, OH
3. TEFLON® Fiber -TFE TEFLON® fiber, flock, 1/64", Du Pont, Textile Fibers

All of the additives at a 10 part level (7.4% by weight of total compound) will reduce modulus, tensile and elongation. Additives which reduce the friction coefficient also improve abrasion resistance. The improvement in abrasion obtained with TEFLON® fluorocarbon fiber addition is significant and was also observed during long-term friction tests.
The 10 parts of additive is not necessarily the optimum. However, 10 parts offer significant frictional improvement over 5 parts and not significantly inferior to 15 parts. The optimum level of additive, considering a balance of physical and frictional properties, probably fails between 5 and 10 parts.

Effect of Additives on Bearing Performance

TEFLON® improves the performance of Die-Thane P-675 in bearing applications. Pressure-Velocity (PV) limit data for bearings based on Die-Thane P-675 urethane rubber, Nylon 66 and DELRIN® acetal resins are shown in Figure 3.

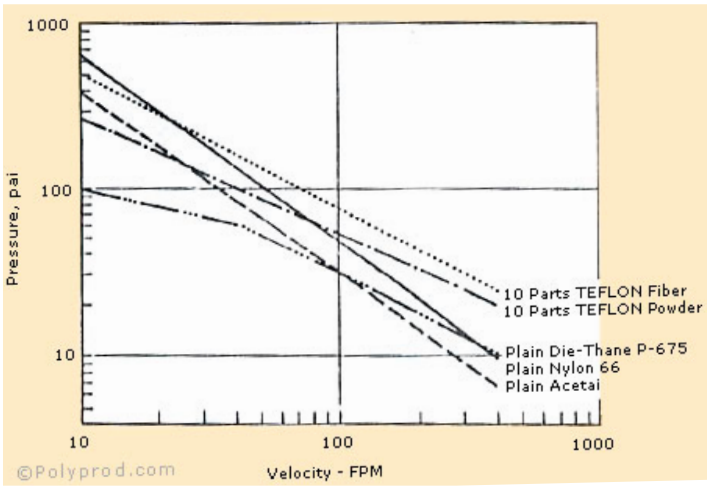

FIGURE 2 DIE-THANE P-675 EFFECT OF ADDITIVES ON COEFFICIENT OF FRICTION

These curves represent the performance limits of the bearings. Bearings can operate at any combination of pressure and velocity below the respective curves without catastrophic failure. The PV limits predict nothing about the length of service however. Although Die-Thane P-675 may be expected to outwear most thermoplastics, its performance will be influenced strongly by temperature and other environmental conditions. The best determination of bearing durability is a service test.

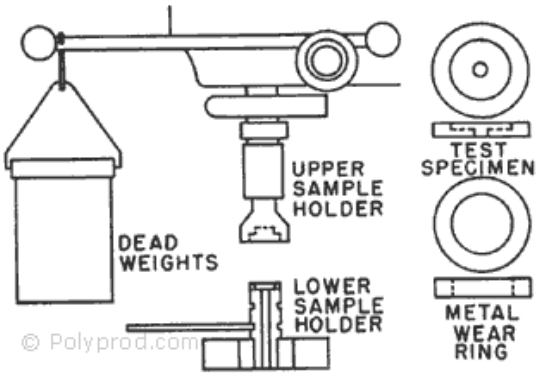

FIGURE 4 THRUST WASHER TESTER

Friction data listed in this chapter were obtained with an apparatus which utilizes a thrust washer principle and the apparatus is shown schematically in Figure 4. It consists of a table mounted drill press, variable speed drive and simple machined parts to accommodate test samples. Friction force and wear can be measured with this device. The use of standard components and small, easily fabricated test samples make this an inexpensive testing apparatus. The sample is a disc with a diameter of 1-1/3", on one side is a rim of 1/16" width; this rim constitutes the area of contact.