TUFNOL Grade 2F/3/PTFE

Cotton fabric based laminate with added PTFE
Dry bearing laminate

A unique self-lubricating material:

- Cost-effective operation
- Reduced wear rate
- Minimizes maintenance
- Eliminates stick-slip motion and running-in periods
- Longer working life
- Easily machined
- Good mechanical strength and dimensional stability

TUFNOL Grade 2F/3/PTFE is a unique, dry-bearing material. It is a cotton fabric reinforced laminate, internally lubricated by very fine particles of PTFE uniformly distributed throughout the material. This dispersion of the PTFE right throughout the material ensures that, whatever shape of component is machined from it, PTFE is always present at the bearing surface, modifying and improving the dry friction properties.

It is a laminated thermosetting resin material incorporating a fluoroplastics lubricant, and provides advantages derived from both materials, successfully combining the excellent mechanical strength, rigidity, toughness and good machining characteristics of phenolic laminates with the self-lubricating and low friction characteristics of PTFE.

This high performance dry bearing material has many applications in the manufacturing industries where non-contaminating, silent running, long-life dry bearings are required.

info@tufnol.co.uk
+44(0)121 356 9351
+44 (0)1355 233 876

STRENGTH AND CHEMICAL PROPERTIES

As a thermoset material, Grade 2F/3/PTFE has several important advantages over thermoplastics, making it more widely acceptable for load bearing applications.

It has a cotton fabric base of medium weave, bonded with phenolic resin. During manufacture of the laminate a controlled percentage of 'Fluon'® PTFE is built in. The mechanical strength of the PTFE lubricated laminate is significantly higher than that of thermoplastics bearing materials, as is its modulus of rigidity.

Grade 2F/3/PTFE can be used continuously at temperatures approaching 100oC and retains sufficient of its properties to be useful at temperatures approaching absolute zero. Under high stress, its creep and cold flow properties are superior to those of thermoplastics bearing materials.

TUFNOL grade 2F/3/PTFE is resistant to dilute acids and bases but may be attacked by concentrated solutions. Its resistance to salts and common solvents is excellent, and its water absorption is low, with good dimensional stability under humid conditions.

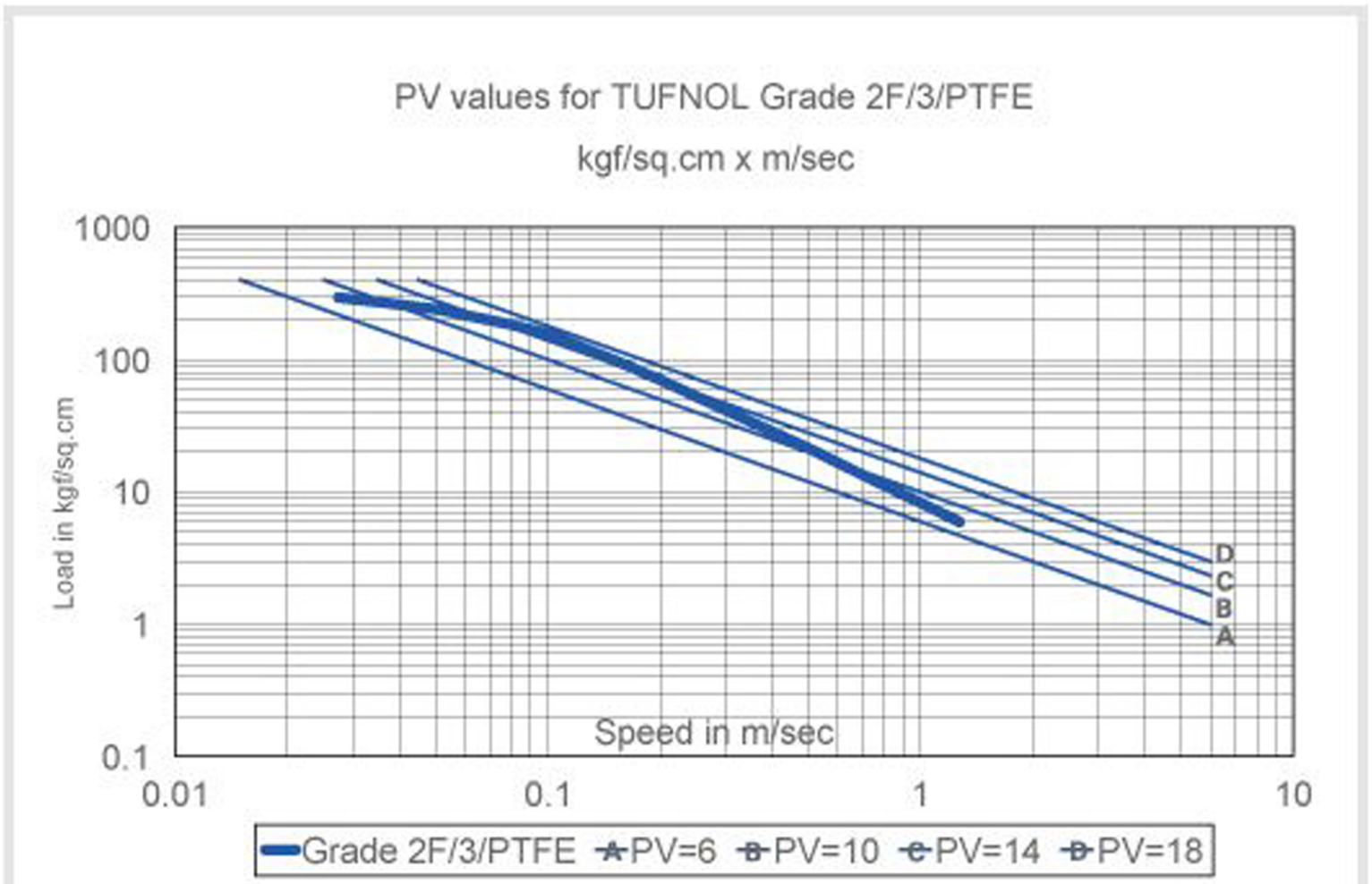
All of these factors contribute to the versatility of TUFNOL Grade 2F/3/PTFE and make it one of the most useful dry-bearing materials available to engineers.

WEAR AND FRICTION PROPERTIES

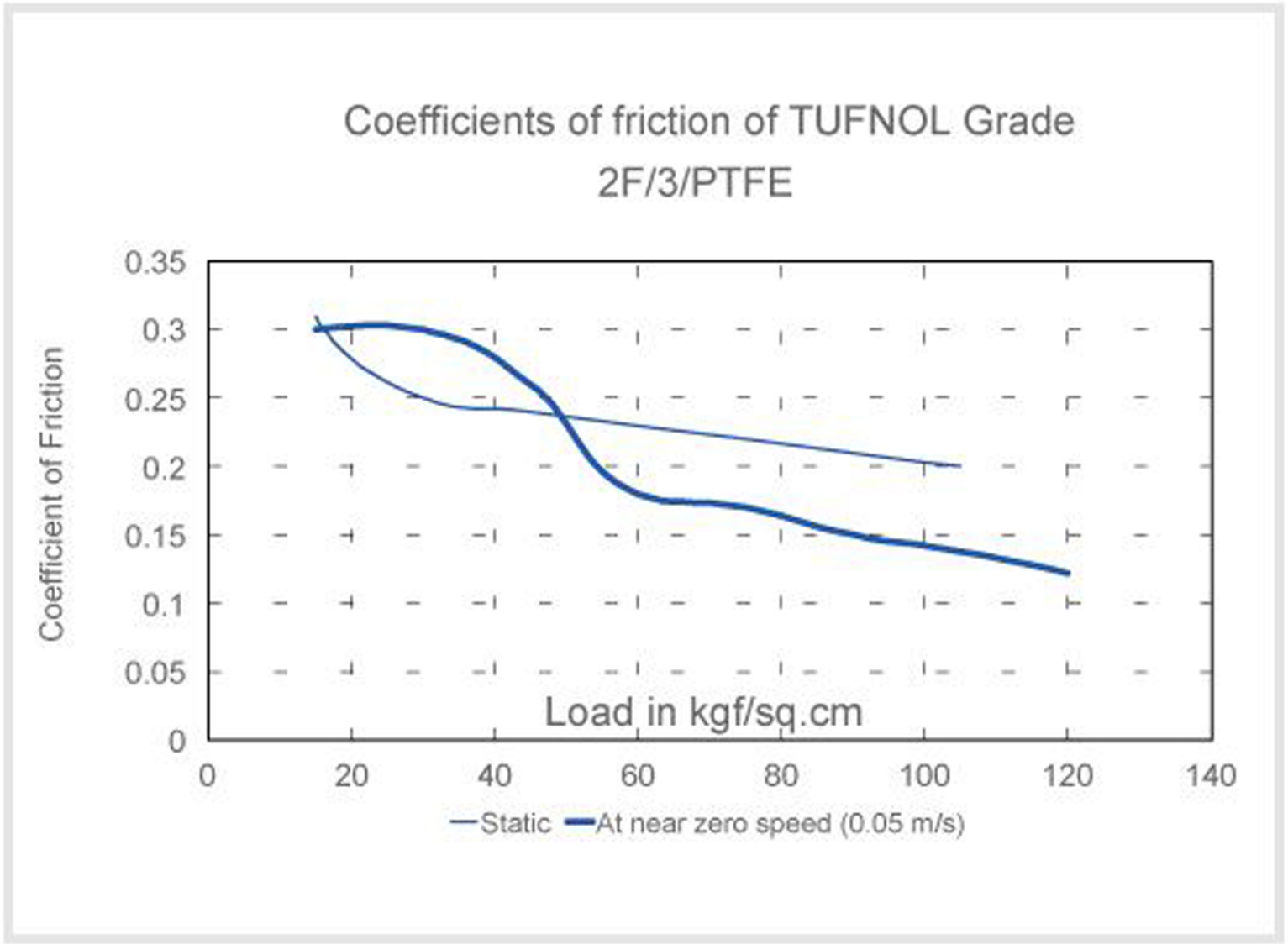
The frictional properties of Grade 2F/3/PTFE are quite outstanding in dry-bearing applications.

The mechanical strength of the base laminate combines with the frictional properties of the PTFE dispersion to give Grade 2F/3/PTFE a wear resistance which is many times greater than that of either of these materials individually. This allows it to be used with confidence at loads and speeds which would be considered prohibitive for many other dry-bearing materials. As shown in Figure 1, optimum balance of wear and performance is achieved at Pressure x Velocity (PV) values around 16.4* under loads of about 127 kgf/cm2 at 0.127 m/sec.

At somewhat lower speeds, say 0.04 to 0.05 m/sec the optimum PV value is about 10.7*. Grade 2F/3/PTFE has, in fact, survived very short term testing under loads exceeding 120 kgf/cm2 at PV values exceeding 36*. It will be appreciated that, although these loads are higher than normal for a dry-bearing material, they are quite realistic, since the material does not deform greatly under load.



The PV values shown in Figure 1 represent the highest values which unlubricated specimens of TUFNOL Grade 2F/3/PTFE withstand in laboratory testing. The test specimen is a rectangular block with one face machined to provide a cylindrical bearing surface which is run against a 35 mm diameter hardened steel ring.



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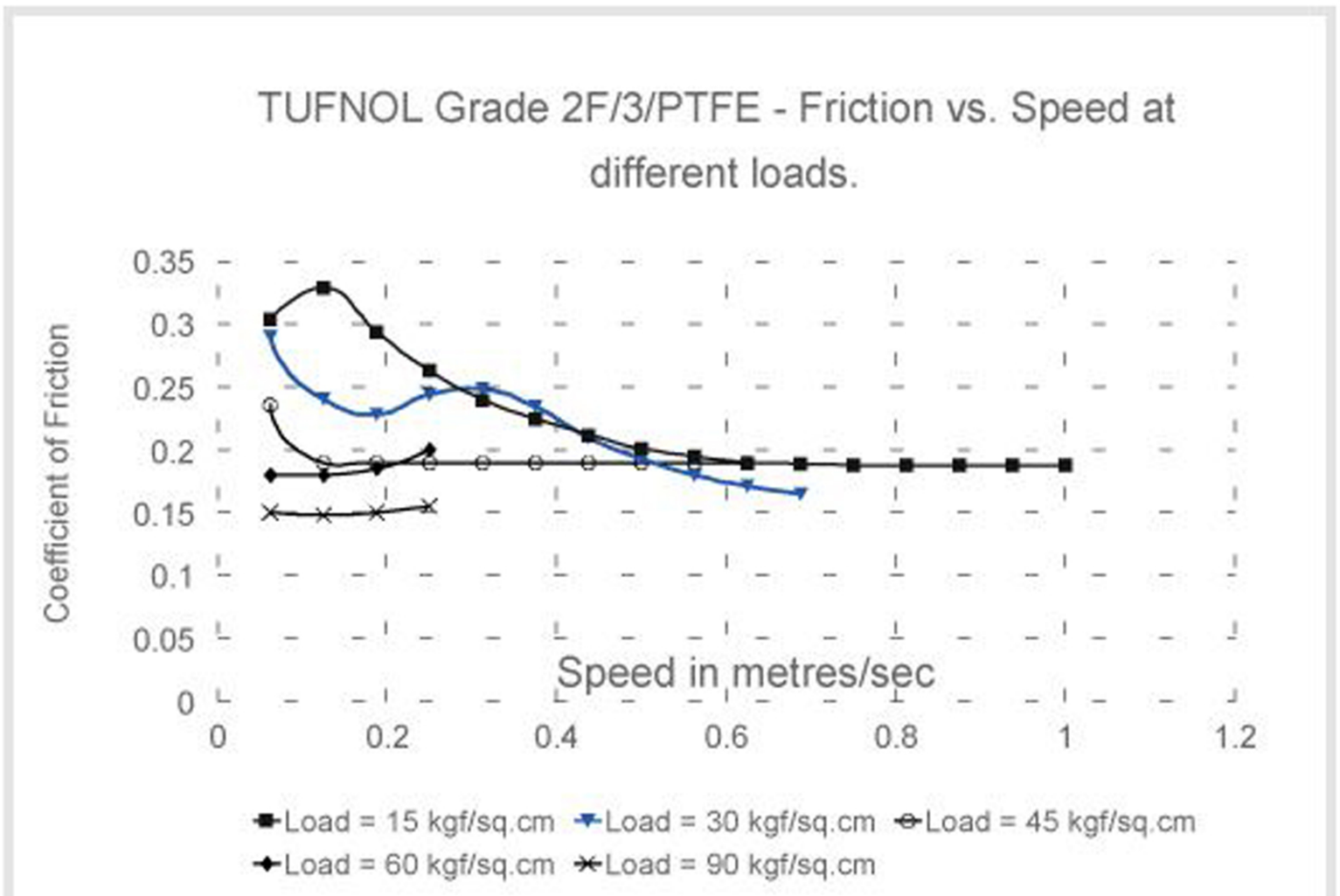
Dynamic coefficients of friction vary between 0.1 and 0.3 depending on load and speed, but tend to lie below 0.2 where high PV values are used. Coefficients of static friction are also low, helping to avoid 'stick-slip' movement at low sliding speeds.



It is commonly accepted that the results of bearing tests depend to some extent on the test method used and on the geometry of the specimen. Furthermore, manufacturers of materials may well have different criteria for judging whether or not a material's performance is satisfactory at a given PV level.

For reasons such as these, the PV values indicated in Figure 1 be accepted as only an approximate guide to the performance of TUFNOL Grade 2F/3/PTFE. In all cases, practical testing should be performed under full working conditions to assess the suitability of this material.

TUFNOL Ltd will, of course, co-operate with engineers and designers wishing to arrange tests, and sample quantities of TUFNOL Grade 2F/3/PTFE are available for experimental purposes. The TUFNOL Technical Advisory Service is available to provide any further information which may be required.

**NOTE: All PV values are expressed in kgf/cm2 x m/sec.*

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MACHINING

Components in a wide variety of shapes and sizes can easily be machined from Grade 2F/3/PTFE and the techniques used for machining it are similar to those for conventional laminated plastics. The uniform distribution of PTFE throughout the laminate ensures that whatever shape be machined, PTFE will be present at the bearing surface.

SPECIFICATIONS

TUFNOL Grade 2F/3/PTFE is a unique material and there are no British Standards or other national published specifications applicable to this type of material.

It is produced to the in-house quality specifications of Tufnol Composites Ltd.

PROPERTIES OF Tufnol Grade 2F/3/PTFE SHEET

PROPERTY	TYPICAL RESULT	UNITS
Cross breaking strength	105	MPa
Impact strength, notched, Charpy	10.0	kJ/m2
Compressive strength, flatwise	205	MPa
Compressive strength, edgewise	100	MPa
Resistance to flatwise compression	2.8	%
Shear strength, flatwise	50	MPa
Water Absorption		
- 3mm thk.	90	mg
- 6mm thk	120	mg

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Electric strength, flatwise in oil at 90o C		
- 3mm thk.	2.3	MV/m
- 6mm thk.	1.8	MV/m
Electric strength, edgewise in oil at 90oC	9	kV
Insulation resistance after immersion in water	5x108	ohms
Relative density	1.50	-
Maximum working temperature**		
- continuous	90	0C
- intermittent	120	0C
Thermal classification	Class E	-
Thermal conductivity through laminae	0.41	W/(mK)
Thermal expansion in plane of laminae	3.0	x10-5/K
Specific heat	1.5	kJ/(kgK)

Test methods as BS EN 60893-2, where applicable.

**Users of highly stressed components at temperatures approaching the maximum are recommended to seek further advice from TUFNOL Ltd.

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ROUND TUBES

PROPERTY	TYPICAL RESULT	UNITS
Axial compressive strength	110	MPa
Cohesion between layers	90	MPa
Water absorption	2.5	mg/cm2
Relative density	1.50	-

Test methods as BS EN 61212-2, where applicable.

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TYPICAL APPLICATIONS

for TUFNOL GRADE 2F/3/PTFE

Some of the wide ranging applications for GRADE 2F/3/PTFE:

Bearing blocks in the pattern control actuators of industrial knitting machines.

Bearing bushes at the connecting points of caravan stabiliser/towing units.

Bearing bushes in milking machine pulsating pumps.

Bearing brushes on the upper welding head of welding machines.

Blade guides acting as wear pads in guillotines.

Bearing bushes in sugar confectionery plant.

Seal rings on vacuum equipment handling a heavy viscous sugar compound.

Bearing bushes in steel conveyor rollers.

Hinge plates locating banks of spindles in weaving equipment.

Bearing bushes in the tensioning roll shaft of bucket conveyors.

Slide shoes fitted to the faces of lift counterweights.

Bearing bushes fitted in the hardened steel cams of lift safety devices.

Pivot bushes on ships' funnel damper gear.

Bearing bushes in the variator pulley drives for beater shafts on combine harvesters.

Bearing bushes supporting small spindles on six spindle horizontal borers.

Thrust washers on the rudder stocks of small cruisers.

Locating plugs in the opening/closing mechanisms of large automatic machine tool chucks.

Slides and separators in the levelling devices of weaving equipment.

Sealing rings at the shaft apertures of food and chemical mixing machinery.

Fairlead bushes supporting fuel pipes on the wings of aircraft.

Slideways on milk bottle capping machinery.

Retaining rings in the rotational mechanisms of infra-red telescopes.

Brake and clutch pedal bushes.

Reverse gear linkages bushes.

Bushes for fly-weight lever pivots in centrifugal clutch.

Bearings for conveyor rollers in mail-sorting equipment.

Bearings in trolley wheels for heavy duty foundry conveyors.

Bearings for pivots of ten ton hydraulic lifting table.

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Bearings for cam fingers of transformer tap changers.

Bearings for reels in float switches.

Bearings for rollers in paper waxing machine.

Support bearings for carrier jigs in vacuum metal coating machine.

Bushes for foot pedals, front suspension and brake torque shafts on industrial trucks.

Bearings in time-lapse mechanism in parachute release device.

Bearings for heavily loaded pivots and spring members in pipe hangers.

Bearings for marine windscreen-wipers.

Bushes in valve linkages in gas meters.

Bushes for carrier jigs in machines for cleaning parts to be electro-plated.

Bearings in food wrapping machines.

Components in printing machines, including big end and shuttle main shaft bearings, carbon mechanism, plate slide and swing lever.

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