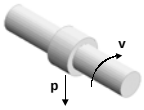
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TechBriefs

BRUSHWELLMAN
ENGINEERED MATERIALS

ToughMet® Plain Bearings -- Performance with High PV

by Ray Cribb
Brush Wellman Inc.



ToughMet®, made by the EquaCast® process, is a spinodally hardened CuNiSn alloy system that has shown exceptional bearing performance in a wide range of demanding applications. This lead-free alloy is pre-heat treated to high yield strengths, in excess of 100 ksi (700Mpa)…while having high corrosion resistance, good thermal conductivity, machinability and low coefficient of friction. ToughMet also provides excellent high temperature stability including 600F (315C) durability and very good creep and stress relaxation resistance.

A series of standardized journal bearing tests showed ToughMet far exceeds conventional bronzes in PV Limit perfomance. ToughMet was evaluated in both cast (CX) and wrought (AT) conditions.

ToughMet® 3 Properties

Temper	*0.2% Offset YS* (ksi)	*Ultimate TS* (ksi)	*Elongation* (%)	*Hardness* (HRC)
CX105	**105**	**110**	**4**	**28**
AT110	**110**	**125**	**10**	**30**

Comparative Behavior

Placed in the context of other materials for plain bearings, the following table illustrates the position of ToughMet.

This extracted table is the result of essentially identical testing over many years at the same testing and evaluation source and provides a baseline by which one might rank materials.

In the non-lubricated condition ToughMet exhibited PV Limit similar to lubricated materials including graphite impregnated copper, low lead tin babbit and carbon bearings, approximately 16-18,000 psi-sfpm (0.56-0.63 MPa-m/s).

In the lubricated condition, ToughMet with a typical bearing finish of 10 μ-in (0.3 μm) showed PV Limit values significantly higher than any other bearing alloy, including the popular cast manganese and aluminum bronzes.

PV Limit Comparisons

Material (Lubricated)	Max .PV (psi-sfpm)
ToughMet® 3	***275,000***
Manganese Bronze	**150,000**
Aluminum Bronze	**125,000**
Cast C93200	**75,000**
SAE 841 Bronze PM	**50,000**
SAE 863 Fe PM	**35,000**
60 Cu 40 Fe PM	**35,000**
SAE 850 Fe	**30,000**
High Tin Babbitt (89%)	**30,000**
Low Tin Babbitt (10%)	**18,000**
ToughMet® 3 Unlubricated	***17,000***
Graphite/Metallized Brgs	**15,000**
Carbon	**15,000**
Low Tin Low Pb (6%) Babbitt	**12,000**

Comparison data from Bunting Bearing Corp.

As a plain bearing, ToughMet achieved a PV-limit of 260-290,000 psi-sfpm (9-10 MPa-m/s), comparable to very high performance hybrid polymeric bearing materials.

Plain Bearing Tests

The basic testing apparatus for determining the PV Limit is a 1 inch diameter shaft of hardened steel (HRC 60) fitted with a plain bearing of nominal 1 inch ID x 1 inch long. The test was run at constant rotational speed with incremental loading to the bearing.

This test has been used for over a decade to establish basic plain bearing alloy performance

comparisons by a prominent bearing manufacturer and data are publicly available.

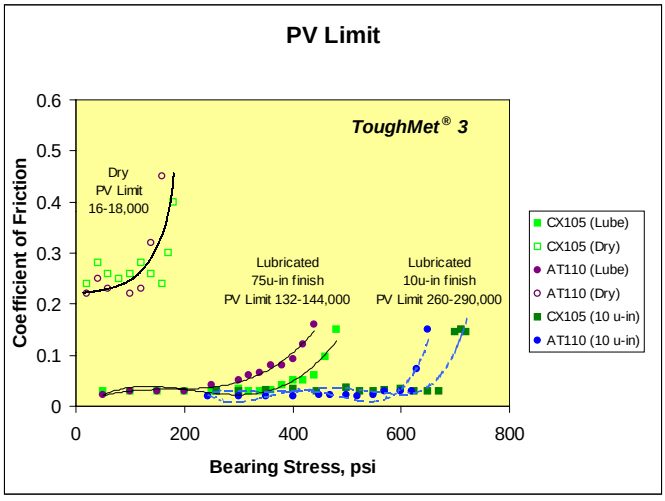
Test Conditions

Bearing Materials	**ToughMet® 3 CX105**
	ToughMet® 3 AT110
Shaft Material	**Case 60**
Velocity	**300 - 400 sfpm**
Temperature	**Room Temp at Start**
Normal Pressure	**20 psi increments**
Lubricant	**SAE 10 W HD**
Surface Roughness	**Shaft -- 10 - 20**
(μ-in R_a)	**Bearing -- 75 and 10**

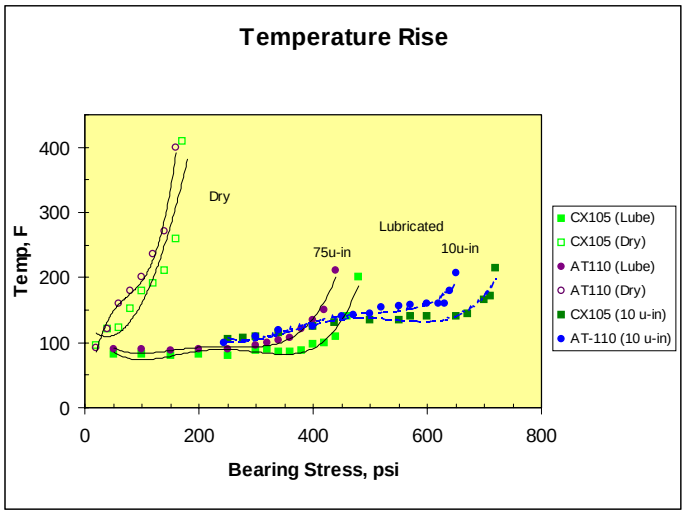
Three sample conditions were assessed including two surface finishes, one of which was tested in the unlubricated condition. Lubricant was wiped on before the test and additional drops of lubricant were applied as necessary to keep the friction coefficient below 0.1 as the load was increased. Failure is defined to have occurred at the projected bearing stress when the coefficient of friction exceeds 0.15 or the measured temperature increases above about 210F (100C).

Results

As with other materials, the PV Limit for ToughMet in the dry condition was considerably lower than that for the lubricated condition as shown in the following figures.



With lubrication and a nominal 10 μ-in (0.3 μm finish typical of plain bearings, PV Limit values were 260-290,000 psi-sfpm (9-10 MPa-m/s) while the nominal 75 μ-in (1.9 μm) finish showed 132-144,000 psi-sfpm (4.6-5.0 MPa-m/s) value.



The PV and Temperature Rise diagrams for the lubricated cases also show the tendency within one category of surface finish, for the cast (CX) microstructures to have slightly better PV Limit than the wrought (AT) material at the same strength level.

Conclusions

Plain Bearing tests were conducted to establish the PV Limit of ToughMet® 3 with a yield strength in excess of 100 ksi (690 MPa):

1. ToughMet exhibited a PV Limit of about 275,000 psi-sfpm (9.6 MPa-m/s) against a high hardness bearing steel, in excess of 75% higher than popular manganese bronze and approaching high performance hybrid polymers.

2. ToughMet CX cast product performed slightly better than the AT wrought product.

3. Non-lubricated testing showed ToughMet to behave similarly to lubricated graphite impregnated copper, low lead tin babbit and carbon bearings.

4. Improving the surface finish from 75 μ-in (1.9 μm) to 10 μ-in (0.3 μm) doubled the PV Limit.

References
1. W.A. Glaeser, "Wear Properties of Heavy Loaded Copper-Based Bearing Alloys", J. Metals, October 1983, pp. 50-55.
2. ToughMet®3 AT and CX Datasheets, Brush Wellman Inc.
3. "Spinodal Decomposition In ToughMet® Alloys", Brush TechBrief AT0025.
4. Machining of ToughMet®, Brush Tech Brief AT0029.

If you require additional information, or technical assistance, contact our Technical Service Department.

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