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Standard Guide for Reporting Friction and Wear Test Results of Manufactured Carbon and Graphite Bearing and Seal Materials¹

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1. Scope

- 1.1 This guide covers the following areas for reporting friction and wear test results of manufactured carbon and graphite bearing and seal materials:
- 1.1.1 Description of test device and techniques (Table 1 and Table 2.)
- 1.1.2 Description of carbon and graphite material test specimen (Table 3).
- 1.1.3 Description of mating member test specimen (Table 4).
 - 1.1.4 Report of friction and wear test results (Table 5).

1.2 Many types of equipment and techniques will yield consistent data characterizing the friction and wear of carbon and graphite materials. However, the ranking of the materials by the various test methods used is not necessarily the same. This guide is an initial effort to promote more complete description of the test methods, whatever they may be. It is the eventual intent to identify one or more specific standard test methods when sufficient information becomes available.

2. Significance and Use

2.1 The purpose of this guide is twofold. First, it is a research tool that will aid in the analysis and correlation of test results obtained on various test devices by different investigators. Second, it serves to identify important considerations that must be made in testing to make the results easily understood and comparable with the results of other investigators.

3. Keywords

3.1 carbon; friction; graphite; reporting; wear

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TABLE 1 Description of Test Device and Techniques

1. DESCRIPTION OF TEST DEVICE	DATE
1.1 Preferred Designation, Manufacturer, and Modifications ————————————————————————————————————	
1.2 Orientation of Carbon Specimen Test Surface: 1.2.1 Horizontal 1.2.2 Vertical 1.2.3 Other (describe)	
1.3 Description of Sliding: 1.3.1 Linear □ 1.3.2 Rotational □ 1.3.3 Discontinuous motion □ Describe □ 1.3.4 Continuous motion □ Describe □ 1.3.5 Discontinuous contact □ Describe □ 1.3.6 Continuous contact □ Describe □ 1.3.7 Approximate duration of test □ minutes, □ hours, □ days	
1.4 Description of Loading System: 1.4.1 Maximum capacity N (lbf) 1.4.2 Type of measuring element 1.4.3 Type of recording device 1.4.4 Estimate of error 1.4.5 Calibration procedure and frequency	
1.5 Description of Speed-Measuring System: 1.5.1 Maximum capacity m/s (ft/s), rev/min, other 1.5.2 Type of measuring element 1.5.3 Type of recording device 1.5.4 Estimate of error 1.5.5 Calibration procedure and frequency	
1.6 Description of Temperature-Measuring System: 1.6.1 Location (describe): 1.6.1.1 Carbon test specimen 1.6.1.2 Mating member test specimen 1.6.1.3 Fluid (for example, upstream and downstream of test specimens and test cavity)	
1.6.2 Maximum value: 1.6.2.1 Carbon test specimen	
1.6.4.1 Carbon test specimen 1.6.4.2 Mating member test specimen 1.6.4.3 Fluid 1.6.5 Estimate of error: 1.6.5.1 Carbon test specimen 1.6.5.2 Mating member test specimen 1.6.5.3 Fluid 1.6.6 Calibration procedure and frequency: 1.6.6.1 Carbon test specimen 1.6.6.2 Mating member test specimen	
1.6.6.3 Fluid 1.7 Description of Pressure-Measuring System Across Test Specimens: 1.7.1 Maximum value: 1.7.1.1 Upstream Pa absolute (
1.7.2.3 Differential 1.7.3 Type of recording device: 1.7.3.1 Upstream 1.7.3.2 Downstream 1.7.3.3 Differential 1.7.4 Estimate of error: 1.7.4.1 Upstream 1.7.4.2 Downstream 1.7.4.3 Differential 1.7.5 Calibration procedure and frequency:	
1.7.5.1 Upstream	

TABLE 2 Description of Test Device and Techniques Continued

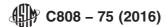
1.7.5.2 Downstream						
1.7.5.3 Differential						
1.8 Description of Fluid Flow Rate Measuring Systems:						
1.8.1 Maximum value: 1.8.1.1 Across test specimens						
1.8.1.2 Through test cavity						
1.8.2 Type of measuring element:						
1.8.2.1 Across test specimens						
1.8.2.2 Through test cavity						
1.8.3 Type of recording device:						
1.8.3.1 Across test specimens						
1.8.3.2 Through test cavity						
1.8.4 Estimate of error:						
1.8.4.1 Across test specimens						
1.8.4.2 Through test cavity						
1.8.5 Calibration procedure and frequency:						
1.8.5.1 Across test specimens						
1.8.5.2 Through test cavity						
1.9 Description of Friction-Measuring System:						
1.9.1 Maximum capacity N (lbf), N·m (lbf·ft), other 1.9.2 Type of measuring element						
1.9.2 Type of measuring element						
1.9.3 Type of recording device						
1.9.4 Estimate of error						
1.9.5 Calibration procedure and frequency —						
2. METHOD OF FIXTURING CARBON TEST SPECIMEN						
2.1 Rigid						
2.2 <i>Pivot</i> (1-D rotational freedom)						
2.3 Swivel, Universal (2-D rotational freedom)						
2.4 Hydraulic						
2.5 Pneumatic						
2.6 Misalignment radians, other						
2.7 Installed Eccentricity (TIR) m (in.)						
2.8 Axial Runout (TIR) m (in.)						
2.9 Radial Runout (TIR) m (in.)						
3. METHOD OF FIXTURING MATING MEMBER						
3.1 Rigid \Box 3.2 Pivot (1-D rotational freedom) \Box						
=						
3.3 Swivel, Universal (2-D rotational freedom)						
3.4 Hydraulic						
3.5 Pneumatic						
3.6 Misalignment radians, other						
3.7 Installed Eccentricity (TIR) m (in.)						
3.8 Axial Runout (TIR) m (in.)						
3.9 Radial Runout (TIR) m (in.)						
4. ENVIRONMENTAL CONDITIONS						
4.1 Carbon Test Specimen Conditioning Environment:						
4.1.1 Fluid medium: air □ (specify moisture content						
4.1.2 Temperature K (°F)						
4.1.3 Pressure: ambient \(\pressure: \)						
4.1.4 Time at these conditions minutes, hours, days						
4.2 Mating Member Test Specimen Conditioning Environment:						
4.2.1 Fluid medium: air (specify moisture content), distilled water , deionized water , other (specify composition quantitatively)						
4.2.2 Temperature K (
4.2.3 Pressure: ambient □, other —						
4.2.4 Time at these conditions minutes, hours, days						
•						
4.3 Test Environment: 4.3.1 Fluid medium:						
4.3.1.1 Before test condition: air (specify moisture content), distilled water , deionized water , other (specify composition quantitatively)						
4.3.1.2 During test condition (specify how monitored and controlled, including limits)						
4.3.1.2 During test condition (specify now monitored and conditioned, including limits)						
4.3.1.3 After test condition (describe quantitatively, if possible, the change in composition or quality)						
4.3.2 Substance other than fluid medium initially applied at test specimens interface (for example, lubricating oil)						
4.3.3 Fluid temperature:						
4.3.3.1 Upstream K (°F)						
4.3.3.2 Downstream K (°F)						
4.3.4 Fluid pressure:						
4.3.4.1 Upstream Pa absolute (psia)						
4.3.4.2 Downstream Pa absolute (psia)						
4.3.4.3 Differential Pa differential (psid)						
4.3.5 Fluid flow through test cavity						
4.3.6 Time to reach test conditions minutes, hours						
4.3.7 Time at test conditions prior to test minutes, hours						

TABLE 3 Description of Carbon Test Specimen

1.4 Raw Ingredients, if not Proprietary: 1.4.2 Binder 1.4.2 Binder 1.4.3 Additives 1.4.4 Impregnants 1.5 Origina Billet Forming Process. 1.5 Origina Billet Size 1.7 Heat Treatment, if not Proprietary: 1.7.1 Graphitizing temperature 1.7.2 Rate of heating Kimin From Imitutes, hours 2. DESCRIPTION OF IEST SPECIMEN 2.1 Incention and Orientation in Trest Specimen 2.2 Grain Size and Orientation in Original Billet Size 2.3 Microstructure (provide sketch or photo) 2.4 Surface Condition: 2.5 Insuperson and Tolerances (provide print) 2.5 Insuperson and Tolerances (provide print) 2.6 Tead Surface Composition Limits 1.1 Manufacturer 1.2 Commercial Name 1.3 Chemical Composition Limits 1.4.1 Hocessing 1.4.2 Heat treatment 2.5 DESCRIPTION OF FEST SPECIMEN 2.1 Location and Orientation in Test Specimen TABLE 4 Description of Mating Member Test Specimen 1. DESCRIPTION OF MATING MEMBER MATERIAL 1.1 Manufacturer 1.2 Commercial Name 1.3 Chemical Composition Limits 1.4.1 Processing 1.4.2 Heat treatment 2.5 DESCRIPTION OF Test SPECIMEN 2.1 Location and Orientation in Re-Received Piece 2.2 Grain Size and Orientation in Test Specimen 2.3 Microstructure; cytalline □, polycrystalline □, amorphous □, other (provide sketch or photo) 4.4 Dimension and Tolerances (provide print) 2.5 Roughness (specify method used) 2.4 Dimension and Tolerances (provide print) 2.5 Test Surface Condition: 2.5.1 Roughness (specify method used) 2.5.2 Warness Expecify method used) 3.5.3 Roughness (specify method used) 4.5.5 Test Surface Condition: 2.5.1 Roughness (specify method used) 4.5.5 Test Surface Condition: 2.5.1 Roughness (specify method used) 4.5.5 Warness Expecify method used) 4.5.7 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.7 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.7 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.8 Roughness (specify method used) 4.5.7 Roughness (specify method used)	1.2 Grade Number 1.4 Raw Ingredients, if not Proprietary: 1.1.4 Filler 1.4.2 Binder 1.4.3 Additives 1.4.4 Impregnants 1.4.5 Other 1.5 Original Billet Forming Process 1.5 Original Billet Size 1.7 Heat Treatment, if not Proprietary: 1.7.1 Graphizing temperature 1.7.2 Rate of heating K/min(1. DESCRIPTION OF CARBON MATERIAL				
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1.4.3 Interpreparits 1.4.5 Other 1.4.5 Original Billet Size 1.6 Original Billet Size 1.7.1 Graphitizing temperature	1.4.3 Additives					
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1.5 Original Billet Size	1.5 Original Billet Size					
1.6 Original Billet Size	1.6 Original Billet Size					
1.7.1 Graphitzing temperature	1.7.1 Graphitzing temperature					
1.7.2 Rate of heating	1.7.2 Rate of heating					
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2.5.1 Roughness (specify method used) µm aa µm aa µm aa 2.5.2 Waviness (specify method used)		2.4 Dimension and Tolerances (provide print)			THE TEST	_
2.5.2 Waviness (specify method used)	2.5 Test Surface Condition:	2.5 Test Surface Condition:		-		
				µm aa		_ µm aa
2.5.3 Flatness (specify method used)	2.5.2 Waviness (specify method used) \mu					- um
	2.6 Hardness and Location Where Measured			_		_ μ····

TABLE 5 Report of Friction and Wear Test Results

1	1. DATE OF TEST TE	ST NO N	MACHINE NO	OPERAT	TOR		
2	2. CARBON TEST SPECIMEN IDE	NTIFICATION: GRADE	NO L	OT NO	SPECIMEN NO		
3	3. MATING MEMBER TEST SPECI	MEN IDENTIFICATION	N: SPECIMEN NO.				
4	4. NUMBER OF TESTS IN THIS SE	ERIES: FRICTION	WEAR				
5.	5. TEST CONDITIONS						
	5.1 Unit Load Pa (on	
5.	5.2 Speed m/s	(//s ,re	ev/min, other			
5.3	.3 <i>Fluid Temperature:</i> 5.3.1 Upstream ———— K (——	0E\					
5.3.	5.3.2 Downstream K (°F)					
5.4	.4 Fluid Pressure:						
	i.4.1 Upstream Pa absol	ute (psia)					
	5.4.2 Downstream Pa al						
	5.4.3 Differential Pa diffe		•				
	.5 Flow Across Test Specimens (if con.6 Flow Through Test Cavity						
	. CARBON TEST SPECIMEN TEMPE						
6.1	.1 Start-Up Temperature	_K (°F); h	ow and when obtain	ed			
6.2	.2 Equilibrium or Average Temperature	re K (°F); how ar	nd when obtained			
6.3	.3 Maximum Temperature	K (°F);	how and when obtain	ined			
	.4 Final Temperature K	(°F); now	and when obtained				
	. FRICTION .1 Break-Away or Static Friction	N/	lbf)	N m /	lbf ft) other	· how obtained	
	.2 Start-Up Friction (if different from t	•	,,	•	**	•	
7.2	.2 Start-Up Friction (if different from tage) and when obtained	break-away friction)	N (lbf),	N⋅m (lbf·ft), other _	; how
7.3 7.4	.3 Equilibrium or Average Friction4 Maximum Friction N	N (N (lbf), N·m (N·m (lbf•ft), (lbf•ft)	other; h	ow and when obtained —; how and when obtained	
7.5	.5 Final Friction N (lbf),	N⋅m (lbf•ft), oth	er; hov	and when obtained	
	. WEAD						
	B. WEAR						
	.1 Carbon Test Specimen:	les ette	t-b.t				
	3.1.1 Wear measurement						
8.1.	3.1.2 If length used, linear dimensional where measured	I change of some referen	ice dimension other	than that used to	measure wear	m/m (in./in.); how and
8.1.	3.1.3 Time duration of wear	minutes.	hours				
8.1.	3.1.4 Wear: per unit time	_ , per unit of distance tr	aveled				
8.1.	3.1.5 Description of worn surface (prov	vide sketch or photo) —					
8.1.	8.1.6 Surface roughness (µm aa): befo	re test			after test		
	3.1.7 Hardness: before test			after te	est		
	3.2 Mating Member Test Specimen: 3.2.1 Wear measurement	length	weight	volume: accura	cy and how obtained		
8.2.	3.2.2 If length used, linear dimensional	I change of some referen	ice dimension other	than that used to	measure wear	m/m (in./in.): how and
8 2	where measured 3.2.3 Time duration of wearing	minutes	hours				
8.2.	3.2.4 Wear: per unit time	per unit of distance tra	aveled				
8.2.	3.2.5 Description of worn surface (prov	vide sketch or photo) —					
8.2.	3.2.6 Surface roughness (µm aa): befo	re test			_ after test		
	3.2.7 Hardness: before test			after te	est ———		
	O. FLOW ACROSS TEST SPECIMENS						
	9.1 Start-Up Flow; how 9.2 Equilibrium or Average Flow						
	9.3 Maximum Flow; hov						
9.4	9.4 Final Flow; how and	d when obtained					
10.	LO. SUSPENDED TEST						
	.0.1 Reason for Test Suspension .0.2 Time Duration Before Suspension	minutes,	hour	s			



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