PUBLICLY AVAILABLE SPECIFICATION



Pre-Standard

First edition 2005-01

Natural graphite brush for rotating electrical machinery – Basic characteristics



Reference number IEC/PAS 62072:2005(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NATURAL GRAPHITE BRUSH FOR ROTATING ELECTRICAL MACHINERY – BASIC CHARACTERISTICS

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A PAS is a technical specification not fulfilling the requirements for a standard but made available to the public.

IEC-PAS 62072 has been processed by IEC technical committee 2: Rotating machinery.

The text of this PAS is based on the	This PAS was approved for
following document:	publication by the P-members of the
	committee concerned as indicated in
	the following document

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2/1301A/NP	2/1318/RVN

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This PAS shall remain valid for an initial maximum period of three years starting from 2005-01. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

NATURAL GRAPHITE BRUSH FOR ROTATING ELECTRICAL MACHINERY – BASIC CHARACTERISTICS

1 Scope

This PAS applies to brushes for commutators and slip-rings in rotating electrical machinery.

This excludes brushes of electrical appliances such as starters of automobiles and tractors, micro-appliances for household and tools, appliances for aeronautics and space, and others operating in special conditions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60276, Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip-rings

IEC 60413, Test procedures for determining physical properties of brush materials for electrical machines

IEC 60773, Test methods and apparatus for the measurement of the operational characteristics of brushes

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

NG brush material

material, which consists of natural graphite mineral with developed crystal structure and a binder able to take appropriate characteristics as brush

3.2

NG brush

brush for commutator and slip-ring made of NG brush material in accordance with IEC 60276, Clause 2

4 Classification

The NG brushes should be classified in accordance with 4.1 to 4.4.

- 4.1 According to usage:
- a) commutator brush;
- b) slip-ring brush.
- 4.2 According to grade of rotating electrical machinery:
- a) for d.c. electrical machine;

- b) for turbine generator;
- c) for hydro generator;
- d) for wound-rotor type asynchronous motor.
- 4.3 According to voltage used:
- a) using up to 100 V;
- b) using in the range of 100 V to 500 V;
- c) using in the range of 5 00 V to 1 000 V;
- d) using in the range of 1 000 V to 3 000V.
- 4.4 According to operating conditions:
- a) operating in current above 600 A;
- b) operating in peripheral velocity above 60 m/s;
- c) operating in vibrating width above 100 μ m;
- d) operating in ambient temperature above +40 °C;
- e) operating in the on-off times per hour above 20;
- f) operating in normal condition.

5 Characteristics

5.1 Physical properties

5.1.1 Bulk density

The bulk density of NG brush material should be in the range of 1,2 g/cm³ to 1,4 g/cm³.

5.1.2 Hardness

The hardness of NG brush material should be in the range of 10 to 40 in HR 2,5/3,5.

5.1.3 Resistivity

The resistivity of NG brush material should be in the range of 10 $\mu\Omega\cdot m$ to 80 $\mu\Omega\cdot m$ for commutators and 6 $\mu\Omega\cdot m$ to 12 $\mu\Omega\cdot m$ for slip-rings.

5.1.4 Bending strength

The bending strength of NG brush material should be in the range of 8 MPa to 15 MPa.

5.1.5 Ash

The ash content in NG brush material should be up to 0,5 %.

5.2 Operating characteristics

5.2.1 Total voltage drop

The total voltage drop should be in the range of 2 V to 3 V.

5.2.2 Coefficient of friction

The coefficient of friction should be up to 0,2.

5.3 Recommended operating conditions

5.3.1 Peripheral velocity

The peripheral velocity should be up to 90 m/s.

5.3.2 Current density

The current density should be in the range of 8 A/cm² to 12,5 A/cm².

5.3.3 Brush pressure

The brush pressure should be in the range of 15 kPa to 35 kPa.

Tables 1 and 2 give basic characteristics of typical NG brushes for commutators and slip-rings respectively.

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PAS

Designation	Bulk density	Hardness HR 2 5/3 5	Resistivity μΩ · m	Bending strength MPa	Ash %	Total voltage drop V	Coefficient of friction	Peripheral velocity m/s	Current density	Brush pressure kPa	Remark
	Average	Average	Average	Average	Max.	Average	Max.	Max.	Average	Average	
KPNG125	1,2-1,3	20-40	40-60	10-12	0,5	2	0,2	40	10	20-25	NOTE 1
KPNG111	1,2-1,3	20-40	10-15	10-12	0,5	2	0,2	40	12	20-25	NOTE 2
KPNG122	1,2-1,3	20-30	60-80	10-12	0,5	2	0,2	60	10	18-20	NOTE 3
KPNG133	1,35	10-20	40-60	14-15	0,5	2	0,2	50	10	25-35	NOTE 4
KPNG143	1,35	10-20	40-80	14-15	0,5	3	0,2	50	10	25-35	NOTE 5
NOTE 1 DC mo	otor and d.c.	generator for to	ool machines, cr	ane and lifter.							
NOTE 2 DC ge	nerators for	coating, weldin	g, electrolysis.								
NOTE 3 Turbin	e generator's	s exciter, high-	speed d.c. motor								
NOTE 4 DC tra	ction motors	for trolley-bus,	tram-bus and s	ubway.							

NOTE 5 DC traction motors for electrical and internal combustion locomotive.

Table 2 –	Basic	characteristics	of NG	brushes	in	slip-rings
10010 -	= = = = = =	0114140101101100		81.401100		0p

Designation	Bulk density	Hardness HR 2 5/3 5	Resistivity μΩ · m	Bending strength MPa	Ash %	Total voltage drop V	Coefficient of friction	Peripheral velocity	Current density	Brush pressure kPa	Remark
	Average	Average	Average	Average	Max.	Average	Max.	Max.	Average	Average	
KPNG422	1,3-1,4	10-20	6-8	10-12	0,5	2-3	0,2	90	10	15-20	NOTE 1
KPNG526	1,3-1,4	20-30	10-12	10-12	0,5	2-3	0,2	40	10	20-25	NOTE 2
KPNG821	1,2-1,3	20-40	6-8	10-12	0,5	2	0,2	40	8	15-20	NOTE 3
NOTE 1 Turbine generator, dipole synchronous motor.											

NOTE 2 Hydro generator, multi-pole synchronous machine.

NOTE 3 Wound-rotor type asynchronous motor.

6 Test methods

The test methods on the physical properties and the operating characteristics of NG brushes shall be performed in accordance with IEC 60413 and IEC 60773 respectively.

Annex A

(informative)

Measurements and performance characteristics

Table A.1 – Measurement of characteristics and particles of NG brushes by international companies*

No	Companies	Date	Contents
4	SGL carbon group	2001.09.21	Section photograph
1	(France)	2002.11.21	Measurement of characteristic value
2	Schunkkohlenstofftechnik GmbH (Germany)	1994.05.30	Crystal structure Measurement of characteristic value
2	Graphit Kropfmühl	2002.07.12	Analysed raw material contents
3	(Germany)	2003.11.27	
4	ARP, Leoben (Austria)	1994.02.23	Measurement of graphite particle size
5	Toyo carbon corporation (Japan)	1996.06.13	Measurement of characteristic value

Table A.2 shows the results of the operating test of the NG brushes in domestic use.

Table A.2 – Performance characteristics of NG brushes in various applications
(measurements performed by the DPR Korea)

Objects	Number of motors	Number of	Period of test	Runni distan	ng ice	B pe	rush wear r 10 000 k mm	r m	Wear of commu-	Spark	V _t	J _B	P _B
		brusiles	h	km		Initial	Middle	Last	lator		m/s	A/cm ²	kPa
Traction	6	48	6 000	80 00	00	1,4	1,2	1,04	Not nearly	No	00.00	6 10	
motor	6	6 48 6 0		60 000		1,7	1,4	0,9	Not nearly	No	20-30	6-10	3
		Numb	er Nu	mber	Pe	riod of	Brush pe	wear	Wear of		V _t	J _B	P _B
Objects		of machir	nes bru	of ushes		h	1 000 km mm		slip-ring	Spark	m/s	A/cm ²	kPa
Wound-ro	otor type	20	20 4		30000		0,66		Not nearly	No	10.35	5.9	150
asynchro	nous motor	300	5	000	3	0000	1,1	6	Not nearly	No	10-55	5-0	1,0-2
High-speed turbine generator		10	9	960	2	4000	7,5		Not nearly	No	90	10	1,5-2

^{*} This information is given for the convenience of users of this PAS and does not constitute an endorsement by IEC.



Manufacture process of the different brushes



Figure B.1 – Diagram of manufacture process

Annex C

(informative)

Comparison of physical properties

Table C.1 shows the physical properties of NG brush material in comparison with others.

Designation Parameter	DPR of KOREA KPNG120	USA 634	Germany F22
Bulk density g/cm ³	1,20	1,28	1,25
Resistivity µΩ ⋅m	18	25	25
Bending strength MPa	8,0	5,2	4,0
Hardness HS	22	16	_

 Table C.1 – Comparison of physical properties of NG brush material

– 12 –

Annex D (informative)

Environmental pollution



Figure D.1 – Environmental pollution of the different brushes



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	librarian						
	researcher						
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				(4) above average.			
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