Product Specification

Product name: Grade 220 polyamideimide enameled round copper wire

Implementation standard number: IEC60317-57:2010

Product Specification

1. Scope of application

This standard applies to the performance requirements of polyamideimide enameled round copper wire with a heat resistance grade of 220.

2. Usage characteristics

2.1 The product has heat resistance and high voltage resistance.

2.2 The thermal grade of the product is 220 (UL certification number: E174580).

3. Model

The model of thin paint layer (grade 1) enameled wire is QXY-1/220.

The model of thick paint layer (grade 2) enameled wire is QXY-2/220.

4. Conductor, insulation coating, lubrication, size and characteristics

4.1 Conductor

The copper used for enameled wire should comply with the requirements of GB/T 3952-2016 "Copper wire blank for electrical use".

4.2 Insulation coating

The paint film should be polyamide-imide resin with good heat resistance, wear resistance and freezing resistance.

4.3 Lubrication

The surface of the enameled wire should be coated with lubricant, which should not have harmful effects on the paint film and use.

4.4 Size

The conductor diameter, tolerance, paint film thickness, maximum finished product diameter (outer diameter) and resistance of the enameled wire shall meet the requirements of Table 1.

Table 1

Conductor nominal diameter（mm）	Conductor tolerance ±(mm)	Minimum paint film (mm)		Maximum outer diameter (mm)		Room temperature breakdown voltage (v)		One-way scratch resistance (N) average/minimum		Resistance （Ω/m）	
		grade 1	grade 2	grade 1	grade 2	grade 1	grade 2	grade 1	grade 2	min	max
0.250	0.004	0.017	0.032	0.281	0.297	2100	3900	3.00/2.55	4.90/4.15	0.3345	0.3628
0.280	0.004	0.018	0.033	0.312	0.329	2200	4000	3.25/2.75	5.25/4.45	0.2676	0.2882
0.315	0.004	0.019	0.035	0.349	0.367	2200	4100	3.50/2.95	5.65/4.80	0.2121	0.2270
0.355	0.004	0.020	0.038	0.392	0.411	2300	4300	3.75/3.20	6.05/5.15	0.1674	0.1782
0.380	0.005	0.021	0.040	0.418	0.438	2300	4400	4.05/3.45	6.50/5.50	0.1457	0.1562
0.400	0.005	0.021	0.040	0.439	0.459	2300	4400	4.05/3.45	6.50/5.50	0.1316	0.1407
0.450	0.005	0.022	0.042	0.491	0.513	2300	4400	4.35/3.70	7.00/5.90	0.1402	0.1109
0.500	0.005	0.024	0.045	0.544	0.566	2400	4600	4.65/3.95	7.50/6.35	0.08462	0.08959

0.510	0.006	0.025	0.047	0.554	0.579	2500	4600	5.00/4.25	8.00/6.80	0.08105	0.08642
0.560	0.006	0.025	0.047	0.606	0.630	2500	4600	5.00/4.25	-	0.06736	0.07153
0.630	0.006	0.027	0.050	0.679	0.704	2600	4800	5.35/4.55	-	0.05335	0.05638
0.700	0.007	0.028	0.053	0.752	0.778	2600	4800	5.70/4.85	-	0.04320	0.04573
0.710	0.007	0.028	0.053	0.762	0.789	2600	4800	5.70/4.85	-	0.04198	0.04442
0.800	0.008	0.030	0.056	0.855	0.884	2600	4900	6.10/5.15	-	0.03305	0.03500
0.810	0.008	0.032	0.060	0.865	0.895	2700	5000	6.55/5.55	-	0.03225	0.03413
0.850	0.009	0.032	0.060	0.909	0.939	2700	5000	6.55/5.55	-	0.02926	0.03105
0.900	0.009	0.032	0.060	0.959	0.989	2700	5000	6.55/5.55	-	0.02612	0.02765
0.950	0.010	0.034	0.063	1.012	1.044	2700	5000	7.05/5.95	-	0.02343	0.02486
1.000	0.010	0.034	0.063	1.062	1.094	2700	5000	7.05/5.95	-	0.02116	0.02240
1.06	0.011	0.034	0.065	1.124	1.157	2700	5000	7.60/6.45	-	0.01882	0.01996
1.08	0.011	0.034	0.065	1.143	1.178	2700	5000	7.60/6.45	-	0.01813	0.01921
1.120	0.011	0.034	0.065	1.184	1.217	2700	5000	7.60/6.45	-	0.01688	0.01786
1.250	0.013	0.035	0.067	1.316	1.349	2700	5000	8.20/6.95	-	0.01354	0.01435
1.33	0.013	0.036	0.069	1.397	1.431	2700	5000	8.80/7.45	-	0.01196	0.01266
1.400	0.014	0.036	0.069	1.468	1.502	2700	5000	8.80/7.45	-	0.01080	0.01143
1.45	0.015	0.038	0.070	1.519	1.554	2700	5000	9.45/8.00	-	0.01006	0.01066
1.600	0.016	0.038	0.071	1.670	1.706	2700	5000	9.45/8.00	-	0.00827	0.00875
1.800	0.018	0.039	0.073	1.872	1.909	2700	5000	10.1/8.60	-	0.00653	0.00691
2.000	0.020	0.040	0.075	2.074	2.112	2700	5000	10.9/9.20	-	0.00529	0.005600
2.240	0.022	0.041	0.077	2.316	2.355	2700	5000	-	-	0.00422	0.00446
2.500	0.025	0.042	0.079	2.578	2.618	2700	5000	-	-	0.00338	0.00358

Note: For the intermediate sizes of conductor nominal diameters, the minimum paint film thickness, minimum breakdown voltage, and minimum average scratch force values of the next largest conductor nominal diameter should be taken.

4.5 Characteristics

When testing in Chapter 5, the characteristics of the enameled wire should meet the requirements of Table 2.

Table 2

Term	Characteristics	Testing method

Size	Meet the requirements of Table 1	See clause 5.1
Ooutward appearance	When the wire wound on the reel is inspected with normal vision, the paint film should be basically smooth and continuous, without bubbles and impurities.	Visual inspection
Flexibility	The conductor coating has no visible cracks and the conductor is not exposed	See clause 5.2
Adhesion	The conductor coating has no visible cracks and the conductor is not exposed	See clause 5.3
Elongation	Meet the requirements of Table 4	See clause 5.4
Rebound Angle	Meet the requirements of Table 5	See clause 5.5
One-way scratch resistance	See Table 1	See clause 5.6
Softening breakdown	At 350℃, there should be no breakdown within 2 minutes.	See clause 5.7
Thermal shock	Minimum thermal shock temperature is 240℃ No cracks, no exposed conductors	See clause 5.8
Resistance	Meet the requirements of Table 1	See clause 5.9
Breakdown voltage	The room temperature voltage complies with Table 1. The high temperature test temperature should be 220℃, which complies with Table 7.	See clause 5.10
Insulation continuity	The number of defects per 30m of enameled wire should not exceed the value specified in Table 8	See clause 5.11
Solvent resistance	No blistering or expansion on the coating, pencil hardness ≥ H	See clause 5.12
Temperature Index	The minimum temperature index should be 220	See clause 5.13

5 Test method

5.1 Size

At two locations 1M apart on a straightened specimen, measure the outer diameter three times evenly along the circumference of the insulated wire at each location. The average of the six readings is the outer diameter. Then remove the paint film in a way that does not damage the bare wire, repeat the above measurement along the bare wire, and the average of the six readings is the bare wire diameter.

The paint film thickness is calculated as follows:

Paint film thickness = outer diameter - bare wire diameter

The conductor roundness is the maximum value of the difference between the two diameter measurements on each cross section of the conductor.

5.2 Flexibility

5.2.1 Winding test (conductor nominal diameter 1.60mm and below):

Cut three specimens of about 35cm in length from the same spool, and tightly wind each specimen with a smooth test rod of the diameter specified in Table 3 for 10 turns so that the turns are in contact with each other. Then check whether the paint film is cracked to expose the conductor.

5.2.2 Tensile test (conductor nominal diameter above 1.60 mm)

After the enameled wire is stretched by 32%, the paint film should not crack.

Table 3

Nominal diameter (mm)	Rod diameter (mm)
0.140	0.150
0.140(above)～1.600(included)	d

Note: d is the nominal diameter of the enameled wire

5.3 Adhesion

5.3.1 Snap-break test (conductor nominal diameter 1.000mm and below)

Take a straight specimen and snap-pull it to break or the specified elongation. The reference distance is 200-250mm. After the specimen is elongated, use a 10x magnifying glass to check whether the paint film is cracked or loses adhesion and there is no visible conductor cracking or cracking, but no assessment is made within 2mm from the breaking point. The test is performed 3 times.

5.3.2 Peel test (conductor nominal diameter above 1.000mm)

For enameled wire with a conductor nominal diameter greater than 1.000mm, the paint film should not lose adhesion after twisting at R=K/d. K=75mm, d is the nominal diameter value of the conductor.

5.4 Elongation

On an extensometer, stretch a straightened specimen with a free test length of 200-250 mm to the conductor breaking point at a rate of (5±1) mm/s. Calculate the ratio of the linear length increment at break to the free test length, expressed as a percentage. Measure 3 specimens and take the average value as the elongation at break. The elongation must comply with the requirements of Table 4.

Table 4

Wire Gauge	Elongation(%)	Wire Gauge	Elongation(%)	Wire Gauge	Elongation(%)
0.140	21	0.450	28	1.400	33
0.160	22	0.500	28	1.600	33
0.180	23	0.560	29	1.800	34
0.200	24	0.630	29	2.000	34
0.224	24	0.710	30	2.240	35
0.250	25	0.800	30	2.500	35
0.280	26	0.900	31	2.800	36
0.315	26	1.000	32	3.150	36
0.355	27	1.120	32	3.550	36
0.400	27	1.250	33	4.000	37

Note: For intermediate sizes of conductor nominal diameters, the minimum elongation value for the next largest conductor nominal diameter should be taken.

5.5 Rebound

5.5.1 Conductor nominal diameter 0.14 to and including 1.6mm

When tested on the required round bar with the specified load, the maximum springback angle of the enameled wire shall not exceed the specified value in Table 5.

5.5.2 Conductor nominal diameter 1.6mm and above

The maximum springback angle of the enameled wire shall not exceed 5°.

Table 5

Nominal diameter (mm)	Maximum rebound angle (°)		Round rod diameter (mm)	Load (N)
	Grade 1	Grade 2		
0.140	59	67	7	0.50
0.160	59	67	10	1.0
0.180	57	65		
0.200	54	62		
0.224	51	59	12.5	2.0
0.250	49	56		
0.280	47	53		
0.315	50	55	19	4.0
0.355	48	53		
0.400	45	50		
0.450	44	48	25	8.0
0.500	43	47		
0.560	41	44		
0.630	46	50	37.5	12.0
0.710	44	47		
0.800	41	43		
0.900	45	48	50	15.0
1.000	42	45		
1.120	39	41		
1.250	35	37		
1.400	32	34		
1.600	28	30		

Note: For intermediate sizes of conductor nominal diameters, the maximum springback angle value of the next largest conductor nominal diameter should be taken.

5.6 Unidirectional scratch resistance

Unidirectional scratch resistance test: a relatively straight sample is wiped clean and placed in the test equipment, then the sample is fixed with a chuck and the support table is adjusted to contact the sample. The initial force applied to the equipment should not exceed 90% of the minimum scratching force specified in the relevant product standards, and the scraper needle and the conductor are short-circuited, and the short-circuit point is between 150mm and 200mm from the fixed support point. The loaded paint scraping device should slowly descend to the surface of the enameled wire and then start scraping. When the scraper needle stops scraping, record the distance data and multiply the data by the load. The test process should be repeated 3 times around the circumference of the sample at an interval of 120 degrees, measure 1 sample, record 3 test values, and take the average value as the average scratching force.

5.7 Softening breakdown

It should comply with Article 4 of IEC60851-6 (2003).

5.8 Thermal shock

Should comply with Clause 3 of IEC60851-6 (2003), heating temperature 240±5℃, heating time 30min. The round bar diameter is specified in Table 6.

Table 6

Conductor nominal diameter (mm)	Round rod diameter (mm)	Conductor nominal diameter (mm)	Round rod diameter (mm)
0.140	0.150	0.500	1.120
0.160	0.250	0.560	1.250
0.180	0.280	0.630	1.400
0.200	0.315	0.710	1.600
0.224	0.355	0.800	1.800
0.250	0.400	0.900	2.000
0.280	0.630	1.000	2.240
0.315	0.710	1.120	3.550
0.355	0.800	1.250	4.000
0.400	0.900	1.400	4.500
0.450	1.000	1.600	5.000

5.9 Resistance

Should comply with Clause 3 of IEC60851-5 (2004).

5.10 Room temperature breakdown voltage

Should comply with Clause 4 of IEC60851-5 (2004), the high temperature test temperature should be 200℃, in accordance with the provisions of Table 7

Table 7

Conductor nominal diameter (mm)	High temperature breakdown voltage (V)		Conductor nominal diameter (mm)	High temperature breakdown voltage (V)	
	Grade 1	Grade 2		Grade 1	Grade 2

0.140	1200	2300	0.400	1700	3300
0.160	1300	2400	0.450	1700	3300
0.180	1300	2500	0.500	1800	3500
0.200	1400	2600	0.560	1900	3500
0.224	1400	2800	0.630	2000	3600
0.250	1600	2900	0.710	2000	3600
0.280	1700	3000	0.800	2000	3700
0.315	1700	3100	0.900	2000	3800
0.355	1700	3200	1.000	2000	3800

5.11 Insulation continuity (conductor nominal diameter 1.600mm and below)

Should comply with Clause 5 of IEC60851-5 (2004), and the number of defects per 30m of enameled wire should not exceed the value specified in Table 8.

Table 8

Conductor nominal diameter (mm)		Maximum number of defects per 30m	
above	until and included	grade 1	grade 2
0.25	1.600	10	5

5.12 Solvent resistance test

The solvent resistance test shall comply with Clause 3 of IEC60851-4 (1997).

5.13 Temperature index value

The test method complies with IEC60172 (1997). The heat resistance index can be proved by UL yellow card, so we do not need to test.