HJ209 Handbook

1. Key Considerations for Using Our Company's HJ209

Currently, there are two types of electric heating wire materials in China suitable for 1400°C: HJ209 and OCr27Al7Mo2. Among these, HJ209 has gained a growing influence in the domestic electric heating alloy market due to its superior cold-working performance and stronger oxidation resistance. When using HJ209, the following points should be noted:

(1) The median resistivity of HJ209 is approximately 1.47, with a maximum reaching 1.54.

(2) HJ209 can be easily cold-rolled into flat strips.

(3) Due to its excellent workability, HJ209 can be produced in large single weights, with common coarse specifications achieving single-coil weights exceeding 50 kg.

(4) The surface finish of HJ209 is available in three states—blue, ordinary oxidation color, and bright wire—with corresponding price differences.

(5) HJ209 can be processed into fine wires with a diameter of 0.1 mm. Its high resistivity allows for space and material savings when designing heating tubes.

(6) Like conventional iron-chromium-aluminum (FeCrAl) materials, HJ209 becomes brittle after high-temperature use and cannot undergo cold deformation afterward.

(7) The most significant quality challenge is occasional cracking, though the incidence has declined in recent years. Large-diameter HJ209 wires often exhibit a black line running longitudinally, which may resemble a crack. Three methods can help distinguish it:

- Examine it under sunlight; if the line appears open and shiny, it may be a crack. If unopened and black, it is not.

- Cut a small section, grind the cross-section flat with a grinding wheel, and etch it with acid. If the depth is much less than one-fifth of the diameter, it is not a crack.

- Twist a small segment on a lathe (10 rotations forward and backward). If it does not split, it is not a crack.

Even with the black line, the performance remains excellent if it is not a crack, indicating minimal impact on usability.

2. Heating Wire Failure Related to Design and Usage

Electric heating alloy wires, as electrothermal conversion materials, operate at the highest temperatures within a system and are often the first components to fail. Short-term failures are not only related to the wire's quality but also to the design and installation of the heating element.

If a batch of heating elements exhibits frequent short-term breakage, statistical analysis should be conducted. For example, by randomly sampling damaged elements and analyzing the distribution of break points, if breaks consistently occur at specific locations, the issue likely stems from design, installation, or environmental factors (e.g., contact materials or atmosphere) rather than wire quality.

3. Reasons for Heating Wire Not Glowing Red

When an electric heating wire is energized, its color changes from dark red to bright red, then to white as the temperature rises. This color shift indicates the wire's increasing temperature.

During heating element design, customers may observe that wires of the same specification sometimes glow red quickly while others do not. This discrepancy is not a quality issue but depends on the surface load (watts per unit area). A higher surface load results in faster temperature rise and visible red glow, while a lower load has the opposite effect.

Designers must account for the total resistance, surface area (wire diameter), and resistance temperature coefficient, as well as inherent resistivity variations within the same specification. Neglecting these factors can lead to inconsistent heating rates, which may reduce production efficiency for end-users. Simply meeting total power requirements is insufficient.

4. Delivery State Color of FeCrAl Alloy Does Not Affect Lifespan

FeCrAl heating alloy wires exhibit different surface colors (e.g., golden, red, blue, or bright) after final heat treatment, depending on the process. However, these colors do not correlate with lifespan.

In air, FeCrAl forms an oxide layer composed of iron, chromium, and aluminum oxides. The layer's composition and thickness vary with temperature, time, and oxygen pressure, affecting the reflected light's color. For instance, after continuous operation at 1000°C+ for 6 hours, the surface turns silver-gray or white as aluminum oxide dominates. Thus, the delivery color is irrelevant to lifespan.

5. Explanation of FeCrAl Alloy "Burning Hollow" Phenomenon

FeCrAl alloys are widely used in industrial furnaces due to their excellent high-temperature oxidation resistance. However, when surface loads are excessively high to save costs, a "burning hollow" failure may occur. The wire appears white and clean, with a shrunken cross-section resembling an empty blood vessel.

This happens because the aluminum oxide layer (high melting point) remains intact while the alloy core (lower melting point) melts under rapid heating. Molten core material escapes through weak points in the oxide layer. To prevent this, reduce the surface load or slow the heating rate, allowing temperature stabilization to extend lifespan.

6. Considerations for FeCrAl Heating Wires in Carburizing Furnaces

In carburizing furnaces, FeCrAl wires must not be exposed to carbon atmospheres. Carbon reacts with chromium, forming brittle grain-boundary compounds that cause "bloating" and shorten lifespan.

Solutions include isolating the wire from carbon or pre-oxidizing it at 950°C for 6 hours to form a protective silver-gray oxide layer. Note: Pre-oxidized wires become brittle and must not be deformed or subjected to impact.

7. Nickel-Chromium Alloys Are Preferred for Tempered Glass Furnaces

Tempered glass furnaces operate below 700°C, where FeCrAl forms rough, black iron oxide scales that can contaminate glass or rollers. FeCrAl performs best above 950°C, forming durable silver-gray aluminum oxide scales.

Thus, despite higher costs, nickel-chromium alloys are more reliable for tempered glass furnaces unless FeCrAl scaling is mitigated in the design.

8. Lifespan Comparison: Our HJ209 vs. Kanthal A-1

Many manufacturers seek domestic alternatives to expensive Kanthal A-1. Our HJ209 was tested under comparable conditions:

- φ0.8mm HJ209 at 1400°C: Average rapid lifespan = 72 hours; elongation = 12.6%.
- φ0.8mm Kanthal A-1 at 1350°C: Average rapid lifespan = 56 hours; elongation = 24.71%.

HJ209 outperforms Kanthal A-1 in lifespan (despite higher test temperature) and high-temperature strength (lower elongation). Additionally, HJ209 costs about one-third of Kanthal A-1. Note: HJ209's resistivity (1.45–1.55) differs slightly from Kanthal A-1's (1.45–1.50), requiring design adjustments.

9. Avoid Direct FeCrAl-Copper Connections in Electric Blowers

A customer reported FeCrAl wire breakage at copper contact points in hair dryers, with 83.7% failures showing melt fractures. Aluminum in FeCrAl reacts with copper, increasing contact resistance and temperature, leading to melting. Avoid direct FeCrAl-copper connections.

10. Detecting Internal Defects in FeCrAl Heating Alloys

FeCrAl alloys may develop longitudinal cracks or delamination, causing processing or operational failures. To detect these:

- Wrap the wire around a mandrel (2–4× wire diameter) for 15–20 cm. Defective wires will exhibit visible splitting.

11. Selecting High-Resistance Heating Wires for Heaters

Heater design must consider surface power, cross-section, length, and shape (straight, spiral, etc.). Resistance is chosen based on power; higher power requires lower resistance. Large industrial heaters use wide/long strips to balance surface power and current.

For low-power devices like electric blankets, manganese-copper wires (lower resistivity than FeCrAl) are used to achieve sufficient length and low unit power.

HJ209 Wire Resistance Chart

Diameter (mm)	Resistance per meter（20℃, Ω/m）	Surface area per ohm（20℃, $cm^2/Ω$）	Weight per meter (g/m)	Surface area per meter (cm^2/m)	Cross-sectional area (mm^2)	Diameter (mm)
10.00	0.0189	16656	557	316	78.5	10.00
9.50	0.0209	14281	503	300	70.8	9.50
9.00	0.0233	12143	451	284	63.6	9.00
8.50	0.0261	10229	403	268	56.7	8.50
8.00	0.0295	8528	357	252	50.2	8.00
7.50	0.0335	7027	314	236	44.2	7.50
7.00	0.0385	5713	273	221	38.5	7.00
6.50	0.0446	4574	235	205	33.2	6.50
6.00	0.0524	3598	201	189	28.3	6.00
5.50	0.0623	2771	169	173	23.7	5.50
5.00	0.0754	2082	139	157	19.6	5.00
4.80	0.0818	1842	128	151	18.1	4.80
4.50	0.0931	1518	113	142	15.9	4.50
4.20	0.1069	1234	98.3	132	13.8	4.20
4.00	0.1178	1066	89.2	126	12.6	4.00
3.80	0.1306	914	80.5	120	11.3	3.80
3.50	0.1539	714	68.3	110	9.6	3.50
3.20	0.1841	546	57.1	101	8.0	3.20
3.00	0.2095	450	50.2	94.3	7.07	3.00
2.80	0.2405	366	43.7	88.0	6.15	2.80
2.50	0.3017	260	34.8	78.6	4.91	2.50
2.20	0.3895	177	27.0	69.2	3.80	2.20
2.00	0.4713	133	22.3	62.9	3.14	2.00
1.90	0.5223	114	20.1	59.7	2.83	1.90
1.80	0.5819	97	18.1	56.6	2.54	1.80
1.70	0.6524	82	16.1	53.4	2.27	1.70
1.60	0.7365	68	14.3	50.3	2.01	1.60
1.50	0.8379	56	12.5	47.1	1.77	1.50
1.40	0.9619	46	10.9	44.0	1.54	1.40
1.30	1.1156	37	9.42	40.8	1.33	1.30
1.20	1.31	28.8	8.03	37.7	1.13	1.20
1.10	1.56	22.2	6.74	34.6	0.950	1.10
1.00	1.89	16.7	5.57	31.4	0.785	1.00
0.95	2.09	14.3	5.03	29.8	0.708	0.95
0.90	2.33	12.2	4.51	28.3	0.636	0.90

0.85	2.61	10.2	4.03	26.7	0.567	0.85
0.80	2.95	8.54	3.57	25.1	0.502	0.80
0.75	3.35	7.04	3.14	23.6	0.442	0.75
0.70	3.85	5.72	2.73	22.0	0.385	0.70
0.65	4.46	4.58	2.35	20.4	0.332	0.65
0.60	5.24	3.60	2.01	18.8	0.283	0.60
0.55	6.23	2.78	1.69	17.3	0.237	0.55
0.50	7.54	2.09	1.39	15.7	0.196	0.50
0.48	8.18	1.85	1.28	15.1	0.181	0.48
0.45	9.31	1.52	1.13	14.1	0.159	0.45
0.42	10.69	1.24	0.983	13.2	0.138	0.42
0.40	11.78	1.07	0.892	12.6	0.126	0.40
0.38	13.06	0.916	0.805	11.9	0.113	0.38
0.35	15.39	0.716	0.683	11.0	0.0962	0.35
0.32	18.41	0.547	0.571	10.0	0.0804	0.32
0.30	20.95	0.5	0.502	9.42	0.0707	0.30
0.28	24.05	0.4	0.437	8.79	0.0615	0.28
0.26	27.89	0.30	0.377	8.17	0.0531	0.26
0.25	30.17	0.27	0.348	7.85	0.0491	0.25
0.24	32.73	0.24	0.321	7.54	0.0452	0.24
0.23	35.64	0.21	0.295	7.22	0.0415	0.23
0.22	38.95	0.18	0.270	6.91	0.0380	0.22
0.21	42.75	0.15	0.246	6.59	0.0346	0.21
0.20	47.13	0.13	0.223	6.28	0.0314	0.20
0.19	52.23	0.11	0.201	5.97	0.0283	0.19
0.18	58.19	0.0976	0.181	5.65	0.0254	0.18
0.17	65.24	0.0823	0.161	5.34	0.0227	0.17
0.16	73.65	0.0686	0.143	5.02	0.0201	0.16
0.15	83.79	0.0566	0.125	4.71	0.0177	0.15
0.14	96.19	0.0460	0.109	4.40	0.0154	0.14
0.13	111.56	0.0369	0.0942	4.08	0.0133	0.13
0.12	130.93	0.0290	0.0803	3.77	0.0113	0.12
0.11	155.81	0.0224	0.0674	3.45	0.00950	0.11
0.10	188.54	0.0168	0.0557	3.14	0.00785	0.10
0.09	232.76	0.0123	0.0451	2.83	0.00636	0.09
0.08	294.59	0.0086	0.0357	2.51	0.00502	0.08
0.07	384.77	0.0058	0.0273	2.20	0.00385	0.07

HJ209 Cold Rolled Flat Strip Resistance Chart

Thickness × Width mm			Resistance per Meter （20℃）Ω	Surface area per ohm （20℃）cm^2/Ω	Weight per meter g/m	Surface area per meter cm^2/m
3	×	25	0.0197	28378	532.5	560
3	×	30	0.0164	40135	639	660
3	×	35	0.0141	53919	745.5	760
3	×	40	0.0123	69730	852	860
3	×	50	0.0099	107432	1065	1060
2.5	×	20	0.0296	15203	355	450
2.5	×	25	0.0237	23226	443.8	550
2.5	×	30	0.0197	32939	532.5	650
2.5	×	35	0.0169	44341	621.3	750
2.5	×	40	0.0148	57432	710	850
2.5	×	50	0.0118	88682	887.5	1050
2	×	15	0.0493	6892	213	340
2	×	18	0.0411	9730	255.6	400
2	×	20	0.037	11892	284	440
2	×	25	0.0296	18243	355	540
2	×	30	0.0247	25946	426	640
2	×	35	0.0211	35000	497	740
2	×	40	0.0185	45405	568	840
2	×	50	0.0148	70270	710	1040
1.8	×	12	0.0685	4028	153.4	276
1.8	×	15	0.0548	6130	191.7	336
1.8	×	18	0.0457	8669	230	396
1.8	×	20	0.0411	10605	255.6	436
1.8	×	25	0.0329	16297	319.5	536
1.8	×	30	0.0274	23205	383.4	636
1.8	×	35	0.0235	31330	447.3	736
1.8	×	40	0.0206	40670	511.2	836
1.8	×	50	0.0164	63000	639	1036
1.5	×	8	0.1233	1541	85.2	190
1.5	×	10	0.0987	2331	106.5	230
1.5	×	12	0.0822	3284	127.8	270
1.5	×	15	0.0658	5017	159.8	330
1.5	×	18	0.0548	7115	191.7	390
1.5	×	20	0.0493	8716	213	430
1.5	×	25	0.0395	13429	266.3	530
1.5	×	30	0.0329	19155	319.5	630
1.5	×	35	0.0282	25895	372.8	730
1.5	×	40	0.0247	33649	426	830

1.5	×	50	0.0197	52196	532.5	1030
1.2	×	5	0.2467	503	42.6	124
1.2	×	6	0.2056	701	51.1	144
1.2	×	7	0.1762	931	59.6	164
1.2	×	8	0.1542	1194	68.2	184
1.2	×	10	0.1233	1816	85.2	224
1.2	×	12	0.1028	2569	102.2	264
1.2	×	15	0.0822	3941	127.8	324
1.2	×	18	0.0685	5604	153.4	384
1.2	×	20	0.0617	6876	170.4	424
1.2	×	25	0.0493	10622	213	524
1.2	×	30	0.0411	15178	255.6	624
1.2	×	35	0.0352	20546	298.2	724
1.2	×	40	0.0308	26724	340.8	824
1.2	×	50	0.0247	41514	426	1024
1	×	5	0.296	405	35.5	120
1	×	6	0.2467	568	42.6	140
1	×	7	0.2114	757	49.7	160
1	×	8	0.185	973	56.8	180
1	×	10	0.148	1486	71	220
1	×	12	0.1233	2108	85.2	260
1	×	15	0.0987	3243	106.5	320
1	×	18	0.0822	4622	127.8	380
1	×	20	0.074	5676	142	420
1	×	25	0.0592	8784	177.5	520
1	×	30	0.0493	12568	213	620
1	×	35	0.0423	17027	248.5	720
1	×	40	0.037	22162	284	820
1	×	50	0.0296	34459	355	1020
0.9	×	5	0.3289	359	32	118
0.9	×	6	0.2741	504	38.3	138
0.9		7	0.2349	673	44.7	158
0.9	×	8	0.2056	866	51.1	178
0.9	×	10	0.1644	1326	63.9	218
0.9	×	12	0.137	1883	76.7	258
0.9	×	15	0.1096	2901	95.9	318
0.9	×	18	0.0914	4138	115	378
0.9	×	20	0.0822	5084	127.8	418
0.9	×	25	0.0658	7875	159.8	518
0.9	×	30	0.0548	11274	191.7	618
0.9	×	35	0.047	15282	223.7	718
0.9	×	40	0.0411	19897	255.6	818
0.9	×	50	0.0329	30953	319.5	1018

0.8	×	5	0.37	314	28.4	116
0.8	×	6	0.3083	441	34.1	136
0.8	×	7	0.2643	590	39.8	156
0.8	×	8	0.2313	761	45.4	176
0.8	×	10	0.185	1168	56.8	216
0.8	×	12	0.1542	1661	68.2	256
0.8	×	15	0.1233	2562	85.2	316
0.8	×	18	0.1028	3658	102.2	376
0.8	×	20	0.0925	4497	113.6	416
0.8	×	25	0.074	6973	142	516
0.8	×	30	0.0617	9989	170.4	616
0.8	×	35	0.0529	13546	198.8	716
0.8	×	40	0.0463	17643	227.2	816
0.8	×	50	0.037	27459	284	1016
0.7	×	5	0.4229	270	24.9	114
0.7	×	6	0.3524	380	29.8	134
0.7	×	7	0.302	510	34.8	154
0.7	×	8	0.2643	658	39.8	174
0.7	×	10	0.2114	1012	49.7	214
0.7	×	12	0.1762	1442	59.6	254
0.7	×	15	0.141	2228	74.6	314
0.7	×	18	0.1175	3184	89.5	374
0.7	×	20	0.1057	3916	99.4	414
0.7	×	25	0.0846	6078	124.3	514
0.7	×	30	0.0705	8712	149.1	614
0.7	×	35	0.0604	11820	174	714
0.7	×	40	0.0529	15400	198.8	814
0.7	×	50	0.0423	23980	248.5	1014
0.6	×	5	0.4933	227	21.3	112
0.6	×	6	0.4111	321	25.6	132
0.6	×	7	0.3524	431	29.8	152
0.6	×	8	0.3083	558	34.1	172
0.6	×	10	0.2467	859	42.6	212
0.6	×	12	0.2056	1226	51.1	252
0.6	×	15	0.1644	1897	63.9	312
0.6	×	18	0.137	2715	76.7	372
0.6	×	20	0.1233	3341	85.2	412
0.6	×	25	0.0987	5189	106.5	512
0.6	×	30	0.0822	7443	127.8	612
0.6	×	35	0.0705	10103	149.1	712
0.6	×	40	0.0617	13168	170.4	812
0.6	×	50	0.0493	20514	213	1012
0.5	×	5	0.592	186	17.8	110

0.5	×	6	0.4933	264	21.3	130
0.5	×	7	0.4229	355	24.9	150
0.5	×	8	0.37	459	28.4	170
0.5	×	10	0.296	709	35.5	210
0.5	×	12	0.2467	1014	42.6	250
0.5	×	15	0.1973	1571	53.3	310
0.5	×	18	0.1644	2250	63.9	370
0.5	×	20	0.148	2770	71	410
0.5	×	25	0.1184	4307	88.8	510
0.5	×	30	0.0987	6182	106.5	610
0.5	×	35	0.0846	8395	124.3	710
0.5	×	40	0.074	10946	142	810
0.5	×	50	0.0592	17061	177.5	1010
0.4	×	5	0.74	146	14.2	108
0.4	×	6	0.6167	208	17	128
0.4	×	7	0.5286	280	19.9	148
0.4	×	8	0.4625	363	22.7	168
0.4	×	10	0.37	562	28.4	208
0.4	×	12	0.3083	804	34.1	248
0.4	×	15	0.2467	1249	42.6	308
0.4	×	18	0.2056	1790	51.1	368
0.4	×	20	0.185	2205	56.8	408
0.4	×	25	0.148	3432	71	508
0.4	×	30	0.1233	4930	85.2	608
0.4	×	35	0.1057	6697	99.4	708
0.4	×	40	0.0925	8735	113.6	808
0.4	×	50	0.074	13622	142	1008
0.3	×	5	0.9867	107	10.7	106
0.3	×	6	0.8222	153	12.8	126
0.3	×	7	0.7048	207	14.9	146
0.3	×	8	0.6167	269	17	166
0.3	×	10	0.4933	418	21.3	206
0.3	×	12	0.4111	598	25.6	246
0.3	×	15	0.3289	930	32	306
0.3	×	18	0.2741	1335	38.3	366
0.3	×	20	0.2467	1646	42.6	406
0.3	×	25	0.1973	2564	53.3	506
0.3	×	30	0.1644	3685	63.9	606
0.3	×	35	0.141	5009	74.6	706
0.3	×	40	0.1233	6535	85.2	806
0.3	×	50	0.0987	10196	106.5	1006
0.2	×	5	1.48	70	7.1	104
0.2	×	6	1.2333	101	8.5	124

0.2	×	7	1.0571	136	9.9	144
0.2	×	8	0.925	177	11.4	164
0.2	×	10	0.74	276	14.2	204
0.2	×	12	0.6167	396	17	244
0.2	×	15	0.4933	616	21.3	304
0.2	×	18	0.4111	885	25.6	364
0.2	×	20	0.37	1092	28.4	404
0.2	×	25	0.296	1703	35.5	504
0.2	×	30	0.2467	2449	42.6	604
0.2	×	35	0.2114	3330	49.7	704
0.2	×	40	0.185	4346	56.8	804
0.2	×	50	0.148	6784	71	1004
0.1	×	5	2.96	34	3.6	102
0.1	×	6	2.4667	49	4.3	122
0.1	×	7	2.1143	67	5	142
0.1	×	8	1.85	88	5.7	162
0.1	×	10	1.48	136	7.1	202
0.1	×	12	1.2333	196	8.5	242
0.1	×	15	0.9867	306	10.7	302
0.1	×	18	0.8222	440	12.8	362
0.1	×	20	0.74	543	14.2	402
0.1	×	25	0.592	848	17.8	502
0.1	×	30	0.4933	1220	21.3	602
0.1	×	35	0.4229	1660	24.9	702
0.1	×	40	0.37	2168	28.4	802