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Heating Element Design Basics

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Ohm' Law Formulas:

Volts = Amperes X Ohms
Amperes = Volts/Ohms
Ohms = Volts/Amperes
Watts = Volts X Amperes
Watts = (Volts X Volts) / Ohms
Watts = Amperes X Amperes X Ohms
Ohms = Watts / (Amperes X Amperes)

Please see the various tables referred to in this section at:

Nichrome Technical Data Page

Note the amperage values in the Current/Temperature Table. For estimating purposes you can assume that the amperage value for a *coiled* wire is roughly 50% less than the capacity of a *straight* wire as referred to in the table. (So divide amps in the table by 2 for your initial calculations)

Using Ohm's Law above, & tables (see the Increased Resistance Table), you can calculate the watts at your intended voltage (115 being most common).

See the Wattage/Amperage/Hot Ohms Table. Note that it is based on 115 V.

Taking into account the available space, you can select a wire size that will provide the required wattage. From the amount of total Hot Ohms of your element design, you can use Ohms/Ft Table to estimate the amount of feet you will need of a given size.

General Design Tips:

Use this information as a guide only. The finished element should be thoroughly tested to verify that the rise in resistance with temperature has been properly accounted for.

If additional technical info on designing heating elements is desired, please request more design info from our sales dept at sales@wiretron.com

Terminate elements by brazing, welding, or spot welding if possible. Pressure joints may be used but there is a possibility of poor contact due to yielding of the clamping device. In such a case, two nuts used to clamp the element are better than one alone.

Allow room in your design for expansion and contraction of the element.

Questions? Pricing? Email Us! sales@wiretron.com (No Attached Files Please)

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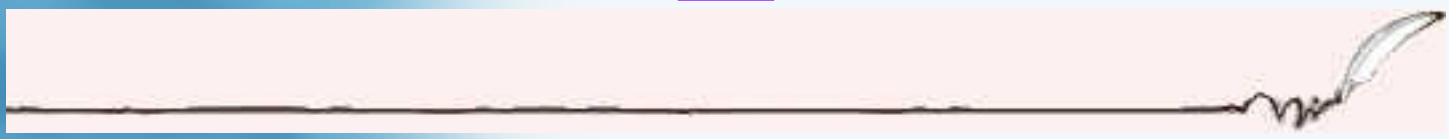

Nichrome & Other Resistance Alloys - Technical Data & Properties

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Heating Element Design Tips (Please Read)

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Current / Temperature Table - Ni Cr A & Ni Cr C

Approx Amperes to heat a Straight Oxidized wire to given temperature

	Degrees F	400	600	800	1000	1200	1400	1600	1800	2000
	Degrees C	205	315	427	538	649	760	871	982	1093
AWG	INCH DIA.	Amperes								
8	.128	22.4	32	41	52	65	79	95	111	128
9	.114	18.8	26.8	34.5	44	55	67	80	94	108
10	.102	16.2	23.3	29.7	37.5	46	56	68	80	92
11	.091	13.8	19.2	24.8	31.5	39	48	57	67	78
12	.081	11.6	16.1	20.8	26.5	33.5	40.8	48	56	65
13	.072	9.8	13.6	17.6	22.5	28.2	34.2	41	48	55
14	.064	8.4	11.6	15	18.8	23.5	29	34.6	40.5	46
15	.057	7.2	10	12.8	16.1	20	24.5	29.4	34.3	39.2
16	.051	6.4	8.7	10.9	13.7	17	20.9	25.1	29.4	33.6
17	.045	5.5	7.5	9.5	11.7	14.5	17.6	21.1	24.6	28.1
18	.040	4.8	6.5	8.2	10.1	12.2	14.8	17.7	20.7	23.7
19	.036	4.3	5.8	7.2	8.7	10.6	12.7	15.2	17.8	20.5
20	.032	3.8	5.1	6.3	7.6	9.1	11	13	15.2	17.5
21	.0285	3.3	4.3	5.3	6.5	7.8	9.4	11	12.9	14.8
22	.0253	2.9	3.7	4.5	5.6	6.8	8.2	9.6	11	12.5
23	.0226	2.58	3.3	4.0	4.9	5.9	7	8.3	9.6	11
24	.0201	2.21	2.9	3.4	4.2	5.1	6	7.1	8.2	9.4
25	.0179	1.92	2.52	3	3.6	4.3	5.2	6.1	7.1	8
26	.0159	1.67	2.14	2.6	3.2	3.8	4.5	5.3	6.1	6.9
27	.0142	1.44	1.84	2.25	2.73	3.3	3.9	4.6	5.3	6
28	.0126	1.24	1.61	1.95	2.38	2.85	3.4	3.9	4.5	5.1
29	.0113	1.08	1.41	1.73	2.10	2.51	2.95	3.4	3.9	4.4
30	.0100	.92	1.19	1.47	1.78	2.14	2.52	2.9	3.3	3.7

AWG	INCH DIA.	Amperes								
31	.0089	.77	1.03	1.28	1.54	1.84	2.17	2.52	2.85	3.2
32	.0080	.68	.90	1.13	1.36	1.62	1.89	2.18	2.46	2.76
33	.0071	.59	.79	.97	1.17	1.40	1.62	1.86	2.12	2.35
34	.0063	.50	.68	.83	1.00	1.20	1.41	1.60	1.80	1.99
35	.0056	.43	.57	.72	.87	1.03	1.21	1.38	1.54	1.71
36	.0050	.38	.52	.63	.77	.89	1.04	1.19	1.33	1.48
37	.0045	.35	.46	.57	.68	.78	.90	1.03	1.16	1.29
38	.0040	.30	.41	.50	.59	.68	.78	.88	.98	1.09
39	.0035	.27	.36	.42	.49	.58	.66	.75	.84	.92
40	.0031	.24	.31	.36	.43	.50	.57	.64	.72	.79

(Note: For *Coiled* elements divide *straight* wire amps by 2 for approximation purposes. Look for a separate table to be added in the near future.)

Resistance by AWG Size

Ohms/ft - Ni Cr A and C @ 20 degrees C

AWG	Dia.	Ni Cr A	Ni Cr C
10	.102	.06248	.06488
11	.091	.07849	.08151
12	.081	.09907	.1029
13	.072	.1254	.1302
14	.064	.1587	.1648
15	.057	.2001	.2078
16	.051	.2499	.2595
17	.045	.3210	.3333
18	.040	.4063	.4219
19	.036	.5015	.5208
20	.032	.6348	.6592
21	.0285	.8002	.8310
22	.025	1.015	1.055
23	.0226	1.273	1.322
24	.020	1.609	1.671
25	.0179	2.029	2.107
26	.0159	2.571	2.670
27	.0142	3.224	3.348
28	.0126	4.094	4.252
29	.0113	5.090	5.286
30	.010	6.500	6.750
31	.0089	8.206	8.522
32	.008	10.16	10.55
33	.0071	12.89	13.39
34	.0063	16.38	17.01
35	.0056	20.73	21.52
36	.005	26.00	27.00
37	.0045	32.10	33.33
38	.0040	40.63	42.19
39	.0035	53.06	55.10
40	.0031	67.64	70.24

Wattage Relationship to Amps & Hot Ohms @ 115 Volts AC or DC

(May be used for Ni Cr A or Ni Cr C)

Watts	40	60	80	100	150	200	300	400	500	600	700
Amps	.348	.522	.695	.870	1.31	1.74	2.61	3.48	4.35	5.22	6.09
Hot Ohms	331	221	165.5	132.3	88.3	66.2	44.2	33.1	26.5	22.1	18.88

Watts	800	900	1000	1100	1200	1300	1400	1500
Amps	6.96	7.83	8.70	9.56	10.44	11.30	12.18	13.05
Hot Ohms	16.54	14.69	13.22	12.02	11.02	10.16	9.44	8.81

Ni Cr A - Increase in Resistance with Temperature

° F	68	200	400	600	800	1000	1200	1400	1600	1800	2000
° C	20	93	204	315	427	538	649	760	871	982	1093
% Increase	0	0.8	2.0	3.3	4.8	6.3	5.8	5.1	5.2	5.6	6.0

Ni Cr C - Increase in Resistance with Temperature

° F	68	200	400	600	800	1000	1200	1400	1600	1800
° C	20	93	204	315	427	538	649	760	871	982
% Increase	0	1.7	3.5	5.2	6.9	8.6	9.2	9.8	10.2	10.5

Properties of Various Heater - Resistance - Mechanical Alloys

Material	Chemical Composition (%)	Resistivity @ 20°C		Tensile Strength (KPSI @ 20°C)		Density - Lbs/Cubic Inch	Magnetic Attraction	Approx. Melting Point (°C)
		Ohms/ CMF	TCR 0-100°C	Min.	Max.			
Alloy 875	22.5 Cr, 5.5 Al, .5 Si, .1 C, bal. Fe	875	.00002	105	175	.256	Strong	1520
Alloy 800	75 Ni, 20 Cr, 2.5 Al, 2.5 Cu	800	.00002	100	200	.293	None	1350
NiCr C	61 Ni, 15 Cr, bal. Fe	675	.00013	95	175	.2979	Faint	1350
NiCr A	80 Ni, 20 Cr	650	.00010	100	200	.3039	None	1400
Stainless Steel 304	18 Cr, 8 Ni, bal. Fe	438	.00017	100	300	.286	None (Annealed)	1399
Alloy 294	55 Cu, 45 Ni	294	.00004*	60	135	.321	None	1210
Ni Co Fe 294	29 Ni, 17 Co, Bal. Fe	294	.0033	65	150	.302	Strong	1450
Manganin	13 Mn, 4 Ni, bal. Cu	290	.000015†	40	90	.286	None	1020
Monel 400**	70 Ni, 30 Cu	290	.0001	70	150	.321	Faint	1350
Alloy 52	50 Ni, bal. Fe	260	.0029	70	150	.301	Strong	1425
Alloy 180	22 Ni, bal. Cu	180	.00018	50	100	.321	None	1100
Alloy 120	70 Ni, bal. Fe	120	.0045	70	150	.305	Strong	1425
Alloy 90	12 Ni, bal. Cu	90	.0004	35	75	.321	None	1100
Alloy 60	6 Ni, bal. Cu	60	.0005	35	70	.321	None	1100
Alloy 30	2 Ni, bal. Cu	30	.0013	30	60	.321	None	1100
Nickel 205	99.5 Ni	57	.0048	60	135	.321	Strong	1450
Nickel 270	99.98 Ni	45	.0067	48	95	.321	Strong	1452

*TCR @ 25 - 105° C **Registered Trademark of Inco family of companies †TCR @ 15 - 35°

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