RAIL

Resistance Alloys (India) Ltd.

Electric Resistance & Heating Alloys

The use of electric heating has been expanding every year as a heat source for various industries and specially in household appliances since it has numerous advantages :

1. It is pollution-free
2. Temperature regulation is easy
3. Uniform temperature distribution is possible
4. Heat can be applied precisely when required
5. It does not damage refractories
6. It can be used in any type of atmosphere

The electric resistance and heating materials required for the purposes should ideally have the following properties :

1. High melting point
2. High temperature strength
3. High oxidation resistance
4. High corrosion resistance at high temperature
5. High volume resistivity
6. Small temperature coefficient of resistance
7. High stability and durability
8. Good workability
9. Low cost

The most popular electric resistance & heating alloy for use in household electric appliances is Fe-Cr-Al heating alloy.

RAIL-LT Plus

RAIL-LT Plus is made out of Iron-Chromium-Aluminium Alloy. Alloy is manufactured with selected alloying materials for purity and is processed using precise and controlled conditions for getting consistent quality with uniform characteristics such as uniform molecular distribution and physical, mechanical, electrical characteristics. The resulting alloy has the high oxidation resistance, it can be said that RAIL-LT Plus proves its merits when used for high temperature service at places where there are no vibrations or shocks.

Physical & Mechanical Properties

			RAIL-LT Plus
Maximum Working Temperature		....	1100°C
Nominal Composition, %	Cr	....	17-21
	Al	....	4
	Fe	....	Balance
Density, g/cm^3		....	7.35

Electrical Resistivity at 20°C Ω mm²/m	....	1.23 ± 0.06
Elongation, %	....	16%
Melting Temperature	....	1500° C
Tensile Strength, N/mm²	....	650 – 750
Magnetic Property	....	Magnetic
Max. operating temperature	....	1100° C

Table for RAIL-LT Plus

Note : Resistance values are at 20°C. For values at working temperature, multiply by the factor Ct from the following table :

°C	20	100	200	300	400	500	600	700	800	900	1000	1100
Ct	1.000	1.005	1.014	1.025	1.038	1.054	1.074	1.086	1.095	1.102	1.107	1.110

SWG	mm	Resistance Ω / m	Length m / kg	Weight g / m	Surface Area cm² / m	cm² / Ω
6	4.88	0.0660	7.274	137.48	153.37	2323.79
7	4.47	0.0784	8.669	115.35	140.49	1791.96
8	4.06	0.0950	10.509	95.16	127.60	1343.16
9	3.66	0.1169	12.931	77.33	115.03	984.00
10	3.25	0.1483	16.400	60.98	102.14	688.74
11	2.95	0.180	19.905	50.24	92.71	515.06
12	2.64	0.225	24.854	40.24	82.97	368.76
13	2.34	0.286	31.635	31.61	73.54	257.13
14	2.03	0.380	42.035	23.79	63.80	167.89
15	1.83	0.468	51.724	19.33	57.51	122.88
16	1.63	0.589	65.20	15.34	51.23	86.98
17	1.42	0.777	85.91	11.64	44.63	57.44
18	1.22	1.052	116.38	8.59	38.34	36.44
19	1.02	1.515	166.49	6.01	32.06	21.30
20	0.914	1.875	207.35	4.82	28.73	15.32
21	0.813	2.37	262.07	3.82	25.55	10.78
22	0.711	3.10	342.66	2.92	22.35	7.21
23	0.610	4.21	465.52	2.15	19.17	4.55
24	0.559	5.01	554.34	1.80	17.57	3.51
25	0.508	6.07	671.23	1.49	15.97	2.63
26	0.457	7.50	829.40	1.21	14.36	1.915
27	0.417	9.01	996.15	1.00	13.11	1.455
28	0.376	11.08	1225.24	0.82	11.82	1.067
29	0.345	13.16	1455.32	0.69	10.84	0.824
30	0.315	15.78	1745.73	0.57	9.90	0.627

Note : Intermediate and special mm sizes available on request.

A short note on design of elements using RAIL-LT Plus Wire

Surface Load

Selection of wire size is on the basis of surface load acceptable for different applications. The following datas can be taken for general guidance, however the actual value to be chosen will depend on the circumstances :

Appliances		Watts / sq. cm.
Electric Stove/Hot Plates	....	6-7
Water Heaters	....	3-30
Immersion Heaters	....	32-60
Toasters	....	4-7
Electric Irons :		
Mica element	....	5-6
Insulating beads	....	4.5–5.5
Embedded element	....	11-13
Tubular element	....	32-60
Soldering Irons :		
Mica Element	....	3.5-5

Design of Wire Element

The value " cm^2 / Ω " given in the wire table can be used to determine wire size, using the formula :

$$cm^2 / \Omega = \frac{I^2 Ct}{p}$$

Where I = Current in Amps
Ct = Temperature factor
p = Surface load in W/cm^2

Having decided the wire diameter, it is multiplied by the following factor to get the spiral diameter for spiral forming heating coils :

Application	Factor
Industrial Ovens & furnaces upto 1000°C	6 to 8
Industrial & domestic heating appliances	4 to 10

Example

For Electric Stove / Hot Plate, 1000 W, 230 V, Temperature 700°C

$$I = \frac{1000}{230} = 4.35 \text{ A}$$

Ct for 700°C = 1.086

Surface Load 'p' chosen = 6.5 W/cm^2

$$cm^2 / \Omega = \frac{4.35^2 \times 1.086}{6.5} \quad 3.16$$

The nearest wire size is SWG 24 with $cm^2 / \Omega = 3.51$, hence this is chosen.
The actual surface load will be then 5.85 W / cm^2.

$$\text{Hot Resistance Rt} = \frac{V}{I} = \frac{230}{4.35} = 52.87 \text{ ohms}$$

Cold Resistance Rc $= \frac{Rt}{Ct} = \frac{52.87}{1.086} =$ 48.68 ohms

Resistance / m of SWG 24 wire = 5.01

Weight / m of SWG 24 wire = 1.80 gms.

Length of SWG 24 wire required $= \frac{Rc}{5.01} = \frac{48.68}{5.01} =$ 9.72

Weight of SWG 24 wire required = 9.72 x 1.80 = 17.5 gms.

Precaution during manufacture

- Strict cleanliness should be maintained. Soap, oil residues, etc. must be removed before manufacturing.
- Winding stress should be uniform and vibration of mandrel should not be there.
- Coil stretching should be uniform.

Packing :

SWG	....	Packing
6-14	....	Coils of max. 50 kgs.
15-19	....	Coils of max. 30 kgs.
20-30	....	Plastic Spool of max. 4 kgs. net wt.

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