ZHENGZHOU CHIDA FURNACE MATERIAL CO.,LTD
B1506,NO.7 DONGQING STREET,
ZHENGZHOU HI-TECH INDUSTRIAL DEVELOPMENT AREA HENAN,CHINA 450001
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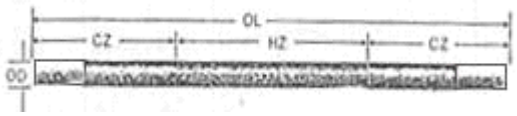
SiC Heating Elements

General description

The silicon carbide heating element is a kind of non-metal high temperature electric heating element.It is made of selected super quality green silicon carbide as main material,which is made into blank,silicided under high temperature and re-crystallized.Compared with metal electric heating element,this kinkd of element is characterized by high-applied temperature,anti-oxidezation,anti-corrosion,long service life,little deformation,easy installation and maintenance.Therefore,it is widely used in various high temperature electric furnaces and other electric heating devices, such as in the industries of magnet,ceramics,powder metallurgy,glass and machinery,etc.

We adopt new production process of cold ends,so our SiC heating elements have excellent specific rate of heat zone resistance and cold end resistance, saving energy, long life, avoiding over-temperature of cold ends to damage the furnace body.

Specs and type of heating elements



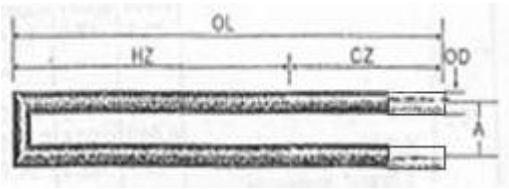
Type:ED

Outer diameter:OD,mm　　Hot zone length:HZ,mm

Cold end length:CZ,mm　　Overall length:OL,mm

Resistance:Ω　　Specify as:

Silca ED,OD/HZ/OL/Ω



Type:U

Outer diameter:OD,mm

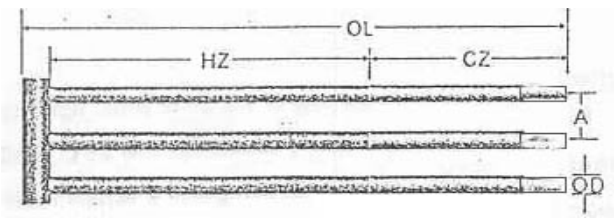
Hot zone length:HZ,mm　　Cold end length:CZ,mm

Overall length:OL,mm　　Shank spacing:A,mm

Resistance:Ω

Specify as:

Silca U,OD/HZ/OL/A/Ω



Type:W

Outer diameter:OD,mm

Hot zone length:HZ,mm　　Cold end length:CZ,mm

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Overall length:OL,mm Shank spacing:A,mm
Resistance:Ω
Specify as: Silca W,OD/HZ/OL/A/Ω

Physical property of elements

Specific gravity	2.6-2.8g/cm^3	Bend strength	>300kg
Hardness	>9MOH'S	Tensile strength	>150kg/cm^3
Porosity rate	<30%	Radiancy	0.85

The linear expansion coefficient ,heat conductivity and specific heat of element will change along with temperature change. And the relational data are the follows:

Temperature (℃)	Linear expansion coefficient (10^{-6}m/℃)	Heat conductivity (Kcal/Mhr℃)	Specific heat (cal/g℃)
0	/	/	0.148
300	3.8	/	/
400	/	/	0.255
600	4.3	14-18	/
800	/	/	0.294
900	4.5	/	/
1100	/	12-16	/
1200	4.8	/	0.325
1300	/	10-14	/
1500	5.2	/	/

Chemistry property of elements

1.Antioxidant property of elements

the element start to being oxidized when heat to 800℃ in air,and a SiO2 protect film will be generated in surface of hot zone when temperature get to 1000-1300℃,cristobalite will be crystallized at 1300℃,the protect film get to a certain thickness when the temperature get to 1500℃ which make the oxidation speed being very slowly to stable.If continue to heat to over 1627℃,the protect film will be damaged and oxidation speed will be more rapid evidently and make the element damaged earlier.

Thought the element will be oxidized very slowly in course of application, it also will make the resistance increased following long time application, this phenomenon calls ageing.in oreder to lower the ageing speed ,we use special technology to spread a protect film on the surface of hot zone in the course of production, which enhance the Antioxidant property of element evidently and lengthen the service life.

2.The effects of alkali and alkaline metal oxide to elements

The alkali & alkaline metal oxide will react with SiC at about 1300℃ and generate silicate,which calls alkali-chemical corrosion ,and can influence the glowing of element.

3.The effects to elements from melting metal

some metal, such as cobalt,nickel,chrome and so on,can corrade the elements in high temperature melting state and affect the service life of element.

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Electric property of elements

SiC heating elements has rather large specific resistance.When it is heated in air and the surface temperature of the hot zone reaches 1050℃,its resistance rate is 600-1400 Ω mm^2/m.Its resistance value changes as the temperature rises.From room-temperature to 800℃ is negative value,over 800℃ is positive value nature curve.

Control of applied temperature and surface load of Silca heating elements under different atmosphere.

Atmosphere	Furnace temp(℃)	Surface Load(w/cm^2)	Acting to the element	Solve way
Ammonia	1290	3.8	Acting on SiC to form thus decrease SiO_2 protective film	Active at dew point
CO_2	1450	3.1	Attack SiC	Protected by quartz tube
18% CO	1500	4.0	No action	
20% CO	1370	3.8	Absorbing C grains to act on SiO_2 protective film	
Halogen	704	3.8	Attacking SiC and decreasing SiO_2 protective film	Protected by quartz tube
Hydrocarbon	1310	3.1	Adsorbing C grains causes hot pollution	Fill with enough air
Hydrogen	1290	3.1	Acting on SiC to form thus decrease SiO_2 protective film	Active at dew point
Methane	1370	3.1	Absorbing C grains causes hot pollution	
N	1370	3.1	Acting with SiC forms SiN insulating layer	
Na	1310	3.8	Attack SiC	Protected by quartz tube
SO_2	1310	3.8	Attack SiC	
Vacuum	1204	3.8		
Oxygen	1310	3.8	SiC is oxided	
Water(different contents)	1090-1370	3.1-3.6	Acting on SiC forms hydtate of Si	

The key factor to the optimum service life of the element is to select the surface load of the element correctly according to the furnace construction,atmosphere and temperature.below figure shows the relation between furnace temperature,element temperature and elements surface load under the condition that the element radiation isn't obstructed.

Recommend surface load:

Furnace temp.	1100	1200	1300	1350	1400	1450

Surface load of hot zone(w/cm^2)	<17	<13	<9	<7	<5	<4

Installation & operaton of elements

1.In order to keep furnace tempetature and the load-bearing uniform of each element,before installation ,resistance distribution must be carried out. The resistance value deviation of each group should be below 10%

2.As the element is very brittle,be careful while install and maintain to avoid any damage.

3.When start to operate the furnace ,raise voltage slowly and gradually ,never give full load at one time, or the heating element will be damaged by over current impulse.

4. To use the elements ,you should prepare the adjustable transformer or silicon controlled transformer,voltage meter,current meter and auto-control temperature meter etc.During the working,the voltage should be increased to maintain the furnace normal temperature because the resistance value will go up gradually caused by the oxidation of element.when the voltage get to the up limit of the transformer and the temperature is still low than the requirement ,the furnace should be stopped ,change the way of wire connection and then continue work.

5.In the course of long operation of the furnace ,if any individual heating element is damaged owing to certain reasons and should be changed ,you should replace it with proper one whose resistance value corresponds to that of the old one ,never use a new heating element random.If the heating element is much damaged or its resistance value increases too much and cannot reach the furnace tempertura,it is better to replace all the heating elements with new ones. Test and mark the resistance value of the old elements having been replaced(with voltmeter and ammeter) and distribute them in low temperature area.

6.Before the now furnace or the furnace that has not been used for a long time is used ,they must be dryinged. When drying them,it is better to use old element or other source.

7.When firing apparatus or material ,if there is water ejection,the furnace should have holes to eject water vapor or other waste gases in order to protect the elements service life.

Reference data for the design of batch-type SiC heating elements electric furnace

1,Heating power(kw)=weight of the object to be heated(kg)*specific heat of the object to be heated*temperature-raising speed max furnace temp.(℃)/[total heating time(hour)*860](860kcal=1kw)

Suppose:unit heat-loss is 740 kcal/m^{2}hour

2,heat-loss(kw)=surface area of furnace chamber(M^2)*740/860

Suppose:furnace wall thickness 10cm and furnace temp.100℃ is a unit constant,then the heat accumulation quantity on the furnace chamber is 635 kcal per M^2

3,Heat accumulation power(kw)={[(furnace wall thickness cm/10cm)*(max. furnace temp. ℃+100℃)]*635}*furnace chamber area M^2/(total heating time(hr)*860)

4,The total power needed(kw) is the sum of the above three terms.Owning to the fact that our SiC heating elements work long-term under high temp. ,it gradually ages and

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its resestance value increases,power decreases.In order to adjust it to the power needed in time,the power of transformer should be larger than 30-50% of the total power needed.

5,Select heating elements dimensions according to furnace sizes.

6,After determining the max furnace temp.,calculate the power(kw) of a single element using the way of multiplying the stipulated surface load of the elements under said furnace temp.(find it out from the above table)by the surface area of hot zone of the elements(fing it out from the product dimension)

7,Total power(kw)needed/single element power=the quantity of elements that should be installed

8,Design the circuit diagram and determine the resistance of the single element.

9,The distance between the element and the furnace wall and the object to be heated.

Element Dia(mm)	8	12	14	16	20	25	30
Minimum distance(mm)	25	38	44	57	68	79	94

10,The diameter of the hole for heating element-inserting on the furnace wall should be 1.5 times of that of the element dia to be installed.The space there is filled with asbestos cord or aluminum silicate fiber felt.

10,The central distance between two heating element-inserting holes should be 3-5 times of the elements diameter.

12,In order to keep the elements and the lead wire well contacting ,better wrap the Al-sprayed heating element end with 2 to 3 layers of pure Al leaf.Then mount the lead wire clamp.

13,In order to save energy resources,for the thermal insulation material applied to building furnace ,better select well insulated high quality light aluminum bricks and proper quantity of aluminium silicate fibre felt or bricks.

Reference data for the design of continuum type SiC heating elements electric furnace(practice)

1,Material loaded on furnace car:transformer power 230kw/M^3,Max work power 193 kw/M^3,Material loaded on pushing plate:transformer power 194 kw/M^3,Max work power 160 kw/M^3.

2,In each,M^3 of furnace chamber,the total area for element hot zone that can be installed is 19620.7cm^2.

3,The quantity of elements that should be installed in the electric furnace used=19620.7cm^2/total surface area of the element hot zone selected(cm^2)

4,For other data,please refer to that batch-type furnace.

Several power calculation ways for wire conection in common use

Connection way	Symbol	Element Qty(no.)	Phase Voltage(V)	Phase resistance(Ω)	Phase current(A)	Total power(kw)
Single phase series connection	+	n	Ux=U	Rx=nr	Ix=U/(nr)	Nx=U^2/(10^3nr)

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Parallel phase connection	=	n	Ux=U	Rx=r/n	Ix=Un/r	$Nx=nU^2/(10^3r)$
Angle connection	△	n	Ux=U	Rx=r	Ix=U/R	$Nx=3U^2/(10^3r)$
Star connection	╳	n	$Ux=U/3^{1/2}$	Rx=r	Ix=Ux/Rx	$Nx=U^2/(10^3r)$

Dimension of SiC heating element

Dia(mm)	Length (mm)			Hotzone surface area(cm^2)	nominal loading(at 1050℃)		
	Hot end	Cold end	total		V	W	Ω
12	150	150	450	56	41	896	1.85
	200	200	600	75	50	1200	2.10
	250	200	650	94	63	1504	2.62
	300	200	700	113	75	1808	3.15
14	200	200	600	88	41	1408	1.22
	250	250	750	110	51	1760	1.50
	300	250	800	132	62	2112	1.80
	350	200	750	154	73	2464	2.14
	400	250	900	176	82	2816	2.40
16	300	250	800	150	62	2400	1.60
	350	350	1050	176	70	2816	1.75
	400	350	1100	200	80	3200	2.00
	450	250	950	225	90	3600	2.25
	500	250	1000	250	100	4000	2.50
	600	250	1100	300	120	4800	3.00
20	300	400	1100	188	59	3008	1.14
	400	350	1100	251	76	4016	1.45
	500	400	1300	314	97	5056	1.85
	600	400	1400	376	114	6016	2.15
	700	400	1500	439	138	7024	2.7

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	800	300	1400	502	148	7530	2.9
	900	300	1500	565	162	8475	3.1
25	300	300	900	236	53	3776	0.75
	400	450	1300	314	71	5024	4
	500	400	1300	392	90	6272	1.3
	600	400	1400	470	108	7520	1.55
	700	400	1500	550	120	8250	1.75
	800	400	1600	627	134	9405	1.9
	900	300	1500	705	151	10575	2.16
	1000	300	1600	785	168	11775	2.4
30	400	300	1000	380	63	5700	0.7
	500	300	1100	470	80	7050	0.9
	600	400	1400	570	92	8550	1
	700	450	1600	660	109	9900	1.2
	800	500	1800	750	125	11250	1.4
	900	400	1700	850	140	12750	1.53
30	1000	300	1600	940	153	14100	1.65
	1100	300	1700	1035	168	15525	1.82
35	400	400	1200	440	67	6600	0.68
	500	400	1300	550	84	8250	0.85
	600	400	1400	660	100	9900	1.02
	700	400	1500	770	117	11550	1.19
	800	400	1600	880	134	13200	1.36
	900	400	1700	990	151	14850	1.53
	1000	400	1800	1100	167	16500	1.69
	1100	400	1900	1210	184	18150	1.87
	1200	400	3000	1320	201	19800	2.04
	1300	400	2100	1430	218	21450	2.21
	1400	400	2200	1540	234	23100	2.38
	1500	400	2300	1650	251	24750	2.55
	1600	300	2200	1760	263	25520	2.72
	1700	300	2300	1870	280	27115	2.89
40	500	400	1300	628	75	9420	0.6
	600	400	1400	753	90	11295	0.72
	700	400	1500	880	105	13200	0.84
	800	400	1600	1005	118	14573	0.96
	900	400	1700	1130	133	16385	1.08
	1000	400	1800	1255	148	18198	1.2
	1100	400	1900	1381	163	20025	1.32
	1200	400	2000	1506	177	21837	1.44

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	1300	400	2100	1630	192	23635	1.56
	1400	400	2200	1760	207	25520	1.68
	1500	400	2300	1880	222	27260	1.8
	1600	300	2200	2010	236	29145	1.91
	1700	300	2300	2140	250	31030	2.02
	508	280	1067	708	61	10625	0.36
	559	394	1346	780	68	11690	0.4
	610	305	1219	851	74	12760	0.43
	660	293	1245	921	81	13805	0.47
	711	394	1499	992	87	14970	0.51
	762	394	1549	1063	93	15935	0.55
	813	394	1600	1134	99	17000	0.59
	864	394	1651	1205	104	18070	0.61
	914	394	1702	1275	112	19115	0.65
	965	394	1753	1346	118	20180	0.7
	991	419	1829	1382	120	20725	0.69
45	1016	394	1803	1417	122	21250	0.7
	1118	419	1956	1560	136	23380	0.8
	1219	432	2083	1700	148	25490	0.87
	1270	394	2057	1772	155	26560	0.92
	1295	381	2057	1806	155	27082	0.89
	1321	394	2108	1843	161	27625	0.95
	1372	394	2159	1914	168	28690	1
45	1422	394	2210	1984	173	29740	1.03
	1473	394	2261	2055	180	30805	1.07
	1524	394	2311	2126	186	31870	1.1
	1575	419	2413	2197	192	32940	1.15
	1626	394	2413	2268	197	34005	1.17
	1676	420	2515	2338	205	35050	1.24
	1829	280	2388	2551	218	38250	1.24
	2437	420	3277	3401	291	50985	1.66