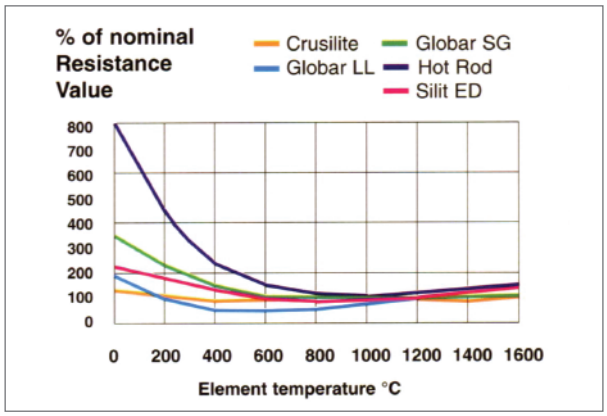
SILICON CARBIDE ELEMENTS

Silicon Carbide is a semiconductor material, and has a much higher resistivity than metallic resistance materials. Room temperature resistivity is fairly high, and falls with increasing temperature to a minimum value at about 600-900°C. At elements temperature above 900° C. Resistivity increase with rising temperature, as shown in figure.

ELEMENTS PERFORMANCE

All silicon carbide elements gradually increase in resistance during their life in operation and the rate at which this occurs is affected by the following factors:

a) Element Specific Loading
b) Operating Temperature
c) Process Atmosphere
d) Mode of Operation (continuous or intermittent)
e) Power Supply Type used
f) Element Type



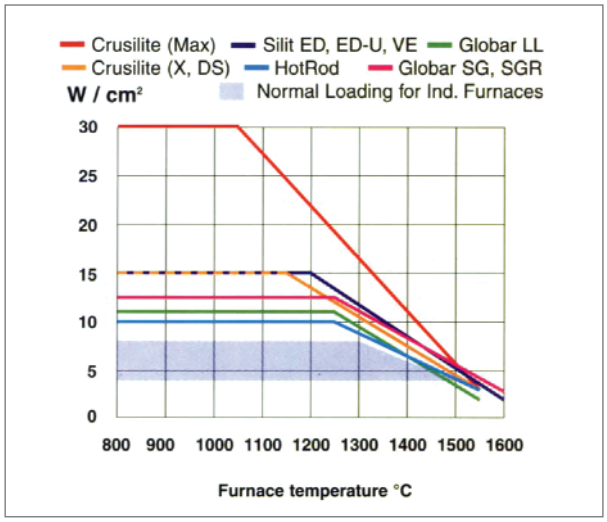
Maximum Permitted Element Loading

To optimize element life, the right type of element should be selected and the lowest specific loading consistent with the fournace design should be used. To compensate for the gradual increase in element resistance (ageing), a variable voltage power supply is usually provided, to enable the design power to be maintained throughout the life of the element.

ELEMENTS LOADING

The element temperature and hence the ageing rate, is directly proportional to the specific loading which is expressed in W/cm2 of the hot zone surface area.

For optimum life therefore, the lowest power loading consistent with the furnace design should be used (see figure 2)



WORKING TEMPERATURE

Higher is the working temperature and shorter is the element life. For high temperatures must be provided a voltage reserve of 100%. This is true when elements are used at high temperatures (1400°C or more) and element's life becomes short.
When furnace works at lower temperatures can be sufficient a 50% voltage reserve.

GENERAL RULE FOR VOLTAGE RESERVE

$$V_{old} = V_{new}\sqrt{\frac{R_{old}}{R_{new}}}$$

To have more details ask to CD AUTOMATION the application note on "Silicon Carbide Elements".

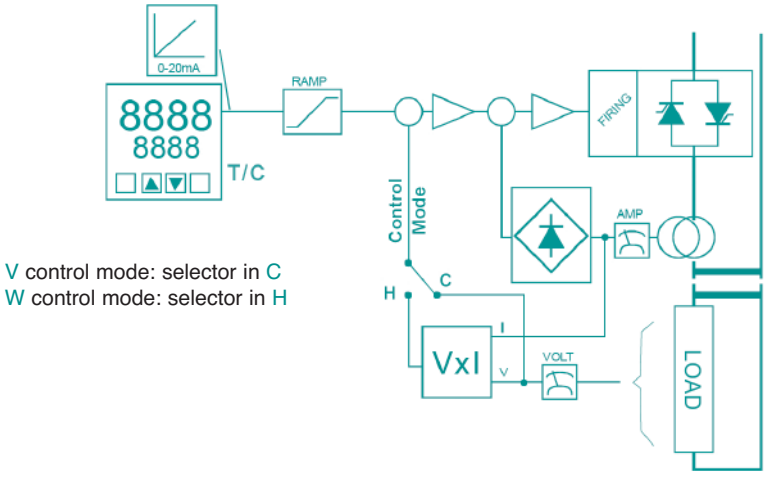
THYRISTOR FIRING METHOD FOR SILICON CARBIDE ELEMENTS

Elements must not be exposed to thermal shock thus the best solution is to use phase angle firing.
This solution generate with Phase Angle Firing harmonics and decrease power factor from 1up to 0,5 depending on firing Angle.

To avoid these problems is possible to use Burst Firing. The CD Automation unit REVO CL, CD3000E and MULTIDRIVE can work in both firing. These units are microprocessor based and can be used with mains supply directly coupled with the Silicon Carbide elements or via a transformer. When a transformer is used to avoid fuse failure must be used Delayed Triggering + Burst Firing.

SYSTEM

Instrument delivers a signal 4÷20mA that is the power demand of process. This power demand is compared with feedback signal and a signal called error is obtained.
Error = Power Demand – Real Power
Error signal fires thyristor unit with the right angle to obtain a costant power demand that doesn't need operator attention to tune power.
Considering cost of silicon carbide elements is important to use this automatic regulation.



V control mode: selector in C
W control mode: selector in H

OUTPUT FEATURES (POWER DEVICE)

For this solution we suggest to use the following CD Automation products:

- REVO CL with V transfer to VxI Control Mode
- CD3000E for 3 phase loads with V transfer to VxI Control Mode
- MULTIDRIVE for 3 phase loads with V transfer to VxI Control Mode

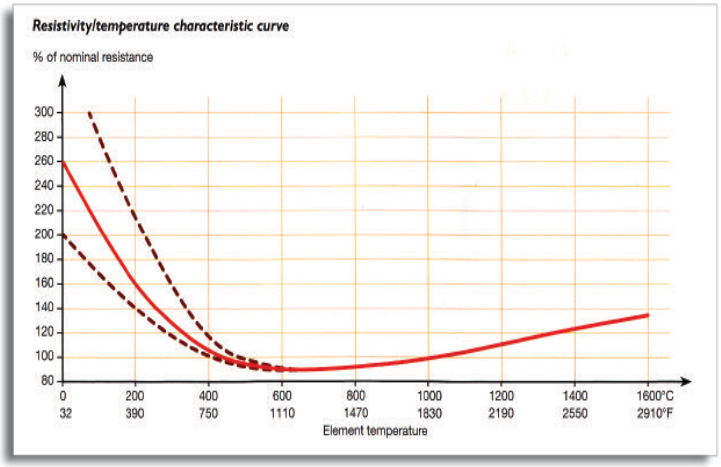
Attention must be payed to the fact that with new and cold elements the resistance can be 3 or 4 times the nominal value and the constant power feedback to reach the power increases the voltage supply at maximum.
This is not good for the elements life and to cure it. CD Automation uses this technique.

The system starts with nominal voltage control mode and when elements are hot thyristor unit switches in VxI power feeedback.
This can be done via a digital input given by: External timer, Low alarm from Temperature contoller T/C, Automatic optional Software embedded able to diagnostic when the resistance is betwenn 600 to 900C°. Despite to element age.

Si-C Touch Panel

CD Automation has developed many applications dedicated to drive particular loads and one of these application is for Silicon Carbide.
The Philosopy is to use standard Thyristor units with serial communication and to implement the control strategy inside the intelligent panel.

This Touch Panel in addition to a CD Automation universal unit able to work with all firing and control mode removing all application risks due to the control type selection.



THIS SOLUTION GIVES MANY ADVANTAGES

- The **Thyristor Units** are standard and easy to be found every where
- An external port is available to connect your normally used PLC
- One Ethernet port is available on 8 " touch panels
- The Human interface is friendly and just feeling few data of thermic project is possible to achive:

Two different modes to drive **SI-C**
Burst Firing with automatic adjustment of Power Limit
Or
Phase Angle with transfer from voltage to Power Control Mode.

FEATURES

- Automatic configuration and tuning of the thyristor unit
- Automatic tuning of Power Control mode VxI
- Message on when to change the elements because are at the end of their life
- Automatic switch from Voltage to VxI control mode when the element temperature is the correct one
- Automatic tuning procedure of Heather break alarm to diagnostic partial or total load failure
- Diagnostic of fuse failure and Thyristor in short circuit
- Recent and Historical Curve of following process variable
  - Power density W/Cm2
  - Load Voltage
  - Load Current
  - Power to the load
  - Resistance value curve with element new
  - Time elapsed from start to actual resistance value

All in line with SANDVIK specifications for a long element life.

These touch panel is available with different features:

- Model 5" in black and white
- Model 5",8",10"and 12" in colour

Below Thyristor units can be connected:
REVO-CL to drive 1 phase unit **SI-C** elements or 3 Phase open delta or star with neutral
MULTIDRIVE or **3000E-3PH** to drive 3 phase loads in delta or star connection.