High Temperature Thermal Processing Systems
ISO 9001:2008 Certified

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Choosing a Heating Method

Kilns and Furnaces are heated using one of two heating methods, fuel fired and electrically heated. Choosing the correct heating technology for your application is a critical step in deciding upon your overall thermal technology solution. A variety of factors should be considered and weighted according to your needs and budget.

As an example, in small scale applications, electric heating will generally involve a significantly lower initial investment than fuel fired heating. At the opposite extreme, very large scale applications will invariably require a lower initial investment when fuel fired.

In addition to initial investment costs, any production plans will require consideration of the ongoing costs of operation due to energy and maintenance costs.

The table below gives an overview of the most common heating technologies, with their theoretical limits and applications.

	Type	Low Temp. Use Limit[1]	High Temp. Use Limit[2]	Furnace Atmosphere	Most Common Applications
Electric Heating					
Metallic	NiCr Alloy	Ambient	2010°F/1100°C	Oxidizing or Short term inert[3]	Low temperature ovens, air heating, submersion heaters, low temperature kilns and furnaces, art pottery, consumer heating appliances
	FeCrAl Alloy	Ambient	2370°F/1300°C	Oxidizing or Short term inert[3]	Medium to High temperature ovens, kilns, and furnaces, art pottery, technical ceramics, advanced materials
	Molybdenum	Ambient	3100°F/1700°C	Inert or Vacuum	Vacuum heat treating systems, advanced materials
	Platinum /Rhodium	Ambient	2750°F/1500°C	Oxidizing, Inert	Small scale laboratory tube furnaces
Inter-Metallic	Molybdenum Disilicide (Moly-D, Kanthal Super)	Ambient	3300°F/1800°C	Oxidizing or Short Term Inert[4]	High temperature kilns and furnaces, Glass melting furnaces
Ceramic	Silicon Carbide	Ambient	2800°F/1538°C	Oxidizing or Short term inert[4]	High temperature kilns and furnaces, glass melting , electronic components
	Zirconia	1120°F/600°C	3600°F/2000°C	Oxidizing[3]	Ultra high temperature applications , generally laboratory scale
Non-Metallic	Carbon / Graphite	Ambient	3630°F/2000°C	Inert or Vacuum	Vacuum heat treating, advanced and carbon materials

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	Type	Low Temp. Use Limit[1]	High Temp. Use Limit[2]	Furnace Atmosphere	Most Common Applications
Fuel Firing					
Gaseous Fuels	Natural Gas	Ambient	3250°F/1800°C	Air or O2	Traditional and structural ceramics, metals heat treating, air heating, porcelain enamel, submersion heaters
	Propane	Ambient	3250°F/1800°C	Air or O2	Traditional and structural ceramics, metals heat treating, air heating, porcelain enamel, submersion heaters
	Butane	Ambient	3250°F/1800°C	Air or O2	Traditional and structural ceramics, metals heat treating, air heating, porcelain enamel, submersion heaters
Liquid Fuels	Light Oil	Ambient	3200°F/1750°C	Air	Structural ceramics, metals, industrial porcelain enamel, indirect air heating
	Heavy Oil	Ambient	3200°F/1750°C	Air	Structural ceramics, refractories[5]
Solid Fuels	Powdered Coal	1400°F/760°C	3200°F/1750°C	Air	Structural ceramics, refractories[5]
	Sawdust	1400°F/760°C	3250°F/1800°C	Air	Structural ceramics, refractories[5]

Notes:

[1] The low temperature use limit for Zirconia is based upon the fact that the material does not become electrically conductive until it is preheated to a relatively high initial temperature. For coal dust and sawdust fuels the process chamber itself must be at a temperature high enough to cause spontaneous ignition of the injected dust or powder to allow safe use.

[2] High-Temp Use Limit for electric heating elements is not element temperature, it is the chamber temperature above which the required element temperature or allowable watt-loading of the element makes application difficult or inefficient. In the case of fuel firing, temperatures given are near the theoretical flame temperatures, and are not achievable by normal means in a production environment. In general, any sort of fuel firing above a temperature of 3100°F is difficult, and may require preheating or oxygen enrichment, or both, of the burner air supply.

[3] Base metal heating alloys depend upon an oxide layer formation to protect the body of the element from further oxidation, corrosion, or vaporization. Inert atmospheres provide no oxygen with which to form an oxide layer. It can be countered by periodic firing to high temperature in an air atmosphere. Use in a reducing atmosphere will also cause deterioration, a phenomenon is known as “green rot”, which is non-reversible.

[4] Silicon Carbide and Molybdenum Disilicide heating elements both depend upon the formation of a glass layer, either on the surface, or between individual material grains. Extended use in inert atmospheres does not allow this glass layer to properly form or heal in the event of spalling. It can be countered by periodic firing to high temperature in an air atmosphere.

[5] Due to the variable nature and content of these fuels, and the difficulty in providing truly uniform conditions within a kiln when fired with them, their use is commonly limited to products where some variability in surface color can be tolerated. In the case of refractories, the base materials for the product are sometimes formulated with sawdust in the mixture to act as a pore former. This sawdust then becomes part of the overall fuel equation for the firing cycle.