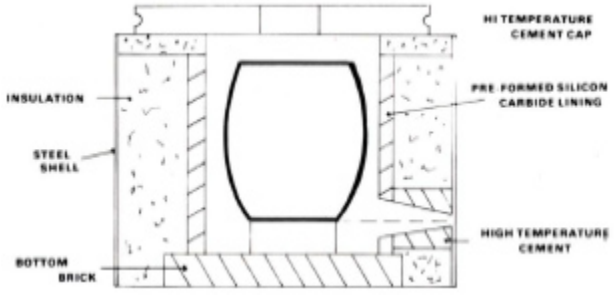
H. KRAMER & CO.

PROPER FURNACE MAINTENANCE

Crucible furnaces are either of the stationary or tilting type, and must be carefully engineered if economical operation and good melt quality are desired. The cross sectional sketch shown below illustrates:—

TYPICAL CRUCIBLE FURNACE



Crucible Furnace Refractories

It is very important to use the right type refactory, install them properly, and then to maintain the furnace properly throughout its life

Take these three main areas separately as follows:—

1. FURNACE LININGS

Furnace linings are made of silicon carbide. Silicon carbide resiste heat, shock, abrasion and erosion and has high heat transfer and generally is agreed to be the best material available for crucible linings. Because of its high thermal conductivity it must be backed up with good insulating material between it and the steel shell which will allow for the natural expansion of the silicon carbide. The materials used for this purpose are insulating brick, cement or castables. These linings may be rammed in, using a plastic ramming mix or may be installed, using prefired shapes made for the furnace involved. These are usually in cylindrical rings which fit on top of each other. The inside diameter of the lining should be enough larger than the bilge of the crucible to provide proper combustion space for efficient melting, and if a lift out furnace, to allow for the application of tongs when used.

Normally this dimensional allowance is five (5) inches on the diameter (or 2½ inches on each side) to allow for the proper combustion space as well as application of the tongs.

Maintenance

Linings should be washed regularly with a silicon carbide cement to maintain a smooth inside surface. Cavities or projections in the lining surface will divert the flame from it's normal course and result in uneven heating. Unless the flame has an unrestricted path all around the crucible incomplete combustion may occur with a resultant drop in efficienty and hence require more heat then necessary. Holes or irregularities in the lining wall should be cleaned out and patched regularly with silicon carbide patching cements.

Since all types of silicon carbide furnace linings have a tendency toward vertical growth the top of a new lining should be approximately 1" to 1½" lower than the top of the furnace shell. The lining should be capped with a layer of good refractory cement of equal thickness so that the furnace cover rests evenly and a good seal is provided. If any growth is noticed on the lining it can be compensated for by merely reducing the amount of cement in the cap.

2. BASE BLOCKS AND FURNACE BOTTOMS

A highly refractory base block should be used in all crucible furnaces to give level even support to the crucible during melting. Old crucible bottoms or firebricks should never be used as base blocks. The base block should be approximately the same diameter as the bottom of the crucible. The height of the base block should be such that the bottom of the crucible is on the same line as the center line of the burner. The other important measurement for proper combustion is that the crucible top should be 2 inches below the furnace cover. The crucible should be well centered to insure uniform combustion space around

it. Sometimes in gas crucible furnaces if the crucible sits too low the melt will spin in the crucible causing erosion at the metal line. Normally a piece of wet cardboard is placed on the base block before placing the crucible on it. This will keep the crucible from sticking.

Maintenance

The furnace lining bottom and the base block must be carefully maintained as they are the foundation of good crucible life and efficient melting. If slag is allowed to build up in the bottom of the furnace it reduces the combustion area, shortening its life.

Because of this it's important that a routine procedure of removing slag is set up at the time when periodic furnace lining check-up and patching is done, or in a tilting furnace when the crucible is replaced.

3. FURNACE COVERS

Furnace covers are usually made of silicon carbide. Before installing a new cover place a layer of silicon carbide cement on top of the lining and sprinkle a thin layer of coarse sand on top. The cover is then lowered into place, making an impression in the cement, thus effecting a smooth seal which prevents gases from escaping between the cover and the furnace top. Normally furnace covers have minimum openings of 6" to 8" through which the metal is charged and furnace gases escape.

Maintenance

Never tighten up the supporting band or ring on a new cover until it is heated. When the cover is hot and has expanded, tighten up the supporting ring or band. This allows the cover to expand and cracking is minimized and cover life increased. It is important to avoid abuse of the cover during use of the furnace. Most cover failures are due to physical abuse and to improper support of the cover or being overloaded with ingots placed on the cover for pre-heating.

4. BURNER AND SLAG BLOCKS

The burner port should be made in such manner that the flame will enter the furnace tangentially and spiral upward in the combustion chamber. A square housing is usually welded onto the side of a furnace to contain the burner and burner block. The burner block is either bought already preformed or rammed from cement. The flame should never impinge directly on the crucible.

The slag opening should be the proper size for the individual furnace involved. The slag hole should always be kept free from all obstructions allowing any slag or spilled metal to run out on the floor rather than fill up the bottom of the furnace. Oversize slag holes are wasteful since they reduce efficiency of secondary air admission to the furnace requiring extra melting time.

The burner block requires proper maintenance in order that the burner port be kept smooth and clean. If this tunnel is not clean and smooth a baffling effect results which will definitely increase the melting time and fuel costs. Also, if a good seal is not maintained between the burner block and the burner the oil or gas mixture will leak back and burn the shell and hot spots will result.

A very important maintenance area involving oil fired crucible furnaces is the burner tip which must be cleaned regularly. A pulsating flame changing color from green to yellow is the usual indication that this variable is out of control. This condition can lead to gassed metal and rejected castings.

CARE AND HANDLING OF CRUCIBLES AND CRUCIBLE FURNACES

Since crucibles have a tendency to pick up moisture present in the atmosphere they should be stored in a warm dry place. Never store crucibles on a damp floor, in an unheated shed or near a door which leads to outside air.

Clay-graphite crucibles are used much more at present since they are required for all crucible electric induction furnaces. They may be used immediately when taken from warm dry storage. On the first heat the temperature

should be brought up slowly. On succeding heats they can be treated in a normal fashion, turning the kilowatt input to the maximum for the furnace involved as soon as possible in order to melt at the rate expected for the furnace.

The silicon carbide crucible does not require a slow heat up on the first melt. The crucibles can be brought up to operative temperature as quickly as possible. This is preferred as most glazes on silicon carbide crucibles do not react properly until they have been brought up to a high temperature. If the silicon carbide crucible is heated slowly the bond is apt to burn out before the glaze has had a chance to work out of the crucible wall and set. Not all crucible manufacturers recommend this procedure, so if you're in doubt about this procedure its well that the crucible manufacturer be contacted before doing it. Another method used by foundries is to preheat the furnace for fifteen minutes and then insert the silicon carbide crucible on its first heat.

It is never recommended to run a fuel fired crucible furnace half full, as the upper half is much hotter than the lower half. This sets up internal thermal stress which often results in cracking. Thus wherever possible, a full crucible of metal should be melted.

In regard to charging a crucible, care should be taken to prevent charging too many ingots, runners and scrap castings into an empty crucible. When the crucible is heated the metal expands much faster than the crucible itself thus the metal which has been wedged inside expands as it becomes hot and this in turn causes the crucible to crack.

The crucible should always be cleaned after each heat while still hot. This only takes a minute or two and prevents oxides from building up on the inside. If not removed the layer of oxide not only builds upon successive heats making the crucible smaller but also can act as an insulator resulting in longer melting time and wasted energy due to the higher fuel consumption involved.

A final point worth mentioning in this section is that ingots should not be dropped into a crucible. They should be inserted with tongs if the crucible is empty after being preheated on top of the furnace cover. A dropped ingot in most cases can be the cause of a cracked crucible.