**Sintering Furnaces**

The choice of a suitable furnace atmosphere, which is governed by the characteristics of the materials and to some extent by the properties -1 desired in the sintered product, is one of the most important factors in practically all sintering processes. Sintering furnaces are either fuel fired or electrically heated. In the first one, heating is relatively cheaper involving low temperature range) since the products of combustion

provide the protective atmosphere. Electrically heated furnaces provide extremely stable temperature conditions by means of proportionate current controllers [38].

There are some difficulties associated with conventional fast firing. Differential sintering that causes differential densification (non­uniform microstructure, low density or specimen cracking) is one of the problems most often encountered when energy is delivered from the surface to the bulk of the sample by thermal conduction. At sufficiently high heating rates, large temperature gradients can be developed since the sample's thermal time constant is larger than the inverse heating rate. In contrast, microwave sintering, which is characterized by volumetric heating, has the potential to overcome this difficulty [39].

Microwave processing of ceramics is an alternate to conventional heating. It offers many advantages over conventional heating. In which, the surface of the material is directly heated, while the heating of the interior is induced by conduction. This will cause large temperature

**Infiltration**

**Post Sintering process**

The infiltration process involves preparing porous metallic body of skelton metal with high melting point and subsequently filling the pore of the skelton with a molten metal (infiltranted) either by immersing the porous skelton metal in the molten infiltrant metal or by placing the skelton compact into contact with the solid infiltrant metal in the form of powder, powder compact of sheet on top of the skelton and then heating in a sintering furnace to a suitable temperature between the melting point of the two metals.

The method is used either to prepare single phase structure or duplex ( two phase) structure, but single phase material is rarely made because of the insig – nifi cant role played by infiltration.

The duplex materials are of two types. The first types ar W – cu, W – Ag, MO – cu etc. where metals shows insolubility in each other at room temperature as well as at infiltration temperature. The second type consists of those exhibiting partial solubility of of the skelton metal in the infiltrant metal at infiltraion temperature.

These include CU- infiltrated Fe and steel products, CO infiltrated tungsten carbide etc.

There is no widely accepted theory of infiltration However it has been noted that very small or very large size of the pore is detrimental.

Thuse, fine powder and high compacting pressure may produce alarge a mount of closed porosity preventing infiltration.

( schwartzkopf) has suggested that two stages occur in the process of infiltration.

The first stage called infiltration proper, involves filling of the process of the skelton with the molten infiltrant metal by capillary action.

The second stage of infiltration process structural changes occure during the soaking period ( i . e the period in which the system is placed at the temperature of infiltration after filling all pore Volumes) because, with a dihedral angle equal to Zero – the infiltrant will penetrate along the grain boundaries and thus destroy the rigid skelton.

Advantages of this process are:-

1. Increased strength due to the formation of a solid solution of skelton and infiltrant and obtaining of nearly theoretical densities with the employment of only moderate pressures during compacting.
2. The infiltrated parts become impermeable due to the absence of interconnected porosity and hence they can be used where pressure – tightness is desired one such example is the infiltrated pump cylinder blocks.

One disadvantage of this method is that erosion of the contact surfaces of the skelton metal takes place because of the dissolution f the surface layers of the sklton metal in the molten infiltrant thereby causing an undesirable pitting on the surface of the sintered component. It can be avoided or minimized by alloying the infiltrant with one or more elements in which the skelton metal does not dissolve.

Thus is the case of copper – infiltrated ferrous base materials, the most widely employed alloy infiltrant consists of cu containing 5 % Mu and 5 % Fe. An alternative way of reducing erosion is the bridge method in which a porous metal part known as bridge is kept between the skelton and the infiltrant. The infiltrant saturates the skelton metal after crossing the bridge.

Thus the essential requirements in choosing a suitable infiltrant are :-

1. its melring point must be considerably lower than that of the skelton metals.
2. It should not form high – melting compound with the skelton metal.
3. There should be good or perfect wetting ( i. e the replacement of gas phase from the solid surface by the infiltrant of the skelton ( solid) by the liquid ( infiltrant) , and.
4. The skelton metal must have only limited solubility in the infiltrant or vice versa.

Though infiltration is considered a post sintering process in true sense, it is often regarded as a special case of sintering. Moreover infiltration of a sintered part rather than of the green compacts causes difficulties owing to the grater amount of closed porosity in the former.